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THE

WORKS

OF

ALEXANDER MONRO, M.D.

ALEXANDER MONRO SEN.ᴿ M. D.

Professor of Anatomy, Fellow of the Royal College of Physicians at Edinburgh, and F. R. S.

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THE

WORKS

OF

ALEXANDER MONRO, M.D.

FELLOW of the ROYAL SOCIETY,

FELLOW of the ROYAL COLLEGE of PHYSICIANS,

AND LATE

PROFESSOR of MEDICINE and ANATOMY in the UNIVERSITY of EDINBURGH.

PUBLISHED BY HIS SON,

ALEXANDER MONRO, M.D.

PRESIDENT OF THE ROYAL COLLEGE OF PHYSICIANS, AND PROFESSOR OF MEDICINE AND OF ANATOMY AND SURGERY IN THE UNIVERSITY OF EDINBURGH.

TO WHICH IS PREFIXED,

The LIFE of the AUTHOR.

ILLUSTRATED WITH COPPERPLATES.

EDINBURGH:

Printed for CHARLES ELLIOT, Parliament-Square; and GEORGE ROBINSON, No. 25, Paternoster-Row, London.

MDCCLXXXI.

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I FLATTER myſelf, that this Collection of the Works of my Father, properly arranged, will prove not only acceptable to his Pupils and Friends, but uſeful to the Public, as many of them treat expreſsly of Practical Subjects, and that in all ſome application to Practice is pointed out.

To the Works printed under his own inſpection, I have added two Pieces.

The firſt *is an Oration* DE CUTICULA HUMANA, *delivered by him above forty years ago in the Common Hall of this Univerſity; in which many curious circumſtances are deſcribed which had eſcaped the obſervation of former Anatomiſts, particularly the appearance of the Fibres that connect the Cuticula to the Cutis Vera, which ſince that time has been annually demonſtrated in the Anatomical Theatre of this Place.*

The other *Piece is an* ESSAY ON COMPARATIVE ANATOMY, *compoſed from notes taken at his Lectures, and publiſhed at London in* 1744.

But as this ESSAY *was publiſhed without his conſent or knowledge, and that of courſe many errors had crept into it; I have endeavoured to correct theſe, and made a few additions to it, from obſervations collected by himſelf with a view to a larger work on that ſubject; but which, by various avocations, he was prevented from proſecuting.*

To the whole are prefixed an Engraving, executed by Mr BASIRE, *from an excellent Portrait of my Father by* ALLAN RAMSAY, *Eſq; and an Account of his Life, compoſed by my brother Dr* DONALD *phyſician at London.*

EDIN. Feb. 5. 1781.

ALEXANDER MONRO.

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THE

AN

ACCOUNT

OF THE

LIFE OF THE AUTHOR.

THE AUTHOR of the following ſheets, the late Dr ALEXANDER MONRO, phyſician, and profeſſor of medicine and of anatomy in the univerſity of Edinburgh, was deſcended by his father from the family of Monro of Milton, which formerly had large poſſeſſions in the county of Roſs; and by his mother, from that of Forbes of Culloden.

His grandfather Sir Alexander Monro of Bearcrofts, and grand-uncle David, were both Colonels in the army of king Charles at the battle of Worceſter, where David was killed. After the Reſtoration, Sir Alexander quitted the profeſſion of arms, and ſtudied the law; and ſoon after being admitted an advocate, was appointed one of the principal clerks of the court of Seſſion. He left two ſons behind him. George, the eldeſt, having entered into the army, arrived at the rank of Major; and after quitting the ſervice, retired to live at Auchinbowie, a ſeat he had in the county of Stirling.

The younger ſon, John, the father of our Author, was bred to phyſic and ſurgery. After having finiſhed his ſtudies, he ſerved for ſome years as a ſurgeon in the army under King William in Flanders. Before his appointment in the army, he had married his couſin Miſs Forbes, niece to Mr Forbes of Culloden; and for ſome years ſucceſſively obtained leave of abſence from the army in the winter, and reſided with his wife in London, where his ſon Alexander was born on the 8th of September O. S. 1697.

About three years thereafter, he quitted the army, and went to ſettle

as a ſurgeon at Edinburgh, where his knowledge in his profeſſion and engaging manners ſoon introduced him into an extenſive practice. Perceiving early marks of ſuperior talents in his ſon (an only child), he paid the greateſt attention to his education, and it became the object from which he ever derived his greateſt felicity.

The ſon ſhewed an early inclination to the ſtudy of phyſic; and the father, after giving him the beſt education that Edinburgh then afforded, ſent him ſucceſſively to London, Paris, and Leyden, to improve himſelf further in his profeſſion.

At London, he attended the lectures of Meſſrs Hawkſbee and Whiſton on experimental philoſophy, and the anatomical demonſtrations of Mr Cheſelden. He at the ſame time employed himſelf much in diſſection; and having been admitted a member of a ſociety of young phyſicians and ſurgeons, who by rotation read diſcourſes on the uſes of the different organs, he read to them the firſt ſketch of his general account of the bones, which has been ſince publiſhed. From the bodies he diſſected he made a great many anatomical preparations, which he ſent home to his father; who, after ſhewing them to the college of phyſicians, gave them to be depoſited in the cabinet of curioſities which was then kept at ſurgeon's hall; and Mr Adam Drummond, who was nominal profeſſor and demonſtrator of anatomy to the ſurgeons company, was ſo well pleaſed with them, that he deſired his father to write to our young ſtudent, that if he continued to improve himſelf in the ſtudy of anatomy as he had begun, he would reſign in his favour ſo ſoon as he ſhould return to Edinburgh.

From London he went to Paris, where he attended the hoſpitals, and the lectures which were read on the different branches of phyſic and ſurgery at that time.

Towards the end of autumn 1718, he went to Leyden, and ſtudied under the great Boerhaave; to whom he became particularly known, by having a great number of caſes ſent to him from Scotland to conſult him upon. Boerhaave ſoon conceived a high opinion of the quickneſs of his parts and of his knowledge in his profeſſion, and wrote a very favourable opinion of him to his friends. And, from manuſcripts which ſtill remain, it appears that he was very aſſiduous, and gave great application to his ſtudies wherever he went.

On

On his return to Edinburgh, in autumn 1719, Meſſrs Drummond and Macgill, who were then conjunct nominal profeſſors and demonſtrators of anatomy to the ſurgeons company, offering to reſign in his favour, he found himſelf under the neceſſity of entering a member with them.

Soon after his appointment, his father prevailed on him to read ſome public lectures on anatomy, and to illuſtrate them by ſhewing the anatomical preparations which he had made and ſent home when abroad; and, without his knowledge, invited the preſident and fellows of the college of phyſicians, and the whole company of ſurgeons, to honour the firſt day's lecture with their preſence. This unexpected company threw him into ſuch confuſion as to make him entirely forget the words of the diſcourſe he had written and committed to memory. Having left his papers at home, he was at a loſs for ſome little time what to do: but having a ready preſence of mind, he immediately began to ſhew ſome of the anatomical preparations, in order to gain a little time for recollection; and very ſoon reſolved not to attempt to repeat the diſcourſe he had written, but to expreſs himſelf in ſuch words as ſhould occur to him from the ſubject, which he was confident he underſtood. The experiment ſucceeded; he delivered himſelf well, and gained great applauſe as a good and ready ſpeaker. After this, being perſuaded that words expreſſive of his meaning would always occur in ſpeaking on a ſubject which he underſtood, he never during his whole lifetime attempted, in teaching, to repeat the words of any written diſcourſe; but ſpoke from memory, and expreſſed himſelf eaſily, and even elegantly, in ſuch words as flowed from the ſubject.

At the ſame time, his father perſuaded Dr Alſton profeſſor of botany and materia medica *, then a young man, to give ſome public lectures on botany.

In the beginning of the winter 1720, theſe two young profeſſors, Dr Alſton and Dr Monro, began to give regular courſes of lectures, the one on the Materia Medica and Botany, the other on Anatomy and Surgery; which were the firſt regular courſes of lectures on any of the branches of medicine that had ever been read at Edinburgh, and may be looked up-

* Many years before this period there was a profeſſor of botany belonging to the univerſity, but none of Dr Alſton's predeceſſors had given regular courſes of lectures.

on as the opening of that medical ſchool which has ſince acquired ſuch great reputation all over Europe.

In ſummer 1721 and 1722, Dr MONRO, by the perſuaſion of his father, read ſome lectures on chirurgical ſubjects; particularly on wounds and tumours, which he never would publiſh, having wrote them in a hurry and before he had much experience; but inſerted from time to time the improvements he thought might be made in ſurgery, in the volumes of Medical Eſſays and Obſervations, of which ſome account will be given hereafter.

About the year 1720, his father communicated to the phyſicians and ſurgeons at Edinburgh, a plan, which he had long formed in his own mind, of having the different branches of phyſic and ſurgery regularly taught at Edinburgh, which was highly approved of by them; and by their intereſt regular profeſſorſhips of anatomy and medicine were inſtituted in the univerſity.

His ſon, Dr MONRO, was firſt made univerſity-profeſſor of Anatomy; and two or three years afterwards, Drs Sinclair, Rutherford, Innes, and Plummer, were made profeſſors of Medicine; the profeſſorſhip of Materia Medica and Botany, which Dr Alſton then held, having been added to the univerſity many years before.

Immediately after theſe gentlemen were elected Profeſſors, they began to deliver regular courſes of lectures on the different branches of medicine, and they and their ſucceſſors have uniformly continued ſo to do every winter.

The plan for a medical education at Edinburgh was ſtill incomplete without an hoſpital, where ſtudents could ſee the practice of phyſic and ſurgery, as well as hear the lectures of the profeſſors. A ſcheme was therefore propoſed by Dr Monro's father, and others, particularly the Members of the Royal College of Phyſicians and Board of Surgeons, for raiſing by ſubſcription a fund for building and ſupporting an hoſpital for the reception of diſeaſed poor, and our Author publiſhed a pamphlet ſetting forth the advantages that would attend ſuch an inſtitution. In a ſhort time a conſiderable ſum of money was raiſed, a ſmall houſe was fitted up, and patients were admitted into it, and regularly attended by many of the phyſicians and ſurgeons * in town.

Some

* For ſeveral years the medicines for the ſick in the hoſpital were furniſhed gratis by the ſurgeon-apothecaries in town.

Some years after this, a plan of a new hoſpital capable of holding near 300 patients, with every ſort of convenience for them, was drawn out by the late Mr Adams, architect, under the inſpection of the managers, and particularly of our Author, who planned the operation-room and ſome other principal parts. A patent was obtained from the Crown, forming the contributors to the charity into a corporation, with the power of nominating eleven managers beſides the profeſſor of anatomy, who by the charter is to be officially one, and making rules for the election of their ſucceſſors. Soon after, that very worthy and moſt excellent citizen the late George Drummond, Eſq; one of the Commiſſioners of Exciſe, who had often ſerved the office of Firſt Magiſtrate (Lord Provoſt) of the city of Edinburgh, and who was one of the moſt active and aſſiduous promoters of this moſt uſeful undertaking, together with our Author, were unanimouſly appointed by the firſt contributors to ſuperintend the building of the preſent elegant and moſt uſeful hoſpital, under the name of the *Building Committee*.

After the firſt ſtone was laid, ſo great was the zeal and public ſpirit of all ranks of people † for promoting this excellent charity, that the building was completed in a much ſhorter time than the moſt ſanguine expectations could have imagined: And it has ſince been ſo largely endowed, as to be capable of receiving a great number of diſeaſed poor, whoſe caſes the ſtudents of phyſic and ſurgery have an opportunity of ſeeing daily treated with the greateſt attention and care by phyſicians and ſurgeons eminent in their profeſſion; and a regiſter of the particulars of

† Dr Moore, in his account of Travels through Scotland, mentions this hoſpital. He ſays, "They have likewiſe an infirmary at Edinburgh, which is a good building: it is well-founded, and very convenient both for the patients and the chirurgical operations. The building was erected by the inhabitants, and they undertook it with great ſpirit: the proprietors of many ſtone-quarries made preſents of ſtone; others of lime; merchants contributed timber; carpenters and maſons were not wanting in their contributions; the neighbouring farmers agreed to carry the materials gratis; the journeymen-maſons contributed their labours for a certain quantity of hewn ſtones; and as this undertaking is for the relief of the diſeaſed, lame, and maimed poor, even the day-labourers could not be exempted, but agreed to work a day in the month gratis towards the erection. The ladies contributed in their way to it; for they appointed an aſſembly for the benefit of the work, which was well attended, and every one contributed bountifully." See Mr Hamilton Moore's Collection of Voyages and Travels, p. 1064.

of all the caſes which have been received into the houſe ſince its firſt opening has been kept, in books appropriated for that purpoſe, for the uſe of the ſtudents.

In order to make the hoſpital of ſtill further uſe to the ſtudents, Dr MONRO frequently, while he continued profeſſor of anatomy, gave lectures on the chirurgical caſes; and the late judicious phyſician, Dr Rutherford, profeſſor of the practice of phyſic, began in the year 1748 to deliver clinical lectures, to be continued every winter, on the moſt remarkable caſes in the hoſpital; and his example was afterwards followed by our Author after he had reſigned the anatomical chair to his ſon, and by Doctors Cullen, Whyte, Home, and Gregory ſenior and junior.

Doctor MONRO, though he was elected Profeſſor of Anatomy in the year 1721, was not received into the Univerſity till the year 1725, when he was inducted along with that great mathematician the late Mr Colin Maclaurin, with whom he ever lived in the ſtricteſt friendſhip.

From the time of his being received into the Univerſity, till the time of his reſigning in favour of his ſon the preſent Dr Alexander, he regularly every winter gave a courſe of lectures on anatomy and ſurgery, which laſted from October to May, digeſted under the following heads.

1. He began with giving a Hiſtory of Anatomy: in delivering of which he ſhewed a ſtrength of memory, and facility of ſpeaking, beyond moſt men; for he gave a regular account of the moſt remarkable anatomiſts from the earlieſt to the preſent times, mentioning their different improvements and diſcoveries, the dates of the times in which they were made, and the different claims of authors to the honour of particular diſcoveries, without ever being at a loſs for words, or uſing any other notes than the names of the anatomiſts, with the times in which they had lived.

2. He entered on the Oſteology; and after giving ſome lectures on the ſtructure, uſes, and diſeaſes, of the bones in general, he entered into the conſideration of the particular bones; each of which he ſhewed to the ſtudents, both ſingly and in the ſkeleton; and after demonſtrating its particular parts and ſtructure, he treated of its uſes, and the diſeaſes and accidents to which it was liable.

3, 4. He

3, 4. He demonſtrated, on adult ſubjects, the Muſcles, the Abdominal and Thoracic Viſcera, and Brain; and ſhewed the Nerves and Blood-veſſels in the dead bodies of children: and after demonſtrating each organ, he always treated particularly of its ſtructure and diſeaſes, and ſhewed preparations of the different parts as he treated of them.

5. He illuſtrated the anatomy of the human body by the diſſection of different animals, Quadrupeds, Fowls, and Fiſhes, and by comparing the ſtructure and uſes of their organs with thoſe of the human body.

6. He conſidered particularly the Diſeaſes for which chirurgical operations were commonly undertaken, and the beſt methods of treating them; and then ſhewed to his pupils the different Operations of Surgery performed on dead human bodies, and mentioned the various methods which had been propoſed for performing them, with the advantages and diſadvantages attending each.

7. After the operations of ſurgery, he ſhewed the different Bandages and Machines uſed in ſurgery, and the manner of applying them; and mentioned particularly the caſes in which they were uſeful.

8. He concluded his winter-courſe with ſome general lectures on the Phyſiology of the human body.

He continued with the greateſt aſſiduity, and without the leaſt interruption, to give ſuch a courſe every winter for near forty years; and ſo great was the reputation he had acquired, that ſtudents flocked to him from the moſt diſtant corners of his Majeſty's dominions.

After he reſigned the anatomical chair to his ſon, he ſtill endeavoured to render his labours uſeful to mankind, by reading clinical lectures at the hoſpital for the improvement of the ſtudents; of which Dr Duncan, who was one of his pupils, has given the following account. "There I "had myſelf the happineſs of being a pupil, who profited by the judi- "cious conduct of his practice, and was improved by the wiſdom and "acuteneſs of his remarks. I have indeed to regret that I attended only "the laſt courſe of his lectures in which he had ever a ſhare, and at a "time when he was ſubjected to a diſeaſe which proved at length fatal. "Still, however, from what I ſaw and from what I heard, I can venture "to aſſert, that it is hardly poſſible to conceive a phyſician more atten-

"tive

" tive to practice, or a preceptor more anxious to communicate inſtruc-
" tions. His humanity, in the former of theſe characters, led him to
" beſtow the moſt anxious care on his patients while they were alive;
" and his zeal in the latter induced him to make them the ſubject of uſeful
" leſſons when they happened to die.

" In the different ſtations of phyſician, of lecturer, and of manager in
" the hoſpital, he took every meaſure for inquiring into the cauſes of
" diſeaſes by diſſection. He perſonally attended the opening of every
" body; and he not only dictated to the ſtudents an accurate report of
" the diſſection, but with nice diſcrimination contraſted the diſeaſed and
" ſound ſtate of every organ. Thus in his own perſon, he afforded to
" the ſtudents a conſpicuous example of the advantages of early anatomi-
" cal purſuits, as the happieſt foundation for a medical ſuperſtructure.
" His being at once engaged in two departments, the Anatomical Theatre
" and Clinical Chair, furniſhed him with opportunities both on the dead
" and living body, and placed him in the moſt favourable ſituation for
" the improvement of medicine, and from theſe opportunities he derived
" every poſſible advantage which they could afford."

Of the Works of our Author, the firſt and greateſt is his Oſteology, or Treatiſe on the Anatomy of the Bones; which was originally publiſhed in the year 1726, for the uſe of the ſtudents who attended his lectures. In this performance he has not confined himſelf to a mere deſcription of the bones, but has added many practical obſervations and corollaries. It met with ſuch a favourable reception, that it underwent eight different editions during his lifetime, and was tranſlated into moſt of the European languages; and the French edition in large folio, publiſhed by Monſieur Sue, demonſtrator to the Royal Academy of Sculpture and Painting at Paris, is adorned with as elegant and maſterly engravings of the figures of the bones as are to be found in any anatomical work.

To the later editions of his Oſteology he annexed a *Neurology* *, or Anatomy of the Human Nerves, in which he deſcribes conciſely the larger branches of the particular nerves; avoiding the deſcription of the very minute branches, as being apt to confound young ſtudents, for whoſe

* This Treatiſe on the Nerves has not only been tranſlated along with the Oſteology into ſeveral living languages; but has been alſo tranſlated into Latin by itſelf with notes, by Dr Coopmans of Franeker in Holland.

whoſe improvement he wrote. In this treatiſe he has alſo mentioned moſt of the prevailing opinions concerning their ſtructure and uſe; and endeavoured to account for many ſymptoms obſerved in diſeaſes from their ſympathy and mutual connexions. He ſubjoined to this work, a more accurate deſcription of the Receptacle of the Chyle, and Thoracic Duct, than is to be found in moſt ſyſtems of Anatomy.

Soon after the eſtabliſhment of the hoſpital, the profeſſors of medicine and many other phyſicians and ſurgeons in town formed themſelves into a Society for collecting and publiſhing ſuch medical obſervations and eſſays as ſhould occur to them, or be ſent to them by their friends, and they appointed Dr MONRO to be their Secretary.—For the firſt year the members attended the meetings of the Society, and reviſed and made remarks on the papers preſented to them: but after the publication of the firſt volume in the year 1732, they grew remiſs in their attendance, and very ſoon the whole care of the collection fell upon the Secretary; in ſo much that, after this, ſcarce any other member ever ſaw a paper of the five laſt volumes, except thoſe they were the authors of, till printed copies were ſent them by the bookſeller.

In the papers of that collection wrote by our Author, and republiſhed in the preſent Volume, he has made many material improvements on the deſcriptions before given of the ſtructure and uſes of ſeveral parts of the body; drawn many uſeful practical corollaries from anatomy; and propoſed many new improvements in the method of performing chirurgical operations, moſt of which are now adopted in the practice and writings of our more modern ſurgeons.

The ſix volumes of Medical Eſſays and Obſervations which contain theſe papers have been ſo much approved of, as to have undergone various editions in the Engliſh language, and to have been tranſlated into many foreign languages; and the late celebrated Dr Haller had ſuch a high opinion of them, as to ſay, they were books which no medical man ought to be without *.

After the publication of the above-mentioned ſix volumes, the late Mr Maclaurin Profeſſor of Mathematics propoſed to enlarge the plan of the

* "Quinque Volumina Speciminum Societatis Edinburgenſis prodierunt, (quorum ultimum "duplex eſt), Medicis perutilia et Chirurgis et Anatomicis. MONROUS ibi eminet." *Haller Meth. Stud. Med.* p. 69.

Society, by admitting Gentlemen eminent in literary and philoſophical learning, and receiving philoſophical as well as medical papers. This propoſal was approved of: but after this new Society was formed, and ſeveral papers read, their meetings were interrupted for ſome years; firſt by the Rebellion breaking out in the year 1745; and afterwards by the death of Mr Maclaurin, which happened ſoon after. At laſt they were renewed, principally by the activity of our Author, who was then elected one of their Vice-Preſidents; and before his death two volumes were publiſhed, and ſome materials for a third collected. In the two firſt volumes, we find ſeveral papers written by our Author, which contain many uſeful remarks and obſervations: Theſe alſo are reprinted in the preſent Collection.

His laſt publication was his *Account of the Succeſs of Inoculation in Scotland;* which was originally written in anſwer to a letter ſent him by the Delegates of the Faculty of Phyſicians at Paris appointed to examine into the merits of that practice. It was afterwards publiſhed at the deſire of ſome of his friends, and had a good effect in rendering this very uſeful practice more univerſal than it had formerly been in Scotland.

Beſides the works which he publiſhed, he left ſeveral Manuſcripts, wrote at different times, on different anatomical and practical ſubjects. Of theſe the principal are, *A Hiſtory of Anatomical Writers.—An Encheireſis Anatomica.—Heads of many of his Lectures.—A Treatiſe on Comparative Anatomy.—A Treatiſe on Wounds and Tumours.—Obſervations on ſome Parts of Heiſter's Surgery.*—An Oration *de Cuticula.*

Few men were members of more Societies than he; ſtill fewer equally aſſiduous in their attendance of thoſe which in any way tended to promote public utility.—He was a manager of many public charities; and not only a member of different medical ſocieties, but likewiſe of ſeveral others inſtituted for promoting literature, arts, ſciences, and manufactures in Scotland, and was one of their moſt uſeful members. While he was held in high eſtimation at home, he was equally eſteemed and reſpected broad, and was elected member of the Royal Society at London, and an honorary member of the Royal Academy of Surgery at Paris.

He was not only very active in the line of his own profeſſion, but as a citizen and general member of the community; for, after he had reſigned the

the anatomical chair to his ſon, he executed with the ſtricteſt punctuality the duties of ſeveral engagements both of a civil and political nature *.

His character was not more conſpicuous in public than it was amiable in private life. He was brought up under the tuition of a fond parent, and diſtinguiſhed himſelf by the moſt exemplary filial piety, affording to an aged father every comfort that a man in the decline of life can well enjoy. The father, perfectly at eaſe with regard to the neceſſaries and conveniencies of life, ſaw with the utmoſt pleaſure an affectionate ſon, eſteemed and regarded by mankind, the principal actor in the execution of his favourite plan, the great object of his life, the founding a ſeminary of medical education in his native country; and, three years after the firſt ſtone of the new hoſpital was laid, ended his days in a calm retreat at a pleaſant country-ſeat which his ſon had purchaſed in the county of Berwick.—The ſon, who ſurvived him near thirty years, had the ſatisfaction to behold this ſeminary of medical education frequented yearly by three or four hundred ſtudents, many of whom came from the moſt diſtant corners of his Majeſty's dominions; and to ſee it arrive at a degree of reputation far beyond his moſt ſanguine hopes, being equalled by few, and inferior to none, in Europe.

He had great humanity and ſweetneſs of temper, and was endowed with a ſingular liberality of ſentiment.—He was a ſincere friend, and an agreeable companion; an affectionate huſband, and a kind father; and was never more happy than when he could ſerve thoſe whom he thought deſerving.

He was a great friend to civil liberty, and ſteadily attached to the preſent royal family. After the unfortunate affair of Preſtonpans in the year 1745, he flew to the field of battle, to aſſiſt the ſick and wounded officers and ſoldiers in his Majeſty's ſervice; and after ſeeing their wounds dreſſed, he, by his ſingular activity, procured them proviſions of every ſort, and afterwards procured carriages for bringing them to town, where he attended them with the greateſt aſſiduity and care. At the ſame time,

* He was a Director of the Bank of Scotland, a Juſtice of the Peace, a Commiſſioner of High-roads, &c.

his humanity led him to give aſſiſtance to many of the wounded rebels, who, from their wounds, had become objects of compaſſion, even though engaged in a cauſe which he did not approve of. The ſame humanity led him, after the rebellion, to repreſent to government the aſſiſtance he had got from ſome of the rebel officers in procuring proviſions and neceſſaries for the wounded officers and ſoldiers in his Majeſty's ſervice on that occaſion, which contributed to procure them pardons. And having by accident got certain information that the late unfortunate Dr Cameron, who was ſo active in the time of the rebellion, had endeavoured to perſuade the Pretender, on his firſt landing in Scotland, to return to France without attempting an inſurrection, and had even left him with a full reſolution of taking ſteps to prevent a rebellion, but was diſappointed by ſome of his relations joining the Pretender ſooner than he expected, making himſelf in a manner priſoner, and over-perſuading him to join them; our Author, alongſt with the late Earl of Morton Preſident of the Royal Society, drew out a memorial repreſenting theſe facts, which Lord Morton laid before the late King and Council while Dr Cameron was under confinement; and his late Majeſty, who was always inclined to mercy, afterwards informed Lord Morton that he would certainly have had a pardon, had it not been for certain information of ſome treaſonable practices that were going on at the time he was apprehended, in which the Doctor was ſuſpected to be concerned.

Dr ALEXANDER MONRO, in the beginning of the year 1725, married Miſs Iſabella Macdonald, ſecond daughter of Sir Donald Macdonald of Macdonald, in the Iſle of Sky, Baronet, by whom he had eight children, four of whom died young; the other four are ſtill alive, viz.

JOHN MONRO, Eſq; of Auchinbowie, Advocate, Counſellor at Law.

Dr DONALD MONRO, Phyſician to the Army and to St George's Hoſpital, London.

Dr ALEXANDER MONRO, Phyſician, and Profeſſor of Medicine and of Anatomy and Surgery at Edinburgh; and Mrs PHILP, wife of James Philp, Eſq; Judge of the Court of Admiralty for Scotland.

To them our Author proved a moſt affectionate father. In their youth, he not only ſuperintended their education, but was himſelf their maſter

in

in ſeveral branches; and when they grew up, he made them his companions and friends.

He was a man of a ſtrong muſcular make, of a middle ſtature, and poſſeſſed of great ſtrength and activity of body; but ſubject for many years to a ſpitting of blood on catching the leaſt cold, and through his whole life to frequent inflammatory fevers; which he uſed to attribute to the too great care his parents took of him in his youth, and to their having had him regularly blooded twice a-year, which in thoſe days was looked upon as a great preſervative of health.

In the year 1762, he was attacked with the epidemical catarrhal fever called *influenza*, attended with pain and uneaſineſs in making water and going to ſtool, which remained ever after during his life, and were the firſt ſymptoms of that long and painful diſorder, a fungous eroding ulcer of the rectum and bladder, which put an end to his life. The diſorder increaſed by ſlow degrees; and, from May 1766 to July 10th 1767, the day on which he died, gave him ſo conſtant and great pain, that he had little reſpite from it except by the force of opium. This long and painful diſorder he ſuffered with the fortitude of a man and the reſignation of a Chriſtian; never once repining at his fate; but conſcious of having acted an upright part, and of having ſpent his life in the conſtant exerciſe of his duty, he viewed death without horror, and talked of his own diſſolution with the ſame calmneſs and eaſe as if he were going to ſleep.

Such was the life of our author; and we ſhall conclude this long narrative with a letter written from the late John Forbes, Eſq; of Culloden, (ſon to that great and excellent man, the late Duncan Forbes, Eſq. * Lord Preſident of the Court of Seſſion), to one of his ſons, on hearing of his death.

Dear Sir,

I MOST heartily condole with you on the loſs of your worthy father, with whom my family have been ſo long and ſo intimately connected. I can, from my own experience, imagine what you muſt feel on this occaſion; but, though nature muſt have its due, we ought not to forget what both of

* So great an opinion had the public of the many ſervices Mr Forbes had done his country, and of his integrity as a judge, that after his death the gentlemen of the law had a ſtatue of him erected in the court of juſtice over which he preſided.

of us owe to Providence for the laſting honour our fathers have done to their country, and to their families, in their different profeſſions. They will be venerated as public bleſſings, while religion, virtue, and uſeful learning, remain; and we have only to follow them, and enforce their good example, to the beſt of our powers. I remain, with the ſincereſt wiſhes for your happineſs, Dear Sir,

Your moſt obedient humble ſervant,

HAMPSTEAD, July 17. 1767.

JOHN FORBES.

POSTSCRIPT.

AS perhaps the hiſtory of our Author's diſorder of which he died, written by himſelf in June 1766, in a letter to his ſon Dr Donald, together with an account of the appearance of the diſeaſed parts obſerved in his body after death, may not be unacceptable to the reader, we ſhall here ſubjoin them by way of poſtſcript.

Copy of a LETTER from Dr ALEXANDER MONRO ſenior, to his ſon Dr DONALD at London.

Dear Donald,

I AM at preſent confined to the houſe, after a ſevere feveriſh diſorder. My ſtate has been ſuch for ſome years paſt, that I have expected to be laid aſide from buſineſs, and that my life will not be of long duration; but I ſhall little regret my diſmiſſion from this world, if you are all once in an eaſy way of living. My caſe is this. In May 1762, I had the epidemic influenza, which affected principally the parts in my pelvis, ſo that I had a difficulty and ſharp pain in making water and going to ſtool. My belly has never ſince been in a regular way, paſſing ſometimes for ſeveral days nothing but bloody mucus, and that with conſiderable teneſmus; then, after ſuffering ſevere gripes, diſcharging as much fæces as I would have done formerly in a week, without ſcybala or water. Several times theſe gripes produced ſomething very like to the iliac paſſion; to wit,

a ſevere fixed pain three inches below the navel and a little to the left ſide, with ſmart fever, vomiting, &c. By blood-letting, and the uſe of cooling and laxative medicines and clyſters, &c. theſe firſt violent attacks were in a great meaſure got the better of, but left behind them an irregularity and ſtoppage of ſtools. About a year ago I was attacked with a frequent deſire of making water, attended with heat and pain; and the frequent and ſudden calls to theſe diſcharges made me decline being engaged in company. Laſt harveſt I happened to obſerve my urine to be of a very red colour; and on examining it found ſmall knots of mucus and blood mixed with it, in which way it has continued ever ſince. I found no change from diet or any medicines I took, which were laxatives, mild mucilaginous decoctions, bark, flowers of ſulphur, uva urſi, &c. About a fortnight ago I had the addition of a ſwelling and inflammation of my right *teſtis*, the pain of which was removed by bleeding and emollient fomentations and cataplaſms, though a little of the ſwelling ſtill continues. No external hæmorrhoids appear, and, ſo far as the finger can reach, there are no tubercles nor hard knots within the rectum.

You know I was always ſubject to feveriſh diſorders, and had ſeveral times the hæmoptoë in my early manhood, and afterwards had ſeveral times the piles; and ſome bloody evacuations have been made by ſtool ſince the year 1762. I never had any uneaſineſs in my kidneys, and have no right to gout or gravel either from my parents or from my own way of life. What do you think may be the diſorder, and proper method of cure?

Whatever may be my ſtate, believe me that your welfare will ever be one of my great concerns.

I am your's affectionately,

ALEX. MONRO.

EDINBURGH,
June 11. 1766.

After this, variety of medicines were recommended to him, but all without effect; his diſorder gained daily ground, with an increaſe of pain and uneaſineſs, attended with various ſymptoms at different times, viz. purging, fainting fits, coſtiveneſs, difficulty of making water, &c. He paſſed for ſome time blood and mucus, and thin matter likewiſe mixed with

with his water; and ſome time before death, the urine uſed to be mixed with air and excrement, and frequently it came away by ſtool.

On opening his body after death, there were found a preternatural adheſion of the rectum to the upper and back part of the bladder; a fungous ulcerous appearance, two fingers-breadth, occupying the whole circle of the rectum, in which the diſeaſe probably began; and an opening, above an inch in diameter, from the rectum into the top of the bladder, which laſt was otherwiſe ſound.

AN

ESSAY

ON THE

ART of INJECTING the VESSELS of ANIMALS.

THE method of filling the veſſels of animals with a coloured liquor, which afterwards hardens, and, by keeping the veſſels diſtended and firm, gives an opportunity of obſerving more exactly their diſtribution, ſituation, and diameters, and of diſcovering numbers of their branches and communications that would otherwiſe be unſearchable, is a modern improvement that has contributed conſiderably to explain the animal œconomy. Anatomiſts are now ſufficiently acquainted with the manner of filling the larger trunks; but few have hit on the art of injecting the very ſmall capillary tubes: wherefore I hope it will not be unacceptable to give a detail of what I have found, after a conſiderable number of different trials, to have ſucceeded beſt in this way of injection; which may at leaſt have one good effect, though I ſhould fail of being the diſcoverer of this art, namely, of ſaving unneceſſary trouble to other inquirers after it, and may ſpur on ſome other more lucky perſon to communicate the whole of it, by which, more anatomiſts being employed in ſearching out the minute veſſels, more diſcoveries may be made than when it is confined to ſo few as it is at preſent.

In deſcribing the trials I have made to ſucceed in ſubtile injections, I can ſcarce help mentioning ſeveral things which are commonly known to all who practiſe injections of any kind; and I ſhall be the leſs anxious to ſhun them, that ſcarce any anatomical books deſcribe with accuracy the method of injecting; and therefore this eſſay may ſave the young unexperienced anatomiſt the trouble of fruitleſs trials.

The inſtrument with which the liquor is commonly thrown into the veſſels is a tight eaſy-going ſyringe of braſs, to which ſeveral ſhort pipes are fitted, and can be fixed by ſcrews, the other extremities of theſe pipes being of different diameters without any ſcrew, that they may ſlide into other pipes which are ſo exactly adapted to them at one end, that, when they are preſſed a little together, nothing can paſs between them: And becauſe their coheſion is not ſo great as to reſiſt the puſhing force of the injection, which would drive off this ſecond pipe, and ſpoil the whole operation; therefore the extremity of this ſecond ſort of pipes, which receives the firſt kind, is formed on the outſide into a ſquare, bounded behind and before by a riſing circle, which hinders the key that cloſely graſps the ſquare part from ſliding backwards or forwards; or a bar of braſs muſt ſtand out from each ſide of it to be held with the fingers. The other extremity of each of theſe ſecond ſort of pipes is of different diameter; and near it a circular notch, capable of allowing a thread to be ſunk into it, is formed: by this the thread tying the veſſel at which the injection is to be made, will not be allowed to ſlide off.

Beſides this form deſcribed, common to all this ſecond ſort of pipes, we ought to have ſome of the larger ones with an additional mechaniſm for particular purpoſes. For inſtance, when the larger veſſels are injected, the pipe faſtened in the veſſel ought either to have a valve or a ſtop-cock that may be turned at pleaſure, to hinder any thing to get out from the veſſel by the pipe; otherwiſe, as the injection in ſuch a caſe takes time to coagulate, the people employed in making the injection muſt either continue all that while in the ſame poſture, or, if the ſyringe is too ſoon taken off, the injected liquor runs out, and the larger veſſels are emptied. When the ſyringe is not large enough to hold at once all the liquor neceſſary to fill the veſſels, there is a neceſſity of filling it again:

again: If, in order to do this, the ſyringe was to be taken off from the pipe fixed in the veſſel, ſome of the injection would be loſt, and what was expoſed to the air would cool and harden; therefore ſome of the pipes ought to have a reflected curve tube coming out of their ſide, with a valve ſo diſpoſed that no liquor can come from the ſtraight pipe into the crooked one, but, on the contrary, may be allowed to paſs from the crooked to the ſtraight one: the injector then taking care to keep the extremity of the reflected pipe immerſed in the liquor to be injected, may, as ſoon as he has puſhed out the firſt ſyringeful, fill it again by only drawing back the ſucker; and, repeating this quickly, will be able to throw ſeveral ſyringefuls into the veſſels.

All theſe different ſorts of pipes are commonly made of braſs.

The liquors thrown into the veſſels with a deſign to fill the ſmall capillary tubes, are either ſuch as will incorporate with water, or ſuch as are oily; both kinds have their advantages and inconveniencies, which I ſhall mention in treating of each, and ſhall conclude with that which I have found by experience to ſucceed beſt.

All the different kinds of glue, or ichthyocolla, ſyths, common glue, &c. diſſolved and pretty much diluted, mix eaſily with the animal-fluids, which is of great advantage, and will paſs into very ſmall veſſels of a well-choſen and prepared ſubject, and often anſwer the intention ſufficiently, where the deſign is only to prepare ſome very fine membrane, on which no veſſels can be expected to be ſeen ſo large as the eye can diſcover, whether the tranſverſe ſections of the veſſels would be circular, or if their ſides are collapſed. But when the larger veſſels are alſo to be prepared, there is a manifeſt diſadvantage to the uſefulneſs and beauty of the preparation: for if nothing but the glutinous liquor is injected, one cannot keep a ſubject ſo long as the glue takes of becoming firm; and therefore, in diſſecting the injected part, ſeveral veſſels will probably be cut and emptied. To prevent this, one may indeed either ſoak the part well in alcohol, which coagulates the glue; but then it becomes ſo brittle, that the leaſt handling makes it crack; and, if the preparation is to be kept, the larger veſſels appear quite ſhrivelled when the watery part of the injection is evaporated: Or the efflux of the injection may be prevented by carefully tying every veſſel before we are obliged to cut it; ſtill,

however, that does not hinder the veſſels from contracting when the glue is drying. If, to obviate theſe difficulties, the glutinous liquor ſhould firſt be injected in ſuch quantity as the capillary veſſels will contain, and the common oily or waxy injection is puſhed in afterwards to keep the larger veſſels diſtended; the wax is very apt to harden before it has run far enough, the two ſorts of liquors never miſs to mix irregularly, and the whole appears interrupted and broken by their ſoon ſeparating from each other; which is ſtill more remarkable afterwards, when the watery particles are evaporated.

Spirits of wine coloured mixes with water and oils, and ſo far is proper to fill the very ſmall veſſels with; but, on the other hand, it coagulates any of our liquors it meets, which ſometimes block up the veſſels ſo much, that no more injection will paſs: then it ſcarce will ſuſpend ſome of the powders that prove the moſt durable colours; and as it entirely evaporates, the veſſels muſt become very ſmall; and the ſmall quantity of powder left, having nothing to ſerve for connecting its particles together, generally is ſeen ſo interrupted, that the ſmall ramifications of veſſels rather have the appearances of random ſcratches of a pencil, than of regular continued canals.

Melted tallow, with a little mixture of oil of turpentine, may ſometimes be made to fill very ſmall veſſels, and keeps the larger ones at a full ſtretch: but where any quantity of the animal-liquors is ſtill in the veſſels, it is liable to ſtop too ſoon, and never can be introduced into numbers of veſſels which other liquors enter; and it is ſo brittle, that very little handling makes it crack, and thereby renders the preparation very ugly *.

The method I have always ſucceeded beſt with, in making what may be called ſubtile or fine injections, is, firſt to throw in coloured oil of turpentine, in ſuch a quantity as might fill the very ſmall veſſels; and immediately

* Rigierus (*introduct. in notitiam rerum natur. et artefact.* 4to, *Hagæ* 1843, *titul. Balſamum*) gives Ruyſch's method of injecting and preſerving animals, which, he ſays, Mr Blumentroſt, preſident of the Peterſburgh academy, aſſured him was copied from the receipt given in Ruyſch's own hand-writing to the Czar. According to this receipt, melted tallow, coloured with vermilion, to which, in the ſummer, a little white wax was added, was Ruyſch's injecting *ceracea materies*.

immediately after to puſh the common coarſe injection into the larger ones. The oil is ſubtile enough to enter rather ſmaller capillary tubes than any colouring can; its reſinous parts, which remain after the ſpirituous are evaporated, give a ſufficient adheſion to the particles of the ſubſtance with which it is coloured, to keep them from ſeparating; and it intimately incorporates with the coarſer injection, by which, if the injection is rightly managed, it is impoſſible for the ſharpeſt eye to diſcover that two ſorts have been made uſe of *.

All the liquors with which the veſſels of animals are artificially filled, having very faint and near the ſame colours, would not at all appear in the very ſmall veſſels, becauſe of their becoming entirely diaphanous, without a mixture of ſome ſubſtance to impart its colour to them; and where ſeveral ſorts of even the larger veſſels of any part were filled, one ſort could not be diſtinguiſhed from another, unleſs the colour of each was different; which has likewiſe a good effect in making preparations more beautiful. Wherefore anatomiſts have made uſe of a variety of ſuch ſubſtances, according to their different fancies or intentions, ſuch as gamboge, ſaffron, ink, burnt ivory, &c. which can be eaſily procured from painters. My deſign being only to conſider thoſe that are fit to be mixed with the injecting liquors propoſed to fill capillary veſſels, which is ſcarce ever to be done in any other, except the branches of the arteries and of ſome veins, I ſhall confine myſelf to the common colours employed to theſe laſt-named two ſorts of veſſels, which colours are red, green, and ſometimes blue, without mentioning the others which require very little choice.

Anatomiſts have, I imagine, propoſed to imitate the natural colours of the arteries and veins in a living creature, by filling the arteries with a red ſubſtance, and the veins with a blue or green: from which, however, there are other advantages; ſuch as, the ſtrong reflection which ſuch bodies make of the rays of light, and the unaptneſs moſt ſuch bodies have to tranſmit theſe ſame rays, without at leaſt a conſiderable reflection of the

* Mr Ranby's injecting matter, as publiſhed by Dr Hales, (*Hæmaſt.* ex. 21.), is white roſin and tallow, of each two ounces, melted and ſtrained through linen; to which was added three ounces of vermilion, or finely ground indigo, which was firſt well rubbed with eight ounces of turpentine varniſh.

the rays peculiar to themſelves, or, in other words, their unfitneſs to become completely pellucid; without which the very fine veſſels, after being injected, would ſtill be imperceptible. The animal or vegetable ſubſtances made uſe of for colouring injections, ſuch as chochineal, laque, *rad. anchuſæ*, brazil-wood, indigo, &c. have all one general fault of being liable to run into little knots which ſtop ſome of the veſſels; their colour fades ſooner when kept dry; they more eaſily yield their tincture when the parts are preſerved in a liquor; and rats, mice, and inſects will take them for food: for which reaſons, though I have frequently ſucceeded in injecting them, I rather prefer the mineral kind, ſuch as minium or vermilion, for red; of which this laſt is, in my opinion, the beſt, becauſe it gives the brighteſt colour, and is commonly to be bought finely levigated. The green-coloured powder generally uſed is verdigreaſe; but I rather chooſe that preparation of it called *diſtilled verdigreaſe*, becauſe its colour is brighter, and it does not ſo often run into ſmall knots as the common verdigreaſe, but diſſolves in the oily liquors.

The method of preparing the injection compoſed of theſe materials, is to take, for the fine one, a pound of clear oil of turpentine, which is gradually poured on three ounces of vermilion or diſtilled verdigreaſe finely powdered, or rather well levigated by grinding on marble; ſtir them well with a ſmall wooden ſpatula till they are exactly mixed, then ſtrain all through a fine linen rag. The ſeparation of the groſſer particles is, however, rather better made, by pouring ſome ounces of the oil upon the powder; and, after ſtirring them together ſtrongly, ſtop rubbing with the ſpatula for a ſecond or ſo, and pour off into a clean veſſel the oil with the vermilion or verdigreaſe ſuſpended in it; and continue this ſort of operation till you obſerve no more of the powder come off, and all that remains is granulated. The coarſer injection is thus prepared: Take tallow, one pound; wax, bleached white, five ounces; ſalad oil, three ounces: melt them in a ſkillet put over a lamp; then add Venice turpentine, two ounces; and as ſoon as this is diſſolved, gradually ſprinkle in of vermilion or verdigreaſe prepared, three ounces: then paſs all thro' a clean, dry, warmed linen-cloth, to ſeparate all the groſſer particles; and when you deſign to make it run far into the veſſels, ſome oil of turpentine may be added immediately before it is uſed.

The

The next thing to be conſidered, and indeed what chiefly contributes to the ſucceſs of injections, is the choice and preparation of the ſubject whoſe veſſels are to be filled.

In chooſing a fit ſubject, take theſe few general rules: 1. The younger the creature to be injected is, the injection will, *cæteris paribus*, go fartheſt, and *vice verſa*. 2. The more the creature's fluids have been diſſolved and exhauſted in life, the ſucceſs of the operation will be greater. 3. The leſs ſolid the part deſigned to be injected is, the more veſſels will be filled. 4. The more membranous and tranſparent parts are, the injection ſhows better; whereas in the ſolid very hard parts of a rigid old creature, that has died with its veſſels full of thick ſtrong blood, it is ſcarce poſſible to inject great numbers of ſmall veſſels.

Therefore, in preparing a ſubject for injecting, the principal things to be aimed at are, To diſſolve the fluids, empty the veſſels of them, relax the ſolids, and prevent the injection's coagulating too ſoon. To anſwer all theſe intentions, authors have propoſed to inject tepid or warm water by the arteries, till it returns clear and untinged by the veins; and the veſſels are thereby ſo emptied of blood, that all the parts appear white: after which they puſh out the water, by forcing in air; and, laſtly, by preſſing with their hands, they ſqueeze the air alſo out. After this preparation, one can indeed inject very ſubtilely, but generally there are inconveniencies attend it: for in all the parts where there is a remarkable *tunica celluloſa*, it never miſſes to be full of the water, which is apt to ſpoil any parts deſigned to be preſerved either wet or dry; and ſome particles of the water ſeldom miſs to be mixed in the larger as well as ſmaller veſſels with the oily injection, and make it appear diſcontinued and broken. Wherefore it is much better to let this injection of water alone, if it can be poſſibly avoided, and rather to macerate the body or part to be injected a conſiderable time in water made ſo warm * as one can hold his hand eaſily in it: taking care to keep it of an equal warmth all the time, by taking out ſome of the water as it cools, and pouring in hot water in its place; by which the veſſels will be ſufficiently ſoftened and

* Ruyſch orders a previous maceration for a day or two in cold water; which muſt have a better effect in melting the blood than warm water has.

and relaxed, the blood will be melted down, and the injection can be in no danger of hardening too ſoon; whereas if the water is too hot, the veſſels ſhrink, and the blood coagulates. From time to time we ſqueeze out the liquids as much as poſſible at the cut veſſel by which the injection is to be thrown in *. The time this maceration is to be continued, is always in proportion to the age of the ſubject, the bulk and thickneſs of what we deſign to inject, and the quantity of blood we obſerve in the veſſels, which can only be learned by experience: at leaſt, however, care ought to be taken, that the whole ſubject or part macerated is perfectly well warmed all through; and that we continue the preſſure with our hands, till no more blood can be brought away, whatever poſition we put the ſubject in.

When the ſyringe, injections, and ſubject, are all in readineſs, one of the ſecond ſort of pipes is choſen, as near to the diameter of the veſſel by which the injection is to be thrown as poſſible: for if the pipe is too large, it is almoſt needleſs to tell it cannot be introduced; if the pipe is much ſmaller than the veſſel, it is ſcarce poſſible to tie them ſo firmly together, but, by the wrinkling of the coats of the veſſel, ſome ſmall paſſage will be left, by which part of the injection will ſpring back on the injector in the time of the operation, and the neareſt veſſels remain afterwards undiſtended by the loſs of the quantity that ouzes out. Having choſen a fit pipe, it is introduced at the cut orifice of the veſſel, or at an inciſion made in the ſide of it; and then a waxed thread being brought round the veſſel, as near to its coats as poſſible, by the help of a needle, or a flexible eyed probe, the ſurgeon's knot is made with the thread, and it is drawn as firmly as the thread can allow: taking care that it ſhall be ſunk into the circular notch of the pipe, all round; otherwiſe it will very eaſily ſlide of, and the pipe will be brought out probably in the time of the operation, which ruins it.

If there have been large veſſels cut, which communicate with the veſſels you deſign to inject; or if there are any others proceeding from the ſame trunk, which you do not reſolve to fill; let them be all carefully now

* When Ruyſch intended to inject the whole body, he put one pipe upwards and another downwards, in the deſcending aorta.

now tied up, to ſave the injected liquor, and make the operation ſucceed better in the view you then have.

When all this is done, both ſorts of injections are to be warmed over a lamp, taking care to ſtir them conſtantly, leſt the colouring powder fall to the bottom and burn *. The oil of turpentine needs be made no warmer than will allow the finger to remain in it, if the ſubject has been previouſly well warmed in water: when the maceration has not been made, the oil ought to be ſcalding hot, that it may warm all the parts which are deſigned to be injected. The coarſe injection ought to be brought near to a boiling. In the mean time, having wrapped ſeveral folds of linen round the parts of the ſyringe which the operator is to gripe, and ſecured the linen with thread, the ſyringe is to be made very hot, by ſucking boiling water ſeveral times up †; and the pipe within the veſſel is to be warmed, by applying a ſponge dipped in boiling water to it ‡.

After all is ready, the ſyringe being cleared of the water, the injector fills it with the finer injection; and then introducing the pipe of the ſyringe into that in the veſſel, he preſſes them together, and either with one hand holds this laſt pipe firm, with the other gripes the ſyringe, and with his breaſt puſhes the ſucker; or, giving the pipe in the veſſel to be held by an aſſiſtant, in any of the ways mentioned in the deſcription of theſe ſort of pipes, he gripes the ſyringe with one hand, and puſhes the ſucker with the other; and conſequently throws in the injection, which ought to be done ſlowly, and with no great force, but proportioned to the length and bulk of the part to be injected, and ſtrength of the veſſels. The quantity of this fine injection to be thrown in is much to be learned by uſe. The only rule I could ever fix to myſelf in this matter, was to continue puſhing till I was ſenſible of a ſtop which would require a conſiderable force to overcome. But this will not hold where all the

* Ruyſch melts his tallow by the heat of warm water, into which he puts the veſſel containing the injection.

† He warms his ſyringe by laying it on hoat coals.

‡ He warms his pipe, by putting the body, after the pipe is fixed in the veſſel, into hot water. When this is to be done, a cork ought to be put into the pipe, to prevent the water from getting into the veſſel that is to be injected.

branches of any veſſel are not injected; as, for inſtance, when the veſſels of the thorax only are to be injected; for the aorta bears too great a proportion to the branches ſent from it, and therefore leſs fine injection is requiſite here. As ſoon as that ſtop is felt, the ſucker of the ſyringe is to be drawn back, that the neareſt large veſſels may be emptied: then the ſyringe is taken off, emptied of the fine injection, and filled with the coarſer, which is to be puſhed into the veſſels quickly and forcibly, having always regard to the ſtrength and firmneſs of the veſſels, bulk, &c. of the part. Continue to thruſt the ſucker till a full ſtop, or a ſort of puſh backwards, is felt; when you muſt beware of thruſting any more, otherwiſe ſome of the veſſels will be burſted, and the whole, or a conſiderable ſhare of the preparation you deſigned, will be ſpoiled by the extravaſation; but rather immediately ſtop the pipe by the turn-cock, and take out the ſyringe to clean it, and allow ſufficient time for the coarſe injection to coagulate fully before any part is diſſected *.

In this way I have frequently injected the cortical part of the brain, *tunica choroides* and *vaſculoſa* of the eye, *perioſteum* of the bones of the ear, veſſels of the teeth, of the ſkin, bones, and viſcera. As a ſpecimen of the ſucceſs of this way, in Plate I. is given the figure of a little piece of the *tunica villoſa* of the inteſtines, at leaſt of that membrane which retains the air in the internal cellular coat of the inteſtines, when they are turned inſide out, and theſe cellules are diſtended by blowing. Fig. 1. repreſents this piece of membrane as it appears to the naked eye; only that the deep red colour, with which it is tinged all over in the original, cannot appear here. In fig. 2. is repreſented the appearance it had when viewed with a microſcope. What looks like a ſort of moſs-work here, ſhews itſelf vaſcular when it is viewed with a microſcope that magnifies more than the one employed when the painter drew this figure.

* Ruyſch, immediately after throwing in the injection, put the body into cold water, and ſtirred it continually for ſome time, to prevent the ſeparation of the vermilion from the tallow.

AN

AN

ESSAY

ON THE

Method of preparing and preſerving the Parts of Animal-Bodies for Anatomical Uſes.

THE moſt artful management of the knife alone cannot diſcover the texture of animals ſufficiently: Anatomiſts are therefore obliged to employ ſeveral other arts, which often require a conſiderable time in their execution, and frequently fail through ſome unfitneſs in the ſubject, or by a very ſmall omiſſion or accident; and when they ſucceed in any attempt of this kind, they endeavour to preſerve the parts thus prepared, that they may always be in readineſs to ſupply what cannot be demonſtrated on the recent ſubject. While each anatomiſt is obliged to his own induſtry only for the diſcovery of theſe arts of preparing and preſerving, it is probable that frequent diſappointments, and the deſpondency theſe will create, may diſcourage many from purſuing the ſtudy of anatomy, who might become the greateſt improvers in it if theſe difficulties did not lie in their way. With a view to remove them in ſome meaſure, I ſhall give an account of ſuch arts of preparing and preſerving the parts of animal-bodies as I have found ſucceſsful; which may ſerve as a foundation, on which others, more induſtrious or ingenious, may build.

The principal preparation that BONES require is to make them white; for which directions are given at conſiderable length by Paulli * and Lyſerus †, who alſo teach the method of putting the bones of adults together. What I have found moſt ſucceſsful for whitening the bones of

* Act. Hafn. vol. ii. § 18. † Cult. Anat. lib. 5.

young creatures, is macerating them long in cold water; which ought to be changed frequently, the bones being laid out each time to dry a little in the ſun. If they lie too long in the water, even thoſe of adults will diſſolve in their more ſpongy parts, and the younger ones loſe all their epiphyſes. If they are allowed to dry before the blood in their veſſels is melted down by the maceration, it ſcarce can be afterwards ſeparated from them, or they will never become white. The marrow of young bones being much leſs oily than in adults, they generally can be made much whiter, and do not readily turn yellow by keeping. The bones of fœtuſes require to be taken frequently out of the water; and the perioſteum muſt not be ſeparated where the epiphyſes are joined, otherwiſe it is ſcarce poſſible to prevent the loſs of theſe additional pieces.

The method of burning and expoſing the bones of adults long to the weather, for unravelling their texture, is ſo generally known, that I need ſcarce mention it.

CARTILAGES are made pellucid in the ſame way that bones are whitened: and they muſt afterwards be brought to their natural ſhape and ſituation; in which they are to be kept by ſtrings, weights, pins, and ſuch other contrivances, if they are to be preſerved dry.

The MUSCLES that have no large cavity are to be laid and ſecured in the poſture they are deſigned to be preſerved in; and they are preſſed with the fingers into a natural ſhape while they are drying.

In the Medical Eſſays † are publiſhed all I know of the method of injecting the VESSELS. That they may appear better, it is neceſſary to macerate in cold water all injected parts that are coloured with blood, till the blood is extracted; after which the water is to be preſſed well out: and even when the preparation is to be preſerved wet, it is of ſervice to let it dry a little in the air, before it is put into the embalming liquor. But before the very minute extremities of injected veſſels can be demonſtrated, there is a farther art requiſite, which is the ſame that has been employed by ſeveral of late for unravelling the texture of leaves and fruits; of which Severinus *, near a century ago, ſays, "Verum me ineptum, quid præ-
"terieram opontii folii reſolutionem artificioſam: parabitur hæc porro
"ſimplici

† Vol. I. art. ix.

* Th. Bartholin. Epiſt. Med. cent. 1. epiſt. 65.

" ſimplici tabefactu per affuſam uberem aquam tamdiu complexuram, " dum fibris lignea duritie reſtibilibus, omnis exſolvatur carnea portio." And Ruyſch † at laſt acknowledged his method of preparing the ſuccous veſſels of fruits, and of the brain, &c. to be the ſame. Put therefore the injected brain, lungs, liver, ſpleen, placenta, or any other part of a tender texture, into water: allow it to remain there, till its involving membrane is raiſed by the water inſinuated into the cellular membrane which connects it to the parts below: then ſeparate the membrane; and afterwards keep the part among the water, till the fibres, connecting the ſmall veſſels, are diſſolved. This is known by ſhaking frequently the part among the water, which waſhes off the corrupted particles; and at laſt the ſuccous veſſels are ſeen diſtinct and floating in the water: then the preparation is taken out; and, by gently preſſing, the water is ſqueezed from it, the remainder of it being waſhed away with ſome of the preſerving liquor, into which it is immediately put; and, by a little twirl of the thread or hair by which it is ſuſpended, the preparation is expanded, and the ſmall veſſels are ſeparated.

It is difficult to divide nerves into their very ſmall filaments, after they have got their firm coat from the *dura mater*; but before they are involved in that membrane, they are eaſily divided. Thoſe that conſtitute the *cauda equina* are fitteſt for this purpoſe; for they are long, and their fibres adhere by very weak fine membranes. One of theſe chords being cut through where it comes off from the *medulla ſpinalis*, and where it is about to enter the *dura mater*, one end is ſecured with a hair, by which it is ſuſpended in a baſon of water; and, after macerating ſome time there, it is raiſed to the ſide of the baſon, upon which it is laid, while one hand holding the hair, with the other a very ſmall needle, fixed in a handle, is ſlightly ſtripped along the nerve. Let this operation be continued, till, upon twirling the nerve among the water, it is expanded into a fine web of very ſmall fibres; when it is put into the embalming liquor. If the blood-veſſels were previouſly injected, the hair muſt be tied on the end of the nerve neareſt to the *dura mater*, that the trunk of the nerve and artery may appear together. When a piece of the *cauda equina* is thus

† Adverſ. Anat. dec. 3. § 2.

thus prepared, it ſhows very prettily; for each filament almoſt of the nerve appears with injected veſſels upon it.

When a fine ſingle MEMBRANE, ſuch as the *pleura* or *peritoneum*, is to be preſerved for demonſtrating its arteries after an injection, as much of the cellular membrane, by which it is connected to the neighbouring parts, is to be ſaved, in diſſecting it off, as can be done without ſpoiling the tranſparency of the membrane; for, when the cellular ſubſtance is wholly ſeparated, very few continued ramifications of veſſels can be ſeen, a great number of exceeding ſhort extremities only appearing, which require a microſcope to view them diſtinctly. When there is little fat lodged in the cells, the membranes of the cellular ſubſtance may be left without a poſſibility of obſerving them: when they are filled with fat, it muſt be preſſed out as much as poſſible, after being well macerated. Even when membranes are to be preſerved in a liquor, they are more eaſily kept extended in it, and their veſſels are better ſeen, if they are previouſly dried. In doing this, they muſt be extended with pins or threads on a finely poliſhed clean board; or it is rather better to keep them on the ſtretch while they are raiſed up from it, that they may bear no print of the board. After membranes are dried, their doubled edges, or other inequalities, are to be cut off with a pair of ſciſſars.

Ruyſch * deſcribes the manner of ſeparating the *cuticula* and *corpus reticulare* from the ſkin, by ſtretching theſe common teguments, well freed from the fat, on a board, with the *cuticula* outmoſt; and then dipping all into boiling water, which looſens the *cuticula* and *corpus reticulare* ſo from the ſkin, that they are eaſily ſeparated with a blunt knife or the thin ivory handle of a ſcalpel; then with the ſame inſtrument he ſeparates the *corpus reticulare* from the *cuticula*, leaving them connected to each other, and to the ſkin in ſome part. After this they may be either dried, or put into the embalming liquor. When either the *corpus reticulare* is not made firm enough by the hot water, or happens to be very thin, it is difficult to ſeparate any conſiderable piece of it entire from the *cuticula*.

A chirotheca or podotheca, a glove or a ſhoe of the ſcarf-ſkin, with the nails adhering to it, is brought off with very little trouble after the *cuticula*

* Adv. Anat. dec. 3. § 2.

cuticula looſens from the parts below by the putrefaction which keeping a ſubject long brings on. This method anſwers the deſign better than forcing off the ſcarf-ſkin with boiling water, which makes the *cuticula* tender.

The cellular membrane under the ſkin cannot be preſerved diſtended with air, except where there is little or no fat contained in it. One of the beſt parts for making a preparation of this kind is the *ſcrotum*; where, what is commonly called *muſculus dartos* may, by blowing into it, be changed entirely into fine membranous cellules: and Carolus Stephanus * very well obſerved, that the cellular ſubſtance any where elſe under the ſkin, puts on a muſcular appearance when the fat is waſted. Will not theſe obſervations ſerve as ſome apology for former anatomiſts, who reckoned a *tunica carnoſa* among the common teguments of the body? May we not hence ſee one reaſon of old emaciated people having ſo many wrinkles in their ſkin?

That the DURA MATER, with all its proceſſes, may be preſerved in a natural ſituation, it is neceſſary to ſaw the *cranium* from near the root of the noſe to the middle of the *os occipitis*, by a perpendicular ſection at half an inch diſtance from the *ſagittal ſuture*, and then by an horizontal ſection, terminating at the extremities of the former perpendicular ſection, to take off a conſiderable ſhare of the ſide of the *cranium*: after which, the *dura mater* being cut by an inciſion in form of a T, the brain and *cerebellum* are taken out, and the head is put amongſt a liquor to preſerve it; or the bones are made clean and expoſed to the air to dry; taking care to keep the cut parts of the *dura mater* ſtretched out with pins, hooks, or threads. If the head of a fœtus, or of a very young child, is thus to be dried, the ligamentous membranes between the bones muſt be kept extended by ſticks, cut of ſuch a length, as, when put into the cavity of the *cranium*, their extremities may reſt on the bones, and puſh them outwards.

The proceſſes of the PIA MATER, which are placed in the interſtices of the convolutions of the brain, may be eaſily ſeparated entire with the *pia mater*, when that membrane is preternaturally thickened by diſeaſes, as it frequently is: and, even in a ſound ſtate, large pieces of it may be got

* De Diſſect. Part. Corp. Human. lib. ii. cap. 2.

got with its proceſſes, after macerating the brain in water. As ſoon as it is ſeparated, and the water preſſed from it, it ought to be immerſed in the embalming liquor; where it is to be kept extended by threads or ſmall branches of plants.

The BRAIN requires no preparation, except either for demonſtrating its ſuccous veſſels, the method of doing which I have already mentioned; or for hardening it, which I ſhall afterwards ſpeak of.

Before the coats, humours, and veſſels of the EYE, can be rightly prepared for preſerving, ſo as to demonſtrate all of them, it is neceſſary to coagulate the cryſtalline and vitreous humours, by immerſing the eye for ſome time in a proper liquor; of which hereafter. After this, they will bear maceration in water, for the ſeparation of the choroid and Ruyſch's coat.

The ſebaceous glands and ducts of the eye-lids, appear much better after a ſubtile injection of the arteries, and the coagulation of their liquors, than in the recent body.

Dr Trew * has very juſtly obſerved, that, by macerating the EAR in water, the membrane which is continued from the *epidermis* of the ear to line the *meatus auditorius externus*, and to form the outer lamella of the *membrana tympani*, may be brought off entire in adults, as well as it is eaſily ſeparated in fœtuſes or very young children. And indeed the *membrana tympani* appears to be no other than this *cuticula* and the membrane that lines the *tympanum*, connected by a thin cellular ſubſtance, in which, as in all other ſuch parts of the body, the larger branches of the veſſels run.

The *epithelia* of the LIPS, as Ruyſch calls the *cuticula* covering the *papillæ* there, is to be taken off by macerating in water; which makes the ſurface appear better in the villous way, when the lips are afterwards put into a glaſs with the embalming liquor.

The villous ſubſtance of the TONGUE is very eaſily made quite red with injection thrown in by the arteries; and a membrane analogous to a *cuticula* ſeparates by ſoaking in water: and, upon comparing the lips, tongue, œſophagus, ſtomach, and inteſtines, the ſtructure ſeems to be ſo far alike in all, as they are covered with this ſort of *cuticula*; which is connected

* Act. Phyſico-medic. Acad. N C. vol. ii. obſ. 56.

connected to the muſcular part by a cellular ſubſtance, in which the numerous nerves, veſſels, and glands, are lodged. This cellular ſubſtance either is formed into ridges and valves where it is thick and looſe, or appears like a fine membrane where it is thin and ſtretched.

There are no organs in the body of which I find a greater difficulty to give the ſtudents of anatomy a good idea, than thoſe employed in deglutition. In the recent body, they cannot ſee them all at once in the natural ſituation; they can ſcarce be held in a wet preparation, ſo as to ſhew them well enough. What has the beſt effect, is to demonſtrate the groſſer parts firſt in a dry preparation; which requires patience to execute right: for all the muſcles belonging to theſe organs, that are fixed to any of the ſurrounding parts, muſt be all clean diſſected, and then cut off from theſe ſurrounding parts; after which the tongue, *os hyoides*, *fauces*, *velum pendulum palati*, with the *uvula*, the *larynx*, *pharynx*, *aſpera arteria*, and *æſophagus*, are taken out with the diſſected muſcles hanging at them, to be all ſecured in their natural ſituation with ſmall pieces of thin boards, and threads faſtened to hooks: a cork is then put into the lower part of the *trachea*; round which and the *æſophagus* a ſtrong thread is tied firmly, and quickſilver is poured by the *fauces*, or by the paſſage which formerly led to the noſtrils, till the *æſophagus*, *trachea*, *larynx*, and *pharynx*, are filled: in which condition it is allowed to hang till the parts are pretty firm, but not near fully dry; when the quickſilver is poured out; and the parts overſtretched by its weight, ſuch as the *glottis* and ſpace between the tongue and *larynx*, are, by preſſing and ſqueezing with the fingers, to be brought near to the natural ſituation; and others that ſhrivel too much, as, for inſtance, the *uvula* and *epiglottis*, are kept near to the natural form, by drawing and preſſing them from time to time till they are fully dried.

The hollow VISCERA of the *thorax* and *abdomen* are not only to have their veſſels demonſtrated in the ways mentioned formerly, when ſpeaking of the blood-veſſels; but, when they are to be kept dry, they require a particular preparation for preſerving their form, and for ſhowing their interior ſtructure; which is to fill them with ſome proper ſubſtance. The properties I think this ſhould have are, to be able to reſiſt the ſhrivelling contraction of their fibres, to fill them all equally, and to leave

them clean if it ſhould be taken out. For theſe reaſons, cotton, wool, ſand, or ſuch like, are improper: all that I uſe is air, quickſilver, or melted wax.

Wax is only to be employed where there is no farther deſign than to view the exterior ſurface; for which purpoſe it may be thrown into any of the hollow bowels: but in all other caſes, air or quickſilver muſt be uſed.

Where air will anſwer the deſign, it is preferable to the quickſilver, for it ſtretches every where equally; whereas mercury preſſes moſt on the depending parts. Air dries the bowels in the twentieth part of the time that quickſilver does; and it leaves no colouring or gilding on them, which the mercury always does. On the other hand, air does not ſtretch ſome parts ſufficiently, cannot be retained, and inſenſibly eſcapes ſo from others, as to allow them to collapſe in drying; which inconveniencies the quickſilver is not ſo ſubject to.

From what has been ſaid, it is evident, that air is required, or is much preferable to quickſilver, for making dry preparations of the *æſophagus*, ſtomach, guts, *veſica fellea*, with the biliary ducts, and bladder of urine, with the ureters. And it is as plain, on the other ſide, that the *pericardium* and *uterus* can only be kept diſtended in their natural form with mercury. The heart with its blood-veſſels, and the *pelvis* of the kidney with the ureter, generally have ſome ſmall paſſages for the air to eſcape at, and it ſcarce can reſiſt the ſhrivelling contraction of their fibres; wherefore mercury is preferable in drying them. The *corpora cavernoſa penis*, and the *veſiculæ ſeminales*, retain both air and mercury: but this laſt leaves a gilding in the *corpora cavernoſa*, which hinders ſuch a clear view as could be wiſhed of their veſſels and texture; and there is a difficulty to fill the *veſiculæ ſeminales* with it, for the orifices at the *caput gallinaginis* will not admit it from the *urethra*: and when it is poured in at the *vas deferens*, the moiſture of this narrow pipe is liable to ſtop it; and after you have got it to run in this canal, its weight forces open the orifice into the *urethra* of the ſmall duct common to the *vas deferens* and *veſicula ſeminalis*, ſo that it will not mount into the *veſicula* till the *urethra* is filled: whereas the contraction of that orifice reſiſts a ſmall blaſt of air, which readily regurgitates into the veſicula. For which reaſons, air is

preferable

preferable for the *corpora cavernoſa* and *veſiculæ ſeminales*.——It is ſeldom we meet with ſubjects whoſe lungs or ſpleen will retain air; and the glans of the penis is very liable to allow it to eſcape: wherefore, generally, we are obliged to make uſe of quickſilver for theſe parts; which, however, does conſiderable prejudice in all of them, but eſpecially in the lungs and glans, whoſe cellules are ſmaller than thoſe of the ſpleen.

Being determined, by the foregoing rules, which of the two liquors to uſe, we preſs out all the blood or other liquors contained in the bowels we deſign to fill, and then tie all the paſſages from them, except the one by which we are to introduce the diſtending liquor: and in caſe we diſcover any others in the time of filling them, at which the air or quickſilver eſcapes, we tie them likewiſe.

The paſſage by which the liquors ſhould be introduced, is to be choſen ſuch as ſooneſt allows them to paſs every where into the cavity to be filled, and that is moſt eaſily ſecured afterwards. What was ſaid of the organs of deglutition, will readily lead one to know how to diſtend the *pericardium* and *uterus*. The place for blowing up the alimentary tube, *veſica fellea*, and *urinaria*, is known to every body. Liquors are poured into the heart and large arteries through the ſuperior *vena cava* and any branch of the pulmonary veins. The *trachea arteria* receives what the lungs are to be diſtended with; the kidney is to be filled by the ureter; the veins of the ſpleen, *capſula atrabilaris*, and *corpora cavernoſa penis*, are to convey the ſubſtance with which they are diſtended.

We muſt always make uſe of a pipe when we are to blow up any part. The beſt ſort of pipe for this uſe is what has a ſmall extremity, with a notch round it, and a ſtop-cock a little higher in it. We introduce the ſmall extremity into the proper canal, which is tied upon it with a waxed thread, that is made to ſink into the notch; and as ſoon as the bowel is ſufficiently diſtended, the ſtop-cock is turned, to prevent the air to get out. If any of it eſcapes, it is eaſily ſupplied by a new blaſt at the pipe, which is ſupported by ſome ſtring or board, to hinder it to preſs or draw the preparation while it is drying.——If the anatomiſt is provided with no other than a common blow-pipe, the canal by which the air is introduced muſt be tied tight upon it with a thread, which is drawn with a firm knot by an aſſiſtant, while the air is blown in. As ſoon as the

bowel is ſufficiently diſtended, a ſignal is given to the aſſiſtant for pulling the ends of the thread, while the pipe is drawn out of the canal; and immediately another knot being made, the preparation is ſuſpended by this thread.

When quickſilver is employed, the paſſage by which it is poured muſt be higher than any other part of the preparation; and when that paſſage is narrow, a ſmall glaſs funnel or pipe muſt be put into it. This pipe muſt be long, where the weight of a high column of mercury is wanted to make it run through ſmall veſſels. If the preparation will allow, the paſſage by which the mercury entered is to be tied firmly; otherwiſe, before any mercury is poured in, that paſſage muſt be ſecured, ſo as to remain uppermoſt all the time the preparation is drying.—— When a conſiderable quantity of mercury is poured into any part whoſe texture is tender, it is neceſſary not only to ſuſpend it with threads and hooks in the ſuperior part, but to ſupport it alſo by a ſmall net extended below it, upon a proper veſſel for receiving the quickſilver, if by any accident it ſhould run out.

The directions now given will ſerve for preparing the moſt part of the bowels; but the LUNGS and SPLEEN, whoſe membranes very difficultly retain either quickſilver or air, eſpecially this laſt, require more care. Theſe bowels muſt not be taken indifferently from any ſubject; but ſuch muſt be choſen as have the exterior membrane thick and ſtrong. After they have been diſtended as above directed, they ſhould be expoſed to the warm ſun, or near a fire, to dry them ſoon; returning frequently to ſupply by a new blaſt what they loſe in very little time. As ſoon as their outer ſurface is dry, immerſe them into ſtrong turpentine varniſh, ſo as their whole ſurface may be covered; after which they will retain the air much better: continue to place them ſo that they may ſooneſt dry, taking care to rub on varniſh with a feather wherever it is wanting, and to blow in new air whenever they ſubſide.

After the human ſpleen has been kept diſtended with quickſilver, or air, till it is dried, it ſeems to be wholly compoſed of cells communicating with each other; upon the ſides of which the ſmall branches of the artery are obſerved to ſpread in great numbers, if they have been previouſly injected.

Upon

Upon cutting the lungs thus prepared, their veſicles appear far from being ſpheres, or any other figure whoſe tranſverſe ſection is circular; for they evidently are polygons, generally irregular ſquares and pentagons. And indeed one might conclude *a priori*, that they are rather more ſo in a living creature: for ſeeing the exterior membrane is of a firmer texture than the veſicles, and will not ſtretch out ſo far as they could be extended, they muſt puſh violently on each other; and therefore be preſſed from a ſpherical form into as many ſides and angles as there are contiguous veſicles: and the *thorax* of a living creature does not allow the lungs to be extended ſo far as their exterior membrane can be ſtretched, as is evident from their ſtarting out at wounds of the *thorax*, or by blowing into the *trachea arteria*, after the *ſternum* of a creature is taken away; and therefore their veſicles muſt be more compreſſed, and conſequently their ſides be ſtraiter in reſpiration, than when they are diſtended after being taken out of the body. Theſe conſiderations, and the obvious polygon form of the cells in the ſimple lungs of ſerpents, frogs, &c. make me ſurpriſed that ever the veſicles of more complicated lungs ſhould have been imagined to be ſpheres, or any other figure whoſe tranſverſe ſection is circular.

I come now to conſider the manner of preſerving preparations: which is, either by expoſing them to the air till all their moiſture is evaporated, and they become dry, rigid, and out of hazard of corrupting; or by immerſing them in a proper liquor. Beſides what has been already ſaid concerning the manner of drying preparations, it is alſo neceſſary, eſpecially when the parts are thick and bulky, and the weather is warm, to guard further againſt putrefaction; to hinder flies from laying their eggs upon them, which ſoon growing into maggots would deſtroy them; and to prevent inſects, mice, or rats, from feeding on them. All this may be done, by ſoaking the preparation, ſome time before it is expoſed to dry, in a ſolution of corroſive mercury in ſpirit of wine. The proportions I uſe are two drachms of the corroſive to a pound of the ſpirit; and while it is drying, it is to be moiſtened frequently with the ſame liquor. By this method one can, without any of the dangers above-mentioned, dry the diſſected bodies of pretty large children in the midſt of ſummer; which ſooner anſwers the deſign than the cold moiſture of winter can.

—After

——After the preparation is dry, it is ſtill liable to moulder away, become brittle, crack, and have an unequal ſurface; wherefore it is neceſſary to defend all its ſurface with a thick varniſh, with which it is to be covered over as often as the luſtre of the former application wears off; and it muſt always be kept well from all duſt and moiſture. The varniſh I always uſe is the common ſpirit one, which I buy from the painters *.

Dry preparations are very uſeful in ſeveral caſes; but there are a great many where it is neceſſary the parts ſhould be flexible, and nearer a natural ſtate, than the ſhrivelling and rigidity in this way of preparing can allow. The difficulty has hitherto been, to find a liquor that would preſerve them ſo near to a natural condition. Watery liquors do not prevent the putrefaction, and they diſſolve the hardeſt parts of the body. Acids prevent putrefaction, but diſſolve the parts into a mucilage. Ardent ſpirits harden the parts, change their colour, and deſtroy the red colour of the injected veſſels. Oil of turpentine, beſides the faults of the ardent ſpirits, becomes thick and viſcous. But without dwelling longer on the faulty liquors, I ſhall obſerve, that what I have always found to anſwer beſt, is a rectified ardent ſpirit, no matter whether from wine or malt, that is ſtill limpid, without having any yellow tincture, to which a ſmall quantity of a foſſil acid ſpirit, ſuch as that of vitriol or nitre, is added: both of them reſiſt putrefaction; and what might be looked on as faults, if each was conſidered ſingly, is mended by the other. When theſe are mixed in a right proportion, the compound liquor changes neither the colour nor conſiſtency of the parts, except where there are ſerous or mucous liquors, which it hardens much in the way that boiling water does. The brain, even of a new-born child, is made ſo firm by it, that it can be handled with great freedom. The cryſtalline and vitreous humours of the eye become firm, but white and opaque, by ſoaking in it. The liquor of ſebaceous glands, of mucous folliculi, the ſeed, &c. are coagulated by it. The lymphatic, or watery liquors, ſuch as the aqueous humour of the eye, water of the *pericardium* and *amnios*, are not changed by it. It heightens the red colour of injected liquors ſo much, that veſſels which did not at firſt appear are plainly ſeen, after the part has been in it ſome time.

* Ruyſch recommends a varniſh made of *gum copal* and *ol. ſpicæ*.

time. If theſe effects are compared with what Ruyſch has ſaid here and there of his preparations, it will be found, that the liquor deſcribed comes pretty much up to the properties of his balſam, as he calls the liquor in which he preſerved his wet preparations *.

The proportion of the acid to be mixed with the ardent ſpirit, is to be varied according to the part to be immerſed in it, and the deſign the anatomiſt has. When the brain, humours of the eye, &c. are to be coagulated, a larger proportion of acid is neceſſary, ſuch as two drachms of ſpirit of nitre to a pound of alcohol. When the parts are only to be preſerved, eſpecially if there are any bones in the preparation, forty, thirty, or fewer drops of the acid, will be ſufficient. If too large a proportion of the acid is mixed, the bones become firſt flexible, and then diſſolve.

After any part is embalmed, particular care muſt be taken to keep it always covered with the liquor; otherwiſe its colour ſpoils, and ſome parts harden, others diſſolve. To prevent, therefore, the evaporation as much as poſſible, and to exclude the air, which makes the ſpirits extract a tincture, the mouth of the glaſs is to be carefully ſtopped with a glaſs or a waxed cork, cover, or ſtopper; over which, leaf-tin, a bladder, or injected membrane, is tied; in which way it will keep a conſiderable time without any great waſte. Whenever the ſpirits ſink near to the top of the preparation, more of the ſpirit of wine muſt be added, without the acid, which flies little off. If at any time the ſpirits acquire too high a tincture, they muſt be poured off, and new ſpirits, with a leſs proportion of the acid than at firſt, muſt be put in their place; the old ones being kept in a well-corked bottle, for waſhing away the natural liquors of any new preparation, which ought always to be carefully done before any part is embalmed; and the old tinctured ſpirits are likewiſe to be waſhed off with a ſmall quantity of limpid ſpirits, every time the old ones are renewed, or a new preparation is to be preſerved. The ſpirits unfit to be longer ſhown in glaſſes, may alſo be ſtill employed in preſerving parts in earthen veſſels, or glaſs ones, out of which the preparation muſt be taken when it is to be viewed.

It

* Ruyſch's balſam, according to Rigierus, *(Notit. rerum natural. et artefact.)*, is rectified ſpirit of malt *(frumenti)*, to which a third part of water is added. Ruyſch diſtilled this ſpirit in a tin alembic, with a ſlow fire; and thought that the addition of a handful of black pepper made the ſpirit penetrate better into the fleſhy parts.

It may not be amiſs to remark here, that the glaſſes in which preparations are to be demonſtrated, ought to be of the fineſt moſt tranſparent thick kind: for theſe allow the parts to be ſeen moſt diſtinctly, without changing their colour, and at the ſame time magnify the objects; diſcovering parts which, when they are out of the glaſs, could not be ſeen with the naked eye. Since, then, the glaſs with the liquor has a certain focus where objects are ſeen moſt diſtinctly, it will be neceſſary to uſe ſome contrivance for keeping the preparation at the proper diſtance from the ſide of the glaſs; which may be done, by putting in a ſmall branch of ſome plant, or a little ſtick, or by faſtening the thread or hair by which the preparation is ſuſpended towards one ſide of the glaſs. Such little arts, for keeping the parts expanded, or placing them ſo as to be ſeen to the beſt advantage, will eaſily occur to any one who practiſes anatomy.

I ſhall finiſh this eſſay with a caution to anatomiſts, to ſhun as much as poſſible putting their fingers into theſe acidulated ſpirits, or handling the preparations that are very wet with them; for they bring ſuch a numbneſs on the ſkin for ſome time, as makes the fingers unfit for any nice diſſection. The beſt cure I have uſed for this numbneſs, is waſhing the hands with water, into which a few guts of *ol. tartar. per deliquium* have been dropped.

THE

No. 3.

THE

ANATOMY

OF THE

HUMAN BONES.

TO THE

STUDENTS OF ANATOMY

IN THE

UNIVERSITY OF EDINBURGH.

GENTLEMEN,

WHEN this *Osteology* was first printed in 1726, I did not know that Albinus, Winslow, and Palfyn, were to publish descriptions of the bones; otherwise my papers probably would have remained yet undelivered to the printers. I however flatter myself, that this *Essay* has been of use to the Gentlemen who did me the honour to attend my lectures, by assisting them to understand my sense and representation of things in this fundamental part of anatomy; nay, that it has possibly been of more advantage to them than a more complete work from an abler hand, unless my demonstrations had been in the order and method of such an author.

This view of your improvement, Gentlemen, is a prevailing argument with me to cause this essay to be reprinted; and you cannot reasonably blame me, if I likewise acknowledge another motive for it, which more particularly relates to myself. In a new edition, an author has an opportunity of making his works more correct, complete, and consequently acceptable to the public; who may perhaps be indulgent enough to think this little treatise not altogether useless, since more reasoning on the structure and morbid *phænomena* of bones is to be found in it than in the other writers, who have confined themselves almost entirely to the descriptive or proper anatomical part of the *osteology*.

I have here kept to the plan of the former editions; by first considering, in the order that seemed to me most natural and methodical, every

thing which I thought neceſſary to be known concerning bones in general; and, in the ſecond part, I have deſcribed the ſeveral bones compoſing the ſkeleton.

The bones of adults are what I principally endeavour to deſcribe; but I have added as much of the *oſteogenea* as I think ſerviceable in the practice of phyſic and ſurgery.

That little might be omitted of what was formerly done on this ſubject, I have taken all the aſſiſtance I could from books; but have never aſſerted any anatomical fact on their authority, without conſulting nature, from which all the deſcriptions are made: and therefore the quotations from ſuch books ſerve only to do juſtice to the authors who have remarked any thing in the ſtructure of the parts that was commonly omitted, and to initiate you in the hiſtory of anatomy; which I once propoſed to make complete, ſo far as related to this ſubject: but not being able to procure ſeveral books, and being ſenſible how many more may have never come to my knowledge, I laid aſide this deſign, of purpoſe omitted many I could have inſerted, and in ſome places I have changed an older author for a later one who has more fully or clearly deſcribed what I treated of. Beſides anatomiſts, I have alſo named ſeveral other authors to confirm my reaſoning by practical caſes; of which it is not to be ſuppoſed my own experience could furniſh a ſufficient variety.

You will readily obſerve, that I quote no paſſages with a view to criticiſe or condemn them. This precaution of giving no offence, is very neceſſary in thoſe who are ſufficiently conſcious of their being liable to lay themſelves open to juſt cenſure; and it prevents occaſions of uſeleſs wrangling; in which, generally, both parties are loſers, and the public has little advantage.

In this Treatiſe I always make uſe of the moſt common name of each part; and have put the ſynonimous names to be met with in books at the foot of the page, that the reading might be ſmoother, and you might conſult them at your leiſure, to aſſiſt you in underſtanding different authors.

The deſcriptions and reaſoning are here blended; without which I always

ways find young anatomiſts are ſoon diſguſted with authors: Their imaginations cannot follow a long chain of deſcriptions, eſpecially when they are not taught at the ſame time the uſes which the deſcribed parts ſerve: Their minds muſt have ſome relaxation, by a mixture of reaſoning, which never miſſes to ſtrike the fancy agreeably, and raiſes a ſtrong deſire to underſtand the principles on which it depends.

The *phænomena* of diſeaſes are all deduced in this Eſſay from the ſtructure of the parts, by way of corollaries and queſtions; which ſuch an anatomical work confined me to. And this method has otherwiſe a good effect: for when one meets with an uſeful propoſition, and is obliged to employ a little thought to find out its ſolution, the impreſſion it makes is deeper, and he acquires a fondneſs for it, as being in part his own diſcovery. My pupils have frequently aſſured me, that they could, with very ſmall reflection, trace out the whole reaſoning from which my concluſions were drawn. I hope their ſucceſſors will alſo think this an agreeable manner of being inſtructed.

Thoſe Gentlemen who deſired I would add the lectures which I pronounce in my colleges as a commentary upon the text, where the diſeaſes are mentioned, will, I perſuade myſelf, excuſe me for not complying with their deſire, when they conſider the deſign of this is to be a ſchool-book, and how great the difference is between inſtructing youth in private and pretending to inform the public. Art. xxv. vol. v. of Medical Eſſays and Obſervations *, publiſhed in this place, is one of thoſe lectures which I gave as a commentary on the paragraph (p. 38.) concerning the different kinds of *caries*.

In this edition, I have corrected the miſtakes and obſcure paſſages which I diſcovered in the former, and in ſome places I have made the deſcriptions more full and exact; aiming all I could to ſhun unneceſſary minuteneſs on the one hand, and a blameable inaccuracy on the other. Whether I have hit that juſt medium, is what you and the public muſt now judge.

I am ſtill of opinion, that figures of the bones would at any rate have been unneceſſary in a book that is intended to be illuſtrated and explained by

* Or N° 9. of this Collection.

by the originals themſelves; but would be much more ſo now, when my late ingenious friend Mr Cheſelden, Dr Albinus, and Mr Sue *, have publiſhed ſuch elegant ones.

You have advantageous opportunities in this place of ſtudying all parts of Medicine, under the Profeſſors of its different branches in the Univerſity; and of ſeeing the practice of Pharmacy, Surgery, and Phyſic, with our Surgeon-apothecaries, and in the Royal Infirmary, where the diſeaſed poor are carefully treated. Theſe, your intereſt, and I hope your inclinations, will lead you, Gentlemen, ſo to improve, as that they may become the happy means of your making a conſiderable figure in your ſeveral ſtations. Whatever aſſiſtance is in my power towards ſuch a deſirable event, ſhall be given with the greateſt pleaſure, by

Your humble Servant,

ALEX^R MONRO.

* Traitè d'Oſteologie, traduit de l'Anglois de M. MONRO, ſeconde partie.

THE

THE

ANATOMY

OF THE

HUMAN BONES.

PART I.

Of the BONES in general.

BONES are covered by a membrane, named on that account PERIOSTEUM *; which is ſo neceſſary to them, that we muſt examine its texture and uſes, before we can underſtand their ſtructure.

The *perioſteum*, as well as moſt other membranes, can be divided into *layers* of fibres. The *exterior* ones, compoſed of the fibres of the muſcles connected to the bones, vary in their number, ſize, and direction; and conſequently occaſion a very great difference in the thickneſs and ſtrength of the *perioſteum* of different bones, and even of the different parts of the ſame bone. The *internal* layer is every where nearly of a ſimilar ſtructure, and has its fibres in the ſame direction with thoſe of the bone to which

* Membrana circumoſſalis, omentum oſſibus impoſitum.

which they are contiguous. Ought not then the name *perioſteum* to be applied, ſtrictly ſpeaking, only to this internal layer, to which the others are joined in an uncertain manner and number?

Some authors * endeavour to prove the internal layer of fibres of the *perioſteum* to be derived from the *dura mater*: For, ſay they, ſince the membrane covering the ſkull is plainly a production or continuation of the *dura mater*, which paſſes out between the *ſutures*; and ſince there are muſcles on the head, as well as in other parts, which might furniſh a *perioſteum*; it is needleſs to aſſign different origins to membranes which have the ſame texture and uſes. They add further, in proof of this doctrine, that the *perioſteum* extends itſelf along the ligaments of the articulations from one bone to another; and therefore is continued from its origin over all the bones of the body.—While anatomiſts were fond of the hypotheſis of all membranes being derived from one or other of the two that cover the brain, a diſpute of this kind might be thought of conſequence: but now that the hypotheſis is neglected as uſeleſs, it is needleſs to examine the arguments for or againſt it.

Except where muſcles, cartilages, or ligaments, are inſerted into the *perioſteum*, its external ſurface is connected to the ſurrounding parts by thin cellular membranes, which can eaſily be ſtretched conſiderably, but ſhorten themſelves whenever the ſtretching force is removed. When theſe membranes are cut off or broken, they collapſe into ſuch a ſmall ſpace, that the ſurface of the *perioſteum* ſeems ſmooth and equal.

When we attempt to tear off the *perioſteum* from bones, we ſee a great number of white threads produced from the membrane into them; and after a ſucceſsful injection of the arteries with a red liquor, numerous veſſels are not only ſeen on the *perioſteum* †, but moſt of the fibres, ſent from the membrane to the bone, ſhow themſelves to be veſſels entering it, with the injected liquor in them; and when they are broken, by tearing off the *perioſteum*, the ſurface of the bone is almoſt covered with red points.

The veins correſponding to theſe arteries are ſometimes to be ſeen in ſubjects that die with their veſſels full of blood; though ſuch numerous ramifications

* Havers, Oſteolog. Nov. diſc. 1. p. 16.

† Ruyſch, epiſt. 5. tab. 5. fig. 1, 2.; epiſt. 8. tab. 9. fig. 1, 9.

ramifications of them, as of the arteries, can ſeldom be demonſtrated, becauſe few of them naturally contain coloured liquors, and ſuch liquors can difficultly be injected into them. This, however, is ſometimes done *.

The great ſenſibility of the *perioſteum* in the deep-ſeated ſpecies of *paronychia*, in *exoſtoſes*, *nodi*, *tophi*, and *gummata*, from a *lues venerea*, or whenever this membrane is in an inflamed ſtate, is a ſufficient proof that it is well provided with nerves, though they are perhaps too ſmall to be traced upon it; and therefore one cannot well determine whether they are ſent along with the arteries in the common way, or are derived from the tendinous fibres of the muſcles expanded on the *perioſteum* †.

Veſſels alſo paſs through the *perioſteum* to the marrow; of which more hereafter. And frequently muſcles, ligaments, or cartilages, pierce through the *perioſteum*, to be inſerted into the bones.

The chief uſes of the *perioſteum* are: 1. To allow the muſcles, when they contract or are ſtretched, to move and ſlide eaſily upon the bones; the ſmooth ſurface of this membrane preventing any ill effects of their friction upon each other. 2. To keep in due order and to ſupport the veſſels in their paſſage to the bones. 3. By being firmly braced on the bones, to aſſiſt in ſetting limits to their increaſe, and to check their overgrowth. 4. To ſtrengthen the conjunction of the bones with their *epiphyſes*, ligaments, and cartilages; which are eaſily ſeparated in young creatures when this membrane is taken away. 5. To afford convenient origin and inſertion to ſeveral muſcles which are fixed to this membrane. And, laſtly, To warn us when any injury is offered to the parts it covers; which, being inſenſible, might otherwiſe be deſtroyed without our knowledge, or endeavouring to procure a remedy.

When the cellular ſubſtance, connecting the *perioſteum* to the ſurrounding parts, is deſtroyed, theſe parts are fixed to that membrane, and loſe the ſliding motion they had upon it; as we ſee daily in iſſues, or any other tedious ſuppurations near a bone.—When the veſſels which go from

* Sue traitè d'Oſteologie, traduit de l' Anglois de Mr Monro. Note in p. 9.

† See the diſpute about the ſenſibility of this and of other membranes, in Zimmerman. Diſſert. de Irritabilit.;—Act. Gotting. vol. ii.;—Haller ſur la Nature Senſible et Irratible;—Whytt's Phyſiolog. eſſay 2.;—Reimar. Diſſert. de Fungo Articulor. § 26, 34.

the *perioſteum* to the bones are broken or eroded, a collection of liquor is made between them, which produces a ſordid ulcer or rotten bone. This often is the caſe after fractures of bones and inflammations of the *perioſteum*, or after *ſmall-pox*, *meaſles*, *ſpotted fevers*, and *eryſipelas*.—Do not the diſorders of the *perioſteum*, coming rather along with, or ſoon after, the cutaneous, than other diſeaſes, indicate ſome ſimilarity of ſtructure in the *perioſteum* and ſkin?

The BONES are the moſt hard and ſolid parts of the body, and, as all other parts where large veſſels do not enter, are generally of a white colour; only in a living creature they are blueiſh, which is owing to the blood in the ſmall veſſels under their ſurface. The leſs therefore, and fewer, the veſſels are, and the thicker and firmer the bony ſurface covering the veſſels is, the bones are whiter. Hence the bones of adults are whiter than thoſe of children: and, in both young and old, the white colour of different bones, or of the ſeveral parts of the ſame bone, is always in proportion to their veſſels and ſolidities; which circumſtances ought to be regarded by ſurgeons, when they are to judge of the condition of bones laid bare.

Bones are compoſed of a great many *plates* *, each of which is made up of fibres or ſtrings united by ſmaller fibrils †; which being irregularly diſpoſed and interwoven with the other larger fibres, make a reticular work.—This texture is plainly ſeen in the bones of fœtuſes, which have not their parts cloſely compacted; and in the bones of adults, which have been burnt, long expoſed to the weather, or whoſe compoſition has been made looſe by diſeaſes.—The chinks, which are generally made according to the direction of the larger fibres, of bones that have undergone the action of fire, or of the weather, ſhow the greater ſtrength of theſe than of the fibres which connect them.—Numerous accurate obſervations of the different times in which exfoliations are made from the ſides or ends of ſimilar bones, might bid fair to determine what is the proportional force of coheſion in the two ſorts of fibres.

The plates are ſaid ‡ to be firmly joined to each other by a great number of *claviculi*, or ſmall bony proceſſes; which, riſing from the inner plates,

* Squamæ, bracteæ, laminæ. † Malpigh. Anat. Plant. et Oper. Poſthum.

‡ Gagliard. Anat. Oſſium. nov. invent. illuſtrat. cap. 1. obſ. 2.

plates, pierce through ſome, and are fixed into the more external ones. Of theſe nails, four kinds, viz. the *perpendicular*, *oblique*, *headed*, and *crooked*, have been deſcribed: but in bones fitly prepared, I could only ſee numerous irregular proceſſes riſing out from the plates *.

Though the exterior part of bones is compoſed of firm compact plates, yet they are all more or leſs cavernous internally. In ſome (*e. g.* middle thin part of the *ſcapula* and *os ilium*) the ſolid ſides are brought ſo near, that little cavity can be ſeen; and in others (middle of *os humeri*, *femoris*, &c.) the cavities are ſo large, that ſuch bones are generally eſteemed to be hollow or fiſtular: But the internal ſpongy texture is evident in young animals; and ſome of it may be ſeen to remain in thoſe of greateſt age, when bones are cautiouſly opened, after they have been kept ſo long as to be free of the oil they contain, or after being burnt.

This ſpongy cavernous internal part of bones, is generally called their *cancelli* or LATTICE-WORK, and is formed in the following manner. The plates are firmly joined about the middle of the bone; but as they are extended towards its ends, the more internal plates ſeparate from the exterior, and ſtretch out their fibres towards the axis of the bone, where they are interwoven with the fibres of other plates that have been ſent off in the ſame way. Seeing the plates are thus conſtantly going off, the ſolid ſides of the bones muſt become thinner, and the lattice-work muſt be thicker and ſtronger, towards their ends. This is evident in many of them, where the ſolid ſides of their middle are very thick, and the *cancelli* are ſcarce obſervable: whereas at the ends, where their diameter is greateſt, the ſolid walls or ſides are not thicker than paper; and the *cancelli* are numerous, and large enough to fill up the whole ſpace left between the ſides.

The twiſting and windings which theſe *cancelli* make, and the interſtices which they leave, differ conſiderably in figure, number, and ſize; and therefore form little cells, which are as different, but communicate with each other. Some writers † minutely remark theſe different appearances of the *cancelli*, after they begin to ſeparate from the plates; and from thence diſtinguiſh them into *wrinkled*, *perforated*, and *net-like*.

The *cancelli* ſuſtain the membranous bags of the marrow which are

 ſtretched

* Malpigh. Oper. Poſthum.

† Gagliard. Anat. Oſſium, cap. 1. obſ. 4, 5, 6, 7.

ſtretched upon them; and thereby hinder theſe membranous parts from being torn, or removed out of their proper places, in the violent motions and different poſtures which the bones are employed in. This ſupport which the *cancelli* afford the marrow, alſo ſaves its membranes and veſſels, in the lower parts of the bones, from being compreſſed by the weight of the marrow above.

The depreſſions between the fibres of the external plates of bones appear like ſo many furrows on their ſurface, into each of which the *perioſteum* enters; by which the ſurface of contact, conſequently the coheſion, between it and the bone, is conſiderably increaſed, and a greater number of veſſels is ſent from it into the bone than if it was a plain ſurface.

Both on the ridges and furrows, numerous little pits, or orifices of canals, are to be ſeen, by which the veſſels paſs to and from the bones.

After a ſucceſsful injection, the arteries can be traced in their courſe from the pits to the plates and fibres; and in ſawing, cutting, or raſping the bones of living creatures, theſe veſſels diſcover themſelves by the ſmall drops of blood which then ooze out from the moſt ſolid part of the bones. But the cleareſt demonſtration of the intimate diſtribution of theſe ſmall arteries, is to obſerve the effect of ſuch a tinging ſubſtance as can retain its colour, when ſwallowed, digeſted, and mixed with the blood of any living animal, and at the ſame time has particles ſmall enough to be conveyed into the veſſels of the bones; ſuch is *rubia tinctorum*, madder-root *: for we ſee the gradual advances which this tincture makes from the *perioſteum* into the more internal parts of the bones, and how univerſally the diſtribution of the liquors is made, the whole bony ſubſtance being tinged.

The arteries are larger near each end than at the middle of the large bones that are much moved; becauſe they not only ſerve the bony plates near the ends, but paſs through them to the marrow.—As animals advance in age, the arteries of the bones become leſs capacious; as is evident, 1. From the bones of adults having leſs blood in them than thoſe of children have. 2. From many of them becoming incapable in old age of admitting the coloured powders uſed in injections, which eaſily paſs in

* Philoſoph. Tranſact. n° 442. art. 8.; n° 443. art. 2.; n° 457. art. 4. Mem. de l'Acad. des Sciences, 1739, 1742.

in youth. And, 3. From the bones of old creatures being more difficultly tinged with madder than thoſe of young ones.—If authors have not miſtaken, the arteries of bones have ſometimes become very large *.

We may conclude, from arteries being accompanied with veins ſo far as we can trace them in every other part of the body, that there are alſo veins in the bones; nay, the veins of bones can ſometimes be injected, and then ſeen †.

The bones of a living animal are ſo inſenſible, that they can be cut, raſped, or burnt, without putting the creature to pain; and the nerves diſtributed in their ſubſtance cannot be ſhewn by diſſection: from which it might be inferred, that they have no nerves diſtributed to them. But the general tenor of nature, which beſtows nerves to all the other parts, ſhould prevent our drawing ſuch a concluſion. And if ſenſibility is a ſure proof of nerves entering into the compoſition of any part, as it is generally allowed to be, we have ſufficient evidence of nerves here in the bones: for the granulated red fleſh which ſprouts out from them, after an amputation of a limb, or performing the operation of the *trepan*, or after an *exfoliation*, is exquiſitely ſenſible; and in ſome ulcers of bones, where the *perioſteum* was all ſeparated, the patient ſuffered racking pain if the bone was touched with a rough inſtrument, nor was he free of pain after the bone was perforated ‡.—The reaſon why the nerves of rigid hard bones become inſenſible, is, that all nerves muſt have a conſiderable degree of flexibility at the part where objects are applied, otherwiſe it cannot be affected by their impreſſions. We ſee this illuſtrated in a very common analogous caſe, the growth of a new nail. When the former one has ſuppurated off, the thin membrane which firſt appears is exquiſitely ſenſible; but gradually becomes dull in its ſenſation, till it can be cut or ſcraped without cauſing pain, after it is formed into a hard nail.

From what has been ſaid of the veſſels of bones, it is evident, that there is a conſtant circulation of fluids in every part of them; and that there is a perpetual waſte and renewal of the particles which compoſe the ſolid fibres of bones, as well as of other parts of the body; the addition from the fluids exceeding the waſte during the growth of the bones, the renewal

* Diemerbroek Anat. lib. 9. cap. 1. Mery Hiſt. de l'Acad. des Sciences, 1704.

† Sue trad. d'Oſteolog. p. 9. ‡ Nicol. Maſſa, lib. introd. anat. cap. 30.

newal and waſte keeping pretty near *par* in adult middle age, and the waſte exceeding the ſupply from the liquors in old age: as is demonſtrable from their weight; for each bone increaſes in weight as a perſon approaches to maturity, continues of nearly the ſame weight till old age begins, and then becomes lighter.—The ſpecific gravity of the ſolid ſides, on the contrary, increaſes by age; for then they become more hard, compact, and denſe. In conſequence of this, the bones of old people are thinner and firmer in their ſides, and have larger cavities, than thoſe of young perſons.

The vaſcular texture of bones muſt make them ſubject to *obſtructions*, *ecchymoſes*, *ulcers*, *gangrenes*, and moſt other diſeaſes which the ſofter parts are affected with; and therefore there may be a greater variety of *caries* than is commonly deſcribed *.

Hence we can account for the following appearances.

Hæmorrhages from fungous fleſh riſing out from the moſt ſolid part of a cut bone †.

The regular alternate elevation and ſubſiding, or apparent pulſation, frequently to be ſeen in ſome of the cells of a carious bone.

Cells reſembling *cancelli*, ſometimes ſeen in the part of a bone which, in a natural ſtate, is the moſt ſolid and firm ‡.

A bone as a tube, including another bone within it §.

On the internal ſurface of the ſolid parts of bones, there are orifices of canals, which paſs outwards through the plates to open into other canals that are in a longitudinal direction, from which other *tranſverſe* paſſages go out to terminate in other *longitudinal* canals; and this ſtructure is continued through the whole ſubſtance of bones, both theſe kinds of canals becoming ſmaller gradually as they approach the outer ſurface **. —Theſe canals are to be ſeen to the beſt advantage in a bone burnt till it is white: When it is broken tranſverſely, the orifices of the *longitudinal* canals are in view; and when we ſeparate the plates, the *tranſverſe* ones are to be obſerved. Here, however, we are in danger of believing both

* Edinburgh Medical Eſſays and Obſ. vol. v. art. 25. or N° 9. of the preſent Collection.

† Medical Eſſays, vol. iv. art. 21. or N° 19. of the preſent Collection.

‡ Ruyſch. Theſ. 8. n° 8. Theſ. 10. n° 176. § Idem, ibid.

** Havers Oſteolog. Nov. p. 43.

both theſe ſorts of canals more numerous than they really are; becauſe the holes made by the proceſſes connecting the plates of bones have the appearance of the *tranſverſe* *, and the paſſages for the blood-veſſels reſemble the *longitudinal* canals. I do not know how we are to keep free of error about the *tranſverſe* canals; but think we may diſtinguiſh between the two kinds of *longitudinal* ones: for the paſſages of the veſſels are largeſt near the external ſurface of the bone, and every tranſverſe ſection of them is circular; whereas the *longitudinal canals* are largeſt near the *cancelli*, and their tranſverſe ſections appear to me of a flat oval figure; which may be owing to the different *momentum* of the fluids conveyed in them.—The ſituation of the larger longitudinal canals, and of the paſſages of the larger veſſels, makes a bone appear more denſe and compact in the middle of its ſolid ſides, than towards its outer and inner ſurfaces, where it is ſpongy.

We ſee marrow contained in the larger tranſverſe and longitudinal canals juſt now deſcribed; and from thence judge that it paſſes alſo into the ſmaller ones. The drops of oil which we diſcover with a microſcope every where on the ſurface of a recent bone fractured tranſverſely, and the oozing of oil through the moſt ſolid bones of a ſkeleton, which renders them greaſy and yellow, are a confirmation of the uſe of theſe canals. Of what advantage this diſtribution of the marrow through the ſubſtance of bones is, will be mentioned when the nature and uſe of this animal-oil is inquired into.

Moſt bones have one or more large oblique canals formed through their ſides, for the paſſage of the medullary veſſels, which are to be deſcribed afterwards.

Bones expoſed to a ſtrong fire in chemical veſſels, are reſolved, in the ſame manner as the other parts of animals, into *phlegm*, *ſpirit*, *volatile ſalt*, *fetid oil*, and a black *caput mortuum*. But the proportion of theſe principles varies according to the age, ſolidities, and other circumſtances of bones. Young bones yield the largeſt proportion of *phlegm*; ſpongy bones afford moſt oil, and ſolid ones give moſt ſalt and black *reſiduum*. Though this *reſiduum* can ſcarce be changed by the force of fire while it is in cloſe veſſels; yet when it is burnt in an open fire, the tenacious oil, to

* Morgagn. Adverſ. 2. animad. 25.

to which it owes its black colour, is forced away, and a white earth is left, that has little or no fixed ſalt in it. This earth ſeems to be the proper conſtituent ſolid part of bones; and the other principles give it firmneſe and tenacity: For the quantity of the earth is ſo great, that, after all the other principles are ſeparated from a bone, its former ſhape and ſize remain *; but it is very brittle till it is moiſtened with water or oil, when it recovers ſome tenacity.—The increaſe of the proportion of earth in old peoples bones, is one reaſon of their being more brittle than thoſe of young people are.

Leſt any imagine the ſalts and oils of bones, while in a natural ſtate, to be of the ſame acrid kind with thoſe obtained from them by the chemical analyſis, it is to be obſerved, that theſe principles may be extracted from bones in the form of a very mild jelly, by boiling them in water.

The bones ſuſtain and defend the other parts of the body.

Bones are lined within, as well as covered externally, with a membrane; which is therefore commonly called PERIOSTEUM INTERNUM.

The *internal perioſteum* is an extremely fine membrane; nay, frequently it has a looſe reticular texture: and therefore it is compared by ſome to the *arachnoid* coat of the ſpinal marrow. So that we cannot expect to divide it into layers as we can divide the *external perioſteum*. We can, however, obſerve its proceſſes entering into the tranſverſe pores of the bones, where probably they are continued to form the immediate canals for the marrow diſtributed through the ſubſtance of the bones; and along with them veſſels are ſent, as from the external *perioſteum*, into the bone †. The proceſſes being of a very delicate texture, the adheſion of this membrane to the bone is ſo ſmall, that it ſeparates commonly more eaſily from the bone than from the marrow which it contains; wherefore one might call it the common membrane of the marrow, rather than by the name it now has: but whether the one or the other deſignation ought to be given it, is not worthy a diſpute.

From the internal ſurface of the internal *perioſteum*, a great number of thin membranes are produced; which, paſſing acroſs the cavity, unite with others of the ſame kind, and form ſo many diſtinct bags, which communicate

* Havers Oſteolog. Nov. diſc. 1. p. 32.

† Winſlow Expoſition Anat. des Os frais, § 82, 83.

communicate with each other; and theſe again are ſubdivided into communicating veſicular cells, in which the marrow is contained. Hence it is, that the marrow, when hardened and viewed with a microſcope, appears like a cluſter of ſmall pearl; and that the hardened marrow of bones buried long under ground, or laid ſome time in water, and then dried, is granulous (*a*). This texture is much the ſame with what obtains in the other cellular parts of the body, where fat is collected: only that the cells containing the marrow are ſmaller than thoſe of the *tunica adipoſa* or *celluloſa* elſewhere; which probably is owing to their being incloſed in the bones, where they are not ſo much ſtretched or extended as in other parts.

The MARROW is the oily part of the blood, ſeparated by ſmall arteries, and depoſited in theſe cells. Its colour and conſiſtence may therefore vary according to the ſtate of the veſſels, and their diſtribution on the membranes of the cells.

The marrow, as well as the other fat of the body, chemically analyzed, yields, beſides oil and water, a conſiderable proportion of an acid liquor, but no *alkali* (*b*). This may be the reaſon of its being leſs putreſcent than the blood, or moſt other parts of animals (*c*); which is a neceſſary quality in a ſubſtance that is conſtantly expoſed to a conſiderable degree of heat, and is more in a ſtagnating condition than the other liquors.

Beſides the arteries, which I mentioned already (p. 36.) to be ſent from the bones to the marrow, there is at leaſt one artery for each bone; ſeveral bones have more, whoſe principal uſe is to convey and ſecern this oily matter. After theſe arteries have pierced the ſolid ſide of a bone, they are divided into ſeveral branches; which ſoon are diſtributed every where on the internal *perioſteum*, and afterwards ſpread their branches inwards on the medullary cells, and outwards through the tables of the bone.

The blood, which remains after the ſecretion of the marrow, is returned by proper veins, which are collected from the membranes into one or

(*a*) Ruyſch Theſaur. 9. n° 2. et Adverſ. dec. III. obſ. 9.

(*b*) Grutzmaker Diſſert. de Oſſium Medulla. Haller Element. Phyſiolog. lib. 4. ſect. 4.

(*c*) Pringle Append. to Camp-diſeaſes, exper. 47.

two large trunks, to paſs out at the ſame holes or paſſages at which the artery or arteries enter.

The general rule of the ſmall veſſels decreaſing in their capacities as animals advance in age, to which many phænomena in the animal œconomy are owing, obtains here: for though the trunks of the medullary veſſels enlarge as animals turn older, yet the ſmall branches become ſmaller; as is evident from injections, which cannot be made to paſs near ſo far in theſe veſſels of adults as of children. Hence the marrow is bloody in children, oily and balmy in middle age, and thin and watery in old people.

By experiments made on the marrow, when bones of living animals are opened or cut through (*a*), and from the racking pain with which ſuppurations within bones are frequently attended, we have ſufficient proof that the membranes here are ſenſible, and conſequently have nerves diſtributed to them. Hippocrates (*b*) might therefore ſay juſtly, that a wound penetrating into the cavity of a bone may produce a *delirium*.

The veſſels of the marrow, wrapped up in one common coat from the *perioſteum*, paſs through the bones by proper canals; the moſt conſiderable of which are about the middle of each bone, and are very oblique. Sometimes theſe veſſels continue at a little diſtance in their paſſage, when the canal is divided by a ſmall bony partition or two.

From the ſtructure of the contents of the bones, we may judge how theſe parts, as well as others, may be ſubject to oedema, phlegmon, eryſipelas, ſcirrhus, &c.; and may thence be led to a cure of each, before the common conſequence, putrefaction, takes place, and frequently occaſions the loſs of the limb, if not of the patient.

The marrow is of very conſiderable uſe to the bones; for by entering their tranſverſe canals, and paſſing from them into the longitudinal ones, it is communicated to all the plates, to ſoften and connect their fibres: whereby they are preſerved from becoming too brittle; as we ſee they do in burnt bones, or thoſe long expoſed to the air; in people labouring under old age, pox, or ſcurvy. In all which caſes, the oil is either in too little quantity, or has its natural good qualities changed for worſe ones.

Beſides this advantage which the ſubſtance of bones has from the marrow,

(*a*) Du Verney, Memoires de l'Acad. des Sciences, 1700. (*b*) Aphoriſm. § 7. aph. 24.

row, their articulations are ſaid * to receive no leſs benefit from it: for it is thought that the marrow paſſes into the articular cavities through the holes which are in the bones near the large joints. And as a proof of this, it is alleged, that butchers, upon ſeeing the greater or leſſer quantity of marrow in the bones of cows, can tell whether they have travelled far or little before they were ſlaughtered.

When the marrow, after having ſerved the uſes mentioned, is reaſſumed into the maſs of blood, (as it is continually, in common with all other ſecreted liquors that have not paſſages formed for conveying them out of the body), it corrects the too great acrimony communicated to the ſaline particles of our fluids by their circulation and heat; in the ſame manner as lixivial ſalts are blunted by oil in making ſoap. Hence, in acute diſeaſes, the marrow, as well as the other fat of the body, is quickly waſted, but muſt be immediately ſupplied by liquors from the veſſels; ſeeing the cells within the bones, which have no aſſiſtance to their contraction from the preſſure of the atmoſphere, cannot collapſe, as the *tela cellularis* under the ſkin does when the liquor in its cells is abſorbed; the bones therefore are always full.

Since it is the nature of all oil to become thin and rancid when expoſed long to heat, and bones have much oil in their firm hard ſubſtance, we may know why an ungrateful ſmell, and dark-coloured thin *ichor*, proceed more from corrupted bones than from other parts of the body; and we can underſtand the reaſon of the changes of colour which bones undergo, according to their different degrees of mortification. Hence likewiſe we may learn the cauſe of a *ſpina ventoſa*, and of the difficulty of curing all *caries* of bones proceeding from an obſtruction and conſequent putrefaction of the marrow; and of the quick pulſe, thirſt, and *hectic paroxyſms*, ſo often attending theſe diſeaſes. Theſe *phænomena* alſo teach us the reaſon of the fatal *prognoſis* taken from black fetid urine in fevers.

Though bones ſo far agree in their ſtructure and annexed parts, yet we may obſerve a conſiderable difference among them in their magnitude, figure, ſituation, ſubſtance, connection, uſes, &c. From which

* Joan de Muralto Vade-mecum Anat. exercit. 5. § 3. Havers Oſteolog. Nov. diſc. 3. p. 179.

authors have taken occaſion to diſtinguiſh them into as many claſſes as they could enumerate of theſe different circumſtances. But theſe being obvious to every perſon that looks on bones, I ſhall only mention one of them, which comprehends very near the whole bones of the body, and at the ſame time leads us to examine the moſt conſiderable variety that is to be found in the diſpoſition of their conſtituent parts, and in their uſes. It is this, that ſome bones are *broad* and *flat*, while others are *long* and *round*.

The *broad* bones have thin ſides, by the plates being ſoon and equally ſent off to form the lattice-work; which therefore is thicker, and nearly of an equal form all through. By this ſtructure, they are well adapted to their uſes, of affording a large enough ſurface for the muſcles to riſe from, and move upon, and of defending ſufficiently the parts which they incloſe.

The *round* bones have thick ſtrong walls in the middle, and become very thin towards their ends: which is owing to very few plates ſeparating at their middle; where, on that account, the *cancelli* are ſo fine and ſmall, that they are not taken notice of. But ſuch bones are ſaid to have a large reſervoir of oil in this place. Towards their ends, the lattice-work becomes very thick, and rather more complete than in the other ſort of bones. Theſe round bones having ſtrong forces naturally applied to them, and being otherwiſe expoſed to violent injuries, have need of a cylindrical figure to reſiſt external preſſure, and of a conſiderable quantity of oil to preſerve them from becoming too brittle. Beſides which, they are advantageouſly provided with thick ſides towards their middle, where the greateſt forces are applied to injure them; while their hollowneſs increaſes their diameter, and conſequently their ſtrength to reſiſt forces applied to break them tranſverſely *. Thus, for inſtance, in eſtimating the proportional reſiſtance of two cylindrical bones of unequal diameters, but conſiſting of an equal number of ſimilar fibres uniformly diſpoſed round each, it is plain,

1. That the abſolute force of theſe two bones is equal, becauſe they conſiſt of equal numbers of ſimilar fibres.

2. That the abſolute forces of all the fibres in each bone have the ſame effect

* Galilei Mechanic. dialog. 2.

effect in reſiſting any power applied to break them, as if the ſum of all their forces was united in the reſpective centres of the tranſverſe ſections where the fractures are to be made: for, by hypotheſis, the fibres being uniformly diſpoſed in each, there is not any fibre in either bone that has not a correſponding fibre, the ſum of both whoſe diſtances from the axis of revolution (about which all the parts of the bone muſt revolve in breaking) is equal to two ſemidiameters of the bone: conſequently each fibre, and all the fibres, may be regarded as reſiſting at the diſtance of one ſemidiameter or *radius* from this axis, that is, in the centre.

3. Since the united force of all the fibres is to be regarded as reſiſting at a diſtance from the centre of motion equal to the ſemidiameter, it follows, that the total reſiſtance of all theſe fibres, or the ſtrength of the bone, is proportional to its ſemidiameter, and conſequently to its diameter.

I have here taken for an example one of the moſt ſimple caſes for calculating the proportional forces of bones: but, was it not too foreign to the preſent deſign; it might be univerſally demonſtrated, that of whatever figure bones are, and in whatever manner their fibres are diſpoſed, their ſtrength muſt always be in a *ratio*, compounded of the area of their tranſverſe ſections, or of their quantity of bony matter, and of the diſtance of the centre of gravity of theſe ſections from the centre of motion or fulcrum on which the bone is ſuppoſed to be broken *.

Since therefore the ſtrength of bones depends on their number of fibres, or quantity of matter, and the largeneſs of their diameters, one may conclude, that the part of a bone formerly fractured, and reunited by a *callus*, muſt be ſtronger than it was before the fracture happened; becauſe both theſe advantages are obtained by a *callus*: which is a wiſe proviſion, ſince bones are never ſet in ſuch a good direction as they were naturally of; and then, wherever a *callus* is formed, there is ſuch an obſtruction of the veſſels, that if the bone was again broken in the ſame place, the *oſſific* matter could not ſo eaſily be conveyed to reunite it. This *callus* may indeed, for want of compreſſion, be allowed to form into a ſpongy

* See the demonſtration of this theorem by Dr. Porterfield, in the Edinburgh Medical Eſſays, vol. i. art. 10.

ſpongy cellular ſubſtance (*a*); but, even in this caſe, the ſtrength of the bone is here increaſed by one or both the cauſes above-mentioned.

Many bones have protuberances, or *proceſſes* (*b*), riſing out from them. If a *proceſs* ſtands out in a roundiſh ball, it is called *caput*, or *head*.—If the head is flatted, it obtains the appellation of *condyle*.——A rough, unequal protuberance, is called *tuberoſity*.——When a *proceſs* riſes narrow, and then becomes large, the narrow or ſmall part is named *cervix*, or *neck*.——Long ridges of bones are called *ſpines*.——Such proceſſes as terminate in a ſharp point, have the general name of *coronæ* (*c*), or *coronoid*, beſtowed on them; though moſt of them receive particular names from the reſemblance they have, or are imagined to have, to other ſubſtances, *e. g. maſtoid*, *ſtyloid*, *anchoroid*, *coracoid*, *ſpinal*, &c.——Such proceſſes as form brims of cavities, are called *ſupercilia* (*d*).

Proceſſes ſerve for the advantageous origin and inſertion of muſcles, and render the articulations firm and ſtable.

Before leaving this ſubject, we muſt remark, that much the greater number of what are called proceſſes in adult bones, diſcover themſelves in children to be *epiphyſes*, or diſtinct bones, which are afterwards united to the other parts; ſuch are the *ſtyloid* proceſſes of the temporal bones, proceſſes of the *vertebræ*, *trochanters* of the thigh, &c. However, as I deſign to inſiſt chiefly on the deſcription of the adult ſkeleton, in which the union of theſe parts is ſo intimate that ſcarce any veſtige remains of their former ſeparation, I ſhall retain the common appellation of *apophyſe*, or proceſs, to all ſuch protuberances; but ſhall remark the principal ones that have no juſt title to this name, when they occur in the deſcription of particular bones.

On the ſurfaces of a great many of the bones, there are cavities or depreſſions. If theſe are deep, with large brims, authors name them *cotylæ* (*e*). If they are ſuperficial, they obtain the deſignation of *glenæ*, or *glenoid*.—Theſe general claſſes are again divided into ſeveral *ſpecies*. Of which, *pits* are ſmall roundiſh channels ſunk perpendicularly into the bone:

(*a*) Ruyſch Theſaur. 8. n. 49. Muſ. Anat. thec. B. repoſit. 2. n. 2.

(*b*) Ἀπορυσις, ἐκφυσις, ἐξοχη, προβολη, προβλημα, exceſſus, explanatio, tuberculum, gibbus, eminentia, productio, extuberantia, projectura, enaſcentia.

(*c*) Roſtra, glandes. (*d*) Τρυς, ὀφρυς, ἀμβονις, χειλη. Labra.

(*e*) Κοτυλιδες, ὀξυβαφοι, acetabula, pixides, buccellæ.

bone:—*Furrows* are long narrow canals, formed in the ſurface;—*nitches*, or *notches*, ſmall breaches in the bone;—*ſinuoſities*, broad, but ſuperficial, depreſſions without brims;—*foſſæ*, large deep cavities, which are not equally ſurrounded by high brims;—*ſinuſes*, large cavities within the ſubſtance of the bones, with ſmall apertures;—*foramina*, or holes, canals that pierce quite through the ſubſtance of the bones.——When this laſt ſort of cavity is extended any long way within a bone, the middle part retains the name of *canal*, and its ends are called *holes*.

The cavities allow the heads of bones to play in them; they lodge and defend other parts; they afford ſafe paſſage to veſſels, muſcles, &c. To mention more would engage us too much in the hiſtory of particular bones, which more properly belongs to the demonſtration of the *ſkeleton*, where we ſhall have occaſion to obſerve theſe ſeveral ſpecies of cavities.

To far the greater number of bones, whoſe ends are not joined to other bones by an immoveable articulation, there are ſmaller ones annexed, which afterwards become ſcarce diſtinguiſhable from the ſubſtance of the bone itſelf. Theſe are called *epiphyſes*, or *appendices* (*a*.) Some bones have one, others have two, three, or four of theſe *appendices* annexed by the means of cartilages, which are of a conſiderable thickneſs in children, but by age became thinner; the oſſification proceeding from the end of the bone on one ſide, and from the *epiphyſes* on the other, till at laſt, in adults, the place of their conjunction can ſcarcely be ſeen on the external ſurface, and it is only ſometimes that we can then ſee any mark of diſtinction in the *cancelli* (*b*).

Several proceſſes (*e. g. trochanters* of the thigh, *ſpine* of the *ſcapula*, &c.) have *epiphyſes*; and proceſſes frequently riſe out from *epiphyſes*; for example, at the lower end of the *femur*, *ulna*, *tibia*, &c. (*c*).

The *epiphyſes* are united chiefly to ſuch bones as are deſtined for frequent and violent motion; and for this purpoſe they are wiſely framed of a larger diameter than the bone they belong to: for by this means the ſurface of contact between the two bones of any articulation being increaſed, their conjunction becomes firmer, and the muſcles inſerted into them

(*a*) Applantatio, additamentum, adnaſcentia, adnexum, perone.

(*b*) Winſlow, Expoſition Anatomique de Corps Humain, traité des os ſecs, § 116.

(*c*) Veſal. de Human. Corp. Fabrica, lib. 1. cap. 3.

them act with greater force, by reaſon of their axes being further removed from the centre of motion. Theſe advantages might indeed have been obtained by the expanſion of the end of the bone itſelf to a thickneſs equal to that of the *epiphyſes*; but then the conſtant ſeparation of new plates to form ſo wide a cellular ſtructure, muſt have left the ſolid ſides of the bones ſo thin, as to yield eaſily, either to the action of the muſcles fixed to them and paſſing over them, to the weight ſeveral of them are obliged to ſupport, or to the application of any other external force.

Several anatomiſts (*a*) thought that the *epiphyſes* ſerve other purpoſes; ſuch as, ſecuring the ligaments of the articulations which riſe out from between the bones and them: for as ſoon as theſe parts are intimately joined, the ligaments inſinuated betwixt them muſt have a much ſtronger connection than they could have to the ſmooth ſurface of the bones. Such an interception of the ligament between the body of the bone and its *epiphyſe* is not to be ſeen: but as at this place the bone remains longer ſoft than any where elſe, and the adheſion of the *perioſteum* and of ligaments to bones is always ſtronger in proportion to the bones being neareſt to the conſiſtence of thoſe parts, which is, being ſofteſt; the opinion of theſe writers concerning the ſtronger connection of the ligaments where the bones and *epiphyſes* join, is not without ſome foundation.

Poſſibly, too, by the fibres of *epiphyſes* not extending themſelves ſo longitudinally as thoſe of the bones, there may be leſs chance of the former running into each other than of the latter.

The ſoftneſs of the ends of bones may be of ſome advantage in the womb, and at birth; after which the oſſification begins, at different points, to form *epiphyſes*, before the oſſification can extend from the middle to the ends of the bones (*b*).

However ſolid and compact adult bones are, yet they were once cartilages, membranes, nay, a mere jelly. This needs no further proof than repeated obſervations of *embryos* when diſſected: And how much more tender muſt the bones be before that time, when neither knife nor eye is capable

(*a*) Columb. de Re Anatomica, lib. 1. cap. 2.——Fallop. Expoſ. de Oſſibus, cap. 11.

(*b*) Haller de Studio Medic. p. 267.

capable to diſcover the leaſt rudiments of them? By degrees they become more ſolid, then aſſume the nature of griſtles, and at laſt oſſify; the coheſion of their plates and fibres always increaſing in proportion to their increaſed ſolidities; as is evident from the time neceſſary to unravel the texture of bones of people of different ages, or of denſe and of ſpongy bones, or of the different parts of the ſame bone, and from the more tedious exfoliations of the bones of adults than of children.

After any part of a bone is fully oſſified, its fibres are extended little more in length at that part, though they increaſe there in thickneſs, and though their ſofter parts continue to become longer (*a*).

As the ſolidity of bones increaſes, their *perioſteum* more eaſily ſeparates from them. When bones are membranous, the *perioſteum* and they cannot be diſtinguiſhed; they appear to be the ſame ſubſtance. When they are cartilages, their membrane adheres ſo firmly to them, that it is difficult to ſeparate it from them. Where the rigid bony fibres are, the *perioſteum* is eaſily taken off.—Is the ſimilarity of ſtructure and conſequent greater attraction of the membrane and ſubſtance it incloſes, while they are both flexible, the cauſe of their greater adheſion? or is it owing to the veſſels that go from the one to the other being then larger? or do both theſe cauſes combine to produce this effect? Or is the membrane or cartilage, which becomes bone afterwards, to be conſidered as the ſame ſubſtance with the *perioſteum* (*b*)? and muſt all theſe plates of bones be therefore ſaid to be layers of the *perioſteum* hardened (*c*)?

The oſſification of bones depends principally on their veſſels being ſo diſpoſed, and of ſuch diameters, as to ſeparate a liquor, which may eaſily turn into a bony ſubſtance when it is deprived of its thinner parts; as ſeems plain from the obſervation of the callous matter ſeparated after fractures and ulcers, where part of the bone is taken out: For, in theſe caſes, the veſſels extending themſelves, and the liquors added to them, are gradually formed into granulated fleſh; which fills up all the ſpace where the bone is taken from, then hardens, till it becomes as firm as any other part of the bone. This happens frequently, even when

(*a*) Hales's Vegetable Statics, p. 293.—Du Hamel, Memoires de l'Acad. des Sciences, 1742.
(*b*) Memoires de l'Acad. des Sciences, 1744.
(*c*) Memoires de l'Acad. des Sciences, 1743.

the ends of the diſeaſed bone are at a conſiderable diſtance from each other (*a*).

The induration of bones is alſo greatly aſſiſted by their being expoſed, more than any other parts, to the ſtrong preſſure of the great weights they ſupport, to the violent contraction of the muſcles fixed to them, and to the force of the parts they contain, which endeavour to make way for their own further growth. By all this preſſing force, the ſolid fibres and veſſels of bones are thruſt cloſer, and ſuch particles of the fluids conveyed in theſe veſſels as are fit to be united to the fibres are ſooner and more firmly incorporated with them, while the remaining fluids are forcibly driven out by the veins, to be mixed with the maſs of blood. In conſequence of this, the veſſels gradually diminiſh as the bones harden. From which, again, we can underſtand one reaſon why the bones of young animals ſooner reunite after a fracture than thoſe of old, and why cattle that are put too ſoon to hard labour ſeldom are of ſuch large ſize as others of the ſame brood who are longer kept from labour.

That the oſſifying of bones greatly depends on preſſure, ſeems to be evinced from the frequent examples we meet with of other parts turning bony, when long expoſed to the preſſing force of the ſurrounding parts, or when they are ſubjected to the like circumſtances by their own frequent and violent contraction. Witneſs the bones found frequently near the baſe of the heart in ſome old men (*b*), and in ſeveral other creatures. Nay, the muſcular ſubſtance of the heart has been oſſified in ſuch (*c*), and the arteries of old men often become bony.——The cartilages of the *larynx* are generally oſſified in adults.—In beaſts of burden, the cartilages between the *vertebræ* of the back very often change into complete bones; and, being intimately united with the *vertebræ*, the whole appears one continued bone:—Nor is the *perioſteum* exempted from ſuch an induration (*d*.)

To

(*a*) Hildan. de Vuln. Graviſſ.——Med. Eſſays, vol. i. art. 23.——Job a Meckren, obſ. 69.—Mem. de l'Acad. des Sciences, 1742.——See a collection of ſuch caſes in Boehmer *de Oſſium Callo.*

(*b*) Riolan. Comment. de Oſſibus, cap. 32.——Bartholin. Hiſt. Medic. cent. 1. hiſt. 50.—Ibid. cent. 2. hiſt. 45.

(*c*) Cheſelden's Anatomy, book 1. introd.—Garengeot, Hiſt. de l'Acad. des Sciences, 1726.

(*d*) Peyer. Ephemerid. German. decur. 2. ann. 7. obſerv. 205.

To confirm this argument ſtill farther, we may obſerve, that bones begin their oſſification at the places where they are moſt expoſed to theſe cauſes; *viz.* in the cylindrical bones from a middle ring, and in the broad ones, at or near their centre, from one or more diſtinct points. The reaſon of which is, that theſe parts are contiguous to the bellies of the muſcles annexed to the bones, where the ſwelling of theſe moving powers is greateſt. What the effects of this may be, let any judge, who view ſome of the bones, as the *ſcapula* and *oſſa ilium*, which are covered with muſcles on each ſide; how compact and thin they are in adults, where the bellies of the muſcles were lodged; whereas in children they are thicker. But this being the middle part of theſe bones, where the greateſt number of fibres is, this particular place would have been much thicker in adults, had not this forcible cauſe been applied, which has not had ſuch effects in children whoſe muſcles have not been much exerciſed. —Beſides, if we allow that all the parts of a bone are equally increaſed by the conſtant ſupply of new particles, each fibre, and every particle of a fibre, endeavours to make way for its own growth, by puſhing the one next to it; and conſequently by far the greateſt preſſure is on the middle, to make the particles firm, and therefore to begin their oſſification there. Laſtly, the pulſation of the medullary arteries, which enter the bones near to this middle part, may, as authors have alleged, contribute perhaps ſomewhat to this induration.

From the effects of preſſure only it is that we can account for the bones of old people having their ſides much thinner, yet more denſe and ſolid, while the cavities are much larger than in thoſe of young people; and for the prints of muſcles, veſſels, &c. being ſo much more ſtrongly marked on the ſurfaces of the former than of the latter, if they belong to people of near the ſame condition in life.—Preſſure muſt likewiſe be the cauſe which, in people of equal ages, makes theſe prints ſtronger in the bones of thoſe who had much labour and exerciſe, than they are in people who have led an indolent inactive life.

Perhaps both the cauſes of oſſification above-mentioned may be aſſiſted by the nature of the climate people live in, and the food they uſe. Whence, in hot countries, the inhabitants ſooner come to their height of ſtature than in the northerly cold regions: And thence ſeems to have

ariſen the common practice among the ladies, of making puppies drink brandy or ſpirit of wine, and of bathing them in theſe liquors, to prevent their growing big. Nay, it has been obſerved, that much uſe of ſuch ſpirits has occaſioned parts, naturally ſoft, to petrify in ſome, and to oſſify in other people of no great age (*a*).

From the foregoing account of the ſtructure of bones, and of their oſſification, we may underſtand the reaſons of the following phenomena.

How the natural colour of bones may be changed by ſome ſorts of food (*b*).

Why the bones of ſome people are ſo long in hardening, and in others never completely indurate.

Why, in ſuch whoſe oſſification is ſlow, the bones are generally thicker in proportion to their lengths, eſpecially at their ends; as in the *rickets*.

How hard firm bones have become ſoft and pliable by diſeaſes (*c*).

Why, in ſome diſeaſes, *epiphyſes* ſeparate from bones (*d*), and the ends of fractured bones come aſunder many years after their fractures appeared to be cured (*e*).

How bones may waſte and diminiſh (*f*).

How bones may become ſolid all through, without any appearance of *cancelli* (*g*).

How *nodes*, *tophi*, and *exoſtoſes*, happen after the eroſion of the external plates of bones in the *lues venerea*, *ſcurvy*, *rheumatiſm*, and *gout*.

How

(*a*) Littre, Hiſtoire de l'Acad. des Sciences, 1706.—Geoffroy, Memoires de l'Acad. ces Sciencies, 1706.

(*b*) Philoſoph. Tranſact. n° 442. art. 8. no 443. art. 2. n° 457. art. 4.;—Mem. de l'Acad. des Sciences, 1739, 1742.

(*c*) Hiſtoire de l'Acad. des Sciences, 1700.—Mem. 1722.—Gagliardi, Anatom. Oſſium, cap. 2. obſerv. 3.—Ephem. Germ. decur. 1. ann. 1. obſ. 37. et ſchol. decur. 2. ann. 7. obſ. 212, 235. decur. 3. ann. 2. obſ. 3.—Philoſoph. Tranſ. no 470. § 3.; Ibid. vol. xlviii. § 4. and 44.

(*d*) Memoires de l'Acad. des Sciences, 1699.—Diemerbroek, Anat. lib. 9. cap. 19.—Cowper's Anat. Explic. tab. 96. fig. 1.

(*e*) Anſon's Voyage.

(*f*) Cheſelden's Anat. book 1. introd.—Hiſt. de l'Acad. des Sciences, 1700.

(*g*) Ruyſch. Theſaur. 2. arc. 5. theſ. 3. loc. 1. n° 5. theſ. 9. n° 2. not. 3.—Boehmer de Callo Oſſium.

How bones exfoliate by the riſing of granulated fleſh from their ſurface.

How, and from what, *callus* is formed after a fracture (*a*).

Why *callus* appears to be rather the continued ſubſtance of the *perioſteum* than of the bone, while it remains ſoft and flexible; but ſeems continued with the bone after it oſſifies (*b*).

Why *callus* is ſenſible while it is ſoft, but becomes inſenſible when it hardens.

What occaſions ſometimes ſuch difficulty in curing fractured bones; or why they never reunite, though they are reduced, and all proper means towards a cure are uſed (*c*). Are the bones of women with child more tedious in reuniting than thoſe of other people (*d*).

Why *calluſes*, after fractures, are ſometimes very thick and protuberant.

What difference there ought to be in the application of bandages to fractures of the bones of old and of young patients.

How bones, remaining long unreduced after a luxation, may have their form ſo changed, as to make their reduction very difficult, if not impoſſible (*e*).

Whoever is deſirous to know, in what time and order each bone and its ſeveral parts begin to aſſume a bony nature, let him conſult *Kerckringius* (*f*), who gives us the delineations of abortions from three days after conception, and traces the oſſification of the bones from three weeks and a month till the time of the birth. To whom ſhould be added *Coiterus* (*g*), and *Eyſſonius* (*h*). An account of this ſubject might alſo be collected out of Ruyſch's works, where ſome of the miſtakes committed by the former authors

(*a*) Memoires de l'Acad. des Sciences, 1741.—Dehtleef de Oſſium Callo.

(*b*) Mem. de l'Acad. 1741.

(*c*) Meckren Obſerv. Medico-chirurg. obſ. 71.—Ruyſch. Adverſ. dec. 2. § 2.; Obſer. Anat.-chir. obſ. 4.—Van Swieten in Boerhaave Aphor. § 354.

(*d*) Hildan. centur. 5. obſ. 87. et cent. 6. obſ. 68.—Philoſoph. Tranſact. nº 494. § 21.

(*e*) Saltzman, Obſ. Decur. obſ. 6.—Memoires de l'Acad. de Chirurgie, tom. ii. p. 155. Boehmer Inſtit. Oſteolog. § 596.

(*f*) Anthropograph. Ichnograph. et Oſteogenea Fœtuum

(*g*) De Oſſibus Fœtûs Abortivi.

(*h*) De Oſſibus Infant. cognoſcend. et curand.

authors are corrected; and ſeveral more particulars, to make the hiſtory of the *oſteogenea* more accurate, have ſince been added by *Neſbitt* (*a*) and *Albinus* (*b*).

I muſt refer to the authors now quoted for the more curious part of the human oſteogeny; not having preparations enough to give ſuch a full hiſtory of it as is done by them. But I ſhall endeavour to explain the more uſeful and neceſſary parts of the oſteogeny, by ſubjoining to the deſcription of each bone of an adult, its condition in ripe children, that is, in ſuch as are born at the ordinary time; and ſhall point out what parts of each are afterwards joined in form of *epiphyſes*. This, with the following general rules, ſeem to me ſufficient for underſtanding what of this ſubject is neceſſary in the practice of phyſic and ſurgery.

1. Wherever I mention any parts being cartilaginous, or their being ſtill ſeparable from the other parts of the bone to which they belong, I would be underſtood to hint, that, about ſeven or eight years of age, ſuch parts are oſſified and united to their proper bones, unleſs when it is ſaid that they are afterwards formed into *epiphyſes*.

2. Such as become *epiphyſes*, are generally oſſified at ſeven or eight years of age; but being for the moſt part moiſtened by *ſynovia*, their external ſurface is ſtill ſomewhat cartilaginous, and they are not yet united to their bones.

3. At eighteen or twenty years of age, the *epiphyſes* are entirely oſſified, and have blended their fibres ſo with the body of the bone, as to make them inſeparable without violence.

The knowledge of this part of the oſteogeny I think neceſſary, to prevent dangerous miſtakes in the cure of ſeveral diſeaſes. As, for example, without this knowledge, the ſeparation of an *epiphyſe* might be miſtaken for a fracture or luxation; the interſtice of two parts of a bone not yet joined, might be judged to be a fiſſure; a *diaſtaſis*, or ſeparation of ſuch diſjoined pieces of a bone, might be thought a fracture; the protruſion of one piece, or its overlopping any other, could be miſtaken for an excreſcence or *exoſtoſis*. Such errors about the nature of a diſeaſe would give one very different indications of cure, from what he would have if

(*a*) Human Oſteogeny explained.

(*b*) Icones Oſſium Fœtûs Humani; accedit, Oſteogeneæ brevis hiſtoria.

if he really underſtood his patient's caſe. And very often the knowledge of the different inequalities on the ſurfaces of bones, muſt direct us in the execution of what is proper to be done to cure ſeveral of their diſeaſes.

Having thus conſidered the bones when ſingle, we ought next to ſhow the different manner of their conjunctions (*a*). To expreſs theſe, anatomiſts have contrived a great number of technical terms; about the meaning, propriety, and claſſing of which, there has unluckily been variety of opinions. Some of theſe terms it is neceſſary to retain, ſince they ſerve to expreſs the various circumſtances of the articulations, and to underſtand the writers on this ſubject.

The ARTICULATIONS are moſt commonly divided into three claſſes, viz. *ſymphyſis*, *ſynarthroſis*, and *diarthroſis*.

Symphyſis, which properly ſignifies the concretion or growing together of parts, when uſed to expreſs the articulations of bones, does not ſeem to comprehend, under the meaning generally given to it, any thing relating to the form or motion of the conjoined bones; but by it moſt authors only denote the bones to be connected by ſome other ſubſtance: and as there are different ſubſtances which ſerve this purpoſe, therefore they divide it into the three following ſpecies.

1. *Synchondroſis* (*b*), when a cartilage is the connecting ſubſtance. Thus the ribs are joined to the *ſternum*; thus the bodies of the *vertebræ* are connected to each other, as are likewiſe the *oſſa pubis*.

2. *Synneuroſis*, or *ſyndeſmoſis*, when ligaments are the connecting bodies, as they are in all the moveable articulations.

3. *Syſſarcoſis*, when muſcles are ſtretched from one bone to another, as they muſt be where there are moveable joints.

The *ſecond* claſs of articulations, the *ſynarthroſis*, which is ſaid to be the general term by which the immoveable conjunction of bones is expreſſed, is divided into three kinds.

1. The *future* (*c*) is that articulation where two bones are mutually indented

(*a*) Συνταξις, συνδεσις, συμβολη, ομιλια, compoſitio, connexio, articulatio, conjunctio, nodus, commiſſura, ſtructura, compages.

(*b*) Amphiarthroſis.

(*c*) Ραφη.

dented into each other, or as if they were ſewed together; and is formed by the fibres of two bones meeting while they are yet flexible and yielding, and have not come to their full extent of growth: ſo that they mutually force into the interſtices of each other, till, meeting with ſuch reſiſtance as they are not able to overcome, they are ſtopped from ſprouting out farther, or are reflected; and therefore theſe indentations are very different both in figure and magnitude. Thus the bones of the head are joined; thus *epiphyſes* are joined to the bones, before their full connection and union with them.

Under this title of *future*, the *harmonia* of the ancients may be comprehended; ſcarce any unmoved bones being joined by plain ſurfaces (*a*.)

2. *Gomphoſis* (*b*) is the fixing one bone into another, as a nail is fixed in a board. Thus the teeth are ſecured in their ſockets.

3. *Schindyleſis*, or *ploughing* (*c*), when a thin *lamella* of one bone is received into a long narrow furrow of another. Thus the *proceſſus azygos* of the *ſphenoid*, and the naſal proceſs of the *ethmoid* bone, are received by the *vomer*.

The *third* claſs, or *diarthroſis* (*d*), is the articulation where the bones are ſo looſely connected as to allow large motion. This is ſubdivided into three kinds.

The firſt is *enarthroſis*, or the ball and ſocket, when a large head is received into a deep cavity; as the head of the *os femoris* is into the *acetabulum coxendicis*.

The ſecond is *arthrodia*, when a round head is received into a ſuperficial cavity; as in the articulation of the arm-bone and *ſcapula*. Theſe two ſpecies of *diarthroſis* allow motion to all ſides.

The third is *ginglimus* (*e*), which properly ſignifies the hinge of a door or window: in it the parts of the bones mutually receive and are received, and allow of motion two ways. Workmen call it *charnal*.

The *ginglimus* is generally divided into three kinds; to which ſome (*f*) give the names of *contiguous* (*g*), *diſtant* (*h*), and *compound* (*i*.)

The

(*a*) Veſal. Obſer. Fallop. Examen. (*b*) Conclavatio. (*c*) Keil, Anat. cap. 5. § 3.
(*d*) Ἀναρθρωσις, dearticulatio, abarticulatio. (*e*) Articulatio Mutua.
(*f*) Baker, Curſ. Oſteolog. demonſtr. 1. (*g*) Proximus. (*h*) Longus.
(*i*) Compoſitus.

The firſt kind of *ginglimus* is, when a bone has ſeveral protuberances and cavities, which anſwer to as many cavities and proceſſes of the other bone with which it is articulated; as in the conjunction of the *femur* with the *tibia*.

The ſecond ſpecies is, when a bone receives another at one end, and is received by the ſame bone at the other end; as in the *radius* and *ulna*.

The laſt ſort is, when a bone receives another, and is received by a third; as in the oblique proceſſes of the *vertebræ*.

When I firſt mentioned the articulations of bones, I ſaid there were different opinions concerning the uſe of their technical names: *e. g.* It has been ſaid, That *ſymphyſis* ſhould be the name for the immoveable articulations, and *ſynarthroſis* ſhould be underſtood to be the conjunction of bones by ſome connecting *medium*. Thoſe who have taken *ſymphyſis* in the ſenſe I did, of its expreſſing the conjunction of bones with a connecting ſubſtance, have diſagreed in their definition of it; ſome inſerting, and others leaving out, its allowing motion. Where they have agreed in their definition, they have not been of the ſame mind concerning the ſpecies of it: for ſeveral think the *ſyſarcoſis* and *ſyndeſmoſis* applicable to ſo many joints, which are univerſally allowed to be claſſed under the *diarthroſis*, that it muſt create confuſion to name them by any ſpecies of the *ſymphyſis*. Few keep to ſuch a general definition of the *ſynchondroſis* as I have done; and, whether they determine it to allow no motion, or an obſcure or a manifeſt one, bring themſelves into difficulties, becauſe there are examples of all theſe three kinds. Some again, by too nicely diſtinguiſhing obſcure and manifeſt motions of bones, have blended the *ſynarthroſis* and *diarthroſis*, and from thence have branched out the different compound ſpecies of articulations that may be formed of them, ſo far, that they could find no examples in the body to illuſtrate them by. It would be tedious to enumerate more of the jarring opinions; and it would be far more ſo to give a detail of the arguments uſed by the diſputants. It is ſufficient for my purpoſe, that it is underſtood in what ſenſe I take theſe technical terms; which I do in the following manner.

When I mention the *ſymphyſis* or *ſynarthroſis*, or any ſpecies of them, I ſhall always underſtand them according to the explication already given of them. But though the preceding account of the *diarthroſis*, or articu-

lation of moveable bones, has been almoſt univerſally received; yet ſeeing it does not comprehend all the moveable articulations of the body, and one of its ſpecies does not anſwer to any notion we can have of the conjunction of two bones, I muſt beg leave to change the definitions and kinds of theſe joints.

I would call *diarthroſis* that conjunction of bones, whereby they are fitted for motion, being each covered with a ſmooth cartilage, connected by one or more common ligaments, and lubricated with liquor at the conjoined parts. In which definition, I have no regard to the quantity of motion which they really do perform; the motion being often confined or enlarged by ſome other cauſe not immediately depending on the frame of the two furfaces of the bones forming the particular joint which then is conſidered.

The firſt ſpecies of the *diarthroſis*, viz. the *enarthroſis*, or ball and ſocket, I would define, more generally than above, That articulation where a round head of one bone is received into a cavity of another; and conſequently, without ſome foreign impediment, is capable of motion to all ſides. Examples of this kind are to be ſeen in the articulation of the thigh-bone and *oſſa innominata*; arm-bone and *ſcapula*; *aſtragalus* and *os naviculare*; *magnum* of the wriſt, with the *ſcaphoides* and *lunare*; firſt bone of the thumb with the ſecond, &c.

The ſecond ſort, or the *arthrodia*, differing from the *enarthroſis*, in the preceding account, only in the cavity's being more ſuperficial, which makes no eſſential difference, eſpecially that, in the recent ſubject, cartilages or ligaments ſupply the deficiency of bone, ought, in my opinion, to be called with *Veſalius* (*a*), That articulation of two bones adapted for motion, where it is not at firſt ſight obvious which of the two has the head or cavity, or where they are joined by plain ſurfaces, or nearly ſo; ſuch is the conjunction of the *clavicle* with the *ſcapula*; *oſſa cuneiformia* with the *os naviculare*; *metatarſal* bones with the *oſſa cuneiformia*, &c. From the nature of this ſort of joint, it is plain, that very great motion cannot be allowed, without the bones going farther out of their natural ſituation than is convenient or ſafe.

Ginglimus, I would reckon that articulation by the form of which the motion

(*a*) De Corp. Human. Fabrica, lib. 1. cap. 4.

motion of the joined bones muſt be chiefly confined to two directions, which hinges of doors are.

The firſt ſpecies of this is the *trochoides*, when one bone turns on another, as a wheel does on its axis. Thus the firſt *vertebra* of the neck moves on the tooth-like proceſs of the ſecond. This is the moſt proper kind of *ginglimus*.

The ſecond ſpecies ſhould be eſteemed that articulation where ſeveral prominent and hollow ſurfaces of two bones move on each other within the ſame common ligament; as in the knee, elbow, &c.

The third ſort of *ginglimus* is, when two bones are articulated to each other at different parts, with a diſtinct *apparatus* of the motory machines at each: ſuch is the articulation of the *os occipitis* with the firſt *vertebra* of the neck; of any two contiguous *vertebræ*, by their oblique proceſſes; of the ribs with the bodies and tranſverſe proceſſes of the *vertebræ*; of the *radius* with the *ulna*, *tibia* with the *fibula*, *aſtragalus* with the *calcaneum*, &c.

I would entirely throw out what is commonly called the third kind of *ginglimus*: For in examining the conjunction of a bone with two others, as in the common example of a *vertebra* joined with the one above and below, the connection of the middle one with each of the other two ought to be conſidered ſeparately; otherwiſe we might with the ſame propriety eſteem the articulations that the long bones, the *femur*, *tibia*, *humerus*, &c. have at their different ends, as one articulation; which is abſurd.

If the moveable bones are not connected and kept firm by ſome ſtrong ſubſtance, they would be luxated at every motion of the joints; and if their hard rough unequal ſurfaces were to play on each other, their motion would not only be difficult, but the loſs of ſubſtance from attrition would be great. Therefore *ligaments* are made to obviate the *firſt*, and *cartilages* to prevent the other inconveniency. But becauſe ligaments and cartilages turn rigid, inflexible, and rough, unleſs they are kept moiſt, a ſufficient quantity of proper liquors is ſupplied for their lubrication, and to preſerve them in a flexible ſtate. Seeing then theſe parts are ſo neceſſary to the articulations, I ſhall next conſider their ſtructure,

ſituation, and uſes, ſo far as they are ſubſervient to the bones and their motions.

Ligaments (*a*) are white flexible bodies, thicker and firmer than membranes, and not ſo hard or firm as cartilages, without any remarkable cavity in their ſubſtance, difficultly ſtretched, and with little elaſticity; ſerving to connect one part to another, or to prevent the parts to which they are fixed from being removed out of that ſituation which is uſeful and ſafe.

After maceration in water, the ligaments can eaſily be divided; and each ligamentous layer appears compoſed of fibres, the largeſt of which are diſpoſed in a longitudinal direction.

The *arteries* of ligaments are very conſpicuous after a tolerable injection; and the larger trunks of their veins are ſometimes to be ſeen full of blood.

Such ligaments as form the ſides of cavities, have numerous orifices of their arteries opening upon their internal ſurface, which keep it always moiſt. If we rub off that moiſture, and then preſs the ligament, we can ſee the liquor oozing out from ſmall pores; and we can force thin liquors injected by the arteries into the cavities formed by ligaments.

Theſe exhalent arteries muſt have correſponding abſorbent *veins*, otherwiſe the cavities would ſoon be too full of liquor.

Ligaments, then, muſt be ſubject to the diſeaſes common to other parts where there is a circulation of fluids; allowance always being made for the ſize of veſſels, nature of the fluids, and firmneſs of the texture of each part.

Authors generally ſay, that ligaments are inſenſible; and conſequently it may be inferred, that they have no nerves beſtowed on them. But the violent racking pain felt on the leaſt motion of a joint labouring under a *rheumatiſm*, the ſeat of which diſeaſe ſeems often to be in the ligaments, and the inſufferable torture occaſioned by inciſions of ligaments, and by a collection of acrid matter in a joint, or by *tophi* in the gout, would perſuade us, that they are abundantly ſupplied with nerves.

The ligaments which connect the moveable bones commonly riſe from the conjunction of the *epiphyſes* of the one bone, and are inſerted into the ſame

(*a*) Συνδεσμοι, νευρα, copulæ, vincula.

ſame place of the other; or where *epiphyſes* are not, they come out from the *cervix*, and beyond the *ſupercilia* of the articulated bones; and after ſuch a manner, in both caſes, as to include the articulation in a purſe or bag: with this difference, depending on their different motions, that where the motion is only to be in two directions, the ligaments are ſtrongeſt on thoſe ſides towards which the bones are not moved; and when a great variety of motions is deſigned to be allowed, the ligaments are weaker than in the former ſort of articulations, and are nearly of the ſame ſtrength all round.

Part of the capſular ligaments is compoſed of the *perioſteum*, continued from one bone to another, as was obſerved p. 32.; and their internal layer is continued on the parts of the bone or cartilage which the ligament includes (*a*).

Beſides theſe common caſpular ligaments of the joints, there are particular ones in ſeveral places, either for the firmer connection of the articulated bones, or for reſtraining and confining the motion to ſome one ſide; ſuch are the *croſs* and *lateral* ligaments of the knee, the *round* one of the thigh, &c.

From this account of the ligaments, we may conclude, that, *cæteris paribus*, in whatever articulation the ligaments are few, long, and weak, the motion is more free and quick; but luxations happen frequently: and, on the contrary, where the ligaments are numerous, ſhort, and ſtrong, the motion is more confined; but ſuch a joint is leſs expoſed to luxations (*b*). Whence we may judge how neceſſary it is to attend to the different ligaments, and the changes which have been made on them by a luxation, when it is to be reduced.

Ligaments alſo ſupply the place of bones in ſeveral caſes to advantage. Thus the parts in the *pelvis* are more ſafely ſupported below by ligaments, than they could have been by bone. The ligaments placed in the great holes of the *oſſa innominata*, and between the bones of the fore-arm and leg, afford convenient origin to muſcles. Immoveable bones are firmly connected by them; of which the conjunction of the *os ſacrum* and *innominatum* is an example. They afford a ſocket for moveable bones to

(*a*) Neſbit, Oſteogen.—Phil. Tranſact, n° 470. § 6.

(*b*) Fabric. ab Aquapend. de Articul. Part. Utilit. pars 3.

to play in, as we ſee part of the *aſtragalus* does on the ligament ſtretched from the heel-bone to the *ſcaphoid*.

Numerous inconveniencies may ariſe from too long or ſhort, ſtrong or weak, lax or rigid, ligaments.

CARTILAGES (*a*) are ſolid, ſmooth, white, elaſtic ſubſtances, between the hardneſs of bones and ligaments; and covered with a membrane, named *perichondrium*, which is of the ſame ſtructure and uſe to them as the *perioſteum* is to the bones.

Cartilages are compoſed of plates, which are formed of fibres diſpoſed much in the ſame way as thoſe of bones are; as might be reaſonably concluded from obſerving bones in a cartilaginous ſtate before they oſſify, and from ſeeing, on the other hand, ſo many cartilages become bony. This may be ſtill further confirmed by the *exfoliation* which cartilages are ſubject to as well as bones.

The *perichondrium* of ſeveral cartilages, for example, thoſe of the ribs and *larynx*, has arteries which can be equally well injected with thoſe of the *perioſteum:* but the veſſels of that membrane in other parts, *e. g.* the articular cartilages, are ſmaller; and in none of them does injection enter deep into the ſubſtance of the cartilages; nay, madder mixed with the food of animals, does not change the colour of cartilages as it does that of bones (*b*).

The granulated fleſh which riſes from the ends of metacarpal or metatarſal bones, when the cartilage exfoliates, after a finger or toe has been taken off at the firſt joint, is very ſenſible; from which the exiſtence of nerves in cartilages may be inferred.

While cartilages are in a natural ſtate, it is to be remarked, *firſt*, That they have no cavity in their middle for marrow: *ſecondly*, That their outer ſurface is ſofteſt, which renders them more flexible: *thirdly*, That they do not appear to change their texture near ſo much by acids as bones do: and, *laſtly*, That as the ſpecific gravity of cartilages is near a third leſs than that of bones, ſo the coheſion of their ſeveral plates is not ſo ſtrong as in bones; whence cartilages laid bare in wounds or ulcers, are not only more liable to corrupt, but exfoliate much ſooner than bones do.

Cartilages

(*a*) Χονδρος. (*b*) Philoſ. Tranſact. nº 442. art. 8. nº 443. art. 2. nº 457. art. 4. —Mem. de l'Acad. des Sciences 1739 et 1742.—Dehtleef de Oſſium callo.

Cartilages ſeem to be principally kept from oſſifying, either by being ſubjected to alternate motions of flexion and extenſion, the effects of which are very different from any kind of ſimple preſſure; or by being conſtantly moiſtened (*a*). Thus the cartilages on the articulated ends of the great bones of the limbs, and the moveable ones placed between the moving bones in ſome articulations, which are obliged to ſuffer many and different flexions, and are plentifully moiſtened, ſcarce ever change into bone; while thoſe of the ribs and *larynx* are often oſſified.—The middle angular part of the cartilages of the ribs, which is conſtantly in an alternate ſtate of flexion and extenſion by being moved in reſpiration, is always the laſt of becoming bony.——In the *larynx*, the *epiglottis*, which is oftener bended and more moiſtened than the other four cartilages, ſeldom is oſſified, while the others as ſeldom eſcape it in adults.

The cartilages ſubſervient to bones are ſometimes found on the ends of bones which are joined to no other; but are never wanting on the ends and in the cavities of ſuch bones as are deſigned for motion (*b*). Cartilages alſo are interpoſed between ſuch other cartilages as cover the heads and cavities of articulated bones; nay, they are alſo placed between immoveable bones.

The uſes of cartilages, ſo far as they regard bones, are, To allow, by their ſmoothneſs, ſuch bones as are deſigned for motion to ſlide eaſily without detrition; while, by their flexibility, they accommodate themſelves to the ſeveral figures neceſſary in different motions; and, by their elaſticity, they recover their natural poſition and ſhape as ſoon as the preſſure is removed.——This ſpringy force may alſo aſſiſt the motion of the joint to be more expeditious; and may render ſhocks in running, jumping, &c. leſs.——To theſe cartilages we chiefly owe the ſecurity of the moveable articulations: for without them the bony fibres would ſprout out, and intimately coaleſce with the adjoining bone; whence a true *anchyloſis* muſt neceſſarily follow; which never fails to happen when the cartilages are eroded by acrid matter, or oſſified from want of motion or defect of liquor; as we ſee often happens after wounds of the joints, *paidarthrocace*, *ſcrophula*, and *ſpina ventoſa*, or from old age, and long immobility.

(*a*) Havers Oſteologia Nova.

(*b*) Celſus de Re Medica, lib. 8. cap. 1.

immobility of joints (*a*). Hence we may know what the annihilation is which is ſaid to be made of the head of a bone, and of the cavity for lodging it, after an unreduced fracture (*b*).—The moveable cartilages interpoſed in joints ſerve to make the motions both freer and more ſafe than they would otherwiſe be.——Thoſe placed on the end of bones that are not articulated, as on the *ſpine* of the *os ilium*, baſe of the *ſcapula*, &c. ſerve to prevent the bony fibres from growing out too far.——Cartilages ſometimes ſerve as ligaments, either to faſten together bones that are immoveably joined; ſuch are the cartilages between the *os ſacrum* and *oſſa ilium*, the *oſſa pubis*, &c.: or to connect bones that enjoy manifeſt motion, as thoſe do which are placed between the bodies of the true *vertebræ*, &c. Cartilages very often do the office of bones to greater advantage than theſe laſt could; as in the cartilages of the ribs, thoſe which ſupply brims to cavities, &c.

Too great thickneſs or thinneſs, length or ſhortneſs, hardneſs or ſuppleneſs of cartilages, may therefore cauſe great diſorders in the body.

The liquor which principally ſerves to moiſten the ligaments and cartilages of the articulations is ſupplied by glands, which are commonly ſituated in the joint, after ſuch a manner as to be gently preſſed, but not deſtroyed by its motion. By this means, when there is the greateſt neceſſity for this liquor, that is, when the moſt frequent motions are performed, the greateſt quantity of it muſt be ſeparated. Theſe glands are ſoft and pappy, but not friable: In ſome of the large joints, they are of the conglomerate kind, or a great number of ſmall glandules are wrapped up in one common membrane. Their excretory ducts are long, and hang looſe, like ſo many fringes, within the articulation; which, by its motion and preſſure, prevents obſtructions in the body of the gland or its excretories, and promotes the return of this liquor, when fit to be taken up by the abſorbent veſſels, which muſt be in the joints as well as in the other cavities of the body; and, at the ſame time, the preſſure on the excretory ducts hinders a ſuperfluous unneceſſary ſecretion, while the

(*a*) Columb. de Re Anat. lib. 15.—Deſlandes, Hiſt. de l'Acad. des Sciences, 1716.—Phil. Tranſact. n° 215.—Ibid. n° 461. § 16.

(*b*) Hildan. de Ichor. et Melicer. acri Celſi, cap. 5.—Ruyſch, Theſ. 8. n° 103.—Saltzman in Act. Petropolit. tom. iii. p. 275.

the fimbriated diſpoſition of theſe excretories does not allow any of the ſecreted liquor to be puſhed back again by theſe canals towards the glands (*a*).

Very often theſe fountains of ſlimy liquor appear only as a net-work of veſſels. Frequently they are almoſt concealed by cellular membranes containing the fat; and ſometimes ſmall ſimple mucous *follículi* may be ſeen (*b*).

The different joints have theſe organs in different numbers and ſizes: the conglomerate ones do not vary much, eſpecially as to ſituation, in the ſimilar joints of different bodies; but the others are more uncertain.

Upon preſſing any of theſe glands with the finger, one can ſqueeze out of their excretories a mucilaginous liquor, which ſomewhat reſembles the white of an egg, or *ſerum* of the blood; but it is manifeſtly ſalt to the taſte. It does not coagulate by acids, or by heat, as the *ſerum* does; but by the latter turns firſt thinner, and, when evaporated, leaves only a thin ſalt film.

The quantity of this *mucilage*, conſtantly ſupplied, muſt be very conſiderable, ſince we ſee what a plentiful troubleſome diſcharge of glary matter follows a wound or ulcer of any joint; of which liquor the mucilage is a conſiderable part.

The veſſels which ſupply liquors for making the ſecretion of this mucilage, and the veins which bring back the blood remaining after the ſecretion, are to be ſeen without any preparation; and after a tolerable injection of the arteries, the glands are covered with them.

In a ſound ſtate, we are not conſcious of any ſenſibility in thoſe glands: but in ſome caſes which I have ſeen, when they inflame and ſuppurate, the moſt racking pain is felt in them; a melancholy, though a ſure proof, that they have nerves.

Theſe mucilaginous glands are commonly lodged in a cellular ſubſtance; which is alſo to be obſerved in other parts of the bag formed by the ligaments of the articulation; and contains a fatty matter, that muſt neceſſarily be attenuated, and forced through the including membranes

(*a*) Cowper's Anatomy, explicat. of tab. 79. E. E.

(*b*) Morgagn. Adverſar. 2. animad. 23.

into the cavity of the joint, by the preſſure which it ſuffers from the moving bones.

If then the oil is conveyed from this cellular ſubſtance; and if the attenuated marrow paſſes from the *cancelli* of the bones by the large pores near their ends or in their cavities, and ſweats through the cartilages there into the articulations; which it may, when aſſiſted by the conſtant heat and action of the body, more eaſily do, than when it eſcapes thro' the compact ſubſtance of the bones in a ſkeleton: if, I ſay, this oil is ſent to a joint, and is incorporated with the mucilage, and with the fine lymph that is conſtantly oozing out at the extremities of the ſmall arteries diſtributed to the ligaments, one of the fitteſt *liniments* imaginable muſt be produced; for the *mucus* diluted by the lymph contributes greatly to its lubricity, and the oil preſerves it from hardening. How well ſuch a mixture ſerves the purpoſe it is deſigned for, *Boyle* (*a*) tells us he experienced in working his air-pump; for the ſucker could be moved with much leſs force after being moiſtened with water and oil, than when he uſed either one or other of theſe liquors. And I believe every one, at firſt view, will allow the diluted mucilage to be much preferable to ſimple water. The *ſynovia* (*b*), as this liquor compoſed of oil, mucilage, and lymph, is commonly now called, while in a ſound ſtate, effectually preſerves all the parts concerned in the articulations ſoft and flexible, and makes them ſlide eaſily on each other; by which their mutual detrition and overheating is prevented, in the manner daily practiſed in coach and cart wheels by beſmearing them with greaſe and tar.

After the liquor of the articulations becomes too thin and unſerviceable by being conſtantly pounded and rubbed between the moving bones, it is reaſſumed into the maſs of blood by the abſorbent veſſels.

When the *ſynovia* is not rubbed betwixt the bones, it inſpiſſates: and ſometimes, when the head of a bone has been long out of its cavity, this liquor is ſaid to fill up the place of the bone, and hinder its reduction; or, if a joint continues long unmoved, it is alſo ſaid to cement the bones, and occaſion a true *anchyloſis* (*c*). If the *ſynovia* becomes too acrid, it erodes the cartilages and bones; as frequently happens to thoſe who labour

(*a*) Phyſico-mechanic. Experim. (*b*) Μυξα, mucus, axungia.
(*c*) Paré, Chirurgie, livre 15. chap. 18. et livre 16. chap. 5.

bour under the *lues venerea*, *ſcurvy*, *ſcrophula*, or *ſpina ventoſa*. If this liquor is ſeparated in too ſmall quantity, the joint becomes ſtiff; and when with difficulty it is moved, a crackling noiſe is heard, as people advanced in years frequently experience (*a*). If the mucilage and lymph are depoſited in too great quantity, and the abſorbent veſſels do not perform their office ſufficiently, they may occaſion a dropſy of the joints (*b*). From this ſame cauſe alſo, the ligaments are often ſo much relaxed, as to make the conjunction of the bones very weak: Thence ariſe the luxations from an internal cauſe; which are eaſily reduced, but difficultly cured (*c*). Frequently, when ſuch a ſuperfluous quantity of this liquor is pent up, it becomes very acrid, and occaſions a great train of bad ſymptoms; ſuch as ſwelling and pain of the joints, long ſinuous ulcers and *fiſtulæ*, rotten bones, immobility of the joints, *marcor* and *atrophia* of the whole body, hectic fevers, &c. (*d*). From a depravity in the blood, or diſeaſes in the organs that furniſh the *ſynovia* of the joints, it may be greatly changed from its natural ſtate: it may be purulent after inflammation, mucous in the white ſwellings, gelatinous in the rheumatiſm, chalky from the gout, &c. Hence a great variety of diſorders in the joints (*e*).

(*a*) Galen. de Uſu Part. lib. 12. cap. 2.—Fabric. ab Aquapend. de Articul. Part. Utilitat. pars 3.—Bartholin. Hiſt. Medic. cent. 3. hiſt. 11.

(*b*) Hildan. de Ichore et Meliceria acri Celſi.

(*c*) Hippocrat. de Locis in Homine, § 14. et de Articul.

(*d*) Hildan. de Ichore et Meliceria acri Celſi.

(*e*) See Reimar Diſſert. de Fungo Articulor.

PART II.

Of the SKELETON.

THOUGH any dry ſubſtance may be called *ſkeleton*, yet, among anatomiſts, this word is univerſally underſtood to ſignify the bones of animals connected together, after the teguments, muſcles, bowels, glands, nerves, and veſſels, are taken away (*a*).

A ſkeleton is ſaid to be a *natural* one, when the bones are kept together by their own ligaments; and it is called *artificial*, when the bones are joined with wire, or any other ſubſtance which is not part of the creature to which they belonged. Small ſubjects, and ſuch whoſe bones are not fully oſſified, are commonly prepared the firſt way; becauſe, were all their parts divided, the niceſt artiſt could not rejoin them, by reaſon of their ſmallneſs, and of the ſeparation of their unoſſified parts; whereas the bones of large adult animals are ſooneſt and moſt conveniently cleaned when ſingle, and are eaſily reſtored to and kept in their natural ſituation. Sometimes the ſkeleton of the ſame animal is prepared in both theſe ways; that is, the ſmaller bones are kept together by their natural ligaments, and the larger ones are connected by wires or ſome ſuch ſubſtances.

Before we proceed to the diviſion and particular deſcription of the ſkeleton, it is worth while to remark, that when the bones are put into their natural ſituation, ſcarce any one of them is placed in a perpendicular bearing to another; though the fabric compoſed of them is ſo contrived, that, in an erect poſture, a perpendicular line, from their common centre of gravity, falls in the middle of their common baſe (*b*). On this account,

(*a*) Cadaveris crates. (*b*) Cowper's Anat. of Human Bodies, explic. of tab. 87, 88.

count, we can ſupport ourſelves as firmly, as if the axis of all the bones had been a ſtraight line perpendicular to the horizon; and we have much greater quickneſs, eaſe, and ſtrength, in ſeveral of the moſt neceſſary motions we perform. It is true indeed, that wherever the bones, on which any part of our body is ſuſtained, decline from a ſtraight line, the force required in the muſcles, to counteract the gravity of that part, is greater than otherwiſe it needed to have been: but then this is effectually provided for in ſuch places, by the number and ſtrength of the muſcles. So long therefore as we remain in the ſame poſture, a conſiderable number of muſcles muſt be in a conſtant ſtate of contraction; which we know, both from reaſon and experience, muſt ſoon create an uneaſy ſenſation. This we call *being weary of one poſture:* An inconvenience that we ſhould not have had in ſtanding erect, if the bearing of all the bones to each other had been perpendicular; but is more than compenſated by the advantages above-mentioned.

The human ſkeleton is generally divided into the HEAD, the TRUNK, the SUPERIOR and the INFERIOR EXTREMITIES.

OF THE HEAD.

BY the HEAD is meant all that ſpheroidal part which is placed above the firſt bone of the neck. It therefore comprehends the *cranium* and bones of the *face*.

The *cranium* (*a*), helmet, or brain-caſe, conſiſts of ſeveral pieces, which form a vaulted cavity, for lodging and defending the brain and *cerebellum*, with their membranes, veſſels, and nerves.

The cavity of the *cranium* is proportioned to its contents. Hence ſuch a variety of its ſize is obſerved in different ſubjects; and hence it is neither ſo broad nor ſo deep at its fore-part, in which the anterior lobes of the brain are lodged, as it is behind, where the large poſterior lobes of the brain, and the whole *cerebellum*, are contained.

The roundiſh figure of the ſkull, which makes it more capacious, and better

(*a*) Κογχος, κυτος, κωδια, σκαφιον, calva, calvaria, cerebri galea, theca et olla capitis, teſta capitis, ſcutella capitis.

better able to defend its contents from external injuries, is chiefly owing to the equal preſſure of theſe contained parts as they grow and increaſe before it is entirely oſſified. It is to be obſerved, however, that the ſides of the *cranium* are depreſſed below a ſpherical ſurface by the ſtrong temporal muſcles, whoſe action hinders here the uniform protruſion of the bones, which is more equally performed in other parts where no ſuch large muſcles are. In children, whoſe muſcles have not acted much, and conſequently have not had great effects on the bones, this depreſſion is not ſo remarkable; and therefore their heads are much rounder than thoſe of adults. Theſe natural cauſes, differently diſpoſed in different people, produce a great variety in the ſhapes of ſkulls, which is ſtill increaſed by the different management of the heads of children when very young: So that one may know a *Turk*'s ſcull by its globular figure, a *German*'s by its breadth and flatneſs of the *occiput*, *Dutch* and *Engliſh* by their oblong ſhapes, &c. (*a*). Two advantages are reaped from this flatneſs of the ſides of the *cranium*, viz. the enlargement of our ſphere of viſion, and more advantageous ſituation of our ears, for receiving a greater quantity of ſound, and for being leſs expoſed to injuries.

The external ſurface of the upper part of the *cranium* is very ſmooth and equal, being only covered with the *perioſteum*, (common to all the bones; but in the ſkull, diſtinguiſhed by the name of *pericranium*), the thin *frontal* and *occipital* muſcles, their tendinous *aponeuroſis*, and with the common teguments of the body; while the external ſurface of its lower part has numerous riſings, depreſſions, and holes, which afford convenient origin and inſertion to the muſcles that are connected to it, and allow ſafe paſſage for the veſſels and nerves that run through and near it.

The internal ſurface of the upper part of the ſkull is commonly ſmooth, except where the veſſels of the *dura mater* have made furrows in it while the bones were ſoft. Surgeons ſhould be cautious when they trepan here, leſt in ſawing or raiſing the bone where ſuch furrows are, they wound theſe veſſels. In the upper part of the internal ſurface of ſeveral ſkulls, there are likewiſe pits of different magnitudes and figures, which ſeem to be formed by ſome parts of the brain being more luxuriant and prominent

(*a*) Veſal. lib. 1. c. 5.

prominent than others. Where theſe pits are, the ſkull is ſo much thinner than any where elſe, that it is often rendered diaphanous, the two tables being cloſely compacted without a *diploë*; the want of which is ſupplied by veſſels going from the *dura mater* into a great many ſmall holes obſervable in the pits. Theſe veſſels are larger, and much more conſpicuous, than any others that are ſent from the *dura mater* to the ſkull, as evidently appears from the drops of blood they pour out when the ſkull is raiſed from the *dura mater* in a recent ſubject; and therefore they may furniſh a ſufficient quantity of liquors neceſſary to prevent the brittleneſs of this thin part. The knowledge of theſe pits ſhould teach ſurgeons to ſaw cautiouſly and ſlowly through the external table of the ſkull when they are performing the operation of the *trepan*; ſince, in a patient whoſe *cranium* has theſe pits, the *dura mater* and brain may be injured before the inſtrument has pierced near the ordinary thickneſs of a table of the ſkull. The internal baſe of the ſkull is extremely unequal, for lodging the ſeveral parts and *appendices* of the brain and *cerebellum*, and allowing paſſage and defence to the veſſels and nerves that go into or come out from theſe parts.

The bones of the *cranium* are compoſed of two tables, and intermediate *cancelli*, commonly called their *diploë* (*a*). The external table is thickeſt; the inner, from its thinneſs and conſequent brittleneſs, has got the name of *vitrea*. Whence we may ſee the reaſon of thoſe miſchievous conſequences which ſo often attend a collection of matter in the *diploe*, either from an external or internal cauſe, before any ſign of ſuch a collection appears in the teguments that cover the part of the ſkull where it is lodged (*b*).

The *diploë* has much the ſame texture and uſes in the ſkull, as the *cancelli* have in other bones.

The *diploë* of ſeveral old ſubjects is ſo obliterated, that ſcarce any veſtige of it can be ſeen; neither is it obſervable in ſome of the hard craggy bones at the baſe of the ſkull. Hence an uſeful caution to ſurgeons who truſt to the bleeding, want of reſiſtance, and change of ſound, as certain marks, in the operation of the trepan, for knowing when their inſtrument has

(*a*) Meditullium, commiſſura.

(*b*) Boneti Sepulchret. Anat. lib. 1. § 1. obſ. 96—103.

has ſawed through the firſt table, and reached the *diploë* (*a*). In other people, the *diploë* becomes of a monſtrous thickneſs, while the tables of the ſkull are thinner than paper.

The *cranium* conſiſts of eight bones, ſix of which are ſaid to be proper, and the other two are reckoned common to it and to the face. The ſix proper are the *os frontis*, two *oſſa parietalia*, two *oſſa temporum*, and the *os occipitis*. The common are the *os ethmoides* and *ſphenoides*.

The *os frontis* forms the whole fore-part of the vault; the two *oſſa parietalia* form the upper and middle part of it; the *oſſa temporum* compoſe the lower part of the ſides; the *os occipitis* makes the whole hinder part, and ſome of the baſe; the *os ethmoides* is placed in the fore-part of the baſe, and the *os ſphenoides* is in the middle of it.

Theſe bones are joined to each other by five *ſutures*; the names of which are the *coronal*, *lambdoid*, *ſagittal*, and two *ſquamous*.

The *coronal* (*b*) *ſuture* is extended over the head, from within an inch or ſo of the external *canthus* of one eye to the like diſtance from the other; which being near the place where the ancients wore their *vittæ*, *coronæ*, or garlands, this *ſuture* has hence got its name. Though the indentations of this *ſuture* are conſpicuous in its upper part, yet an inch or more of its end on each ſide has none of them; for it is ſquamous and ſmooth there.

The *lambdoidal* (*c*) *ſuture* begins ſome way below, and farther back than the *vertex* or crown of the head; whence its two legs are ſtretched obliquely downwards, and to each ſide, in form of the *Greek* letter Λ; and are now generally ſaid to extend themſelves to the *baſe* of the ſkull: but formerly anatomiſts (*d*) reckoned the proper *lambdoid* ſuture to terminate at the *ſquamous* ſutures; and what is extended at an angle down from that on each ſide, where the indentations are leſs conſpicuous than in the upper part of the ſuture, they called *additamentum ſuturæ lambdoidis* (*e*).

This *ſuture* is ſometimes very irregular, being made up of a great many ſmall ſutures, which ſurround ſo many little bones that are generally larger and more conſpicuous on the external ſurface of the ſkull than internally.

(*a*) Bartholin. Anat. Reform. lib. 4. cap. 4.
(*b*) Στεφανιαι, arcualis, puppis.
(*c*) Laudæ, proræ, hypſyloides.
(*d*) Veſal. Anat. lib. 1. cap. 6.
(*e*) Lambdoides harmonialis, lambdoides inferior, occipitis corona.

nally. Theſe bones are generally called *triquetra* or *wormiania:* but ſome other name ought to be given them; for they are not always of a triangular figure, and older anatomiſts (*a*) than *Olaus Wormius* (*b*) have deſcribed them. The ſpecific virtue which theſe bones were once thought to have in the cure of the epilepſy (*c*), is not now aſcribed to them; and anatomiſts generally agree, that their formation is owing to a greater number of points than ordinary of oſſification in the ſkull, or to the ordinary bones of the *cranium* not extending their oſſification far enough or ſoon enough: in which caſe, the unoſſified interſtice between ſuch bones begins a ſeparate oſſification in one or more points; from which the oſſification is extended to form as many diſtinct bones as there were points, that are indented into the large ordinary bones, and into each other. Probably thoſe children who have a large opening in this place at their birth, will have the largeſt *oſſa triquetra*. To confirm this account of the formation of theſe little bones, we may remark, that ſuch bones are ſometimes ſeen in other ſutures as well as in the *lambdoid* (*d*); and they are ſometimes in one table of the ſkull, and not in the other (*e*).

The *ſagittal* ſuture (*f*) is placed longitudinally in the middle of the upper part of the ſkull; and commonly terminates at the middle of the *coronal* and of the *lambdoid* ſutures, between which it is ſaid to be placed as an arrow is between the ſtring and bow. However, this ſuture is frequently continued through the middle of the *os frontis*, down to the root of the noſe; which, ſome (*g*) ſay, oftener happens in women then in men: but others (*h*) allege, that it is to be met with more frequently in male ſkulls than in female. Among the ſkulls which I have ſeen thus divided,

 the

(*a*) Euſtach. Oſſium Examen.—Bauhin. Theat. Anat. lib. 3. cap. 5.—Paaw in Hippocrat. de Vulner. Cap. p. 56.

(*b*) Muſæum, lib. 3. c. 26.

(*c*) Bauhin. et Paaw, ibid.—Bartholin. Anat. Reform. lib. 4. cap. 5.—Hildan. Epiſtol. 65.

(*d*) See examples in Veſal. lib. 1. cap. 6. fig. 4.—Paaw in Hippocrat. de Cap. Vuln.—Bartholin. Hiſt. Anat. cent. 1. hiſt. 51.—Ruſch, Muſ. Anat.—Sue Trad. d'Oſteolog. p. 47.

(*e*) Hunauld, in Mem. de l'Acad. des Sciences, 1730.

(*f*) Ῥαβδοειδης, σειλαια, ιτιξυγινεα, Inſtar virgæ, nervalis, inſtar teli, inſtar veru, ſecundum capitis longitudinem prorepens, conjungens, columnalis, recta, acualis.

(*g*) Riolan. Comment. de Oſſib. cap. 8. (*h*) Veſal. lib. 1. cap. 6. et in epitome.

the female are the moſt numerous. Several (*a*) have delineated and deſcribed the *ſagittal* ſuture, ſometimes dividing the *occipital* bone as far down as the great hole through which the *medulla ſpinalis* paſſes. This I never ſaw.

In ſome old ſkulls that are in my poſſeſſion, there is ſcarce a veſtige of any of the three *ſutures* which I have now deſcribed. In other heads, only one or two of the ſutures diſappear; but I never could diſcover any reaſon for thinking them diſpoſed in ſuch different manners in ſkulls of different ſhapes, as ſome ancients allege they are (*b*).

The *ſquamous agglutinations*, or *falſe ſutures* (*c*), are one on each ſide, a little above the ear, of a ſemicircular figure, formed by the overlopping (like one ſcale upon another) of the upper part of the *temporal* bones on the lower part of the *parietal*; where, in both bones, there are a great many ſmall riſings and furrows, which are indented into each other; though theſe inequalities do not appear till the bones are ſeparated. In ſome ſkulls, indeed, the indentations here are as conſpicuous externally as in other ſutures (*d*); and what is commonly called the poſterior part of this ſquamous ſuture, always has the evident ſerrated form; and therefore is reckoned by ſome (*e*) a diſtinct ſuture, under the name of *additamentum poſterius ſuturæ ſquamoſæ*. I have ſeen two ſquamous ſutures on the ſame temple, with a ſemicircular piece of bone between them (*f*).

We ought here to remark, that the true ſquamous ſort of ſuture is not confined to the conjunction of the temporal and parietal bones, but is made uſe of to join all the edges of the bones on which each temporal muſcle is placed (*g*): for the two parts of the ſphenoidal ſuture, which are continued from the anterior end of the common ſquamous ſuture juſt now deſcribed, of which one runs perpendicularly downwards, and the other

(*a*) Veſal. lib. 1. cap. 5. fig. 3, 4. et in text. cap. 6.—Paaw in Celſ. de Re Medic. cap. 1.—Laurent. Hiſt. Anat. lib. 2. cap. 16.

(*b*) Hippocrat. de Vulner. Capitis, § 1.—Galen. de Oſſib. et de Uſu Part. lib. 9. cap. 17.

(*c*) Λιτριδοειδη, προσκολλημαται, κροταφιαι, temporales, corticales, mendoſæ, harmoniales, commiſſuræ in unguem.

(*d*) Columb. de Re Anat. lib. 1. cap. 4.—Dionis, Anat. 3. Demonſt. des Os.

(*e*) Albin. de Oſſib. § 54. (*f*) Sue Trad. d'Oſteolog. p. 48.

(*g*) Veſal. Anat. lib. 1. cap. 6.—Winſlow, Mem. de l'Acad. des Sciences, 1720.

other horizontally forwards, and alſo the lower part of the coronal ſuture already taken notice of, may all be juſtly ſaid to pertain to the ſquamous *ſuture*.——The manner how I imagine this ſort of ſuture is formed at theſe places is, that, by the action of the ſtrong temporal muſcles on one ſide, and by the preſſure of the brain on the other, the bones are made ſo thin that they have not large enough ſurfaces oppoſed to each other to ſtop the extenſion of their fibres in length, and thus to cauſe the common ſerrated appearance of ſutures explained in p. 56. but the narrow edge of the one bone ſlides over the other. The *ſquamous* form is alſo more convenient here; becauſe thin edges of bones, when accurately applied one to another, have ſcarce any rough ſurface to obſtruct or hurt the muſcle in its contraction: which is ſtill further provided for by the manner of laying theſe edges on each other; for, in viewing their outſide, we ſee the temporal bones covering the ſphenoidal and parietal, and this laſt ſupporting the ſphenoidal, while both mount on the frontal: From which diſpoſition it is evident, that, while the temporal muſcle is contracting, which is the only time it preſſes ſtrongly in its motion on the bones, its fibres ſlide eaſily over the external edges. Another advantage ſtill in this is, that all this bony part is made ſtronger by the bones thus ſupporting each other.

The bones of the ſkull are joined to thoſe of the face by *ſchyndeleſis* and *ſutures*.—The *ſchyndeleſis* is in the partition of the noſe.——The ſutures ſaid to be common to the *cranium* and face are five, viz. the *ethmoidal*, *ſphenoidal*, *tranſverſe*, and two *zygomatic*.--Parts, however, of theſe ſutures are at the junction of only the bones of the ſkull.

The *ethmoidal* and *ſphenoidal* ſutures ſurround the bones of theſe names; and in ſome places help to make up other ſutures, particularly the *ſquamous* and *tranſverſe*; and in other parts there is but one ſuture common to theſe two bones.

The *tranſverſe* ſuture is extended quite croſs the face, from the external *canthus* of one orbit to the ſame place of the other, by ſinking from the *canthus* down the outſide of the orbit to its bottom; then, mounting upon its inſide, it is continued by the root of the noſe down the internal part of the other orbit, and riſes up again on its outſide to the other *canthus*. It may be here remarked, that there are ſome interruptions of this

ſuture in the courſe I have deſcribed: for the bones are not contiguous every where; but are ſeparated, to leave holes and apertures, to be mentioned hereafter.

The *zygomatic* ſutures are one on each ſide, being ſhort, and ſlanting from above obliquely downwards and backwards, to join a proceſs of the cheek-bone to one of the *temporal* bones, which advances towards the face; ſo that the two proceſſes, thus united, form a ſort of bridge or *jugum*, under which the *temporal* muſcle paſſes; on which account the proceſſes, and ſuture joining them, have been called *zygomatic*.

It muſt be obſerved, that the indentations of the *ſutures* do not appear on the inſide of the *cranium* by much ſo ſtrong as on the outſide; but the bones ſeem almoſt joined in a ſtraight line: nay, in ſome ſkulls, the internal ſurface is found entire, while the ſutures are manifeſt without; which may poſſibly be owing to the leſs extent of the concave than of the convex ſurface of the *cranium*, whereby the fibres of the internal ſide would be ſtretched farther out at the edges of the bones than the exterior ones, if they were not reſiſted. The reſiſtances are, the fibres of the oppoſite bone, the parts within the ſkull, and the *diploë*; of which the laſt being the weakeſt, the moſt advanced fibres or *ſerræ* run into it, and leave the contiguous edges equal and more ready to unite: whereas the *ſerræ* of the external table have ſpace enough for their admiſſion between the fibres of the oppoſite bone; and therefore remain of the indented form, and are leſs liable to the concretion, whereby the ſutures are obliterated (*a*).——By this mechaniſm, there is no riſk of the ſharp points of the bones growing inwards, ſince the external *ſerræ* of each of the conjoined bones reſt upon the internal ſmooth-edged table of the other; and external forces applied to theſe parts are ſtrongly reſiſted, becauſe the ſutures cannot yield, unleſs the ſerrated edges of the one bone, and the plain internal plate of the other, are broken (*b*).

The advantages of the ſutures of the *cranium* are theſe: 1. That this *capſula* is more eaſily formed and extended into a ſpherical figure than if it had been one continued bone. 2. That the bones which are at ſome diſtance from each other at birth might then yield, and allow to the head

a

(*a*) Hunauld, Memoires de l'Acad. des Sciences, 1730.

(*b*) Winſlow, Memoires de l'Acad. des Sciences, 1720.

a change of ſhape accommodated to the paſſage it is engaged in: whence, in hard labour of childbed, the bones of the *cranium*, inſtead of being only brought into contact, are ſometimes made to mount one upon the other. 3. It is alleged, that, through the ſutures, there is a tranſpiration of ſteams from the brain, which was the old doctrine; or ſome communication of the veſſels without, and of thoſe within the ſkull, larger here than in any other part of the *cranium*, according to ſome moderns; and therefore *cucuphæ*, *fomentations*, *cataplaſms*, *cephalic plaſters*, *bliſters*, are applied, and *iſſues* are eroded or cut in the head, at thoſe places where the ſutures are longeſt in forming, and where the connection of the bones is afterwards looſeſt, for the cure of a *phrenitis*, *mania*, *inveterate head-ach*, *epilepſy*, *apoplexy*, and other diſeaſes of the head. The favourers of the doctrine of tranſpiration, or communication of veſſels at the ſutures, endeavour to ſupport it by obſervations of perſons ſubject to head-achs, which cauſed death, from the ſutures being too cloſely united (*a*). 4. That the *dura mater* may be more firmly ſuſpended by its proceſſes, which inſinuate themſelves into this conjunction of the bones: for doing this equally, and where the greateſt neceſſity of adheſion is, the ſutures are diſpoſed at nearly equal diſtances, and the large *reſervoirs* of blood, the *ſinuſes*, are under or near them. 5. That fractures might be prevented from reaching ſo far as they would in a continued bony ſubſtance. 6. That the connection at the ſutures being capable of yielding, the bones might be allowed to ſeparate; which has given great relief to patients from the violent ſymptoms which they had before this ſeparation happened (*b*). And it ſeems reaſonable to believe, that the opening of the ſutures was of great benefit to ſeveral others who were rather judged to have been hurt by it (*c*): for we muſt think, that the conſequences of ſuch a force acting upon the brain as was capable of thruſting the bones aſunder, muſt have been fatal, unleſs it had been thus yielded to.

Having gone through the general ſtructure of the *cranium*, I now proceed

(*a*) Columb. de Re Anat. lib. 1. cap. 5.—Verduc. Nouvelle Oſteologie, chap. 14.—Dionis, Anat. 3. demonſtr. des os.

(*b*) Ephemerid. Germanic. dec. 1. ann. 4. et 5. obſerv. 33.

(*c*) Ephemerid. Germ. dec. 2. ann. 9. obſ. 230. Ibid. cent. 10. obſ. 31.—Vander Linden. Medicin. Phyſ. cap. 8. art. 4. § 16.—Hildan. Obſerv. cent. 1. obſ. 1. cent. 2. obſ. 7.—Bauhin. Theat. Anat. lib. 3. cap. 6.—Pechlin, Obſerv. lib. 2. obſ. 39.

ceed to examine each bone of which that brain-caſe conſiſts, in the order in which I firſt named them.

The OS FRONTIS (*a*) has its name from its being the only bone of that part of the face which we call the *forehead*, though it reaches a good deal farther. It has ſome reſemblance in ſhape to the ſhell of the *concha bivalvis*, commonly called the *cockle:* for the greateſt part of it is convex externally, and concave internally, with a ſerrated circular edge; while the ſmaller part has proceſſes and depreſſions, which make it of an irregular figure.

The external ſurface of the *os frontis* is ſmooth at its upper convex part; but ſeveral proceſſes and cavities are obſervable below: for, at each angle of each orbit, the bone juts out, to form four proceſſes, two internal, and as many external; which, from this ſituation, may well enough be named *angular*. Between the internal and external angular proceſſes on each ſide, an arched ridge is extended, on which the eye-brows are placed.——Very little above the internal end of each of theſe *ſuperciliary* ridges, a protuberance may be remarked, in moſt ſkulls, where there are large cavities, called *ſinuſes*, within the bone; of which hereafter.—Betwixt the internal angular proceſſes, a ſmall proceſs riſes, which forms ſome ſhare of the noſe, and thence is named *naſal*.——Some obſerve a protuberant part on the edge of the bone behind each external angular proceſs, which they call *temporal* proceſſes; but theſe are inconſiderable. ——From the under part of the ſuperciliary ridges, the frontal bone runs a great way backwards; which parts may juſtly enough be called *orbitar* proceſſes. Theſe, contrary to the reſt of this bone, are concave externally, for receiving the globes of the eyes, with their muſcles, fat, &c.

In each of the *orbitar* proceſſes, behind the middle of the ſuperciliary ridges, a conſiderable ſinuoſity is obſerved, where the *glandula innominata Galeni*, or *lachrymalis*, is lodged.—Behind each internal angular proceſs, a ſmall pit may be remarked, where the cartilaginous pulley of the *muſculus obliquus major* of the eye is fixed.——Betwixt the two orbitar proceſſes, there is a large diſcontinuation of the bone, into which the cribriform part of the *os ethmoides* is incaſed.—The frontal bone frequently has little caverns formed in it here where it is joined to the ethmoid bone.—

Behind

(*a*) Μετωπον, βρεγμα, coronale, inverecundum, puppis, ſenſus communis, ſincipitis.

Behind each external angular proceſs, the ſurface of the frontal bone is conſiderably depreſſed where part of the *temporal* muſcle is placed.

The *foramina*, or holes, obſervable on the external ſurface of the frontal bone, are three in each ſide.—One in each ſuperciliary ridge, a little removed from its middle towards the noſe; through which a twig of the *ophthalmic* branch of the fifth pair of nerves paſſes out of the orbit, with a ſmall artery from the internal carotid, to be diſtributed to the teguments and muſcles of the forehead.—Theſe veſſels, in ſome ſkulls, make furrows in *the os frontis*, eſpecially in the bones of children, as has alſo been obſerved of another conſiderable veſſel of this bone near its middle (*a*); and therefore we ought to beware of tranſverſe inciſions on either ſide of the *os frontis*, which might either open theſe veſſels or hurt the nerves, while they are yet in part within the bone: for, when veſſels are thus wounded, it is difficult to ſtop the hæmorrhagy; becauſe the adheſion of a part of the artery to the bone hinders its contraction, and conſequently ſtyptics can have little effect; the ſides of the furrow keep off compreſſing ſubſtances from the artery; and we would wiſh to ſhun cauteries or eſcharotics, becauſe they make the bone carious; and nerves, when thus hurt, ſometimes produce violent ſymptoms.—But, to return to the *ſuperciliary foramina*, we muſt remark, that often, inſtead of a hole, a notch only is to be ſeen: nay, in ſome ſkulls, ſcarce a veſtige even of this is left; in others, both hole and notch are obſervable, when the nerve and artery run ſeparately. Frequently a hole is found on one ſide, and a notch on the other; at other times we ſee two holes; or there is a common hole without, and two diſtinct entries internally. The reaſon of this variety of a hole, notch, depreſſion, or ſmoothneſs, in the ſuperciliary ridge, is the different length and tenſion of the nerves and veſſels; the ſhorter they are, the more they are ſunk into the bone as it grows.—Near the middle of the inſide of each orbit, hard by or in the *tranſverſe ſuture*, there is a ſmall hole for the paſſage of the naſal twig of the firſt branch of the fifth pair of nerves, and of a branch of the ophthalmic artery. This hole is ſaid to be ſometimes entirely formed in the *os frontis*; in moſt ſkulls, the ſides of it are compoſed of this laſt bone, and of the *os planum*. It is commonly known by the name of *orbitarium internum*,

(*a*) Muſ. Anat. theca D. repoſit. 4. n° 3.

num; though *anterius* ſhould be added, becauſe of the next, which is commonly omitted.——This, which may be called *orbitarum internum poſterius*, is ſuch another as the former; only ſmaller, and about an inch deeper in the orbit: Through it a ſmall branch of the ocular artery paſſes to the noſe.—Beſides theſe ſix, there are a great number of ſmall holes obſervable on the outer ſurface of this bone, particularly in the two protuberances above the eye-brows. Moſt of theſe penetrate no further than the *ſinuſes*, or than the *diploë* if the *ſinuſes* are wanting; though ſometimes I have ſeen this bone ſo perforated by a vaſt number of theſe ſmall holes, that, placed between the eye and a clear light, it appeared like a ſieve.——In the orbit of the generality of *ſkeletons*, we may obſerve one, two, or more holes, which allow a paſſage to a hog's briſtle through the ſkull. The place, ſize, and number of theſe, are however uncertain: They generally ſerve for the tranſmiſſion of ſmall arteries or nerves.

The internal ſurface of the *os frontis* is concave, except at the orbitar proceſſes, which are convex, to ſupport the anterior lobes of the brain. This ſurface is not ſo ſmooth as the external; for the larger branches of the arteries of the *dura mater* make ſome furrows in its ſides and back parts. The ſinuoſities from the luxuriant riſings of the brain, mentioned when deſcribing the general ſtructure of the *cranium*, are often very obſervable on its upper part; and its lower and fore parts are marked with the contortions of the anterior lobes of the brain.——Through the middle of this internal ſurface, where always in children, and ſometimes in old people, the bone is divided, either a ridge ſtands out, to which the upper edge of the *falx* is faſtened; or a furrow runs, in which the upper ſide of the ſuperior longitudinal *ſinus* is lodged: on both theſe accounts, chirurgical authors juſtly diſcharge the application of the trepan here.—The reaſon of this difference in ſkulls is alleged by ſome authors to be this, That, in thin ſkulls, the ridge ſtrengthens the bones, and in thick ones there is no occaſion for it. To this way of accounting for this phenomenon, it may juſtly be objected, that generally very thick ſkulls have a large ſpine here, and frequently thin ones have only a furrow. Perhaps this variety may be owing to the different times of complete oſſification of thoſe parts in different ſubjects: for if the two ſides of this bone meet before they arrive at their utmoſt extent of growth, they unite very firmly; and

all

all their fibres endeavour to ſtretch themſelves out where the leaſt reſiſtance is, that is, between the hemiſpheres of the brain. To ſupport this reaſoning, we may remark, that thoſe adults whoſe frontal bone is divided by the ſagittal ſuture never have a ridge in this place.

Immediately at the root of this ridge or furrow, there is a ſmall hole, which ſometimes pierces through the firſt table, and, in other ſkulls, opens into the ſuperior *ſinus* of the *ethmoid* bone within the noſe. In it a little proceſs of the *falx* is lodged, and a ſmall artery, and ſometimes a vein, runs (*a*); and the ſuperior longitudinal *ſinus* begins here.—This hole, however, is often not entirely proper to the *os frontis;* for, in ſeveral ſkulls, the lower part of it is formed in the upper part of the baſe of the *criſta galli*, which is a proceſs of the *ethmoid* bone (*b*).

The *os frontis* is compoſed of two tables and an intermediate *diploë*, as the other bones of the *cranium* are, and in a middle degree of thickneſs between the *os occipitis* and the *parietal* bones; is pretty equally denſe all through, except at the orbitar proceſſes, where, by the action of the eye on one ſide, and preſſure of the lobes of the brain on the other, it is made extremely thin and diaphanous, and the *meditullium* is entirely obliterated. Since in this place there is ſo weak a defence for the brain, the reaſon appears why fencers eſteem a puſh in the eye mortal (*c*).

The *diploë* is alſo exhauſted in that part above the eye-brows, where the two tables of the bone ſeparate, by the external being protruded outwards, to form two large cavities, called *ſinus frontales*.—Theſe are divided by a middle perpendicular bony partition.——Their capacities in the ſame ſubject are ſeldom equal; in ſome the right, in others the left, is largeſt.—And in different bones their ſize is as inconſtant; nay, I have examined ſome where they were entirely wanting; which oftener happens in ſuch as have a flat fore-head, and whoſe ſagittal ſuture is continued down to the noſe, than in others (*d*).—In ſome ſkulls, beſides the large perpendicular *ſeptum*, there are ſeveral bony pillars, or ſhort parti-

(*a*) Morgagn. Adverſar. 6. animad. 31.

(*b*) Ingraſſ. Comment. in Galen. de Oſſib. cap. 1. comment. 8.

(*c*) Ruyſch, Obſerv. Anat.-chir. obſerv. 54.—Diemerbroeck, Anat. lib. 3. cap. 10.—Bonet. Sepulch. Anat. lib. 4. § 3. obſerv. 17.

(*d*) Fallop. Expoſit. de Oſſib. cap. 13.

tions, found in each *ſinus*; in others theſe are wanting.——For the moſt part the *ſeptum* is entire; at other times it is diſcontinued, and the two *ſinuſes* communicate. When the *ſinuſes* are ſeen in ſuch ſkulls as have the frontal bone divided by the ſagittal ſuture, the partition dividing theſe cavities is evidently compoſed of two plates, which eaſily ſeparate. Each *ſinus* commonly opens by a roundiſh ſmall hole, at the inner and lower part of the internal angular proceſſes, into a *ſinus* formed in the noſe, at the upper and back part of the *os unguis*; near to which there are alſo ſome other ſmall *ſinuſes* of this bone (*a*), the greater part of which open ſeparately nearer the *ſeptum narium*, and often they terminate in the ſame common canal with the large ones.

In a natural and ſound ſtate, theſe cavities are of conſiderable advantage: for the organ of ſmelling being thus enlarged, the *effluvia* of odorous bodies more difficultly eſcape it; and their impreſſions being more numerous, are therefore ſtronger, and affect the organ more. That odorous particles may be applied to the membrane of the *ſinuſes*, is evident from the pain felt in this part of the fore-head, when the *effluvia* of volatile ſpirits, or of ſtrong aromatics, are drawn up into the noſe by a quick inſpiration.——Theſe, and the other cavities which open into the noſe, increaſe the ſound of our voice, and render it more melodious, by ſerving as ſo many vaults to reſound the notes. Hence people labouring under a *coryza*, or ſtoppage of the noſe from any other cauſe, when they are by the vulgar, though falſely, ſaid to ſpeak through their noſe, have ſuch a diſagreeable harſh voice.——The liquor ſeparated in the membrane of theſe *ſinuſes*, drills down upon the membrane of the noſe to keep it moiſt.

From the deſcription of theſe *ſinuſes*, it is evident how uſeleſs, nay, how pernicious it muſt be, to apply a trepan on this part of the ſkull; for this inſtrument, inſtead of piercing into the cavity of the *cranium*, would reach no further than the *ſinuſes*; or, if the inner table was perforated, any extravaſated blood that happened to be within the ſkull, would not be diſcharged outwardly, but would fall into the *ſinuſes*, there to ſtagnate, corrupt, and ſtimulate the ſenſible membranes; from which alſo there would be ſuch a conſtant flow of glairy mucus, as would retard, if not

(*a*) Cowper in Drake's Anthropolog. book 3. chap. 1c.

not hinder a cure, and would make the ſore degenerate into an incurable *fiſtula*. Beſides, as it would be almoſt impoſſible in this caſe to prevent the air paſſing through the noſe from having conſtant acceſs to the *dura mater* or brain, ſuch a corruption would be brought on theſe parts as would be attended with great danger. Further, in reſpiration, the air ruſhing violently into theſe cavities of the *os frontis*, and paſſing through the external orifice whenever it was not well covered and defended, would not only prevent the cloſing up of the external orifice, but might otherwiſe bring on bad conſequences (*a*).——The membrane lining theſe *ſinuſes* is ſo ſenſible, that inflammations of it muſt create violent torture (*b*); and worms, or other inſects crawling there, muſt give great uneaſineſs (*c*).

The upper circular part of the *os frontis* is joined to the *oſſa parietalia*, from one temple to the other, by the coronal ſuture. From the termination of the coronal ſuture to the external angular proceſſes, this bone is connected to the *ſphenoid* by the *ſphenoidal* ſuture. At the external *canthi* of the eyes, its angular proceſſes are joined by the tranſverſe ſuture to the *oſſa malarum*, to which it adheres one third down the outſide of the orbits; whence to the bottom of theſe cavities, and a little up on their internal ſides, theſe orbitar proceſſes are connected to the *ſphenoidal* bone by that ſame ſuture. In ſome few ſkulls, however, a diſcontinuation of theſe two bones appears at the upper part of the long ſlit, near the bottom of the orbit. On the inſide of each orbit, the orbitar proceſs is indented between the *cribriform* part of the *ethmoid* bone, and the *os planum* and *unguis*. The tranſverſe ſuture afterwards joins the frontal bone to the ſuperior naſal proceſſes of the *oſſa maxillaria ſuperiora*, and to the naſal bones. And, *laſtly*, its naſal proceſs is connected to the naſal *lamella* of the *ethmoid* bone.

The *frontal* bone ſerves to defend and ſupport the anterior lobes of the brain. It forms a conſiderable part of the cavities that contain the globes

(*a*) Paaw de Oſſibus, pars 1. cap. 7.—Palfyne Anatom. chir. traité 4. chap. 15. Nouvelle Oſteologie, partie 2. chap. 3.

(*b*) Fernel. Patholog. lib. 5. cap. 7.—Saltzman Decur. obſerv. 10.

(*c*) Fernel Patholog. lib. 5. cap. 7.—Bartholin. Epiſtol. Medic. cent. 2. epiſt. 74.—Hiſt. de l'Acad. des Sciences, 1708 et 1733.

of the eyes, helps to make up the *ſeptum narium*, organ of ſmelling, &c. From the deſcription of the ſeveral parts, the other uſes of this bone are evident.

In a ripe child, the frontal bone is divided through the middle; the ſuperciliary holes are not formed; often a ſmall round piece of each orbitar proceſs, behind the ſuperciliary ridge, is not oſſified, and there is no *ſinus* to be ſeen within its ſubſtance.

Each of the two OSSA PARIETALIA (*a*), or bones ſerving as walls to the *encephalon*, is an irregular ſquare; its upper and fore ſides being longer than the one behind or below. The inferior ſide is a concave arch; the middle part receiving the upper round part of the temporal bone. The angle formed by this upper ſide and the fore one, is ſo extended, as to have the appearance of a proceſs.

The external ſurface of each *os parietale* is convex. Upon it, ſomewhat below the middle heighth of the bone, there is a tranſverſe arched ridge, of a whiter colour generally than any other part of the bone; from which, in bones that have ſtrong prints of muſcles, we ſee a great many converging furrows, like ſo many *radii* drawn from a circumference towards a centre. From this ridge of each bone the temporal muſcle riſes; and, by the preſſure of its fibres, occaſions the furrows juſt now mentioned. Below theſe, we obſerve, near the ſemicircular edges, a great many riſings and depreſſions, which are joined to like inequalities on the inſide of the temporal bone, to form the ſquamous ſuture. The temporal bone may therefore ſerve here as a buttreſs, to prevent the lower ſide of the parietal from ſtarting outwards when its upper part is preſſed or ſtruck (*b*).

Near the upper ſides of theſe bones, towards the hind part, is a ſmall hole in each, through which a vein paſſes from the teguments of the head to the longitudinal *ſinus*. Sometimes I have ſeen a branch of the temporal artery paſs through this hole, to be diſtributed to the upper part of the *falx*, and to the *dura mater* at its ſides, where it had frequent anaſtamoſes with the branches of the arteries derived from the external carotids,

(*a*) Κυρτεις, paria, ſyncipitis, verticis, arcualia, nervalia, cogitationis, rationis, bregmatis, madefactionis.

(*b*) Hunauld in Mem. de l'Acad. des Sciences, 1730.

carotids, which commonly have the name of the arteries of the *dura mater*, and with the branches of the internal carotids which ſerve the *falx*. In ſeveral ſkulls, one of the *oſſa parietalia* has not this hole: in others, there are two in one bone; and in ſome, not one in either. Moſt frequently this hole is through both tables; at other times, the external table only is perforated. The knowledge of the courſe of theſe veſſels may be of uſe to ſurgeons, when they make any inciſion near this part of the head, leſt, if the veſſels are raſhly cut near the hole, they ſhrink within the ſubſtance of the bone, and ſo cauſe an obſtinate hæmorrhagy, which neither ligatures nor medicines can ſtop.

On the inner concave ſurface of the parietal bones, we ſee a great many deep furrows, diſpoſed ſomewhat like the branches of trees. The furrows are largeſt and deepeſt at the lower edge of each *os parietale*, eſpecially near its interior angle, where ſometimes a full canal is formed. They afterwards divide into ſmall furrows in their progreſs upwards.—In ſome ſkulls, a large furrow begins at the hole near the upper edge, and divides into branches, which join with thoſe which come upwards, ſhewing the communications of the upper and lower veſſels of the *dura mater*. In theſe furrows we frequently ſee paſſages into the *diploë*; and ſometimes I have obſerved canals going off, which allowed a ſmall probe to paſs ſome inches into the bony ſubſtance. Some (*a*) tell us, that they have obſerved theſe canals piercing the bone towards the *occiput*. On the inſide of the upper edge of the *oſſa parietalia*, there is a large ſinuoſity, frequently larger in the bone of one ſide than of the other, where the upper part of the *falx* is faſtened, and the ſuperior longitudinal *ſinus* is lodged. Generally part of the lateral *ſinuſes* makes a depreſſion near the angle formed by the lower and poſterior ſides of theſe bones; and the pits made by the prominent parts of the brain are to be ſeen in no part of the ſkull more frequent, or more conſiderable, than in the internal ſurface of the parietal bones.

The *oſſa parietalia* are amongſt the thinneſt bones of the *cranium*; but enjoy the general ſtructure of two tables and *diploë* the completeſt, and are the moſt equal and ſmooth.

Theſe bones are joined at their fore-ſide to the *os frontis* by the coronal ſuture;

(*a*) Cowper's Anatomy, explic. of tab. 90. fig. 2.

ſuture; at their long inferior angles, to the *ſphenoid bone*, by part of the ſuture of this name; at their lower edge, to the *oſſa temporum*, by the ſquamous ſuture, and its poſterior *additamentum*; behind, to the *os occipitis*, or *oſſa triquetra*, by the lambdoid ſuture; and above, to one another, by the ſagittal ſuture.

They have no particular uſes beſides thoſe mentioned in the deſcription of their ſeveral parts, except what are included in the account of the general ſtructure of the *cranium*.

In a child born at the full time, none of the ſides of this bone are completed; and there never is a hole in the oſſified part of it near to the ſagittal ſuture.

The large unoſſified ligamentous part of the *cranium* obſervable between the parietal bones and the middle of the divided *os frontis* of new-born children, called by the vulgar the *open of the head*, was imagined by the ancients to ſerve for the evacuation of the ſuperfluous moiſture of the brain; and therefore they named it *bregma* (*a*), or the fountain; ſometimes adding the epithet *pulſatilis*, or beating, on account of the pulſation of the brain felt through this flexible ligamento-cartilaginous ſubſtance. Hence very frequently the parietal bones are called *oſſa bregmatis*.

The upper middle part of the head of a child, in a natural birth, being what preſents itſelf firſt at the *os uteri* (*b*), an accoucheur may reach the *bregma* with his finger, when the *os uteri* is a little opened. If the *bregma* is ſtretched, and the pulſation of the brain is felt through it, the child is certainly alive: but if it is ſhrivelled and flaccid, without any obſervable pulſation in it, there is ſome reaſon to ſuſpect the child to be very weak or dead. Thoſe who practiſe midwifery ſhould therefore examine the ſtate of the *bregma* accurately.

All the *bregma* is generally oſſified before ſeven years of age. Several authors (*c*) ſay they have obſerved it unoſſified in adults; and phyſicians, who order the application of medicines at the meeting of the coronal and ſagittal ſutures, ſeem yet to think, that a derivation of noxious humours from

(*a*) Palpitans vertex, foliolum, folium, triangularis lacuna.

(*b*) Burton's Midwifery, § 51.—Smellie's Midwifery, book 1. chap. 1. § 5.

(*c*) Bartholin. Anat. Reform. lib. 4. cap. 6.—Diemerbroek, Anat. lib. 9. cap. 6.—Kerkring. Oſteogen. cap. 2.

from the *encephalon*, is more eaſily procured at this part than any other of the ſkull; and that medicines have a greater effect here than elſewhere, in the internal diſorders of the head.

Ossa temporum (*a*), ſo named, ſay authors, from the hair's firſt becoming gray on the temples, and thus diſcovering peoples ages, are each of them equal and ſmooth above, with a very thin ſemicircular edge; which, from the manner of its connection with the neighbouring bones, is diſtinguiſhed by the name of *os ſquamoſum*. Behind this, the upper part of the temporal bone is thicker, and more unequal; and is ſometimes deſcribed as a diſtinct part, under the name of *pars mamillaris* (*b*). Towards the baſe of the ſkull, the temporal bone appears very irregular and unequal: and this part, inſtead of being broad, and placed perpendicularly, as the others are, is contracted into an oblong very hard ſubſtance, extended horizontally forwards and inwards; which in its progreſs becomes ſmaller, and is commonly called *os petroſum*.

Three external proceſſes of each temporal bone are generally deſcribed. —The firſt, placed at the lower and hind part of the bone, is, from its reſemblance to a nipple, called *maſtoides*, or *mamillaris*. It is not ſolid; but within is compoſed of *cancelli*, or ſmall cells, which have a communication with the large cavity of the ear, the drum; and therefore ſounds, being multiplied in this vaulted labyrinth, are increaſed before they are applied to the immediate organ of hearing. Into the maſtoid proceſs the *ſternomaſtoideus* muſcle is inſerted; and to its back-part, where the ſurface is rough, the *trachelomaſtoideus*, and part of the *ſplenius*, are fixed.—— About an inch farther forward, the ſecond proceſs begins to riſe out from the bone; and having its origin continued obliquely downwards and forwards for ſome way, it becomes ſmaller, and is ſtretched forwards to join with the *os malæ*; they together forming the bony *jugum*, under which the temporal muſcle paſſes. Hence this proceſs has been named *zygomatic* (*c*). Its upper edge has the ſtrong aponeuroſis of the *temporal* muſcle fixed into it; and its lower part gives riſe to a ſhare of

(*a*) Κροταφων, κορσων, κορρων, λιτιδοειδη, πολυειδη, λιθοειδη, temporalia, lapidoſa, mendoſa, dura, arcularia, tympanum, armalia, ſaxea, parietalia.

(*b*) Albin. de Oſſib. § 26.

(*c*) Καγκρος, paris, anſæ oſſium temporum, oſſa arcualia, paria, jugalia, conjugalia.

of the *maſſeter*.——The fore-part of the baſe of this proceſs is an oblong tubercle, which, in a recent ſubject, is covered with a ſmooth poliſhed cartilage, continued from that which lines the cavity immediately behind this tubercle.——From the under craggy part of the *os temporum*, the third proceſs ſtands out obliquely forwards. The ſhape of it is generally ſaid to reſemble the ancient *ſtylos ſcriptorius*; and therefore it is called the *ſtyloid* proceſs (*a*). Some authors (*b*) however contend, that it ought to be named *ſteloid*, from its being more like to a pillar. Several muſcles have their origin from this proceſs, and borrow one-half of their name from it; as *ſtylo-gloſſus*, *ſtylo-hyoideus*, *ſtylo-pharyngeus*: to it a ligament of the *os hyoides* is ſometimes fixed; and another is extended from it to the inſide of the angle of the lower jaw. This proceſs is often, even in adults, not entirely oſſified, but is ligamentous at its root, and ſometimes is compoſed of two or three diſtinct pieces.—Round the root of it, eſpecially at the fore-part, there is a remarkable riſing of the *os petroſum*, which ſome have eſteemed a proceſs; and, from the appearance it makes with the *ſtyliform*, have named it *vaginalis*.——Others again have, under the name of *auditory* proceſs, reckoned among the external proceſſes that ſemicircular ridge which, running between the root of the *maſtoid* and *zygomatic* proceſſes, forms the under part of the external *meatus auditorius*.

The ſinuoſities or depreſſions on the external ſurface of each *os temporum* are theſe:——A long *foſſa* at the inner and back part of the root of the mammary proceſs, where the poſterior head of the *digraſtic* muſcle has its origin.——Immediately before the root of the *zygomatic* proceſs, a conſiderable hollow is left for lodging the *crotaphite* muſcle.——Between the *zygomatic*, *auditory*, and *vaginal* proceſſes, a large cavity is formed; through the middle of which, from top to bottom, a fiſſure is obſervable, into which part of the ligament that ſecures the articulation of the lower jaw with this bone is fixed. The fore-part of the cavity being lined with the ſame cartilage which covers the tubercle before it, receives the *condyle* of the jaw; and in the back-part, a ſmall ſhare of the parotid gland and a cellular fatty ſubſtance are lodged.—At the inſide of the root of the *ſtyloid apophyſe*, there is a thimble-like cavity, where the beginning of the internal

(*a*) γραφειδη, ξιλοειδη, πλεκτον, os calaminum, ſagittale, clavale, acuale, calcar capitis.

(*b*) Galen, de Uſu Part. lib. 2. cap. 4.—Fallop. Obſerv. Anatom.

internal jugular vein, or end of the lateral *ſinus*, is lodged.—And as the ſinuſes of the two ſides are frequently of unequal ſize, ſo one of theſe cavities is as often larger than the other (*a*).——Round the external *meatus auditorius*, ſeveral ſinuoſities are formed for receiving the cartilages and ligaments of the ear, and for their firm adheſion.

The *holes* that commonly appear on the outſide of each of theſe bones, and are proper to each of them, are five.——The *firſt*, ſituated between the *zygomatic* and *maſtoid* proceſſes, is the orifice of a large funnel-like canal, which leads to the organ of hearing; therefore is called *meatus auditorius externus* (*b*).—The *ſecond* gives paſſage to the *portio dura* of the ſeventh pair of nerves; and, from its ſituation between the *maſtoid* and *ſtyloid* proceſſes, is called *foramen ſtylo-maſtoideum* (*c*).—Some way before, and to the inſide of *the ſtyloid* proceſs, is the *third* hole; the canal from which runs firſt upwards, then forwards, and receives into it the internal *carotid* artery, and the beginning of the intercoſtal nerve. Where this canal is about to make the turn forwards, one, or ſometimes two very ſmall holes go off towards the cavity of the ear, called *tympanum:* Through theſe *Valſalva* (*d*) affirms the proper artery or arteries of that cavity are ſent. —On the anterior edge of this bone, near the former, a *fourth* hole is obſervable, being the orifice of a canal which runs outwards and backwards, in a horizontal direction, till it terminates in the *tympanum*. This, in the recent ſubject, is continued forward and inward, from the parts which I mentioned juſt now as its orifice in the ſkeleton, to the ſide of the noſtrils; being partly cartilaginous, and partly ligamentous. The whole canal is named *iter a palato ad aurem*, or *Euſtachian tube*.—On the external ſide of the bony part of this canal, and a-top of the chink in the cavity that receives the *condyle* of the lower jaw, is the courſe of the little nerve ſaid commonly to be reflected from the lingual branch of the fifth pair, till it enters the *tympanum*, to run acroſs this cavity, and to have the name of *chorda tympani*.—The *fifth* hole is very uncertain, appearing ſometimes behind the *maſtoid* proceſs; ſometimes it is common to the temporal and occipital bones; and in ſeveral ſkulls there is no ſuch hole. The uſe of it,

(*a*) Hunauld, in Mem. de l'Acad. des Sciences, 1730.

(*b* Πορος της ακοης, ουτω τον οτων, feneſtra aurium.

(*c*) Aquæductus Fallopii.

(*d*) De Aure Humana, cap. 2. § 22. et tab. 7. fig. 1.

when found, is for the tranſmiſſion of a vein from the external teguments to the lateral *ſinus:* But, in ſome ſubjects, a branch of the occipital artery paſſes through this hole, to ſerve the back-part of the *dura mater;* in others, I have ſeen two or three ſuch holes; but they are oftener wanting than found. And we may, once for all, in general remark, that the largeneſs, number, ſituation, and exiſtence, of all ſuch holes, that for the moſt part allow only a paſſage for veins from without to the internal receptacles, are very uncertain.

The internal ſurface of the *oſſa temporum* is unequal, the upper circular edge of the ſquamous part having numerous ſmall ridges and furrows for its conjunction with the parietal bones; and the reſt of it is irregularly marked with the convolutions of the middle part of the brain, and with furrows made by the branches of the arteries of the *dura mater.*

From the under part of this internal ſurface, a larger tranſverſe hard craggy protuberance runs horizontally inwards and forwards, with a ſharp edge above, and two flat ſides; one facing obliquely forwards and outwards, and the other as much backwards and inwards. To the ridge between theſe two ſides, the large lateral proceſs of the *dura mater* is fixed.

Sometimes a ſmall bone, a-kin to the ſeſamoid, is found between the ſmall end of this *petrous* proceſs and the *ſphenoid* bone (*a*).

Towards the back-part of the inſide of the *os temporum*, a large deep *foſſa* is conſpicuous, where the *lateral ſinus* lies; and frequently, on the top of the *petrous* ridge, a furrow may be obſerved, where a ſmall ſinus is ſituated.

The internal proper *foramina* of each of theſe bones are, *firſt*, the internal *meatus auditorius* in the poſterior plain ſide of the petrous proceſs. This hole ſoon divides into two; one of which is the *aqueduct* of *Fallopius;* the other ends in ſeveral very ſmall canals (*b*), that allow a paſſage to the branches of the *portio mollis* of the ſeventh pair of nerves, into the *veſtibule* and *cochlea.* Through it alſo an artery is ſent, to be diſtributed to the organ of hearing.——The *ſecond* hole, which is on the anterior plain ſide of the craggy proceſs, gives paſſage to a reflected branch of the

ſecond

(*a*) Riolan. Comment. de Oſſibus, cap. 32.—Winſlow, Expoſition Anatomique de Corps Humain, traite des os ſecs, § 266.

(*b*) Valſalv. de Aure Humana, cap. 3. § 11.

ſecond branch of the fifth pair of nerves, which joins the *portio dura* of the auditory nerve, while it is in the *aqueduct* (*a*); ſmall branches of blood-veſſels accompanying the nerves, or paſſing through ſmaller holes near this one.—The paſſage of the cutaneous vein into the lateral *ſinus*, or of a branch of the occipital artery, is ſeen about the middle of the large *foſſa* for that *ſinus*; and the orifice of the canal of the *carotid* artery is evident at the under part of the point of the *petrous* proceſs.

Beſides theſe proper holes of the temporal bones which appear on their external and internal ſurfaces, there are two others in each ſide that are common to this bone, and to the *occipital* and *ſphenoidal* bones; which ſhall be mentioned afterwards in the deſcription of theſe bones.

The upper round part of the ſquamous bones is thin, but equal; while the low petrous part is thick and ſtrong, but irregular and unequal, having the diſtinction of tables and *diploë* confounded, with ſeveral cavities, proceſſes, and bones within its ſubſtance, which are parts of the organ of hearing. That a clear idea may be had of this beautiful, but intricate organ, anatomiſts generally chooſe to demonſtrate all its parts together. I think the method good; and therefore, ſince it would be improper to inſert a complete treatiſe on the ear here, ſhall omit the deſcription of the parts contained within the *os petroſum* of the ſkeleton.

The temporal bones are joined above to the parietal bones by the ſquamous ſutures and their poſterior *additamenta*: before, to the *ſphenoid* bone by the ſuture of that name; to the cheek-bones, by the *zygomatic* ſutures; behind, to the *occipital* bone by the *lambdoid* ſuture and its *additamenta*; and they are articulated with the *lower jaw* in the manner which ſhall be deſcribed when this bone is examined.

The purpoſes which theſe two bones ſerve are eaſily collected, from the general uſe of the *cranium*, and from what has been ſaid in the deſcription of their ſeveral parts.

In an infant, a ſmall fiſſure is to be obſerved between the thin upper part and the lower craggy part of each of theſe bones; which points out the recent union of theſe parts.——Neither *maſtoid* nor *ſtyloid* proceſſes are yet to be ſeen.—Inſtead of a bony funnel-like external *meatus auditorius*, there is only a ſmooth bony ring, within which the membrane of the

(*a*) Valſalv. de Aure, cap. 3. § 10.

drum is faſtened.——At the entry of the *Euſtachian tube*, the ſide of the *tympannm* is not completed.——A little more outward than the internal auditory canal, there is a deep pit, over the upper part of whoſe orifice the interior ſemicircular canal of the ear is ſtretched; and, ſome way below this, the poſterior ſemicircular canal alſo appears manifeſtly.

Os occipitis (*a*), ſo called from its ſituation, is convex on the outſide, and concave internally. Its figure is an irregular ſquare, or rather *rhomboid;* of which the angle above is generally a little rounded; the two lateral angles are more finiſhed, but obtuſe; and the lower one is ſtretched forward in form of a wedge, and thence is called by ſome the *cuneiform* proceſs.——If one would, however, be very nice in obſerving the ſeveral turns which the edges of the *os occipitis* make, five or ſeven ſides, and as many angles, of this bone might be deſcribed.

The external ſurface is convex, except at the cuneiform apophyſe, where it is flatted. At the baſe of this triangular proceſs, on each ſide of the great hole, but more advanced forwards than the middle of it, the large oblong protuberances, named the *condyles*, appear, to ſerve for the articulation of this bone with the firſt *vertebra* of the neck. The ſmooth ſurface of each of theſe *condyloid* proceſſes is longeſt from behind forwards, where, by their oblique ſituation, they come much nearer to each other than they are at their back-part. Their inner ſides are lower than the external, by which they are prevented from ſliding to either ſide out of the cavities of the firſt *vertebra* (*b*). In ſome ſubjects, each of theſe plain ſmooth ſurfaces ſeems to be divided by a ſmall riſing in its middle; and the lower edge of each condyle, next the great *foramen*, is diſcontinued about the middle, by an intervening notch: whence ſome (*c*) allege, that each of theſe *apophyſes* is made up of two protuberances.—Round their root a ſmall depreſſion and ſpongy roughneſs is obſervable, where the ligaments for ſurrounding and ſecuring their articulations adhere. Though the motion of the head is performed on the condyles, yet the centre of gravity of that globe does not fall between them, but is a good way further forward; from which mechaniſm it is evident, that the muſcles which pull the head back muſt be

(*a*) Ἰνιον, baſilare, proræ, memoriæ, pixidis, fibroſum, nervoſum, lambde.

(*b*) Galen. de Uſu Part. lib. 12. cap. 7. (*c*) Diembroeck, Anat. lib. 9. cap. 6.

be in a conſtant ſtate of contraction; which is ſtronger than the natural contraction of the proper flexors, elſe the head would always fall forwards, as it does when a man is aſleep, or labours under a palſy, as well as in infants, where the weight of the head far exceeds the proportional ſtrength of theſe muſcles. This ſeeming diſadvantageous ſituation of the condyles is however of good uſe to us, by allowing ſufficient ſpace for the cavities of the mouth and *fauces*, and for lodging a ſufficient number of muſcles, which commonly ſerve for other uſes; but may at pleaſure be directed to act on the head, and then have an advantageous lever to act with, ſo as to be able to ſuſtain a conſiderable weight appended, or other force applied, to pull the head back.

Somewhat more externally than the *condyles*, there is a ſmall riſing and ſemilunated hollow in each ſide, which make part of the holes common to the *occipital* and *petrous* bones. Immediately behind this, on each ſide, a ſcabrous ridge is extended from the middle of the condyle towards the root of the *maſtoid* proceſs. Into this ridge the *muſculus lateralis*, commonly aſcribed to *Fallopius*, is inſerted. About the middle of the external convex ſurface, a large arch runs croſs the bone; from the upper lateral parts of which the *occipital* muſcles have their riſe: to its middle the *trapezii* are attached; and half way between this and the great hole, a leſſer arch is extended.—In the hollows between the middle of theſe arches, the *complexi* are inſerted; and in the depreſſions more external and further forward than theſe, the *ſplenii* are inſerted. Between the middle of the leſſer arch and the great hole, the little hollow marks of the *recti minores* appear; and on each ſide of theſe the fleſhy inſertions of the *obliqui ſuperiores* and *recti majores* make depreſſions. Through the middle of the two arches a ſmall ſharp *ſpine* is placed, which ſerves as ſome ſort of partition between the muſcles of different ſides, or rather is owing to the action of the muſcles depreſſing the bone on each ſide of it, while this part is free from their compreſſion. Theſe prints of the muſcles on this bone are very ſtrong and plain in ſome ſubjects, but are not ſo diſtinct in others. All round the great *foramen* the edges are unequal, for the firmer adheſion of the ſtrong circular ligament which goes thence to the firſt *vertebra*. One end of each *lateral* or *moderator* ligament of the head, is fixed to a rough ſurface at the fore-part of each condyle; and

the

the *perpendicular* one is connected to a rough part of the edge of the great hole between the two condyles. Immediately before the condyles, two little depreſſions are made in the external ſurface of the cuneiform proceſs, for the inſertion of the *recti anteriores minores* muſcles, which are unjuſtly aſcribed to *Cowper:* And ſtill further forward, near the *ſphenoid* bone, are two other ſuch depreſſions, for the reception of the *recti anteriores majores*. When we conſider the ſize of the prints of muſcles on the occipital bone, before and behind its condyles, and at the ſame time compare their diſtances from theſe centres of motion of the head, we muſt ſee how much ſtronger the muſcles are which pull the head backwards, than thoſe are which bend it forward; and how much greater force the former acquire by the long lever they act with, than the latter which are inſerted ſo near the condyles. This great force in the extenſor muſcles is altogether neceſſary, that they might not only keep the head from falling forward in an erect poſture, but that they might ſupport it when we bow forward in the moſt neceſſary offices of ſocial life, when the weight of the head comes to act at right angles on the *vertebræ* of the neck, and obtains a long lever to act with.

On the inner ſurface of the *os occipitis* we ſee two ridges; one ſtanding perpendicular, the other running horizontally acroſs the firſt. The upper part of the perpendicular limb of the croſs, to which the *falx* is fixed, is hollowed in the middle, or often on one ſide, for the reception of the *ſuperior longitudinal ſinus*; and the lower part of it has the ſmall or third proceſs of the *dura mater* faſtened to it, and is ſometimes hollowed by the *occipital ſinus*. Each ſide of the horizontal limb is made hollow by the lateral ſinuſes incloſed in the tranſverſe proceſs of the *dura mater;* the *foſſa* in the right ſide being generally a continuation of the one made by the longitudinal ſinus in the perpendicular limb, and therefore is larger than the left one (*a*). Round the middle of the croſs there are four large depreſſions ſeparated by its limbs; the two upper ones being formed by the back-part of the brain, and the two lower ones by the *cerebellum*.— Farther forward than the laſt-mentioned depreſſions, is the lower part of the *foſſa* for the lateral *ſinus* on each ſide. The inner ſurface of the cuneiform apophyſe is made concave for the reception of the *medulla oblongata*,

(*a*) Morgagn. Adverſ. Anat. 6. animad. 1.

gata, and of the *baſilar* artery. A furrow is made on each ſide near the edges of this proceſs, by a *ſinus* of the *dura mater*, which empties itſelf into the lateral *ſinus* (*a*).

The holes of this bone are commonly five proper, and two common to it and to the *temporal* bones. The firſt of the proper holes, called *foramen magnum* (*b*), from its ſize, is immediately behind the wedge-like proceſs, and allows a paſſage to the *medulla oblongata*, *nervi acceſſorii*, to the vertebral arteries, and ſometimes to the vertebral veins. At each ſide of this great hole, near its fore-part, and immediately above the condyles, we always find a hole, ſometimes two, which ſoon unite again into one that opens externally; through theſe the ninth pair of nerves go out of the ſkull. The fourth and fifth holes pierce from behind the *condyle* of each ſide into the *foſſæ* of the lateral *ſinuſes*; they ſerve for the paſſage of the cervical veins to theſe *ſinuſes*. Often one of theſe holes is wanting, ſometimes both, when the veins paſs through the great *foramen*. Beſides theſe five, we frequently meet with other holes near the edges of this bone, for the tranſmiſſion of veins; but their number and diameter are very uncertain. The two common *foramina* are the large irregular holes, one in each ſide, between the ſides of the *cuneiform* proceſs and the edges of the *petrous* bones. In a recent ſubject, a ſtrong membrane runs croſs from one ſide to the other of each of theſe holes; in ſome heads, I have ſeen this membrane oſſified, or a bony partition dividing each hole; and in the great number of adult ſkulls, there is a ſmall ſharp-pointed proceſs ſtands out from the *os petroſum*, and a more obtuſe riſing in the occipital bone, between which the partition is ſtretched. Behind this partition, where the largeſt ſpace is left, the *lateral ſinus* has its paſſage; and before it the eighth pair of nerves and *acceſſorius* make their exit out of the ſkull; and ſome authors ſay an artery paſſes through this hole, to be beſtowed on the *dura mater*.

The *occipital* bone is among the thickeſt of the *cranium*, though unequally ſo; for it is ſtronger above, where it has no other defence than the common teguments, than it is below, where, being preſſed by the lobes of the brain and *cerebellum* on one ſide, and by the action of the muſcles on the other, it is ſo very thin, as to be diaphanous in many ſkulls: but then

(*a*) Albin. de Oſſib. § 65. (*b*) Rachitidis, medullæ ſpinalis.

then theſe muſcles ward off injuries; and the ridges and ſpines, which are frequent here, make it ſufficiently ſtrong to reſiſt ordinary forces.

The tables and *diploë* are tolerably diſtinct in this bone, except where it is ſo thin as to become diaphanous.

The occipital bone is joined above to the *oſſa parietalia*, and *triquetra* when preſent, by the *lambdoid* ſuture; laterally to the temporal bones, by the *additamenta* of the *lambdoid* ſuture; below to the *ſphenoid* bone, by the end of its cuneiform proceſs, in the ſame way that epiphyſes and their bones are joined: for in children a ligamentous cartilage is interpoſed between the occipital and ſphenoid bones, which gradually turns thinner as each of the bones advances, till their fibres at laſt run into each other; and, about ſixteen or eighteen years of age, the union of theſe two bones becomes ſo intimate, that a ſeparation cannot be made without violence. The *os occipitis* is joined by a double articulation to the firſt *vertebra* of the neck, each condyle being received into a ſuperior oblique proceſs of that *vertebra*. What motion is allowed here, we ſhall conſider afterwards, where the *vertebræ* are deſcribed.

The uſes of this bone appear from the preceding deſcription, and therefore need not be repeated.

An infant born at the full time has this bone divided, by unoſſified cartilages, into four parts.——The firſt of theſe is larger than the other three, is of a triangular ſhape, and conſtitutes all the part of the bone above the great *foramen*. Generally fiſſures appear in the upper part and ſides of this triangular bone, when all the cartilage is ſeparated by maceration; and ſometimes little diſtinct bones are ſeen towards the edges of it. The ſecond and third pieces of this bone are exactly alike, and ſituated on each ſide of the great *foramen*: from which very near the whole condyles are produced; and they are extended forwards almoſt to the fore-part of the hole for the ninth pair of nerves. The fourth piece is the cuneiform proceſs, which forms a ſmall ſhare of the great hole, and of theſe for the ninth pair of nerves, and of the condyles; betwixt it and the *ſphenoid* bone a cartilage is interpoſed.

Of the eight bones which belong to the *cranium*, there are anly two which are not yet deſcribed, viz. the *ethmoid* and *ſphenoid*. Theſe we already mentioned, in complaiſance to the generality of writers on this ſubject,

ſubject, as bones common to the *cranium* and face, becauſe they enter into the compoſition of both: but the ſame reaſon might equally be uſed for calling the frontal bone a common one too. I ſhall, however, paſs any idle diſpute about the propriety of ranging them, and proceed to examine the ſtructure of the bones themſelves.

Os ETHMOIDES (*a*), or the ſieve-like bone, has got its name from the great number of ſmall holes with which that part of it firſt taken notice of is pierced. When this bone is entire, the figure of it is not eaſily deſcribed: but by a detail of its ſeveral parts, ſome idea may be afforded of the whole; and therefore I ſhall diſtinguiſh it into the *cribriform lamella* with its proceſs, the *naſal lamella*, *cellulæ*, and *oſſa ſpongioſa*.

The thin horizontal *lamella* is all (except its back-part) pierced obliquely by a great number of ſmall holes, through which the filaments of the olfactory nerves paſs. In a recent ſubject, theſe holes are ſo cloſely lined by the *dura mater*, that they are much leſs conſpicuous than in the *ſkeleton*. From the middle of the internal ſide of this plate a thick proceſs riſes upwards; and being higheſt at the fore-part, gradually becomes lower as it is extended backwards. From ſome reſemblance which this proceſs was imagined to have to a cock's comb, it has been called *criſta galli* (*b*). The *falx* is connected to its ridge, and to the unperforated part of the cribriform plate. When the *criſta* is broke, its baſe is ſometimes found to be hollow, with its cavity opening into the noſe (*c*) Immediately before the higheſt part of this proceſs is the blind hole of the *frontal* bone; which, as was formerly remarked, is often in a good meaſure formed by a notch in the fore-part of the root of the *criſta*.

From the middle of the outer ſuface of the *cribriform lamella*, a thin ſolid plate is extended downwards, having the ſame common baſe with the *criſta galli*. Generally it is not exactly perpendicular, but is inclined to one ſide or other, and therefore divides the cavity of the noſe unequally. Its inclination to one ſide, and flexure in the middle, is ſometimes ſo great, that it fills up a large ſhare of one of the noſtrils, and has been miſtook for a *polypus* there. It is thin at its riſe, and rather ſtill

(*a*) Cribriforme, ανεγγοειδες, ſpongiforme, criſtatum.

(*b*) Verruca prædura, ſeptum oſſis ſpongioſi.

(*c*) Palfyn. Anat. Chir. traité 4. chap. 15.

thinner in its middle; yet afterwards, towards its lower edge, it becomes thicker, that its conjunction with the bones and middle cartilage of the noſe might be firmer.

At a little diſtance from each ſide of this external proceſs, a cellular and ſpongy bony ſubſtance depends from the cribriform plate. The number and figure of the cells in this irregular proceſs of each ſide, are very uncertain, and not to be repreſented in words; only the cells open into each other, and into the cavity of the noſe: the uppermoſt, which are below the aperture of the frontal *ſinuſes*, are formed like funnels. The outer ſurface of theſe cells is ſmooth and plain, where this bone aſſiſts in compoſing the orbit; at which place, on each ſide, it has got the name of *os planum;* on the upper edge of which a ſmall notch or two may ſometimes be obſerved, which go to the formation of the internal orbitar holes; as was remarked in the deſcription of the frontal bone.

Below the cells of each ſide, a thin plate is extended inwards; and then bending down, it becomes thick and of a ſpongy texture.——This ſpongy part is triangular, with a ſtraight upper edge placed horizontally, an anterior one ſlanting from above downwards and forwards, and with a pendulous convex one below.—The upper and lower edges terminate in a ſharp point behind.—The ſide of this pendulous ſpongy part next to the *ſeptum narium* is convex, and its external ſide is concave.——Theſe two proceſſes of the *ethmoid* bone have got the name of *oſſa ſpongioſa*, or *turbinata ſuperiora*, from their ſubſtance, figure, and ſituation.

All the prominences, cavities, and *meanders* of this *ethmoid* bone, are covered with a continuation of the membrane of the noſtrils in a recent ſubject.——Its horizontal cribriform plate is lodged between the orbitar proceſſes of the *frontal* bone, to which it is joined by the *ethmoid* ſuture, except at the back part where it is connected with the *cuneiform* bone, by a ſuture common to both theſe bones, though it is generally eſteemed part of the *ſphenoidal.*——Where the *oſſa plana* are contiguous to the frontal bone within the orbit, their conjunction is reckoned part of the tranſverſe ſuture.——Farther forward than the *oſſa plana*, the cells are covered by the *oſſa unguis;* which are not only contiguous to theſe cells, but cannot be ſeparated from them without breaking the bony ſubſtance; and therefore, in juſtice, thoſe bones ought to be demonſtrated as part of the

ethmoid

ethmoid bone.——Below the *ossa unguis* and *plana*, these cells and *ossa spongiosa* are overlopped by the *maxillary* bones.——The cellular part of each *palate* bone is contiguous to each *os planum* and cells backwards.—The lower edge of the nasal perpendicular plate is received into the furrow of the *vomer*.—Its posterior edge is joined to the fore-part of the *processus azygos* of the *sphenoid* bone.——Its upper edge joins the *nasal* process of the *frontal* and *nasal* bones, and its anterior one is connected to the middle cartilage of the nose.

From all which, the uses of this bone are evident, viz. to sustain the anterior lobes of the brain; to give passage to the olfactory nerves, and attachment to the *falx*; to enlarge the organ of smelling, by allowing the membrane of the nose a great extent; to straiten the passage of the air through the nose, by leaving only a narrow winding canal, on the sensible membranous sides of which the substances conveyed along with the air must strike; to form part of the orbit of the eyes and *septum narium*; while all its parts are so light, as not to be in hazard of separating by their weight; and they are so thin, as to form a large surface without occupying much space. This brittle substance, however, is sufficiently protected from external injuries by the firm bones which cover it.

If this bone is seized on by any corroding matter, we may easily conceive what destruction may ensue. Hence it is, that an *ozæna* is difficult to cure; and that in violent *scurvies*, or in the *lues venerea*, the fabric of the nose, the eyes, and life itself, are in danger.—The situation of the nasal plate may shew us how dangerous a fracture of the bones of the nose may be, when made by a force applied to their middle fore-part, of a person in whom this nasal plate is perpendicular.

The *ethmoid* bone of ripe children is divided into two by a perpendicular cartilage, which, when ossified, is the *crista galli* and nasal plate; but its other parts are ossified and complete.

Os SPHENOIDES (*a*), or wedge-like bone, so called because of its situation in the middle of the bones of the *cranium* and face, is of such an irregular figure, that I know not any thing to which it may be likened,

 unless,

(*a*) Cuneiforme, πολυμορφον multiforme, paxillum, cribratum, palati, colatorii, cavilla, basilare.

unleſs, perhaps, it bear ſome faint reſemblance to a bat with its wings extended.

When we view the external ſurface of the *os ſphenoides*, two or three remarkable proceſſes from each ſide of it may be obſerved, which are all of them again ſubdivided.—The firſt pair is the two large lateral proceſſes or wings; the upper part of each of which is called the *temporal proceſs*, becauſe they join with the temporal bones in forming the temples, and the ſeat for ſome ſhare of the *crotaphite* muſcles. That part of the wings which jutts out towards the inſide, ſomewhat lower than the temporal *apophyſes*, and is ſmooth and hollowed where it makes up part of the orbit, is thence named *orbitar proceſſes*. Behind the edge, ſeparating theſe two proceſſes, there is often a ſmall groove made by a branch of the ſuperior maxillary nerve in its paſſage to the temporal muſcle. The loweſt and back part of each wing, which runs out ſharp to meet the *oſſa petroſa*, has been ſtyled the *ſpinous* proceſs: from near the point of which a ſharp pointed proceſs is frequently produced downwards, which ſome call *ſtyliform*, that affords origin to the *ptery-ſtaphylinus externus* muſcle. From this ſtyloid proceſs a very ſmall groove is extended along the edge of the bone to the hollow at the root of the internal plate of the following proceſſes, which forms part of the *Euſtachian* tube (*a*).—The ſecond pair of external proceſſes of the *cuneiform* bone is the two which ſtand out almoſt perpendicular to the baſe of the ſkull. Each of them has two plates, and a middle *foſſa* facing backwards; and ſhould, to carry on our compariſon, be likened to the bat's legs, but are commonly ſaid to reſemble the wings of that creature; and therefore are named *pterygoid* or *aliform* (*b*) proceſſes. The external plates are broadeſt, and the internal are longeſt. From each ſide of the external plates the *pterygoid* muſcles take their riſe. At the root of each internal plate a ſmall hollow may be remarked, where the *muſculus ptery-ſtaphylinus internus*, or *circumflexus palati*, riſes, and ſome ſhare of the cartilaginous end of the *Euſtachian* tube reſts; and, at the lower end of the ſame plate, is a hook-like riſing or proceſs, round which the tendon of the laſt-named muſcle plays, as on a pulley. From the edge of the external plates ſome ſmall ſharp ſpikes ſtand out; but their number

(*a*) Winſlow, Expoſition Anatomique du Corps Humain, traité des os ſecs, § 233.

(*b*) Naviculares.

number and bulk are uncertain.——To theſe another pair may be added, to wit, the little triangular thin proceſs, which comes from each ſide of the body of the *ſphenoid* bone, where the *pterygoid* proceſſes are riſing from it, and are extended over the lower part of the aperture of the *ſinus* as far as to join the *ethmoid* bone, while their body hangs down into the *nares* (*a*).—Beſides theſe pairs of proceſſes, there is a ſharp ridge which ſtands out from the middle of its baſe: becauſe it wants a fellow, it may be called *proceſſus azygos*. The lower part of this proceſs, where it is received into the *vomer*, is thick, and often not quite perpendicular, but inclining more to one ſide than the other. The fore-part of this proceſs, where it joins the naſal plate of the *os ethmoides*, is thin and ſtraight. Theſe two parts have been deſcribed as two diſtinct proceſſes by ſome.

The depreſſions, ſinuoſities, and *foſſæ*, on the external ſurface of this *ſphenoid* bone, may be reckoned up to a great number, viz. two on the temporal *apophyſes* where the *crotaphite* muſcles lodge.—Two on the *orbitar* proceſſes, to make way for the globes of the eyes.—Two between the *temporal* and *ſpinous* proceſſes, for receiving the temporal bones.—Two between the plates of the *pterygoid* proceſſes, where the *muſculi pterygoidei interni* and *ptery-ſtaphylini interni* are placed.—Two between the *pterygoid* and *orbitar* proceſſes, for forming the holes common to this and to the *cheek* and *maxillary* bones. Two on the lower ends of the *aliform* proceſſes, which the *palate* bones enter into.—Two at the roots of the *temporal* and *pterygoid* proceſſes, where the largeſt ſhare of the external *pterygoid* muſcles have their riſe.—Two at the ſides of the *proceſſus azygos*, for forming part of the noſe, &c.

What I deſcribed under the name of *temporal* and *ſpinous proceſſes* on the outſide of the ſkull, are likewiſe ſeen on its inſide, where they are concave, for receiving part of the brain; and commonly three *apophyſes* on the internal ſurface of the *ſphenoid* bone are only mentioned.—Two, riſing broad from the fore-part of its body, become ſmaller as they are extended obliquely backwards.—The third, ſtanding on a long tranſverſe baſe near the back-part of the body of this bone, riſes nearly erect, and of an equal breadth, terminating often in a little knob on each ſide. The three are called *clinoid*, from ſome reſemblance which they were thought to

(*a*) Albin. Tab. Oſſ. 5. fig. 2. 6. A A.——Bertin. Mem. de l'Acad. des Sciences 1744.—Sue, planche vii. fig. 2, 3, 4, 5, 6.

to have to the ſupporters of a bed. Sometimes one or both the anterior *clinoid* proceſſes are joined to the ſides of the poſterior one, or the body of the bone itſelf.—From the roots of the anterior *clinoid* proceſſes the bone is extended on each ſide outwards and forwards, till it ends in a ſharp point, which may have the name of the *tranſverſe ſpinous* proceſſes.—— Between, but a little farther back than the two anterior *clinoid* proceſſes, we ſee a protuberance conſiderably ſmaller than the poſterior *clinoid* proceſs, but of its ſhape.—Another proceſs from between the tranſverſe proceſſes often forces itſelf forwards into the *os ethmoides*.

Within the ſkull, there are two ſinuoſities on the internal part of each wing of the *ſphenoid* bone, for receiving the middle part of the brain.— One between the tranſverſe ſpinous proceſſes, for lodging the part of the brain where the *crura medullæ oblongatæ* are.——Immediately before the third or middle *clinoid* proceſs, a ſingle pit may generally be remarked, from which a *foſſa* goes out on each ſide to the holes through which the optic nerves paſs. The pit is formed by the conjoined optic nerves; and in the *foſſæ* theſe nerves are lodged, as they run divided within the ſkull.— Between that third protuberance and the poſterior *clinoid* proceſs, the larger pit for the *glandula pituitaria* may be remarked. This cavity, becauſe of its reſemblance to a *Turkiſh* ſaddle, is always deſcribed under the name of *ſella Turcica*, or *ephippium*.——On the ſides of the poſterior *clinoid* proceſs a *foſſa* may be remarked, that ſtretches upwards, then is continued forwards along the ſides of the *ſella Turcica*, near to the anterior *clinoid* proceſſes, where a pit on each ſide is made. Theſe *foſſæ* point out the courſe of the two internal *carotid* arteries, after they have entered the ſkull.—Beſides all theſe, ſeveral other *foſſæ* may be obſerved, leading to the ſeveral holes, and imprinted by the nerves and blood-veſſels.

The holes on each ſide of the *os ſphenoides* are ſix proper, and three common.——The *firſt* is the round one immediately below the anterior *clinoid* proceſſes, for the paſſage of the optic nerve, and of the branch of the internal *carotid* artery that is ſent to the eye.——The *ſecond* is the *foramen lacerum*, or large ſlit between the tranſverſe ſpinous and orbitar proceſſes: the interior end of which ſlit is large; and, as it is extended outwards, it becomes narrower. The outer end of it is formed in the *os frontis*; and therefore this might be reckoned among the common *foramina*.

ramina. Through it the third, fourth, the firſt branch of the fifth, and the greater ſhare of the ſixth pair of nerves, and an artery from the internal carotid, go into the orbit. Sometimes a ſmall branch of the external carotid enters near its end, to be diſtributed to the *dura mater* (*a*), and a vein, ſome call it the *venous duct*, or *Nuck's aqueduct*, returns through it to the cavernous *ſinus*.——The *third* hole, ſituated a little below the one juſt now deſcribed, is called *rotundum*, from its ſhape. It allows paſſage to the ſecond branch of the fifth pair of nerves, or ſuperior maxillary nerve, into the bottom of the orbit.——The *fourth* is the *foramen ovale*, about half an inch behind the round hole. Through it the third branch of the fifth pair, or inferior *maxillary* nerve, goes out; and ſometimes a vein from the *dura mater* paſſes out here (*b*).——Very near the point of the ſpinous proceſs is the *fifth* hole of this bone: it is ſmall and round, for a paſſage to the largeſt artery of the *dura mater*, which often is accompanied with a vein.——The *ſixth* proper hole (*c*) cannot be well ſeen till the cuneiform bone is ſeparated from all the other bones of the *cranium*; for one end of it is hid by a ſmall protuberance of the internal plate of the *pterygoid* proceſs, and by the point of the *proceſſus petroſus* of the *temporal* bone. Its canal is extended above the inner plate of the *pterygoid* proceſs; and where it opens into the cavity of the noſe, it is concealed by the thin laminous part of the *palate* bone. Through it a conſiderable branch of the ſecond branch of the *fifth* pair of nerves is reflected.——Often, in the middle of the *ſella Turcica*, a ſmall hole or two pierce as far as the cellular ſubſtance of the bone; and ſometimes, at the ſides of this *ſella*, one or more ſmall holes penetrate into the *ſphenoidal ſinuſes*. Theſe obſervations afforded ſome anatomiſts (*d*) an argument of weight in their days, in defence of *Galen* (*e*), who aſſerted the deſcent of the *pituita* that way into the *ſinuſes* below.

The *firſt* of the common holes is that unequal fiſſure at the ſide of the *ſella*

(*a*) Winſlow, Expoſition Anatomique du Corps Humain, traite des arteres, § 60. et de la tete, § 26.

(*b*) Ingraſſ. Commentar. in Galen. de Oſſib. lib. 1. comment. 8.

(*c*) Veſal. Anat. lib. 1. cap. 12.—Euſtach. Tab. 46. fig. 13. & 16.—Vidus Vidius, Anat. lib. 2. cap. 2. explicat. tab. 5. & tab. 5. fig. 8, 9, 10. lit. O.

(*d*) Jac. Sylv. Calumniæ ſecundæ amolitio.—Laurent. Hiſt. Anat. lib. 2. queſt. 11.

(*e*) Galen. de Uſu Part. lib. 9. cap. 1.

ſella Turcica, between the extreme point of the *os petroſum* and the *ſpinous* proceſs of the cuneiform bone. This hole only appears after the bones are boiled: for, in a recent ſubject, its back-part is covered by a thin bony plate that lies over the internal carotid artery; and further forward it is filled with a cartilaginous ligament, under which the cartilaginous part of the *Euſtachian tube* is placed: It was by this paſſage that the ancients believed the *ſlimy matter* was conveyed from the emunctory of the brain, the *glandula pituitaria*, to the *fauces*.——The *ſecond* common hole is the large diſcontinuation of the external ſide of the orbit, left between the orbitar proceſſes of the cuneiform bone, the *os maxillare*, *malæ*, and *palati*. In this large hole the fat for lubricating the globe of the eye and temporal muſcle is lodged; and branches of the ſuperior maxillary nerve, with ſmall arteries from the carotid and veins, paſs.——The *third* hole is formed between the baſe of this bone and the root of the orbitar proceſs of the palate-bone of each ſide. Through this a branch of the external carotid artery, and of the ſecond branch of the fifth pair of nerves, are allowed a paſſage to the noſtrils, and a returning vein accompanies them. Sometimes, however, this hole is proper to the palate-bone, being entirely formed out of its ſubſtance.

Under the *ſella Turcica*, and ſome way farther forward, but within the ſubſtance of the *ſphenoid* bone, are two *ſinuſes*, ſeparated by a bony plate. Each of them is lined with a membrane, and opens into the upper and back part of each noſtril by a round hole, which is at their upper fore-part. This hole is not formed only by the *os ſphenoides*, which has an aperture near as large as any tranſverſe ſection of the *ſinus*, but alſo by the *palate* bones which are applied to the fore-part of theſe *ſinuſes*, and cloſe them up, that hole only excepted which was already mentioned. Frequently the two *ſinuſes* are of unequal dimenſions; and ſometimes there is only one large cavity, with an opening into one noſtril. Theſe cavities are likewiſe ſaid (*a*) to be extended ſometimes as far back as the great *foramen* of the occipital bone. In other ſubjects they are not to be found, when the bone is compoſed of large cells (*b*). Some (*c*) mention a cavity within the partition of the *ſinuſes*; but it is ſmall.——The *ſphenoidal ſinuſes* ſerve the ſame uſes as the frontal do.

As

(*a*) Albin. de Oſſib. § 39. (*b*) Veſal. lib. 1. cap. 6. (*c*) Id. ibid.

As this bone is extremely ragged and unequal, ſo its ſubſtance is of very different thickneſs, being in ſome places diaphanous; in others it is of a middle thickneſs, and its middle back-part ſurpaſſes the greateſt ſhare of the *cranium* in thickneſs.

The *os ſphenoides* is joined, by its wings, to the *parietal* bones above, to the *os frontis* and *oſſa malarum* before, to the *temporal* bones behind;—— by the fore-part of its body and ſpinous proceſſes, to the *frontal* and *ethmoid* bones;—by its back-part, behind the two *ſinuſes*, to the *occipital*, where it looks like a bone with the *epiphyſes* taken off, and, as was formerly obſerved in the deſcription of the occipital bone, it cannot be ſeparated without violence in adults;—to the *palate* bones, by the ends of the *pterygoid* proceſſes, and ſtill more by the fore-part of the internal plates of the *pterygoid* proceſſes and of the *ſinuſes*;—to the *maxillary* bones, by the fore-part of the external *pterygoid* plates;—to the *vomer* and naſal plate of the *os ethmoides*, by the *proceſſus azygos*. All theſe conjunctions, except the laſt, which is a *ſchindelyſis*, are ſaid to be by the future proper to this bone; though it is at firſt ſight evident, that ſeveral other ſutures, as the *tranſverſe*, *ethmoidal*, &c. are confounded with it.

We ſee now how this bone is joined to all the bones of the *cranium*, and to moſt of the upper jaw; and therefore obtained the name of the *wedge-like bone*.

The uſes are ſo blended with the deſcription, as to leave nothing new to be added concerning them.

The *ſphenoidal bone* is almoſt complete in a *fœtus* of nine months; only the great *alæ* ſeparate after maceration from the body of the bone.—The *proceſſus azygos* is very large and hollow;—the thin triangular proceſſes are not oſſified;—the internal ſurface of the body is unequal and porous;—the *ſinuſes* do not appear.

Whoever is acquainted with each bone of the *cranium*, can without difficulty examine them as they ſtand united, ſo as to know the ſhapes, ſizes, diſtances, &c. of their ſeveral parts, and the forms, capacities, &c. of the cavities formed by them; which is of great uſe towards underſtanding the anatomy of the parts contiguous to, contained within, or connected to them. Such a review is neceſſary, after conſidering each claſs of bones. Thus the orbits, noſtrils, mouth, face, head, ſpine, *thorax*,

pelvis, trunk, extremities, and ſkeleton, ought likewiſe to be examined.

The FACE is the irregular pile of bones, compoſing the fore and under part of the head, which is divided by authors into the upper and lower *maxillæ*, or jaws.

The *ſuperior maxilla* (*a*) is the common deſignation given to the upper immoveable ſhare of the face; though, if we would follow *Celſus* (*b*), we ſhould apply the word *maxilla* to the lower jaw only, and the name *mala* to this upper jaw. In complaiſance to prevailing cuſtom, I ſhall, however, uſe the terms as now commonly employed. The ſhape of the ſuperior jaw cannot eaſily be expreſſed; nor is it neceſſary, provided the ſhape and ſituation of all the bones which compoſe it are deſcribed. It is bounded above by the tranſverſe ſuture; behind, by the fore-part of the *ſphenoid* bone; and below by the mouth.

The upper jaw conſiſts of ſix bones on each ſide; of a thirteenth bone, which has no fellow, placed in the middle; and of ſixteen teeth. The thirteen bones are, two *oſſa naſi*, two *oſſa unguis*, two *oſſa malarum*, two *oſſa maxillaria*, two *oſſa palati*, two *oſſa ſpongioſa inferiora*, and the *vomer*.

The *oſſa naſi* are placed at the upper part of the noſe;—the *oſſa unguis* are at the internal *canthi* of the orbits;—*oſſa malarum* form the prominence of the cheeks;—*oſſa maxillaria* form the ſide of the noſe, with the whole lower and fore-part of the upper jaw, and the greateſt ſhare of the roof of the mouth;—*oſſa palati* are ſituated at the back-part of the palate, noſtrils, and orbit;—*oſſa ſpongioſa* are ſeen in the lower part of the *nares*;—and the *vomer* helps to ſeparate theſe two cavities.

The bones of the *upper jaw* are joined to the bones of the ſkull by the *ſchindyleſis* and ſutures already deſcribed as common to the *cranium* and *face*; and they are connected to each other by *gomphoſis* and fifteen ſutures.

The *gomphoſis* only is where the teeth are fixed in their ſockets; and the *ſchindyleſis* is only where the edges of the *vomer* are joined to other bones.

The ſutures are generally diſtinguiſhed by numbers, which have been differently

(*a*) Σιαγων, γινος, mandibula. (*b*) Lib. 8. cap. 1.

differently applied; and therefore I join thoſe (*a*) who prefer the giving names to each; which may be eaſily contrived from their ſituation, or from the bones which they connect.

The firſt is the *anterior naſal* (*b*); which is ſtraight, and placed longitudinally in the middle fore-part of the noſe.

The ſecond and third are the *lateral naſal* (*c*); which are at each ſide of the noſe, and almoſt parallel to the firſt ſuture.

Each of the two *lacrymal* is almoſt ſemicircular, and is placed round the *lacrymal* groove.

The ſixth and ſeventh are the *internal orbitar*; each of which is extended obliquely from the middle of the lower ſide of an orbit to the edge of its baſe.

The two *external orbitars* are continued, each from the end of the internal orbitar to the under and fore part of the cheek.

The tenth is the *myſtachial*; which reaches only from the lower part of the *ſeptum narium* to between the two middle *dentes inciſores*.

The *longitudinal palate* (*d*) ſuture ſtretches from the middle of the foremoſt teeth through the middle of all the palate.

The *tranſverſe palate* one (*e*) runs acroſs the palate, nearer the back than the fore part of it.

Each of the two *palato-maxillary* is at the back-part of the ſide of each noſtril.

The fifteenth is the *ſpinous*; which is in the middle of the lower part of the noſtrils. This may perhaps be rather thought a double *ſchindyleſis*.

The connection of the *oſſa ſpongioſa* to the ſide of each noſtril is ſo much, by a membrane in young ſubjects, by a ſort of hook, and afterwards by concretion or union of ſubſtance in adults, that I did not know well how to rank it: But if any chooſes to call it a ſuture, the addition of two *tranſverſe naſal* ſutures may be made to thoſe above named.

Theſe ſutures of the face (commonly called *harmoniæ*) have not ſuch

(*a*) Vander Linden. Medicin. Phyſiolog. cap. 13. art. 2. § 10.—Rolfinc. Anat. lib. 2. cap. 25.—Shenk. Schol. Part. § ult. par. 2. cap. 5.

(*b*) Naſalis recta. (*c*) Naſalis obliqua. (*d*) Laquearia, palataria recta.

(*e*) Arcuata, palatina poſtica.

conſpicuous indentations as thoſe of the ſkull have; the bones here not having ſubſtance enough for forming large indentations, and there being leſs neceſſity for ſecurity againſt external injuries, or any internal protruding force, than in the *cranium*.——Theſe ſutures often diſappear in old people, by the bones running into each other; which can do little prejudice, becauſe the principal uſe of the bones being ſo numerous here, is to allow them to be extended into a proper form.

It is evident, from the manner of conjunction of theſe bones, that they can have no motion, except in common with the *cranium*.

The purpoſes which this pile of bones ſerves will be ſhown in the deſcription which I am to give of each of them.

OSSA NASI, ſo named from their ſituation at the root of the noſe, are each of an irregular oblong ſquare figure, being broadeſt at their lower end, narroweſt a little higher than their middle, and becoming ſomewhat larger at the top, where they are ragged and thickeſt, and have a curvature forwards, that their connection with the *frontal* bone might be ſtronger.——Theſe bones are convex externally, and thereby better reſiſt any violence from without; and they are concave internally, for enlarging the cavity of the noſe.

The lower edge of theſe bones is unequal; and is ſtretched outwards and backwards, to join the cartilages of the noſtrils.—Their anterior ſide is thick, eſpecially above, and unequal, that their conjunction to each other might be ſtronger; and a ſmall riſing may be remarked on their inner edge, where they are ſuſtained by the *ſeptum narium*.——Their poſterior ſide, at its upper half, has externally a depreſſion, where it is overlopped ſome way by the *maxillary* bones, while its lower half covers theſe bones: By which contrivance, they do not yield eaſily to preſſure applied to their fore-part or ſides.

A ſmall hole is frequently to be obſerved on their external ſurface, into which two, three, or four holes, which appear internally, terminate, for the tranſmiſſion of ſmall veins; ſometimes the holes go no further than the *cancelli* of the bones.

The *naſal bones* are firm and ſolid, with very few *cells* or *cancelli* in them; the thin ſubſtance of which they conſiſt not requiring much marrow.

They

They are joined above to the *frontal* bone by the middle of the *tranſverſe* ſuture;——behind, to the *maxillary* bones, by the *lateral naſal* ſutures;——below, to the cartilages of the noſe;—before, to one another, by the *anterior naſal* ſuture;—internally, to the *ſeptum narium*.

Theſe bones ſerve to cover and defend the root of the noſe.

In an infant, the *naſal bones* are proportionally ſhorter, and leſs thick at their upper part, than in an adult, but are otherwiſe complete.

OSSA UNGUIS, or LACRYMALIA, are ſo named, becauſe their figure and magnitude are ſomething near to thoſe of a nail of one's finger, and becauſe the tears paſs upon them into the noſe.

Their external ſurface is compoſed of two ſmooth concavities and a middle ridge.——The depreſſion behind forms a ſmall ſhare of the orbit for the eye-ball to move on; and the one before is a deep perpendicular canal or *foſſa*, larger above than below, containing part of the lacrymal *ſac* and *duct*. This is the part that ought to be pierced in the great operation for the *fiſtula lacrymalis*.——This *foſſa* of the bone is cribriform, or has a great number of ſmall holes through it, that the filaments from the membrane which lines it, inſinuating themſelves into theſe holes, might prevent a ſeparation of the membrane, and ſecure the bone in its natural ſituation.——The ridge between theſe two cavities of the *os unguis* is the proper boundary of the orbit at its internal *canthus*, and beyond which ſurgeons ſhould not proceed backwards in performing operations here.——The internal or poſterior ſurface of this bone conſiſts of a furrow in the middle of two convexities.

The ſubſtance of the *os unguis* is as thin as paper, and very brittle; which is the reaſon that thoſe bones are often wanting in ſkeletons, and need little force to pierce them in living ſubjects.

Each of theſe bones is joined above to the *frontal* bone by part of the *tranſverſe* ſuture;—behind, to the *os planum* of the *ethmoid* bone by the ſame ſuture;—before, and below, to the *maxillary* bone, by the *lacrymal* ſuture.—Internally, the *oſſa unguis* cover ſome of the *ſinus ethmoidales*; nay, are really continuous with the bony *lamellæ* which make up the ſides of theſe cells; ſo that they are as much part of the *ethmoid* bone as the *oſſa plana*.

Theſe unguiform bones compoſe the anterior internal parts of the orbits, lodge a ſhare of the lacrymal ſac and duct, and cover the *ethmoid* cells.

cells.——Their ſituation and tender ſubſtance make a raſh operator in danger of deſtroying a conſiderable ſhare of the organ of ſmelling, when he is performing the operation of the *fiſtula lacrymalis:* but when theſe bones are hurt, they caſt off without much difficulty, and conſequently the wound is ſoon cured, unleſs the patient labours under a general *cacoethes*, or there is a prediſpoſition in the bones to *caries;* in which caſe, a large train of bad ſymptoms follow, or, at beſt, the cure proves tedious.

Theſe bones are fully formed in a new-born child.

Ossa malarum (*a*) was the name given by *Celſus*, as was already remarked, to all the upper jaw; but is now appropriated to the prominent ſquare bones which form the cheek on each ſide.——Before, their ſurface is convex and ſmooth; backward, it is unequal and concave, for lodging part of the *crotaphyte* muſcles.

The four angles of each of theſe bones have been reckoned proceſſes by ſome.—The one at the external *canthus* of the orbit, called the *ſuperior orbitar* proceſs, is the longeſt and thickeſt.—The ſecond terminates near the middle of the lower edge of the orbit in a ſharp point, and is named the *inferior orbitar* proceſs.—The third, placed near the lower part of the cheek, and thence called *maxillary*, is the ſhorteſt, and neareſt to a right angle.—The fourth, which is called *zygomatic*, becauſe it is extended backwards to the *zygoma* of the temporal bone, ends in a point, and has one ſide ſtraight and the other ſloping.—Between the two orbitar angles there is a concave arch, which makes about a third of the external circumference of the orbit, from which a fifth proceſs is extended backwards within the orbit, to form near one third of that cavity; and hence it may be called the *internal orbitar* proceſs.—From the lower edge of each of the *oſſa malarum*, which is between the maxillary and zygomatic proceſſes, the *maſſeter* muſcle takes its origin; and from the exterior part of the *zygomatic* proceſs, the *muſculus diſtortor oris* riſes; in both which places the ſurface of the bone is rough.

On the external ſurface of each cheek-bone, one or more ſmall holes are commonly found, for the tranſmiſſion of ſmall nerves or blood-veſſels from and ſometimes into the orbit.—On the internal ſurface are the holes for the paſſage of the nutritious veſſels of theſe bones.—A notch on the

(*a*) Jugalia vel zygomatica, hypopia, ſubocularia.

the outſide of the internal *orbitar* proceſs of each of theſe bones aſſiſts to form the great ſlit common to this bone, and to the ſphenoid, maxillary, and palate bones.

The ſubſtance of theſe bones is, in proportion to their bulk, thick, hard, and ſolid, with ſome *cancelli*.

Each of the *oſſa malarum* is joined, by its ſuperior and internal orbitar proceſſes, to the *os frontis*, and to the orbitar proceſs of the *ſphenoid* bone, by the *tranſverſe* ſuture.—By the edge between the internal and inferior orbitar proceſſes, to the *maxillary* bone, by the *internal orbitar* ſuture.—By the ſide between the maxillary and inferior orbitar proceſs, again to the maxillary bone, by the *external orbitar* ſuture.—By the zygomatic proceſs, to the *os temporum*, by the *zygomatic* ſuture.

The cheek-bones are entire, and fully oſſified in all their parts, in infants.

OSSA MAXILLARIA SUPERIORA, are the largeſt bones, and conſtitute the far greater part of the upper jaw; which has appropriated the name of *maxillaria* to them. The figure of one of them, or of the two when joined, is ſo irregular, that words can ſcarce give an idea of it.

The proceſſes of each *os maxillare* may be reckoned ſeven.—The *firſt* is the long naſal one at its upper and fore part; which is broad below, and turns ſmaller as it riſes upwards, to make the ſide of the noſe.—At the root of this, a tranſverſe ridge may be obſerved within the noſtrils, which ſupports the fore-part of the upper edge of the *os ſpongioſum inferius*.—The *ſecond* is produced backwards and outwards from the root of the naſal proceſs, to form the lower ſide of the orbit; and therefore may be called *orbitar*.—The edge of this orbitar proceſs, and the ridge of the naſal one which is continued from it, make a conſiderable portion of the external circumference of the orbit.—From the proper orbitar proceſs, a very rough triangular ſurface is extended downwards and outwards, to be connected to the cheek-bone; and therefore may be called the *malar* proceſs; from the loweſt protuberant part of which ſome ſhare of the maſſeter muſcle takes its riſe.—Behind the orbitar proceſs, a large tuberoſity or bulge of the bone appears, which is eſteemed the *fourth* proceſs. On the internal part of this we often meet with a ridge, almoſt of the ſame height with that in the naſal proceſs, which runs tranſverſely, and

is

is covered by a ſimilar ridge of the *palate* bone, on which the back-part of the upper edge of the *os ſpongioſum inferius* reſts.—The convex back-part of this tuberoſity is rough, for the origin of part of the external *pterygoid* muſcle (*a*); and more internally is ſcabrous, where the palate and ſphenoid bones are joined to it.—That ſpongy protuberance (*b*) at the lower circumference of this bone, where the ſockets for the teeth are formed, is reckoned the *fifth*.—The *ſixth* is the horizontal plate, which forms the greater part of the baſe of the noſtrils and roof of the mouth: its upper ſurface, which belongs to the noſtrils, is very ſmooth; but the other below is arched and rough, for the ſtronger adheſion of the membrane of the mouth, which is ſtretched upon it, and in chewing, ſpeaking, &c. might otherwiſe be liable to be ſeparated.—The *ſeventh* riſes like a ſpine from the inner edge of the laſt, and forms a ſmall part of the partition of the noſtrils.

The depreſſions in each *maxillary* bone are, 1. A ſinuoſity behind the orbitar proceſs, made by the *temporal* muſcle. 2. A pit immediately before the ſame proceſs, where the origin of the *muſculus elevator labiorum communis*, and *elevator labii ſuperioris*, with a branch of the fifth pair of nerves, are lodged ſecurely. 3. The hollow arch of the palate. 4. The ſemicircular great notch, or entry to the lower part of the noſtrils, betwixt the root of the naſal proceſs and ſpine of the palate-plate. Below this, the fore-part of the bone is flatted, or ſometimes hollowed, by the *muſculus depreſſor labii ſuperioris*. 5. Sockets for the teeth (*c*): The number of theſe ſockets is uncertain: for the ſame number of teeth is not in all people, and the four backmoſt teeth of each ſide of each jaw vary greatly in their number of roots; and when the teeth of a living perſon fall out, or are taken away, the ſockets fill up with an oſſeous net-work, which becomes ſolid afterwards. 6. The *lacrymal foſſa* in the *naſal proceſs*, which aſſiſts the *os unguis* to form a paſſage for the *lacrymal duct*. This part of the bone forming this *foſſa* is ſo firm and ſtrong, that a ſurgeon ſcarce can perforate it with the ordinary inſtruments for the *fiſtula lacrymalis*; and therefore ought to avoid it in doing this operation.——Immediately on

(*a*) Albin. de Oſſib. § 79. (*b*) ταινια.

(*c*) Βοθρια, ολμισκοι, alveoli, foſſulæ, mortariola, frænа, locelli, cavæ, pralſepiola, loculamenta.

on the outſide of this there is a ſmall depreſſion, from which the inferior or leſſer oblique muſcle of the eye has its origin (*b*). 7. The canal on the upper part of the great tuberoſity within the orbit, which is almoſt a complete hole: in this a branch of the ſuperior maxillary nerve paſſes.—Beſides theſe, the ſuperior ſurface of the great bulge is concave, to receive the under part of the eye.—Immediately above the tranſverſe ridge in the naſal proceſs, a ſmall hollow is formed by the *os ſpongioſum*.——In ſome ſubjects, the naſal proceſs has a ſmall round pit above the lacrymal duct, where the little tendon or ligament of the orbicular muſcle of the eye-lids is inſerted. It is this tendon, and not the tendon of the larger oblique muſcle of the eye, which there is ſome hazard of cutting in the operation of the *fiſtula lacrymalis*.

The holes of this bone are two proper and two common, which are always to be found, beſides ſeveral others, whoſe magnitude, number, &c. are uncertain.—The firſt of the proper is the *external orbitar*, immediately below the orbit; by which the infra-orbitar branch of the ſecond branch of the fifth pair of nerves, and a ſmall artery, come out, after having paſſed in the canal at the bottom of the orbit deſcribed *numb.* 7. of the depreſſions.—This hole is often double, and that when the nerve has happened to ſplit before it has eſcaped from the bone.—The ſecond is the *foramen inciſivum*, juſt behind the fore-teeth, which, at its under part, is one irregular hole common to both the *maxillary* bones when they are joined: but, as it deſcends, ſoon divides into two, three, or ſometimes more holes; ſome of which open into each noſtril. Through them ſmall arteries and veins, and a twig of the ſecond branch of the fifth pair of nerves paſs, and make a communication between, or join the lining coats of the noſe and mouth.—In ſome ſubjects, *Steno*'s duct may be traced ſome way on the ſide of theſe paſſages next to the noſe, and ſmall orifices may be obſerved opening into the mouth.

The firſt common hole is that which appears at the inner ſide of the back-part of the *tuberoſity* and of the ſockets of the teeth, and is formed by a *foſſa* in this bone, and a correſponding one in the *os palati*: Through it a nerve, which is a branch of the ſecond branch of the fifth pair, runs to the palate.——The other common hole is the great ſlit in the outſide

(*b*) Winſlow, Expoſition Anatomique des Os Secs, § 276.

of the orbit deſcribed already as the ſecond common hole of the ſphenoid bone.

On the naſal proceſs often holes may be obſerved for the paſſage of veſſels to the ſubſtance of the bones; and at the back-part of each tuberoſity ſeveral *foramina* are placed, for the tranſmiſſion of nerves to the cavity within: But theſe are uncertain.

All the body of the *maxillary* bone is hollow, and leaves a large *ſinus* a-kin to the *frontal* and *ſphenoid*; which is commonly, but unjuſtly, called *antrum Highmorianum* (*a*). When the *os maxillare* is ſingle, or ſeparated from all the other bones of a ſkeleton, its *antrum* appears to have a large aperture into the noſtrils: but, in a recent ſubject, it is ſo covered at its back-part by the *palate* bone, in the middle by the *os ſpongioſum inferius*, before by a ſtrong membrane, that one or ſometimes two holes, ſcarce larger than a crow-quill, are only left at the upper part; which, after a ſhort winding progreſs, open into the noſtrils between the two *oſſa ſpongioſa*.—At the bottom of this cavity, we may often obſerve ſome protuberances, in which the ſmall points of the roots of the teeth are contained (*b*).—This cavern and the ſockets of the teeth are often divided by the interpoſition only of a very thin bony plate, which is liable to be eroded by acrid matter collected in the *antrum*, or to be broke in drawing a tooth (*c*). The ſymptoms of a collection of matter here naturally led us to the practice of pulling out the teeth, and piercing through this plate into the *antrum*, to procure an evacuation of the collected matter; by which conſiderable ſervice is frequently done (*d*).

The *maxillary ſinuſes* have the ſame uſes as the *frontal* and *ſphenoidal*; and the ſituation of the *ſinuſes* is ſuch, that the liquor drilling from them, from the cells of the ethmoid and palate bones, and from the lacrymal ducts, may always moiſten all the parts of the membrane of the *nares* in the different ſituations which the head is in.

Though the membranes which line the *frontal*, *ſphenoidal*, and *maxillary ſinuſes*, are continuations of the one which covers the bones within the noſe; yet they are much thinner than it is, and have ſo much ſmaller veſſels,

(*a*) Genæ. (*b*) Highmore, Diſquiſ. Anat. lib. 3. part 2. cap. 1. (*c*) Id. ibid.

(*d*) Cowper in Drake's Anthropol. book 3. chap. 10.—Medical Eſſays and Obſervations, vol. v. art. 30. or n° 27. of this Collection.

veſſels, that the injection, which makes the membrane of the noſe red all over, fills only ſome few veſſels of the *maxillary ſinuſes*, and ſcarce is obſerved in the *frontal* and *ſphenoidal*. Are not the larger veſſels intended for a more plentiful ſecretion of a viſcid liquor to defend the membrane from the effects of the *perflatus*, which is conſtantly through the noſe? Are not the membranes which have the ſmalleſt veſſels, *cæteris paribus*, the moſt ſenſible? Are not many phenomena of ſmelling, inflammations of theſe parts, *megrim*, *polypi*, &c. depending on this ſtructure of theſe membranes?

The ſubſtance of the *oſſa maxillaria* is compact and firm, except at the inferior proceſſes, in which the teeth are lodged, where it is very ſpongy.

The *maxillary* bones are joined above by the upper ends of their naſal proceſſes to the *os frontis*, by the *tranſverſe* ſuture;—at the ſides of theſe proceſſes, to the *oſſa unguis*, by the *lacrymal* ſutures;—to the *naſal* bones, by the *lateral naſal* ſutures;—by their orbitar proceſſes, to the *cheek* bones, by the *external orbitar* ſutures;—by the internal ſides of the internal orbitar proceſſes, to the *oſſa plana*, by part of the *ethmoidal* ſuture;—by the back-part of the tuberoſities, to the *palate* bones, by the *ſuturæ palato-maxillares*;—by the poſterior edges of their palatine *lamellæ*, to the *oſſa palati*, by the *tranſverſe* palate ſuture;—by their naſal *ſpines*, to the *vomer*, by the *ſpinous* ſuture;—by their ſockets, to the teeth, by *gomphoſis*;—by the internal edge of the palate-plate, to one another, by the *longitudinal* palate ſuture, on the upper and fore-part of which a furrow is left for receiving the cartilage which forms the partition of the noſtrils;—between the fore-part of the noſtrils and mouth, to each other, by the *myſtachial* ſuture;—ſometimes they are connected to the *oſſa ſpongioſa inferiora*, by a plain concretion or union of ſubſtance.

Theſe bones form the greater part of the noſe and of the roof of the mouth, and a conſiderable ſhare of the orbit. They contain ſixteen teeth, give riſe to muſcles, tranſmiſſion to nerves, &c. as mentioned in the deſcription of their ſeveral parts.

In each of the *maxillary* bones of a new-born child, the external orbitar proceſs is hollow, with remarkable holes in it:—there are five ſockets for the teeth; of which the two poſterior are very large, and, when di-

vided by a ſecond croſs partition, make the number of ſockets ſix (*a*).—The palate-plate is cribriform about the middle. The great tuberoſity is not formed;—inſtead of the *antrum*, there is only an oblong depreſſion at the ſide of the noſtrils.

OSSA PALATI are commonly deſcribed as two ſmall ſquare bones, at the back-part of the palate or roof of the mouth; though they are of much greater extent, being continued up the back-part of the noſtrils to the orbit (*b*). Each palate-bone may therefore be divided into four parts; the palate ſquare bone, the pterygoid proceſs, naſal *lamella*, and orbitar proceſs.

The ſquare bone is unequally concave, for enlarging both the mouth and cavity of the noſe. The upper part of its internal edge riſes in a ſpine, after the ſame manner as the palate-plate of the *maxillary* bone does, to be joined with the *vomer*.—Its anterior edge is unequally ragged, for its firmer connection with the palate-proceſs of the *os maxillare*.—The internal edge is thicker than the reſt, and of an equal ſurface, for its conjunction with its fellow of the other ſide.—Behind, this bone is ſomewhat in form of a creſcent, and thick, for the firm connection of the *velum pendulum palati*; the internal point being produced backwards, to afford origin to the *palato-ſtaphylinus* or *azygos* muſcle.—This ſquare bone is well diſtinguiſhed from the *pterygoid* proceſs by a perpendicular *foſſa*, which, applied to ſuch another in the *maxillary* bone, forms a paſſage for the palatine branch of the fifth pair of nerves; and by another ſmall hole behind this, through which a twig of the ſame nerve paſſes.

The *pterygoid* proceſs is ſomewhat triangular, having a broad baſe, and ending ſmaller above. The back-part of this proceſs has three *foſſæ* formed in it: the two lateral receive the ends of the two plates of the ſphenoid bone, that are commonly compared to a bat's wing; the middle *foſſa* makes up a part of what is commonly called the *foſſa pterygoidea*. The fore-ſide of this palatine pterygoid proceſs is an irregular concave, where it receives the back-part of the great *tuberoſity* of the *maxillary* bone.—Frequently ſeveral ſmall holes may be obſerved in this triangular proceſs, particularly

(*a*) Albin. Oſteogen. tab. 5. fig. 45.—Ungebav. de Dentit. ſecund. jun. § 1.

(*b*) Euſtach. tab. 47. fig. 1, 3, 6, 7, 8.—Vidus Vidius, de Anat. lib. 2. cap. 2. explicat. tab. 6. fig. 19.—Winſlow, Memoires de l'Acad. des Sciences, 1720.

particularly one near the middle of its baſe, which a little above communicates with the common and proper holes of this bone already taken notice of.

The *naſal lamella* of this bone is extremely thin and brittle, and riſes upwards from the upper ſide of the external edge of the ſquare-bone, and from the narrow extremity of the *pterygoid* proceſs; where it is ſo weak, and at the ſame time ſo firmly fixed to the *maxillary* bone, as to be very liable to be broken in ſeparating the bones.——From the part where the plate riſes, it runs up broad on the inſide of the *tuberoſity* of the *maxillary* bone, to form a conſiderable ſhare of the ſides of the *maxillary ſinus*, and to cloſe up the ſpace between the *ſphenoid* and the great bulge of the maxillary bone, where there would otherwiſe be a large ſlit opening into the noſtrils (*a*). From the middle internal ſide of this thin plate, a croſs ridge placed on ſuch another of the maxillary bone is extended; on it the back-part of the *os ſpongioſum inferius* reſts.—Along the outſide of this plate, the perpendicular *foſſa* made by the palate nerve is obſervable.

At the upper part of this naſal plate, the palate-bone divides into two proceſſes, which I already named *orbitar*;—between which and the body of the *ſphenoid* bone, that hole is formed which I mentioned as the laſt of the holes common to the *ſphenoid* bone.—Sometimes this hole is wholly formed in the *os palati*, by a croſs plate going from the one orbitar proceſs to the other. A nerve, artery, and vein, belonging to the noſtrils, paſs here.—The anterior of the two orbitar proceſſes is the largeſt, and has its fore-part contiguous to the back-part of the *maxillary ſinus*, and its upper ſurface appears in the bottom of the orbit, behind the back-part of the *os maxillare* and *planum*.—It has cells behind, reſembling thoſe of the *ethmoid* bone, to which it is contiguous: it is placed on the aperture of the *ſinus ſphenoidalis*, ſo as to leave only a round hole at its upper fore-part.—The other part of the orbitar proceſs is extended along the internal ſide of the upper back part of the maxillary *tuberoſity*, to the baſe of the *ſphenoid* bone, between the root of the *proceſſus azygos* and the pterygoid proceſs.

The palate ſquare part of this palate-bone, and its pterygoid proceſs, are

(*a*) Albin. de Oſſib. § 88.

are firm and ſtrong, with ſome *cancelli;* but the naſal plate and orbitar proceſſes are very thin and brittle.

The palate-bones are joined to the *maxillary*, by the fore-edge of the palate ſquare bone, by the *tranſverſe palate* ſuture:—By their thin naſal plates, and part of their orbitar proceſſes, to the ſame bones, by the *palato-maxillares* ſutures:—By their *pterygoid* proceſſes, and back-part of the *naſal plates*, to the *alæ veſpertilionum*, by the *ſphenoid* ſuture:——By the tranſverſe ridges of the naſal plates, to the *oſſa ſpongioſa inferiora*, by contact; hence frequently there is an intimate union of the ſubſtance of theſe bones in old ſkulls:——By the orbitar proceſſes, to the *oſſa plana* and *cellulæ ethmoideæ*, by the *ethmoid* ſuture:——To the body of the *ſphenoid* bone, by the *ſphenoid* ſuture:—By the internal edge of the ſquare bones, to each other, by the *longitudinal* palate-ſuture; and by their naſal ſpines, to the *vomer*, by the *ſpinous* ſuture.

The palate-bones form part of the palate, noſtrils, orbits, and *foſſæ pterygoideæ;* and they cover part of the *ſinus maxillares*, *ſphenoidales*, and *ethmoidei.*

Theſe bones are very complete in a new-born infant, the naſal plates being then thicker and ſtronger than in adults; but the orbitar proceſſes have not the cells which appear in the bones of adults.

When we are acquainted with the hiſtory of theſe bones, the reaſon is evident why the eyes are ſo much affected in ulcers of the palate, as to be often attended with blindneſs, which frequently happens in an ill-managed *lues venerea;* or why, on the other hand, the palate ſuffers from an *ægylops* (*a*).

OSSA TURBINATA, or *ſpongioſa inferiora*, reſemble the ſuperior *oſſa ſpongioſa* in ſhape and ſubſtance, but have their anterior and upper edges contiguous to the tranſverſe ridges of the naſal proceſſes of the *maxillary* and *palate bones.*——From their upper ſtraight edge, two ſmall proceſſes ſtand out: the poſterior, which is the broadeſt, deſcends to cover ſome of the *antrum Highmorianum;* the anterior riſes up to join the *os unguis*, and to make part of the *lacrymal duct.*

Below the ſpongy bones already mentioned, there are ſometimes two others, one in each noſtril, which ſeem to be a production of the ſides of the

(*a*) Hoffman. in Ephemerid. German. cent. 1. & 2. obſerv. 135.

the maxillary *ſinus* turned downwards (*a*). When this third ſort of ſpongy bones is found, the middle one of the three in each noſtril is the largeſt, and the loweſt is the ſmalleſt.—Beſides all theſe, there are often ſeveral other ſmall bones ſtanding out into the noſtrils, that, from their ſhape, might alſo deſerve the name of *turbinata*, but are uncertain in their bulk, ſituation, and number (*b*).

The names of theſe bones ſufficiently declare their ſpongy ſubſtance, which has no firm external plate covering it.

They are joined to the *oſſa maxillaria*, *palati*, and *unguis*, in old ſubjects, by a firm union of ſubſtance: and as this happens alſo frequently in people of no great age, ſome (*c*) are of opinion that they ſhould be eſteemed part of the palate-bones; others (*d*) think, that, ſince their upper edge is continued by a plate to part of the *os ethmoides*, they ought to be eſteemed to be a part of this bone.

Their uſe is, to ſtraiten the noſtrils, to afford a large ſurface for extending the organ of ſmelling, to cover part of the *antra maxillaria*, and to aſſiſt in forming the under-part of the lacrymal ducts, the orifices of which into the noſe are concealed by theſe bones.

The *oſſa turbinata* are nearly complete in a new-born infant.

Vomer, or bone reſembling a plough-ſhare, is the thirteenth of the upper jaw, without a fellow, forming the lower and back parts of the partition of the noſe (*e*).

The figure of this bone is an irregular rhomboid.—Its ſides are flat and ſmooth.—Its poſterior edge appears in an oblique direction at the back-part of the noſtrils.—The upper one is firmly united to the baſe of the *ſphenoid* bone, and to the naſal plate of the *ethmoid*; and, when it can be got ſeparated, is hollow, for receiving the *proceſſus azygos* of the *ſphenoid*. ——The anterior edge has a long furrow in it, where the middle cartilage of the noſe enters.—The lower edge is firmly united to the naſal ſpines of the maxillary and palate bones.—Theſe edges of this bone are much thicker than its middle, which is as thin as the fineſt paper; by which,

(*a*) Cowper in Drake's Anthropol. book 3, chap. 10.
(*b*) Santorin. Obſervat. Anatomic. cap. 5. § 9. (*c*) Id. ibid. cap. 5. § 7.
(*d*) Hunauld, in Memoires de l'Acad. des Sciences, 1730.
(*e*) Columb. de Re Anat. lib. 1. cap. 8.—Fallop. Obſervat. Anatom.

which, and the firm union or connection this bone has above and below, it can very ſeldom be ſeparated entire in adults: but in a child it is much more eaſily ſeparated entire, and its ſtructure is more diſtinctly ſeen; wherefore I ſhall examine all its parts of ſuch a ſubject.

Its ſituation is not always perpendicular, but often inclined and bended to one ſide, as well as the naſal plate of the *ethmoid* bone.

The *vomer* is convex at its upper part; and then is ſtraight as it is extended downwards and forwards, where it is compoſed of two plates; the edges of which have a great number of ſmall proceſſes, diſpoſed ſomewhat like the teeth of a ſaw, but more irregularly, and ſeveral of them are reflected back. Between theſe plates a deep *foſſa* is left, which, ſo far as the top of the curvature, is wide, and has ſtrong ſides, for receiving the *proceſſus azygos* of the *ſphenoid* bone. Beyond the arch forwards, the *foſſa* is narrower and ſhallower gradually to the point of the bone, receiving for ſome way the naſal *lamella ethmoidea*; which, after the oſſification is complete, is ſo cloſely united to the *vomer* by the little proceſſes piercing into its ſubſtance, as to prevent any ſeparation; on which account it has been eſteemed by ſome (*a*) a part of the ethmoid bone. The middle cartilage of the noſe fills up what remains of the *foſſa* at its fore-part.——The poſterior edge of the *vomer*, which appears above the back-part of the palate-bones, is broader above; but, as it deſcends forwards, becomes thinner, though it is ſtill ſolid and firm.—The lower edge of this bone, which reſts on the naſal ſpine of the *palate* and *maxillary* bones, has a little furrow on each ſide of a ſmall middle ridge, anſwering to the ſpines of the bones of different ſides, and the interſtices between them. This edge and the upper one meet in the pointed fore-end of this bone.

The body of the *vomer* has a ſmooth ſurface, and ſolid but thin ſubſtance; and towards its ſides, where it is thickeſt, ſome *cancelli* may be obſerved when the bone is broken.

It is joined above to the *ſphenoid* and *ethmoid* bones, and to the middle cartilage of the noſe, by *ſchindyleſis*;—below, to the maxillary and palate-bones, by the *ſpinous* ſuture.

The *vomer* divides the noſtrils; enlarges the organ of ſmelling, by allowing

(*a*) Lieutaud, Eſſais Anatomiques 1. ſect. l'os ethmoide.

lowing place for expanding the membrane of the noſe on its ſides; and ſuſtains the palate-plates of the *maxillary* and *palate* bones, which otherwiſe might be in hazard of being preſſed into the noſtrils; while the *vomer* is ſecured from ſhuffling to one ſide or other by the double *ſchindyleſis*, by which it is joined to the bones above and below.

Theſe, then, are all the bones which compoſe the upper jaw, except the teeth, which are ſo much a-kin to thoſe of the lower jaw, that I chooſe to make one deſcription ſerve for both; in which the differences obſervable in them ſhall be remarked, after the ſecond part of the face, the lower jaw, is examined; becauſe the ſtructure of the teeth cannot be well underſtood, until the caſe in which they are ſet is explained.

MAXILLA INFERIOR (*a*), the lower jaw, conſiſts only of one moveable bone, and ſixteen teeth incaſed into it.

This bone, which is ſomewhat of the figure of the Greek letter ν, is ſituated at the lower part of the face, ſo as its convex middle part is forwards, and its legs are ſtretched back. It is commonly divided into the chin, ſides, and proceſſes.—The *chin* is the middle fore-part; the extent of which to each ſide is marked on the external ſurface by the holes obſervable there, and internally by the beginning of an oblique ridge.—Beyond theſe, the *ſides* appear; and are continued till the bone, by bending upwards, begins to form the proceſſes.

On the fore-part of the *chin*, a tranſverſe ridge appears in the middle, on each ſide of which the *muſculi quadrati*, or *depreſſores labii inferioris*, and the *levatores labii inferioris*, depreſs the bone: and, below theſe prints, a ſmall riſing may be obſerved, where the *depreſſores* commence.——On the back-part of the chin, ſometimes three, always two, ſmall protuberances appear in the middle. To the uppermoſt, when it is ſeen, the *frænum* of the tongue is connected. From the middle one, the *muſculi genioglоſſi* riſe; and from the loweſt the *geniohyoidei* have their origin. Below the laſt, we ſee two rough ſinuoſities, formed by the *digaſtric* muſcles.

At the lower and fore part of the external ſurface of each ſide of the lower jaw, a ſmall eminence may be obſerved, where the *depreſſor laborium communis* riſes. Near the upper edge of the ſide, a ridge runs

(*a*) Τυπος, σιαγων, mandibula, facies.

lengthwiſe, to which the under-part of the *muſculus buccinator* is connected.——Internally, towards the upper edge of each ſide, another ridge appears, from which the *mylohyoidei* have their origin, and to which the internal membrane of the gums adheres.

In the upper edge of both chin and ſides, are a great many deep pits or ſockets, for receiving the roots of the teeth. The number and magnitude of theſe ſockets are various, becauſe of the different number, as well of the teeth themſelves as of their roots, in different people. Theſe ſockets in this lower jaw, as well as in the upper one, are leſs deep as old age comes on: when freed from the teeth by any means, they are ſome time after filled up with an oſſeous net-work, which at laſt becomes entirely ſolid, and as ſmooth as any other part of the bone; ſo that, in a great many old jaws, one cannot obſerve a veſtige of the ſockets: but then the jaw-bone becomes leſs, and much narrower (*a*).—Hence we may know why the chin and noſe of edentulous people are much nearer than before the teeth were loſt; while their lips either fall in towards the mouth, or ſtand prominent forwards.——When new teeth are protruded, new ſockets are formed (*b*).——The lower edge of the chin and ſides is ſmooth and equal, and is commonly called the *baſe* of the lower jaw.—The ends of the baſe, where the jaw turns upwards, are called its *angles:* the external ſurface of each of which has ſeveral inequalities upon it, where the *maſſeter* muſcle is inſerted; as the internal ſurface alſo has, where the *pterygoideus internus* is inſerted, and a ligament, extended from the *ſtyloid* proceſs of the temporal bone, is fixed.

The proceſſes are two on each ſide.——The anterior ſharp thin *coronoid* ones have the *crotaphite* muſcles inſerted into them.——The poſterior proceſſes, or *condyles* (*c*), terminate in an oblong ſmooth head, ſupported by a *cervix*. The heads, whoſe greateſt length is tranſverſe, and whoſe convexity is turned forwards, are tipped with a cartilage, as the articulated parts of all other moved bones are.—The fore-part of the root and neck of theſe *condyloid* proceſſes are a little hollow and rough, where the external *pterygoid* muſcles are inſerted.

The holes of the lower jaw are two on each ſide; one at the root of the proceſſes internally, where a large branch of the third branch of the fifth

(*a*) Veſal. Anat. lib. 1. cap. 10. (*b*) Fallop. Obſerv. Anat. (*c*) Articulatorii.

fifth pair of nerves enters with an artery, and a vein returns. A ſmall ſharp proceſs frequently juts out backwards from the edge at the fore-part of this hole, to which a ligament, extended from the temporal bone, is fixed (*a*), which ſaves the nerve and veſſels from being too much preſſed by the *pterygoid* muſcles.——From the lower ſide of this hole, either a ſmall ſuperficial canal or a furrow deſcends, where a branch of the nerve is lodged, in its way to the *mylo-hyoideus* muſcle and ſublingual gland (*b*).——The other hole is external, at the confines of the chin, where branches of the nerve and veſſels come out.——The canal betwixt theſe two holes is formed in the middle of the ſubſtance of the bone; and is pierced by a great number of ſmall holes, by which the nerves and blood-veſſels of the *cancelli* and teeth paſs. This canal is continued a little further than the external hole at the chin.—On account of the veſſels and nerves in the lower jaw, fractures of it may be attended with dangerous ſymptoms.

The ſurface of the lower jaw is hard and firm, except at the ſpongy ſockets, where, however, it is ſtronger than the upper jaw.——Its internal ſubſtance is cellular, without any ſolid partition between the *cancelli* in its middle.——At the baſe, eſpecially of the chin, where this bone is moſt expoſed to injuries, the ſolid ſides of it are thick, compact, and hard.

The lower jaw generally receives the roots of ſixteen teeth into its ſockets by *gomphoſis*; and its *condyloid* proceſſes, covered with cartilage, are articulated with the *temporal* bones, in a manner that is not commonly deſcribed right: For, as was already mentioned in the deſcription of the temporal bones, not only the fore-part of the cavity between the *zygomatic*, *auditory*, and *vaginal* proceſſes, but alſo the adjoining tubercle at the root of the *zygomatic* proceſs of each *os temporum*, is covered with a ſmooth cartilage, for this articulation.——Here alſo an intermediate moveable cartilage is placed, which being thin in the middle, and thick at the edges, is concave on both ſides; and is connected ſo firmly by ligaments to each *condyle*, as to follow the motions of the *condyle*; and ſo looſely to the *temporal* bone, as readily to change its ſituation from the cavity to the tubercle, and to return again; while the common ligament of

(*a*) Weitbrecht. Syndeſmolog. fig. 32. 1. (*b*) Palfyn. Anat. Chirur. traite 5. chap. 6.

the articulation affords ſpace enough for ſuch a change of place backwards and forwards; but, like other ligaments of the joints by *ginglimus*, is ſtrong and ſhort at the ſides, to confine the lateral motions.

When, therefore, the teeth of both jaws coincide, the *condyles* are lodged ſecurely in the temporal cavities; but their motions to either ſide muſt be confined both by the firmneſs of the ligaments, and the riſing brims which are on each ſide of the cavities.——When the jaw is brought directly forwards, the condyle and intermediate cartilages deſcend and advance forwards upon the tubercles.——In this ſituation, the lateral motions are a little more free than in the former one, from the want of riſing brims to ſtop the condyles.——When the fore-teeth of the lower jaw are moved forwards, and to a ſide, the condyle of the oppoſite ſide is either advanced from the cavity to the tubercle, while the condyle of the ſame ſide remains in the cavity; or if both condyles are on the tubercles, when the jaw is moved obliquely to a ſide, the condyle of the ſide to which the motion is made ſlides back from the tubercle to the cavity.——When the mouth is opened by the deſcent of the lower jaw, the fore-part of it, where the *depreſſing* muſcles are fixed, is drawn backwards, as well as downwards, while reſiſtance is made to the angles moving backwards by the *maſſeter* and *internal pterygoid* muſcles, and at the ſame time the *external pterygoid* draw the condyles and their moveable cartilages forwards; and therefore, when the mouth is opened, the condyles are carried forwards upon the tubercles, and the axis of motion of the bone is a little above its angles. But in this ſituation there is leſs reſiſtance than in any other to the condyles luxating forwards; a diſeaſe which ſeldom happens, except when people are gaping too wide: and therefore the common practice of nurſes, who ſupport the jaw of infants when yawning, is reaſonable.—In chewing, there is a ſucceſſion of the motions above deſcribed (*a*).

Here a general remark may be made, That wherever moveable cartilages are found in joints, either the articulated bones are of ſuch a figure, or ſo joined and fixed by their ligaments, that little motion would be allowed without ſuch cartilages; or elſe ſome motions are neceſſary to the right

(*a*) For a more full account of this articulation, vid. Edinburgh Medical Eſſays and Obſervations, vol. i. art. 11. and vol. iii. art. 13. or N° V. of this COLLECTION.—Memoires de l'Acad. des Sciences, 1744.

right uſe of the member, which the form of the articulation would not otherwiſe admit of. This will more fully appear after the other joints with ſuch cartilages are deſcribed.

In a child born to the full time, the lower jaw is compoſed of two bones, connected by a thin cartilage in the middle of the chin, which gradually oſſifies, and the two bones intimately unite.—In each of theſe bones there are five or ſix ſockets for teeth, as in the upper jaw.

After I have thus deſcribed the incaſement of the teeth, the inſertion of ſo many muſcles of the tongue and of the *os hyoides*, the connection of the membrane of the tongue to the maxillary bone, and the motions of this bone; it is eaſy to ſee, that the lower jaw muſt be a principal inſtrument in manducation, deglutition, and ſpeech.

The TEETH are the hard white bodies placed in the ſockets of both jaws. Their number is generally ſixteen above, and as many below; though ſome people have more, others have fewer.

The broad thick part of each tooth which appears without the ſocket, is the *baſe* or body (*a*).——The ſmaller proceſſes ſunk into the *maxillæ*, are the *roots* or *fangs*; which become gradually ſmaller towards the end fartheſt from the baſe, or are nearly conical, by which the ſurface of their ſides divides the preſſure made on the baſes, to prevent the ſoft parts, which are at the ſmall points of the ſockets, to be hurt by ſuch preſſure.—At the place where the baſe ends and the roots begin, there is generally a ſmall circular depreſſion, which ſome call the *neck* or *collar*.

Without the gums the teeth are covered with no membrane, and they are ſaid to have no proper *perioſteum* within the ſockets: but that is ſupplied by the reflected membrane of the gums; which, after a good injection, may be evidently ſeen in a young ſubject, with the veſſels from it penetrating into the ſubſtance of the teeth; and it may be diſcovered in any tooth recently pulled, by macerating it in water (*b*). The adheſion of this membrane to theſe roots is ſtrengthened by the ſmall furrows obſervable on them.

Each tooth is compoſed of its *cortex* or *enamel*, and an internal bony ſubſtance. The *cortex* has no cavity or place for marrow; and is ſo ſolid and hard, that ſaws or files can with difficulty make impreſſion on it.

It

(*a*) Corona.

(*b*) Cowper, Anatom. explicat. tab. 92. fig. 7. E.

It is thickeſt upon the baſe; and gradually, as the roots turn ſmaller, becomes thinner, but not proportionally to the difference of the ſize of the baſe and roots.——The fibres of this enamel are all perpendicular to the internal ſubſtance; and are ſtraight on the baſe, but at the ſides are arched with a convex part towards the roots (*a*); which makes the teeth reſiſt the compreſſion of any hard body between the jaws, with leſs danger of breaking theſe fibres, than if they had been ſituated tranſverſely. The ſpongy ſockets in which the teeth are placed, likewiſe ſerve better to prevent ſuch an injury, than a more ſolid baſe would have done.——Notwithſtanding the great hardneſs of this *cortex*, it is waſted by manducation. Hence the ſharp edges of ſome teeth are blunted and made broad, while the rough ſurfaces of others are made ſmooth and flat, as people advance in life.

The bony part of the teeth has its fibres running ſtraight, according to the length of the teeth. When it is expoſed to the air, by the breaking or falling off of the hard *cortex*, it ſoon corrupts: And thence carious teeth are often all hollow within, when a very ſmall hole appears only externally.

The teeth have canals formed in their middle, wherein their nerves and blood-veſſels are lodged: Which they certainly need, being conſtantly waſted by the attrition they are ſubjected to in manducation, and for their further growth, not only after they firſt appear, but even in adults; as is evident when a tooth is taken out: for then the oppoſite one becomes longer, and thoſe on each ſide of the empty ſocket turn broader; ſo that when the jaws are brought together, it is ſcarce obſervable where the tooth is wanting (*b*).

The veſſels are eaſily traced ſo long as they are in the large canal, but can ſcarce be obſerved in their diſtribution from that to the ſubſtance of the teeth of adults. Ruyſch (*c*) however affirms, that after injection he could trace the arteries into the hardeſt part of the teeth: And Leewenhoek (*d*) ſuſpected the fibres of the *cortex* to be veſſels.——This plentiful ſupply of veſſels muſt expoſe the teeth to the ſame diſorders that attack other vaſcular parts; and ſuch teeth as have the greateſt number of veſ-

ſels

(*a*) Havers Oſteolog. Nov. diſc. 1.
(*b*) Ingraſ. de Tumor. cap. 1. p. 24, 25, 26.
(*c*) Theſaur. 10. n° 27.
(*d*) Arcan. Natur. Continuat. Epiſt. p. 3.

ſels muſt have the moſt numerous chances of being ſeized with theſe diſeaſes.

Every root of each tooth has ſuch a diſtinct canal, with veſſels and nerves in it. Theſe canals in the teeth with more than one root, come nearer each other as they approach the baſe of the tooth; and at laſt are only ſeparated by very thin plates; which being generally incomplete, allow a communication of all the canals; and frequently one common cavity only appears within the baſe, in which a pulpy ſubſtance, compoſed of nerves and veſſels, is lodged. The condition therefore of the nerves here bears a ſtrong analogy to that of the cutaneous nerves which ſerve for the ſenſation of touching.

The entry of the canals for theſe veſſels is a ſmall hole placed a little to a ſide of the extreme point of each root: ſometimes, eſpecially in old people, this hole is entirely cloſed up, and conſequently the nerves and blood-veſſels are deſtroyed (*a*).

The teeth are ſeen for a conſiderable time in form of *mucus* contained in a membrane; afterwards a thin cortical plate, and ſome few oſſeous layers, appear within the membrane, with a large cavity filled with *mucus* in the middle; and gradually this exterior ſhell turns thicker, the cavity decreaſes, the quantity of *mucus* is leſſened, and this induration proceeds till all the body is formed; from which the roots are afterwards produced.

In young ſubjects, different *ſtamina* or rudiments of teeth are to be obſerved. Thoſe next the gums hinder ordinarily the deeper ſeated ones from making their way out; while theſe prevent the former from ſending out roots, or from entering deep into the bony ſockets of the jaws; by which they come to be leſs fixed.

Children are ſeldom born with teeth; but at two years of age they have twenty; and their number does not increaſe till they are about ſeven years old, when the teeth that firſt made their way through the gums are thruſt out by others that have been formed deeper in the jaw, and ſome more of the teeth begin to diſcover themſelves farther back in the mouth. About fourteen years of age, ſome more of the firſt crop are ſhed, and the number is increaſed.—This ſhedding of the teeth is of good uſe:

(*a*) De la Hiſtoire de l'Acad. des Sciences, 1699.

uſe: For if the firſt had remained, they would have ſtood at a great diſtance one from another; becauſe the teeth are too hard in their outer-cruſt, to increaſe ſo faſt as the jaws do: whereas both the ſecond layer, and the teeth that come out late, meeting, while they are ſoft, with a conſiderable reſiſtance to their growth in length from thoſe ſituated upon them, neceſſarily came out broad, and fit to make that cloſe guard to the mouth (*a*) which they now form.

The teeth are joined to the ſockets by *gomphoſis*, and the gums contribute to fix them there; as is evident by the teeth falling out when the gums are any way deſtroyed, or made too ſpongy; as in the *ſcurvy* or *ſalivations*: whence ſome (*b*) claſs this articulation with the *ſyſſarcoſis*.

The uſes of the teeth are, to maſticate our aliment, and to aſſiſt us in the pronunciation of ſeveral letters.

Though the teeth ſo far agree in their ſtructure, yet becauſe of ſome things wherein they differ, they are generally divided into three claſſes, viz. *inciſores*, *canini*, and *molares*.

The *inciſores* (*c*) are the four fore-teeth in each jaw, receiving their name from their office of cutting our aliment; for which they are excellently adapted, being each formed into a ſharp-cutting edge at their *baſe*, by their fore-ſide turning inwards there, while they are ſloped down and hollowed behind (*d*): ſo that they have the form of wedges; and therefore their power of acting muſt be conſiderably increaſed.——Seeing, in the action of the *inciſores*, a particular compreſſion is only neceſſary, without any lateral motion, they are not ſo firmly fixed in their ſockets as the other teeth are, each only having one ſhort root; but that is broader from before backwards than to either ſide, to have the greateſt ſtrength where it is expoſed to the ſtrongeſt force applied to it (*e*).

The *inciſores* of the upper jaw, eſpecially the two middle ones (*f*), are broader and longer generally than thoſe of the under jaw.

In a new-born infant, the outer ſhell of the body of theſe teeth is only hardened.——Afterwards, when the *ſtamina* of two ſets are formed, each has

(*a*) ῥαγμος. (*b*) Drake's Anthropol. book 4. chap. 3.

(*c*) Γιλασινοι, τομικοι, διχασηρις, κτενις, τομις, προωσθιοι, οξις, riſorii, quaterii, primi, primores, anteriores, acuti.

(*d*) Ολμισκος. (*e*) Lettre ſur l'Oſteologie, aſcribed to Du Verney. (*f*) Duales.

has its own ſocket; thoſe neareſt to the edge of the gums being placed more forward, and the others are lodged farther back within the jaw-bones.

Canini (*a*), from the reſemblance to dogs tuſks, are one on each ſide of the *inciſores* in each jaw.——The two in the upper jaw are called *eye-teeth*, from the communication of nerves which is ſaid to be betwixt them and the eyes.——The two in the lower jaw are named *angular* or *wike-teeth*, becauſe they ſupport the angles of the mouth.

The *canini* are broader, longer, and ſtronger, than the *inciſores*.—Their baſes are formed into a ſharp edge, as the *inciſares* are; only that the edge riſes into a point in the middle.—Each of them has generally but one long root, though ſometimes they have two (*b*). The roots are crooked towards the end.—The *canini* of the upper jaw are larger, longer, and with more crooked roots than thoſe of the under jaw.—The form of their baſe is fit both for piercing and cutting, and the long crooked root of each makes it ſecure in the ſocket.

The *canini* of a child are in much the ſame condition as the *inciſores* are.

The *dentes molares*, or *grinders* (*c*), which have got their name becauſe they grind our food, are generally five in each ſide of each jaw; in all, twenty. Their baſes are broader, more ſcabrous, and with a thinner cortical ſubſtance, than the other teeth. They have alſo more roots; and as theſe roots generally divaricate from each other, the partitions of the ſockets between them bear a large ſhare of the great preſſure they ſuffer, and hinder it from acting on their points (*d*).

The baſe of the firſt grinder has an edge pointed in the middle on its outſide, reſembling the *canini*; from which it ſlopes inwards till it riſes again into a point.——It has generally but one root, which ſometimes is long and crooked at its point.

The ſecond *dens molaris* has two points on its baſe, riſing near equally on its out and inſide.——It has two roots, either ſeparate or run together,

(*a*) Κυνοδοντες, riſorii, fractorii, collaterales, collumellares.

(*b*) Fauchard, Chirurgien Dentiſte, chap. 1.

(*c*) Μυλιται, γομφοι, μυλοι, πλατιις, φραστρις, maxillares, menſales, clavales, buccarum.

(*d*) Lettre ſur l'Oſteologie.

but ſhorter than the root of the firſt.——Theſe two anterior grinders are much ſmaller than the three that are placed farther back in the mouth.

The third and fourth are very broad in their baſes, with four or five points ſtanding out; and they have three or more roots.

The fifth, called commonly *dens ſapientiæ* (*a*), from its coming through the gums later than the other grinders, has four points on its baſe, which is not ſo large as the baſe of the third and fourth, and its roots are leſs numerous.

The *inciſores* of the upper jaw being broader than thoſe of the lower jaw, make the ſuperior grinders to be placed ſo much farther back than the lower ones, that when they are brought together, by ſhutting the mouth, the points of the grinders of the one jaw enter into the depreſſions of the oppoſite grinders; and they are all equally applied to each other, notwithſtanding the inequality of their ſurface.

The numerous roots of the *dentes molares* prevent their looſening by the lateral preſſure they ſuffer in grinding; and as the ſockets in the upper jaw are more ſpongy, and the teeth are more liable by their ſituation to fall out (*a*), the grinders there have more numerous and more ſeparated roots than in the lower jaw (*c*). The number, however, of the roots of the teeth of both jaws is very uncertain; ſometimes they are more, ſometimes fewer: frequently ſeveral roots are joined together; at other times, they are all diſtinct. The diſpoſition of ſuch as are diſtinct is alſo various; for in ſome the roots ſtand out ſtraight, in others they ſeparate, and in others again they are crooked inwards. When the roots are united, we can ſtill diſtinguiſh them, by remarking the number of ſmall holes at their points, which determine the number of roots each tooth ought to be reckoned to have.

At the time of birth, only two *dentes molares* in each jaw have begun to oſſify; and that at little more than the baſe, which has ſeveral ſharp points ſtanding out from it.—The temporaneous grinders are placed more directly upon the internal ſet than the other two claſſes are; ſometimes there

(*a*) Σωφρονιστηρες, κρανιτηρες, οψιγονοι, ſenſûs, intellectûs, ſerotini, ætatem complentes, genuini, moderatores.

(*b*) Galen. de Oſſib. cap. 5.

(*c*) Fauchard. Chirurg. Dent. chap. 1.

there is a piece of the bone of the jaws between the two ſets; in other children, the two ſets have no bone interpoſed between them.

From what has been ſaid, the anſwers to the following queries may be given.

Why are children ſubject to ſalivation, fever, convulſion, vomiting, purging, &c. when their teeth are breeding or cutting the gums?

Why in children do the *dentes inciſores* firſt cut the gums, the *canini* next, and *molares* laſt?

Why do children ſhed their teeth?

Wherefore have theſe *temporaneous* teeth generally no roots, or very ſmall ones?

Why have theſe firſt teeth ſometimes roots, and that more frequently in teeth pulled by art than in thoſe which are ſhedded by nature (*a*)?

Why do theſe roots frequently come outwards through the gums?

Whence come *butter* or *buck* teeth?

How do theſe teeth ſometimes go into the natural row with the others, after pulling a rotten tooth near them?

How have ſome people got two rows of teeth in one or both jaws (*b*)?

Why do the teeth of old people looſen, and then drop out entire?

Whence ariſe the new ſets of teeth which ſeveral old people obtain (*c*)?

Why are not the gums of toothleſs old people torn by the hard ſockets in chewing?

Why are the teeth inſenſible when ſlightly filed or raſped?

How come they to be ſenſible of heat or cold, to be ſet on edge by acids, or to give an uneaſy ſenſation when gritty or ſandy ſubſtances are rubbed between them?

Why does a perſon who has a pained tooth imagine it longer than any other?

What is the reaſon of ſome perſons dying convulſed, upon raſping or filing down an overgrown tooth (*d*)?

(*a*) Fauchard. Chirurgien-dentiſte, p. 7.

(*b*) Blaſ. Comment. ad Veſling. Syntagm. cap. 13.

(*c*) Hoffman. in Van. Horn. Microcoſm. p. 38.

(*d*) Bartholin. Anat. Reformat. lib. 4. cap. 12.

How do the teeth break and moulder away without any pain in ſome people, and not in others?

What parts are affected in the tooth-ach?

What are the cauſes of the tooth-ach?

May worms be reckoned among theſe cauſes (*a*)?

Why are the *dentes molares* moſt ſubject to that diſeaſe?

In what different manners ought the ſeveral claſſes of teeth to be extracted when ſuch an operation is neceſſary?

Whence proceeds the violent obſtinate *hemorrhagy* which ſometimes attends the drawing of teeth (*b*)?

Why is it more difficult and dangerous to draw the eye-teeth than any other?

What makes it impoſſible frequently to draw *grinders* without bringing away part of the jaw-bone with them, or breaking the fangs?

Why do teeth, ſoon replaced after being extracted, become again fixed in the ſockets (*c*)?

According to the diviſion made of the ſkeleton, we ſhould now proceed to the deſcription of the trunk of the body; but muſt firſt conſider a bone, which cannot well be ſaid to belong to either the head or the trunk; nor is it immediately joined to any other, and therefore is very ſeldom preſerved with ſkeletons. However, it is generally deſcribed by authors after the bones of the face.—In compliance therefore with the prevailing method, I ſhall next examine the ſtructure of

The OS HYOIDES (*d*), which is ſituated horizontally between the root of the tongue and the *larynx*. It is properly enough named *hyoides*, from the reſemblance it bears to the *Greek* letter υ; and may, for a clearer demonſtration of its ſtructure, be diſtinguiſhed into its *body*, *cornua*, and *appendices*.

The

(*a*) Jacob. in Act. Hafn. vol. v. obſ. 107.—Pechlin. Obſerv. Medic. lib. 2. obſ. 36.——Bartholin. Hiſt. Medic. cent. 3. hiſt. 96.

(*b*) Parè, livre 6. chap. 2.——Rolfinc. lib. 2. cap. 27. & 30.——Moebii Fundam. Medicin. cap. 9.—Ephemerid. German. dec. 1. ann. 3. obſ. 319.—Fauchard. Chirurg. Dentiſte, tom. i. chap. 23. obſ. 7.

(*c*) De la Motte Chirurgie, tom. i. chap. 4. obſ. 2.——Fauchard. Chirurgien Dentiſte, tom. i. chap. 29.

(*d*) Hypſyloides, lambdoides, παρασατη, φαρυγγιτιρον, os gutturis, os linguæ, os morſus Adami, aſſeſſor, os laude, bicorne.

The body is the middle broad part, convex before, and hollow behind. —The convex fore-part is divided into two by a ridge, into the middle of which the *mylo-hyoidei*, and into the ſides the *ſtylo-hyoidei*, muſcles are inſerted.—Above the ridge, the bone is horizontal, but pitted in the middle by the inſertion of the two *genio-hyoidei* muſcles, and a little hollowed more laterally by the *baſio-gloſſi*.—Below the ridge it is convex, but a little flatted in the middle by the *ſterno-hyoidei*, and pitted more externally by the *coraco-hyoidei*.—The concavity behind faces backwards and downwards, to receive the *thyroid* cartilage, when the *larynx* and the *os hyoides* are pulled towards each other by the action of the *ſterno-hyoidei* and *hyothyroidei* muſcles; and to its upper edge, the ligamentous membranes of the *epiglottis*, tongue, and *thyroid* cartilage, are fixed.

The *cornua* of the (*a*) *os hyoides* are ſtretched backwards from each ſide of its body, where often a ſmall furrow points out the former ſeparation: for in young ſubjects, the body and *cornua* are not one continued ſubſtance as they come afterwards to be in adults.——Theſe *cornua* are not always ſtraight, nor of equal length; their two plain ſurfaces ſtand obliquely ſloping from above outwards and downwards.—Into the external, the *cerato-gloſſus* is inſerted above, and the *thyro-hyoideus* muſcle below; and to the one behind, the ligamentous membrane of the tongue and *larynx* adheres. Each of the *cornua* becomes gradually ſmaller as it is extended from the baſe; but ends in a round tubercle, from which a moveable cartilage ſtands out, which is connected to the upper proceſs of the *cartilago thyroidea*.

Where the body of the *os hyoides* joins on each ſide with its *cornua*, a ſmall ſtyliform proceſs, called *appendix* (*b*), riſes upwards and backwards, into which the *muſculi ſtylo-hyoidei alteri* and part of the *hyo-gloſſi* muſcles are fixed. From each of them a ligament is ſometimes extended to the *ſtyloid* proceſſes of the temporal bones, to keep the *os hyoides* from being drawn too much forwards or downwards. The part of this ligament next to theſe proceſſes ſometimes forms into ſeveral cartilages, which afterwards oſſify in old people. *Ruyſch* (*c*) ſays, that he has ſeen this oſſification

(*a*) Crura, latera inferiora.

(*b*) Crura ſuperiora, latera ſuperiora, oſſa graniformia.

(*c*) Adverſ. Anat. dec. 2.

cation continued as far up as the ſtyloid proceſſes, which were therefore joined to the *os hyoides* by *anchyloſis*.

The ſubſtance of the *os hyoides* is cellular; but covered with a firm external plate, which is of ſufficient ſtrength to bear the actions of ſo many muſcles as are inſerted into it.

It is not articulated with any bone of the body, except by means of the muſcles and ligaments mentioned.

The uſe of the *os hyoides* is to ſerve as a ſolid lever for the muſcles to act with, in raiſing or depreſſing the tongue and *larynx*, or in enlarging and diminiſhing the capacity of the *fauces*.

At birth, this bone is in a cartilaginous ſtate; excepting a ſmall point of bone in the middle of its body, and in each of the *cornua*.——The *appendices* frequently remain cartilaginous many years.

Of the TRUNK.

THE TRUNK conſiſts of the *ſpine*, *pelvis*, and *thorax*.

The SPINE (*a*) is the long pile of bones extended from the *condyles* of the *occiput* to the end of the rump. It ſomewhat reſembles two unequal pyramids joined in a common baſe. It is not, however, ſtraight; for its upper part being drawn backwards by ſtrong muſcles, it gradually advances forwards, to ſupport the *æſophagus*, veſſels of the head, &c. Then it turns backwards, to make place enough for the heart and lungs. It is next bended forwards, to ſupport the *viſcera* of the *abdomen*. It afterwards turns backwards, for the enlargement of the *pelvis*. And, laſtly, it is reflected forwards, for ſuſtaining the loweſt great gut.

The *ſpine* is commonly divided into *true* and *falſe vertebræ*; the former conſtituting the long upper pyramid, which has its baſe below; while the *falſe vertebræ* make the ſhorter lower pyramid, whoſe baſe is above.

The TRUE VERTEBRÆ (*b*) are the twenty-four upper bones of the *ſpine*, on which the ſeveral motions of the trunk of our bodies are performed; from which uſe they have juſtly got their name.

Each

(*a*) Ραχις νωτου ακανθα, ιτυς συριγξ, σωλην, tergum, hominis carina.

(*b*) Στροφις, σπονδυλος, ſpondyli, oſſa orbiculata, oſſa vertebrata, verticula.

Each of theſe *vertebræ* is compoſed of its body and proceſſes.

The body is the thick ſpongy fore-part, which is convex before, concave backwards, horizontal and plain in moſt of them above and below. ——Numerous ſmall holes, eſpecially on the fore and back part of their ſurface, give paſſage to their veſſels, and allow the ligaments to enter their ſubſtance.——The edges of the body of each *vertebra* are covered, eſpecially at the fore-part, with a ring of bone firmer and more ſolid than the ſubſtance of the body any where elſe. Theſe rings ſeem to be joined to the *vertebræ* in the form of *epiphyſes*, but are alledged by ſome (*a*) to be the ligaments oſſified. They are of great uſe in preventing the ſpongy bodies from being broken in the motions of the trunk.

Between the bodies of each two adjoining *vertebræ*, a ſubſtance between the nature of ligament and cartilage is interpoſed; which ſeems to conſiſt of concentrical curve fibres, when it is cut horizontally; but when it is divided perpendicularly, the fibres appear oblique and decuſſating each other (*b*).—The outward part of the intervertebral ligaments is the moſt ſolid and hard; and they gradually become ſofter, till they are almoſt in the form of a glairy liquor in the centre; and therefore theſe ſubſtances were not improperly called *mucous ligaments* by the ancients (*c*). The external fibrous part of each is capable of being greatly extended, and of being compreſſed into a very ſmall ſpace, while the middle fluid part is incompreſſible, or nearly ſo; and the parts of this ligament between the circumference and centre approach in their properties to either, in proportion to their more ſolid or more fluid texture. The middle point is therefore a *fulcrum*, or *pivot*, on which the motion of a ball and ſocket may be made, with ſuch a gradual yielding of the ſubſtance of the ligament, in which-ever direction our ſpines are moved, as ſaves the body from violent ſhocks, and their dangerous conſequences (*d*).—This *ligamento*-cartilaginous ſubſtance is firmly fixed to the horizontal ſurfaces of the bodies of the *vertebræ*, to connect them; in which it is aſſiſted by a ſtrong membranous ligament, which lines all their concave

(*a*) Fallop. Obſervat. Anatom.

(*b*) Blancard, Anat. Reform. cap. 32.—Weitbrecht, Syndeſmolog. ſect. 4. § 14.

(*c*) Galen. de Uſu Part. lib. 12. cap. 16.

(*d*) Medical Eſſays and Obſervations, vol. v. art. 28.

cave ſurface, and by ſtill a ſtronger ligament that covers all their anterior convex ſurface.

We may lay it down as a general rule, notwithſtanding ſome exceptions, That the *bodies* of the *vertebræ* are ſmaller and more ſolid above, but as they deſcend they appear larger and more ſpongy; and that the cartilages between them are thick, and the ſurrounding ligaments ſtrong, in proportion to the largeneſs of the *vertebræ*, and to the quantity of motion they perform: By which diſpoſition, the greater weight is ſupported on the broadeſt beſt ſecured baſe, and the middle of our body is allowed a large and ſecure motion.

From each ſide of the body of each *vertebra*, a bony bridge is produced backwards and to a ſide; from the poſterior end of which, one ſlanting proceſs riſes, and another deſcends: the ſmooth, and what is generally the flatteſt ſide of each of theſe four proceſſes, which are called the *oblique* (*a*), is covered with a ſmooth cartilage; and the two lower ones of each *vertebra* are fitted to and articulated with the two upper or aſcending oblique proceſſes of the *vertebra* below, having their articular ligaments fixed into the rough line round their edges.

From between the oblique proceſſes of each ſide, the *vertebra* is ſtretched out laterally into a proceſs that is named *tranſverſe*.

From the back-part of the roots of the two oblique, and of the tranſverſe proceſs of each ſide, a broad oblique bony plate is extended backwards; where theſe meet, the ſeventh proceſs of the *vertebræ* takes its riſe, and ſtands out backwards: This being generally ſharp-pointed and narrow-edged, has therefore been called *ſpinal* proceſs; from which this whole chain of bones has got its name.

Beſides the common ligament which lines all the internal ſurface of the ſpinal proceſſes, as well as of the bodies, there are particular ligaments that connect the bony bridges and proceſſes of the contiguous *vertebræ* together.

The ſubſtance of the proceſſes is conſiderably ſtronger and firmer, and has a thicker external plate than the bodies of the *vertebræ* have.

The ſeven proceſſes form a concavity at their fore-part, which, joined to the one at the back-part of the bodies, makes a great hole; and the holes

(*a*) Articulatorii, minimi.

holes of all the *vertebræ* form a long large conduit (*a*), for containing the *ſpinal* marrow.——In the upper and lower edge of each *lateral bridge*, there is a notch. Theſe are ſo adapted to each other in the contiguous *vertebræ*, as to form a round hole in each ſide between each two *vertebræ*, through which the nerves that proceed from the *ſpinal* marrow and its blood-veſſels paſs.

The articulations, then, of theſe *true vertebræ* are plainly double: for their bodies are joined by the intervening cartilage above deſcribed; and their oblique proceſſes, being tipped with cartilages, are ſo connected by their ligaments as to allow a ſmall degree of motion to all ſides. Hence it is evident, that their centre of motion is altered in different poſitions of the trunk: For, when we bow forwards, the upper moved part bears entirely on the bodies of the *vertebræ*; if we bend back, the oblique proceſſes ſupport the weight; if we recline to one ſide, we reſt upon the oblique proceſſes of that ſide and part of the bodies; if we ſtand erect, all the bodies and oblique proceſſes have their ſhare in our ſupport.

Hence it follows, 1. That becauſe the joints of which the ſpine is compoſed are ſo numerous, the *ſpinal* marrow, nerves, blood-veſſels, &c. are not liable to ſuch compreſſion and over-ſtretching in the motion of the trunk of the body, as they would otherwiſe be, ſince ſeveral *vertebræ* muſt be concerned in every motion of the ſpine; and therefore a very ſmall curvature is made at the conjunction of any two *vertebræ* (*b*). 2. That an erect poſture is the ſureſt and firmeſt; becauſe the ſurface of contact of the *fulcra* is largeſt, and the weight is moſt perpendicular to them (*c*). 3. That the muſcles which move the ſpine act with greater force in bringing the trunk to an erect poſture, than in drawing it to any other: For, in bending forwards, backwards, or to a ſide, the muſcles which perform any of theſe actions are nearer the centre of motion; conſequently the lever with which they act is ſhorter than when the centre of motion is on the part of the *vertebra* oppoſite to that where theſe muſcles are inſerted; which is the caſe in raiſing the trunk. This is extremely neceſſary; ſince, in the deflections of the ſpine from a perpendicular bearing, the weight of the body ſoon inclines it which way

(*a*) Ἰσχε συριγξ, σωλην, canalis. (*b*) Galen de Uſu Part. lib. 12. cap. 12.
(*c*) Paaw de Oſſib. pars 2. cap. 3.

we deſign; whereas, in raiſing us erect, this great weight muſt be more than counteracted. 4. In calculating the force exerted by the muſcles which move the ſpine, we ſhould always make allowance for the action of the cartilages between the *vertebræ*, which, in every motion from an erect poſture, muſt be ſtretched on one ſide, and compreſſed on the other, to both which they reſiſt; whereas, in raiſing the trunk, theſe cartilages aſſiſt by their ſpringy force (*a*). 5. We are hence naturally led into the reaſon of our height of ſtature increaſing in the morning, and diminiſhing at night (*b*): for the intermediate cartilages of the *vertebræ* being preſſed all day long by the weight of our body, become more compact and thin in the evening; but when they are relieved from this preſſure in the night, they again expand themſelves to their former thickneſs: and ſeeing the bulk of any part muſt vary according to the different diſtenſion or repletion of the veſſels compoſing it, we may underſtand how we become taller after a plentiful meal, and decreaſe after faſting or evacuations (*c*). 6. From the different articulations of the bodies, and oblique proceſſes of the *vertebræ*, and the different ſtrength of the ligaments, it is plain, that they are formed ſo as to allow much larger motion forwards than backwards; this laſt being of much leſs uſe, and might be dangerous, by overſtretching the large blood-veſſels that are contiguous to the bodies of the *vertebræ* (*d*). 7. The intervertebral cartilages ſhrivelling as they become more ſolid by age, is the cauſe why old people generally bow forwards, and cannot raiſe their bodies to ſuch an erect poſture as they had in their youth.

The *true vertebræ* ſerve to give us an erect poſture; to allow ſufficient and ſecure motion to the head, neck, and trunk of the body; and to ſupport and defend the bowels and other ſoft parts.

At the ordinary time of birth, each *vertebra* conſiſts of three bony pieces, connected by cartilages; to wit, the *body*, which is not fully oſſified, and a long crooked bone on each ſide; on which we ſee a ſmall ſhare of

(*a*) Borelli de Motu Animal. pars 1. ſchol. ad propoſ. 58.—Parent. Hiſtoire de l'Acad. des Sciences, 1702.

(*b*) Waſſe, Philoſoph. Tranſact. nº 383. art. 1.

(*c*) Abbe Fontenu, Hiſtoire de l'Acad. des Sciences, 1725.

(*d*) Galen de Uſu Part. lib. 1. cap. 16.

of the bony bridge, the oblique proceſſes complete, the beginning tranſverſe proceſſes, and the oblique plate, but no ſpinal proceſs; ſo that the teguments are in no danger of being hurt by the ſharp ends of theſe ſpinal proceſſes, while a child is in its bended poſture in the womb, nor while it is ſqueezed in the birth.

From this general mechaniſm of the ſpine, an account is eaſily deduced of all the different preternatural curvatures which the ſpine is capable of: For if one or more *vertebræ*, or their cartilages, are of unequal thickneſs in oppoſite ſides, the ſpine muſt be reclined over to the thinner ſide; which now ſuſtaining the greateſt ſhare of the weight, muſt ſtill be more compreſſed, conſequently hindered from extending itſelf in proportion to the other ſide, which, being too much freed of its burden, has liberty to enjoy a luxuriant growth. The cauſes on which ſuch an inequality of thickneſs in different ſides of the *vertebræ* depends may vary: For either it may be owing to an over-diſtenſion of the veſſels of one ſide, and from thence a preternatural increaſe of the thickneſs of that part; or, which more commonly is the caſe, it may proceed from an obſtruction of the veſſels, by which the application of proper nouriſhment to the bony ſubſtance is hindered, whether that obſtruction depends on the faulty diſpoſition of the veſſels or fluids; or if it is produced by an unequal mechanical preſſure, occaſioned by a paralytic weakneſs of the muſcles and ligaments, or by a ſpaſmodic over-action of the muſcles on any ſide of the ſpine, or by people continuing long or putting themſelves frequently into any poſture declining from the erect one: In all theſe caſes one common effect follows; to wit, the *vertebræ*, or their cartilages, or both, turn thick on that ſide where the veſſels are free, and remain thin on the other ſide where the veſſels are ſtraitened or obſtructed.—Whenever any morbid curvature is thus made, a ſecond turn, but in an oppoſite direction to the former, muſt be formed; both becauſe the muſcles on the convex ſide of the ſpine being ſtretched, muſt have a ſtronger natural contraction to draw the parts to which their ends are fixed; and becauſe the patient makes efforts to keep the centre of gravity of the body perpendicular to its baſe, that the muſcles may be relieved from a conſtant violent contractile ſtate, which always creates uneaſineſs and pain.

When once we underſtand how theſe crooked ſpines are produced, there is little difficulty in forming a juſt prognoſis; and a proper method of cure may be eaſily contrived, which muſt vary as to the internal medicines, according to the different cauſes on which the diſeaſe depends: But one general indication muſt be purſued by ſurgeons; which is, to counteract the bending force, by increaſing the compreſſion on the convex part of the curvature, and diminiſhing it on the concave ſide. The manner of executing which, in particular caſes, muſt be different, and requires a very accurate examination of the circumſtances both of the diſeaſe and patient. In many ſuch caſes, I have found ſome ſimple directions, as to poſtures in which the patient's body ſhould be kept, of very great advantage.

Though the true *vertebræ* agree in the general ſtructure which I have hitherto deſcribed; yet becauſe of ſeveral ſpecialities proper to a particular number, they are commonly divided into three claſſes, viz. *cervical*, *dorſal*, and *lumbar*.

The *cervical* (*a*) are the ſeven uppermoſt *vertebræ*; which are diſtinguiſhed from the reſt by theſe marks.——Their bodies are ſmaller and more ſolid than any others; and flatted on the fore-part, to make way for the *æſophagus*; or rather this flat figure is owing to the preſſure of that pipe, and to the action of the *longi colli* and anterior *recti* muſcles.—They are alſo flat behind, where ſmall proceſſes riſe, to which the internal ligaments are fixed.——The upper ſurface of the body of each *vertebra* is made hollow, by a ſlanting thin proceſs which is raiſed on each ſide:—The lower ſurface is alſo excavated, but in a different manner; for here the poſterior edge is raiſed a little, and the one before is produced a conſiderable way.——Hence we ſee how the cartilages between thoſe bones are firmly connected, and their articulations are ſecure.

The cartilages between theſe *vertebræ* are thick, eſpecially at their fore-part; which is one reaſon why the *vertebræ* advance forward as they deſcend, and have larger motion.

The oblique proceſſes of theſe bones of the neck more juſtly deſerve that name than thoſe of any other *vertebræ*. They are ſituated ſlanting; the upper ones having their ſmooth and almoſt flat ſurfaces facing obliquely

(*a*) Τραχηλος, αυχην, colli.

liquely backwards and upwards, while the inferior oblique proceſſes have theſe ſurfaces facing obliquely forwards and downwards.

The tranſverſe proceſſes of theſe *vertebræ* are framed in a different manner from thoſe of any other bones of the ſpine: For beſides the common tranſverſe proceſs riſing from between the oblique proceſſes of each ſide, there is a ſecond one that comes out from the ſide of the body of each *vertebra*; and theſe two proceſſes, after leaving a circular hole for the paſſage of the cervical artery and vein, unite, and are conſiderably hollowed at their upper part, with riſing ſides, to protect the nerves that paſs in the hollow; and at laſt each ſide terminates in an obtuſe point, for the inſertion of muſcles.

The ſpinal proceſſes of theſe cervical bones ſtand nearly ſtraight backwards; are ſhorter than thoſe of any other *vertebræ*; and are forked or double at their ends, and hence allow a more convenient inſertion to muſcles.

The thick cartilages between the bodies of theſe *cervical vertebræ*, the obliquity of their *oblique* proceſſes, and the ſhortneſs and horizontal ſituation of their *ſpinal* proceſſes, all conſpire to allow them large motion.

The holes between the bony croſs bridges, for the paſſage of the nerves from the *ſpinal marrow*, have their largeſt ſhare formed in the loweſt of the two *vertebræ*, to which they are common.

So far moſt of the cervical *vertebræ* agree; but they have ſome particular differences, which oblige us to conſider them ſeparately.

The firſt, from its uſe of ſupporting the head, has the name of *atlas* (*a*); and is alſo called *epiſtrophea*, from the motion it performs on the ſecond.

The *atlas*, contrary to all the other *vertebræ* of the ſpine, has no body; but inſtead of it, there is a bony arch.—In the convex fore-part of which a ſmall riſing appears, where the *muſculi longi colli* are inſerted; and on each ſide of this protuberance a ſmall cavity may be obſerved, where the *recti interni minores* take their riſe.—The upper and lower parts of the arch are rough and unequal, where the ligaments that connect this *vertebra* to the *os occipitis*, and to the ſecond *vertebra*, are fixed.—The back-part of the arch is concave, ſmooth, and covered with a cartilage, in a recent ſubject, to receive the tooth-like proceſs of the ſecond *vertebra*.—

In

(*a*) Ἄτλας.

In a firſt *vertebra*, from which the ſecond has been ſeparated, this hollow makes the paſſage for the *ſpinal* marrow to ſeem much larger than it really is. On each ſide of it a ſmall rough ſinuoſity may be remarked, where the ligaments going to the ſides of the tooth-like proceſs of the following *vertebra* are faſtened; and on each ſide a ſmall rough protuberance and depreſſion is obſervable, where the tranſverſe ligament, which ſecures the tooth-like proceſs in the ſinuoſity, is fixed, and hinders that proceſs from injuring the *medulla ſpinalis* in the flections of the head.

The *atlas* has as little ſpinal proceſs as body; but inſtead thereof, there is a large bony arch, that the muſcles which paſs over this *vertebra* at that place might not be hurt in extending the head. On the back and upper part of this arch there are two depreſſions, where the *recti poſtici minores* take their riſe; and at the lower part are two other ſinuoſities, into which the ligaments which connect this bone to the following one are fixed.

The ſuperior oblique proceſſes of this *atlas* are large, oblong, hollow, and more horizontal than in any other *vertebra*.——They riſe more in their external than internal brim; by which their articulations with the *condyloid* proceſſes of the *os occipitis* are firmer.—Under the external edge of each of theſe oblique proceſſes, is the *foſſa*, or deep open channel, in which the vertebral arteries make the circular turn, as they are about to enter the great *foramen* of the occipital bone, and where the tenth pair of nerves goes out.——In ſeveral bodies I have ſeen this *foſſa* covered with bone.—The inferior oblique proceſſes, extending from within outwards and downwards, are large, concave, and circular. So that this *vertebra*, contrary to the other ſix, receives the bones with which it is articulated both above and below.

The tranſverſe proceſſes here are not much hollowed or forked; but are longer and larger than thoſe of any other *vertebra* of the neck, for the origin and inſertion of ſeveral muſcles; of which thoſe that ſerve to move this *vertebra* on the ſecond have a conſiderable lever to act with, becauſe of the diſtance of their inſertion from the *axis* of revolution.

The hole for the *ſpinal marrow* is larger in this than in any other *vertebra*, not only on account of the *marrow* being largeſt here, but alſo to prevent its being hurt by the motions of this *vertebra* on the ſecond one.

—This

—This large hole, and the long tranſverſe proceſſes, make this the broadeſt *vertebra* of the neck.

The *condyles* of the *os occipitis* move forwards and backwards in the ſuperior oblique proceſſes of this *vertebra :* but from the figure of the bones forming theſe joints, it appears, that very little motion can here be allowed to either ſide; and there muſt be ſtill leſs circular motion.

In new-born children, this *vertebra* has only the two lateral pieces oſſified; the arch which it has at its fore-part, inſtead of a body, being cartilaginous.

The ſecond *vertebra colli* is called *dentata*, from the tooth-like proceſs on the upper part of its body. Some authors call it *epiſtrophea ;* but improperly, ſince this deſignation is only applicable to the firſt, which moves on this as on an axis.

The body of this *vertebra* is ſomewhat of a pyramidal figure, being large, and produced downwards, eſpecially at its fore-ſide, to enter into a hollow of the *vertebra* below; while the upper part has a ſquare proceſs with a ſmall point ſtanding out from it. This it is that is imagined to reſemble a tooth (*a*), and has given name to the *vertebra.*—The ſide of this proceſs, on which the hollow of the anterior arch of the firſt *vertebra* plays, is convex, ſmooth, and covered with a cartilage; and it is of the ſame form behind for the ligament, which is extended tranſverſely from one rough protuberance of the firſt *vertebra* to the other, and is cartilaginous in the middle, to move on it.—A ligament likewiſe goes out in an oblique tranſverſe direction from each ſide of the *proceſſus dentatus*, to be fixed at its other end to the firſt *vertebra*, and to the occipital bone; and another ligament riſes up from near the point of the proceſs to the *os occipitis*.

The ſuperior oblique proceſſes of this *vertebra dentata* are large, circular, very nearly in an horizontal poſition, and ſlightly convex, to be adapted to the inferior oblique proceſſes of the firſt *vertebra.*—A moveable cartilage is ſaid by ſome authors to be interpoſed between theſe oblique proceſſes of the firſt and ſecond *vertebra ;* but I could never find it.—The inferior oblique proceſſes of this *vertebra dentata* anſwer exactly to the deſcription given of thoſe common to all the cervical *vertebræ*.

The

(*a*) Conoides, pyrenoides, odontoides.

The tranſverſe proceſſes of the *vertebra dentata* are ſhort, very little hollowed at their upper part, and not forked at their ends; and the canals through which the cervical arteries paſs, are reflected outwards about the middle ſubſtance of each proceſs, ſo that the courſe of theſe veſſels may be directed towards the tranſverſe proceſſes of the firſt *vertebra*.—Had this curvature of the arteries been made in a part ſo moveable as the neck is, while they were not defended by a bone, and fixed to that bone, ſcarce a motion could have been performed without the utmoſt hazard of compreſſion, and a ſtop put to the courſe of the liquids, with all its train of bad conſequences. Hence we obſerve this ſame mechaniſm ſeveral times made uſe of, when there is any occaſion for a ſudden curvature of a large artery. This is the third remarkable inſtance of it we have ſeen. The firſt was the paſſage of the *carotids* through the *temporal* bones; and the ſecond was that lately deſcribed in the vertebral arteries, turning round the oblique proceſſes of the firſt *vertebra*, to come at the great hole of the occipital bone.

The ſpinal proceſs of this *vertebra dentata* is thick, ſtrong, and ſhort, to give ſufficient origin to the *muſculi recti majores* and *obliqui inferiores*, and to prevent the contuſion of theſe and other muſcles in pulling the head back.

This ſecond *vertebra* conſiſts, at the birth, of four bony pieces: For beſides the three which I already mentioned as common to all the *vertebræ*, the tooth-like proceſs of this bone is begun at this time to be oſſified in its middle, and is joined as an appendix to the body of the bone.—Leſt this appendix be bended or diſplaced, nurſes ought to keep the heads of new-born children from falling too far backwards, by *ſtay-bands*, or ſome ſuch means, till the muſcles attain ſtrength ſufficient to prevent that dangerous motion.

When we are acquainted with the ſtructure and articulations of the firſt and ſecond *vertebræ*, and know exactly the ſtrength and connection of their ligaments, there is no difficulty in underſtanding the motions that are performed upon or by the firſt; though this ſubject was formerly matter of hot diſpute among ſome of the greateſt anatomiſts (*a*). It is none of my purpoſe at preſent to enter into a detail of the reaſons advanced

(*a*) See Euſtach. de Motu Capitis.

vanced by either party; but to explain the fact, as any one may ſee it who will remove the muſcles, which, in a recent ſubject, hinder the view of theſe two joints, and then will turn the head into all the different poſitions it is capable of. The head may then be ſeen to move forwards and backwards on the firſt *vertebra*, as was already ſaid, while the *atlas* performs the *circumgyratio* upon the ſecond *vertebra*; the inferior oblique proceſſes of the firſt *vertebra* ſhuffling eaſily in a circular way on the ſuperior oblique proceſſes of the ſecond, and its body or anterior arch having a rotation on the tooth-like proceſs, by which the perpendicular ligament that is ſent from the point of the tooth-like proceſs to the occipital bone is twiſted, while the lateral ligaments that fix the *proceſſus dentatus* to the ſides of the firſt *vertebra*, and to the *os occipitis*, are very differently affected; for the one upon the ſide towards which the face is turned by the *circumgyratio* is much ſhortened and lax, while the oppoſite one is ſtretched and made tenſe, and, yielding at laſt no more, prevents the head from turning any farther round on this *axis*. So that theſe lateral ligaments are the proper *moderators* of the *circumgyratio* of the head here; which muſt be larger or ſmaller, as theſe ligaments are weaker or ſtronger, longer or ſhorter, and more or leſs capable of being ſtretched. Beſides the revolution on this *axis*, the firſt *vertebra* can move a ſmall way to either ſide; but is prevented from moving backwards and forwards by its anterior arch, and by the croſs ligament, which are both cloſely applied to the tooth-like proceſs. Motion forwards here would have been of very bad conſequence, as it would have brought the beginning of the *ſpinal* marrow upon the point of the tooth-like proceſs.

The rotatory motion of the head is of great uſe to us on many accounts, by allowing us to apply quickly our organs of the ſenſes to objects: and the *axis* of rotation was altogether proper to be at this place; for if it had been at a greater diſtance from the head, the weight of the head, if it had at any time been removed from a perpendicular bearing to the ſmall very moveable joint, and thereby had acquired a long lever, would have broke the ligaments at every turn inconſiderately performed, or theſe ligaments muſt have been formed much ſtronger than could have been connected to ſuch ſmall bones. Neither could this circular motion be performed on the firſt *vertebra* without danger; becauſe the immove-

able part of the *medulla oblongata* is ſo near, that at each large turn, the beginning of the *ſpinal* marrow would have been in danger of being twiſted, and of ſuffering by the compreſſion this would have made on its tender fibrils.

It is neceſſary to obſerve, that the *lateral* or *moderator* ligaments confine ſo much the motion of the firſt *vertebra* upon the ſecond, that tho' this joint may ſerve us on ſeveral occaſions, yet we are often obliged to turn our faces farther round than could be done by this joint alone, without the greateſt danger of twiſting the ſpinal marrow too much, and alſo of luxating the oblique proceſſes: therefore, in large turns of this kind, the rotation is aſſiſted by all the *vertebræ* of the neck and loins; and if this is not ſufficient, we employ moſt of the joints of the lower extremities.—This combination of a great many joints towards the performance of one motion, is alſo to be obſerved in ſeveral other parts of the body; notwithſtanding ſuch motions being generally ſaid to be performed by ſome ſingle joint only.

The third *vertebra* of the neck is by ſome called *axis;* but this name is applied to it with much leſs reaſon than to the ſecond.——This third, and the three below, have nothing particular in their ſtructure; but all their parts come under the general deſcription formerly given, each of them being larger as they deſcend.

The ſeventh (*a*) *vertebra* of the neck is near to the form of thoſe of the back, having the upper and lower ſurfaces of its body leſs hollow than the others.—The oblique proceſſes are more perpendicular:—neither ſpinal nor tranſverſe proceſſes are forked.—This ſeventh and the ſixth *vertebra* of the neck have the hole in each of their tranſverſe proceſſes more frequently divided by a ſmall croſs bridge, that goes between the cervical vein and artery, than any of the other *vertebræ*.

The twelve *dorſal* (*b*) may be diſtinguiſhed from the other *vertebræ* of the ſpine by the following marks.

Their bodies are of a middle ſize, betwixt thoſe of the neck and loins: they are more convex before than either of the other two ſorts; and are flatted laterally by the preſſure of the ribs, which are inſerted into ſmall cavities formed in their ſides. This flatting on their ſides, which makes the

(*a*) Atlas quibuſdam, maxima, magna vertebra, prominens.

(*b*) Θωρακος, μεταφρενιν, νωτιν, υποτραχηλιον, antiſterni, pectoris, tergi.

the figure of theſe *vertebræ* almoſt an half oval, is of good uſe; as it affords a firm articulation to the ribs, allows the *trachea arteria* to divide at a ſmall angle, and the other large veſſels to run ſecure from the action of the vital organs.——Theſe bodies are more concave behind than any of the other two claſſes: — their upper and lower ſurfaces are horizontal.

The cartilages interpoſed between the bodies of theſe *vertebræ* are thinner than in any other of the *true vertebræ*; and contribute to the concavity of the ſpine in the thorax, by being thinneſt at their fore-part.

The *oblique* proceſſes are placed almoſt perpendicular; the upper ones ſlanting but a little forwards, and the lower ones ſlanting as much backwards.—They have not as much convexity or concavity as is worth remarking.—Between the oblique proceſſes of oppoſite ſides, ſeveral ſharp proceſſes ſtand out from the upper and lower parts of the plates which join to form the ſpinal proceſs; into theſe ſharp proceſſes ſtrong ligaments are fixed for connecting the *vertebræ*.

The *tranſverſe* proceſſes of the *dorſal vertebræ* are long, thicker at their ends than in the middle, and turned obliquely backwards; which may be owing to the preſſure of the ribs, the tubercles of which are inſerted into a depreſſion near the end of theſe proceſſes.

The *ſpinal* proceſſes are long, ſmall pointed, and ſloping downwards and backwards; from their upper and back part a ridge riſes, which is received by a ſmall channel in the fore-part of the ſpinal proceſs immediately above, which is here connected to it by a ligament.

The *conduit* of the *ſpinal* marrow is here more circular; but, correſponding to the ſize of that cord, is ſmaller than in any of the other *vertebræ*; and a larger ſhare of the holes in the bony bridges, for the tranſmiſſion of the nerves, is formed in the *vertebra* above than in the one below.

The connection of the *dorſal vertebræ* to the ribs, the thinneſs of their cartilages, the erect ſituation of the oblique proceſſes, the length, ſloping, and connection of the ſpinal proceſſes, all contribute to reſtrain theſe *vertebræ* from ſuch motion, which might diſturb the actions of the heart and lungs; and, in conſequence of the little motion allowed here, the *intervertebral* cartilages ſooner ſhrivel, by becoming more ſolid: and therefore the firſt remarkable curvature of the ſpine obſerved as people advance

to old age, is in the leaſt ſtretched *vertebræ* of the back; or old people firſt become round-ſhouldered.

The bodies of the four uppermoſt *dorſal vertebræ* deviate from the rule of the *vertebræ* becoming larger as they deſcend: for the firſt of the four is the largeſt; and the other three below gradually become ſmaller, to allow the *trachea* and large veſſels to divide at ſmaller angles.

The two uppermoſt *vertebræ* of the back, inſtead of being very prominent forwards, are flatted by the action of the *muſculi longi colli* and *recti majores*.

The proportional ſize of the two little depreſſions in the body of each *vertebra* for receiving the heads of the ribs, ſeems to vary in the following manner; the depreſſion on the upper edge of each *vertebra* decreaſes as far down as the fourth, and after that increaſes.

The tranſverſe proceſſes are longer in each lower *vertebra* to the ſeventh or eighth, with their ſmooth ſurfaces, for the tubercles of the ribs, facing gradually more downwards; but afterwards, as they deſcend, they become ſhorter, and the ſmooth ſurfaces are directed more upwards.

The ſpinous proceſſes of the *vertebræ* of the back become gradually longer and more ſlanting from the firſt, as far down as the eighth or ninth *vertebra*; from which they manifeſtly turn ſhorter and more erect.

The firſt (*a*) *vertebra*, beſides an oblong hollow in its lower edge, that aſſiſts in forming the cavity wherein the ſecond rib is received, has the whole cavity for the head of the firſt rib formed in it.

The ſecond has the name of *axillary* (*b*), without any thing particular in its ſtructure.

The eleventh (*c*) often has the whole cavity for the eleventh rib in its body, and wants the ſmooth ſurface on each tranſverſe proceſs.

The twelfth (*d*) always receives the whole head of the laſt rib; and has no ſmooth ſurface on its tranſverſe proceſſes, which are very ſhort.—The ſmooth ſurfaces of its inferior oblique proceſſes face outwards as the *lumbar* do.——And we may ſay in general, that the upper *vertebræ* of the back loſe gradually their reſemblance to thoſe of the neck, and the lower ones come nearer to the figure of the *lumbar*.

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(*a*) Ἀορτικὴ, gutturalis. (*b*) Μασχαλιστὴρ. (*c*) Ἀφεστὼς, in neutram partem inclinans.
(*d*) Διασωστὴρ, præcingens.

The articulation of the *vertebræ* of the back with the ribs ſhall be more particularly conſidered after the ribs are deſcribed. Only it may be proper now to remark, that the ligaments which ſerve that articulation aſſiſt in connecting the *vertebræ*.

The loweſt order of the *true vertebræ* is the *lumbar* (*a*), which are five bones, that may be diſtinguiſhed from any others by theſe marks: 1. Their bodies, though of a circular form at their fore-part, are ſomewhat oblong from one ſide to the other; which may be occaſioned by the preſſure of the large veſſels, the *aorta* and *cava*, and of the *viſcera*. The *epiphyſes* on their edges are larger; and therefore the upper and lower ſurfaces of their bodies are more concave than in the *vertebræ* of the back. 2. The cartilages between theſe *vertebræ* are much the thickeſt of any; and render the ſpine convex within the *abdomen*, by their greateſt thickneſs being at their fore-part. 3. The oblique proceſſes are ſtrong and deep; thoſe in oppoſite ſides being almoſt placed in parallel planes; the ſuperior, which are concave, facing inwards, and the convex inferior ones facing outwards: and therefore each of theſe *vertebræ* receives the one above it, and is received by the one below; which is not ſo evident in the other two claſſes already deſcribed. 4. Their tranſverſe proceſſes are ſmall, long, and almoſt erect, for allowing large motion to each bone, and ſufficient inſertion to muſcles, and for ſupporting and defending the internal parts. 5. Betwixt the roots of the ſuperior oblique and tranſverſe proceſſes, a ſmall protuberance may be obſerved, where ſome of the muſcles that raiſe the trunk of the body are inſerted. 6. Their ſpinal proceſſes are ſtrong, ſtraight, and horizontal, with broad flat ſides, and a narrow edge above and below; this laſt being depreſſed on each ſide by muſcles: and at the root of theſe edges we ſee rough ſurfaces for fixing the ligaments. 7. The canal for the numerous cords, called *cauda equina*, into which the ſpinal marrow divides, is rather larger in theſe bones than what contains that *marrow* in the *vertebræ* of the back. 8. The holes for the paſſage of the nerves are more equally formed out of both the contiguous *veretebræ* than in the other claſſes; the upper one furniſhes, however, the larger ſhare of each hole.

The thick cartilages between theſe *lumbar vertebræ*, their deep oblique proceſſes,

(*a*) Οσφυος ιξυος, ψοιων, renum, lumborum.

proceſſes, and their erect ſpinal proceſſes, are all fit for allowing large motion: though it is not ſo great as what is performed in the neck; which appears from comparing the arches which the head deſcribes when moving on the neck or the loins only.

The *lumbar vertebræ*, as they deſcend, have their oblique proceſſes at a greater diſtance from each other, and facing more backwards and forwards.

Both tranſverſe and ſpinal proceſſes of the middlemoſt *vertebræ* of the loins are longeſt and thickeſt; in the *vertebræ* above and below they are leſs. So that theſe proceſſes of the firſt (*a*) and fifth (*b*) are the leaſt, to prevent their ſtriking on the ribs or *oſſa ilium*, or their bruiſing the muſcles in the motions of the ſpine.

The *epiphyſes* round the edges of the bodies of the *lumbar vertebræ* are moſt raiſed in the two loweſt; which conſequently make them appear hollower in the middle than the others are.

The body of the fifth *vertebra* is rather thinner than that of the fourth. The ſpinal proceſs of this fifth is ſmaller, and the oblique proceſſes face more backwards and forwards than in any other *lumbar vertebra*.

After conſidering the ſtructure of the particular *vertebræ*, and their mutual connection, we may obſerve a ſolicitous care taken that they ſhall not be disjoined but with great difficulty: for, beſides being connected by ſtrong ligaments proportioned to the forces which are to be reſiſted, their bodies either enter ſo into each other, as to prevent their being diſplaced any way, as in the *vertebræ* of the neck; or they are propped on all ſides, as thoſe of the *back* are by the ribs; or their ſurfaces of contact are ſo broad, as to render the ſeparation almoſt impracticable, as in the *loins*; while the depth and articulation of the oblique proceſſes are exactly proportioned to the quantity of motion which the other parts of the bones allow, or the muſcles can perform: yet as theſe oblique proceſſes are ſmall, and therefore not capable of ſo ſecure a conjunction as the larger bodies, they may ſooner yield to a disjoining force; but then their diſlocation is not of near ſo bad conſequence as the ſeparation of the bodies would be. For by the oblique proceſſes being diſlocated, the muſcles, ligaments, and *ſpinal* marrow, are indeed ſtretched; but this marrow

(*a*) Νεφριτης, renalis. (*b*) Ασχαλιτης, ſulciens.

marrow muſt be compreſſed, or entirely deſtroyed, when the body of the *vertebra* is removed out of its place.

The FALSE VERTEBRÆ compoſe the under pyramid of the *ſpine*. They are diſtiguiſhed from the bones already deſcribed juſtly enough by this epithet of *falſe:* becauſe though each bone into which they can be divided in young people reſembles the *true vertebræ* in figure, yet none of them contribute to the motion of the trunk of the body; they being intimately united to each other in adults, except at their lower part, where they are moveable; whence they are commonly divided into two bones, *os ſacrum* and *coccygis*.

Os SACRUM (*a*) is ſo called, from being offered in ſacrifice by the ancients, or rather becauſe of its largeneſs in reſpect of the other *vertebræ*. This bone is of an irregular triangular ſhape; broad above, narrow below, convex behind for the advantageous origin of the muſcles that move the *ſpine* and thigh backwards, and concave before for enlarging the cavity of the *pelvis*.——Four tranſverſe lines, of a colour different from the reſt of the bone, which are ſeen on its fore-part, are the marks of diviſion of the five different bones of which it conſiſts in young perſons.

The fore-part of the *os ſacrum*, analogous to the bodies of the *true vertebræ*, is ſmooth and flat, to allow a larger ſpace for the contained bowels, without any danger of hurting them; or this flat figure may be owing to the equal preſſure of theſe bowels, particularly of the laſt gut.—The back-part of it is almoſt ſtraight, without ſo large a cavity as the *vertebræ* have; becauſe the ſpinal marrow, now ſeparated into the *cauda equina*, is ſmall.——The bridges between the bodies and proceſſes of this bone, are much thicker, and in proportion ſhorter, than in the former claſs of bones.——The ſtrength of theſe croſs bridges is very remarkable in the three upper bones; and is well proportioned to the incumbent weight of the trunk of the body, which theſe bridges ſuſtain in a tranſverſe, conſequently an unfavourable ſituation, when the body is erect.

There are only two oblique proceſſes of the *os ſacrum;* one ſtanding out on each ſide from the upper part of the firſt bone.—Their plain erect ſurfaces face backwards, and are articulated with the inferior oblique proceſſes of the laſt *vertebra* of the loins, to which each of theſe proceſſes is

(*a*) Ἱερον, σπονδυλες μεγας, Hippocrat. ὑποσπονδυλον, Oribaſ. Πλατυ, latum, os clunium, clavium.

is connected by a ſtrong ligament, which riſes from a ſcabrous cavity round their roots, where mucilaginous glands are alſo lodged.—Inſtead of the other oblique proceſſes of this bone, four rough tubercles are to be ſeen on each ſide of its ſurface behind, from which the *muſculus ſacer* has its origin.

The tranſverſe proceſſes here are all grown together into one large ſtrong oblong proceſs on each ſide; which, ſo far as it anſwers to the firſt three bones, is very thick, and divided into two irregular cavities, by a long perpendicular ridge.——The foremoſt of the two cavities has commonly a thin cartilaginous ſkin covering it in the recent ſubject, and is adapted to the unequal protuberance of the *os ilium*, and a ſtrong ligament connects the circumference of theſe ſurfaces of the two bones.—The cavity behind is divided by a tranſverſe ridge into two, where ſtrong ligamentous ſtrings, that go from this bone to the *os ilium*, with a cellular ſubſtance containing *mucus*, are lodged.

The tranſverſe proceſſes of the two laſt bones of the *os ſacrum* are much ſmaller than the former.——At their back-part, near their edge, a knob and oblong flat ſurface give riſe to two ſtrong ligaments which are extended to the *os iſchium*; and are therefore called *ſacro-ſciatic*.

The ſpinal proceſſes of the three uppermoſt bones of the *os ſacrum* appear ſhort, ſharp, and almoſt erect, while the two lower ones are open behind; and ſometimes a little knob is to be ſeen on the fourth, though generally it is bifurcated, without the two legs meeting into a ſpine; in which condition alſo the firſt is often to be ſeen; and ſometimes none of them meet, but leave a *ſinus*, or rather *foſſa*, inſtead of a canal (*a*). The *muſculus latiſſimus* and *longiſſimus dorſi*, *ſacro-lumbalis*, and *glutæus maximus*, have part of their origins from theſe ſpinal proceſſes.

The canal between the bodies and proceſſes of this bone, for the *cauda equina*, is triangular; and becomes ſmaller as it deſcends, as the *cauda* alſo does.——Below the third bone, this paſſage is no more a complete bony canal, but is open behind; and is only there defended by a ſtrong ligamentous membrane ſtretched over it, which, with the muſcles that cover it, and are very prominent on each ſide, is a ſufficient defence for the bundle of nerves within.

At

(*a*) Verheyen, Anat. tract. 5. cap. 9.——Sue Trad. d'Oſteol. p. 127.

At the root of each oblique proceſs of this bone, the notch is conſpicuous; by which, and ſuch another in the laſt *vertebra* of the loins, a paſſage is left for the twenty-fourth ſpinal nerve; and, in viewing the *os ſacrum*, either before or behind, four large holes appear in each ſide, in much the ſame height as where the marks of the union of its ſeveral bones remain. Some of the largeſt nerves of the body paſs through the anterior holes; and ſuperficial grooves running outwards from them in different directions, ſhew the courſe of theſe nerves.——From the intervals of theſe grooves, the *pyriformis* muſcle chiefly riſes.——The holes in the back-part of the bone are covered by membranes which allow ſmall nerves to paſs through them.——The two uppermoſt of theſe holes, eſpecially on the fore-ſide, are the largeſt; and, as the bone deſcends, the holes turn ſmaller. Sometimes a notch is only formed at the lower part in each ſide of this bone; and, in other ſubjects, there is a hole common to it and the *os coccygis*, through which the twenty-ninth pair of ſpinal nerves paſſes; and frequently a bony bridge is formed on the back-part of each ſide by a proceſs ſent up from the back-part of the *os coccygis*, and joined to the little knobs which the laſt bone of the *os ſacrum* has inſtead of a ſpinal proceſs. Under this bridge or *jugum*, the twenty-ninth pair of ſpinal nerves runs in its courſe to the common holes juſt now deſcribed.

The upper part of the body of the firſt bone reſembles the *vertebræ* of the loins; but the ſmall fifth bone is oblong tranſverſely, and hollow in the middle of its lower ſurface.

The ſubſtance of the *os ſacrum* is very ſpongy, without any conſiderable ſolid external plates, and is lighter proportionally to its bulk than any other bone in the body; but is ſecured from injuries by the thick muſcles that cover it behind, and by the ſtrong ligamentous membranes that cloſely adhere to it.——As this is one of the moſt remarkable inſtances of this ſort of defence afforded a ſoft weak bone, we may make the general obſervation, That wherever we meet with ſuch a bone, one or other, or both theſe defences, are made uſe of; the firſt to ward off injuries, and the ſecond to keep the ſubſtance of the bone from yielding too eaſily.

This bone is articulated above to the laſt *vertebra* of the loins, in the

manner that the *lumbar vertebræ* are joined; and therefore the ſame motions may be performed here.——The articulation of the lower part of the *os ſacrum* to the *os coccygis* ſeems well enough adapted for allowing conſiderable motion to this laſt bone, was it not much confined by ligaments. Laterally, the *os ſacrum* is joined to the *oſſa ilium* by an immoveable *ſynchondroſis*, or what almoſt deſerves the name of a ſuture: for the cartilaginous cruſt on the ſurface of the bones is very thin, and both their ſurfaces are ſo ſcabrous and unequal as to be indented into each other; which makes ſuch a ſtrong connection, that great force is required to ſeparate them, after all the muſcles and ligaments are cut.——Frequently the two bones grow together in old ſubjects.

The uſes of the *os ſacrum* are, to ſerve as the common baſe and ſupport of the trunk of the body, to guard the nerves proceeding from the end of the ſpinal marrow, to defend the back-part of the *pelvis*, and to afford ſufficient origin to the muſcles which move the trunk and thigh.

The bones that compoſe the *os ſacrum* of infants have their bodies ſeparated from each other by a thick cartilage; and, in the ſame manner as the *true vertebræ*, each of them conſiſts of a body and two lateral parts, connected together by cartilages; the ends of the plates ſeldom being contiguous behind.

Os COCCYGIS (*a*), or *rump-bone*, is that triangular chain of bones depending from the *os ſacrum*; each bone becoming ſmaller as they deſcend, till the laſt ends almoſt in a point. The *os coccygis* is convex behind, and concave before; from which crooked pyramidal figure, which was thought to reſemble a cuckow's beak, it has got its name.

This bone conſiſts of four pieces, in people of middle age: in children, very near the whole of it is cartilage: in old ſubjects, all the bones are united, and become frequently one continued bone with the *os ſacrum*.

The higheſt of the four bones is the largeſt, with ſhoulders extended farther to each ſide than the end of the *os ſacrum*. Which enlargement ſhould, in my opinion, ſerve as a diſtinguiſhing mark to fix the limits of either bone; and therefore ſhould take away all diſpute about reckoning the number of bones, of which one or other of theſe two parts of the *falſe vertebræ* is compoſed: which diſpute muſt ſtill be kept up, ſo long as the

(*a*) Ὀβϱοκυγιον ὀϱϱος, caudæ os, ſpondylium, os cuculi.

the numbering five or ſix bones in the *os ſacrum* depends upon the uncertain accident of this broad-ſhouldered little bone being united to or ſeparated from it.——The upper ſurface of this bone is a little hollow.—From the back of that bulbous part called its *ſhoulders*, a proceſs often riſes up on each ſide, to join with the bifurcated ſpine of the fourth and fifth bones of the *os ſacrum*, to form the bony bridge mentioned in the deſcription of the *os ſacrum*.—Sometimes theſe ſhoulders are joined to the ſides of the fifth bone of the *os ſacrum*, to form the hole in each ſide common to theſe two bones, for the paſſage of the twenty-ninth pair of ſpinal nerves.——Immediately below the ſhoulders of the *os coccygis*, a notch may be remarked on each ſide, where the thirtieth pair of the ſpinal nerves paſſes.——The lower end of this bone is formed into a ſmall head, which very often is hollow in the middle.

The three lower bones gradually become ſmaller, and are ſpongy; but are ſtrengthened by a ſtrong ligament which covers and connects them. ——Their ends, by which they are articulated, are formed in the ſame manner as thoſe of the firſt bone are.

Between each of theſe four bones of young ſubjects, a cartilage is interpoſed; therefore their articulation is analogous to that of the bodies of the *vertebræ* of the neck: For, as has been often above remarked, the lower end of the *os ſacrum*, and of each of the three ſuperior bones of the *os coccygis*, has a ſmall depreſſion in the middle; and the upper part of all the bones of the *os coccygis* is a little concave, and conſequently the interpoſed cartilages are thickeſt in the middle, to fill up both cavities; by which they connect the bones more firmly.—When the cartilages oſſify, the upper end of each bone is formed into a cavity, exactly adapted to the protuberant lower end of the bone immediately above.—From this ſort of articulation, it is evident, that, unleſs when theſe bones grow together, all of them are capable of motion; of which the firſt and ſecond, eſpecially this laſt, enjoys the largeſt ſhare.

The lower end of the fourth bone terminates in a rough point, to which a cartilage is appended.

To the ſides of theſe bones of the *os coccygis*, the *coccygæi* muſcles (*a*), and part of the *levatores ani*, and of the *glutæi maximi*, are fixed.

(*a*) Douglas, Myograph. cap. 40.——Euſtach. tab. 36. n° 45. 20.

The ſubſtance of theſe bones is very ſpongy, and in children cartilaginous; there being only a part of the firſt bone oſſified in a new-born infant.—Since, therefore, the *inteſtinum rectum* of children is not ſo firmly ſupported as it is in *adults*, this may be one reaſon why they are more ſubject to a *procidentia ani* than old people (*a*).

From the deſcription of this bone, we ſee how little it reſembles the *vertebræ*; ſince it ſeldom has proceſſes, never has any cavity for the *ſpinal* marrow, nor holes for the paſſage of nerves.—Its connection hinders it from being moved to either ſide; and its motion backwards and forwards is much confined: yet, as its ligaments can be ſtretched by a conſiderable force, it is a great advantage in the excretion of the *fæces alvinæ*, and much more in child-bearing, that this bone ſhould remain moveable; and the right management of it, in delivering women, may be of great benefit to them (*b*).——The mobility of the *os coccygis* diminiſhing as people advance in age, eſpecially when its ligaments and cartilages have not been kept flexible by being ſtretched, is probably one reaſon why the women, who are old maids before they marry, have generally hard labour in child-bed.

The *os coccygis* ſerves to ſuſtain the *inteſtinum rectum:* and, in order to perform this office more effectually, it is made to turn with a curve forwards; by which alſo the bone itſelf, as well as the muſcles and teguments, is preſerved from any injury when we ſit with our body reclined back.

The ſecond part of the trunk of the ſkeleton, the PELVIS, is the cylindrical cavity at the lower part of the *abdomen*, formed by the *os ſacrum*, *os coccygis*, and *oſſa innominata;* which laſt, therefore, fall now in courſe to be examined.

Though the name of OSSA INNOMINATA (*c*) contributes nothing to the knowledge of their ſituation, ſtructure, or office, yet they have been ſo long and univerſally known by it, that there is no occaſion for changing it.—They are two large broad bones, which form the fore-part and ſides of the *pelvis*, and the lower part of the ſides of the *abdomen*.—In children,

(*a*) Spigel. de Humani Corp. Fabric. lib. 2. cap. 22.—Paaw de Oſſib. pars 2. cap. 3.

(*b*) Paaw, ibid.——Deventer, Operat. Chirurg. cap. 27.

(*c*) Σχιλιον, προσφυσις, ſacro conjuncta.

children, each of theſe bones is evidently divided into three; which are afterwards ſo intimately united, that ſcarce the leaſt mark of their former ſeparation remains: This notwithſtanding, they are deſcribed as conſiſting each of three bones, to wit, the *os ilium*, *iſchium*, and *pubis*; which I ſhall firſt deſcribe ſeparately, and then ſhall conſider what is common to any two of them, or to all three.

Os ILIUM (*a*), or *haunch bone*, is ſituated higheſt of the three, and reaches as far down as one third of the great cavity into which the head of the thigh-bone is received.

The external ſide of this bone is unequally convex, and is called its *dorſum*;—the internal concave ſurface is by ſome (but improperly) named its *coſta*.——The ſemicircular edge at the higheſt part of this bone, which is tipped with a cartilage in the recent ſubject, is named the *ſpine*, into which the external or deſcending oblique muſcle of the *abdomen* is inſerted; and from it the internal aſcending oblique, and the tranſverſe muſcles of the belly, with the *glutæus maximus*, *quadratus lumborum*, and *latiſſimus dorſi*, have their origin. Some (*b*) are of opinion, that it is only the tendinous cruſt of all theſe muſcles, and not a cartilage, as commonly alleged, that covers this bony edge.—The ends of the ſpine are more prominent than the ſurface of the bone below them; therefore are reckoned proceſſes.—From the anterior ſpinal proceſs, the *ſartorius* and *faſcialis* muſcles have their riſe; and the outer end of the doubled tendon of the external oblique muſcle of the *abdomen*, commonly called *Fallopius*'s or *Poupart*'s ligament, is fixed to it.——The inſide of the poſterior ſpinal proceſs, and of part of the ſpine forward from that, is made flat and rough where the *ſacro-lumbalis* and *longiſſimus dorſi* riſe; and to its outſide ligaments, extended to the *os ſacrum* and tranſverſe proceſſes of the fifth and fourth *vertebræ* of the loins, are fixed (*c*).—Below the anterior ſpinal proceſs another protuberance ſtands out, which, by its ſituation, may be diſtinguiſhed from the former, by adding the epithet of *inferior*, where the *muſculus rectus tibiæ* has its origin (*d*).—Betwixt theſe two anterior proceſſes

(*a*) Λαγονων, ιλιον, ſcaphium, lumbare, clunium, clavium, anchas.

(*b*) Winſlow, Expoſition Anatomique du Corps Humain, traité des Os Frais, §96.

(*c*) Weitbrecht, Syndeſmolog. ſect. 4. § 39, 40, 46, 47.

(*d*) Baker, Curſ. Oſteolog. demonſtr. 3.

proceſſes, the bone is hollowed where the beginning of the *ſartorius* muſcle is lodged.—Below the poſterior ſpinal proceſs, a ſecond protuberance of the edge of this bone is in like manner obſervable, which is cloſely applied to the *os ſacrum*.—Under this laſt proceſs a conſiderable large niche is obſervable in the *os ilium*; between the ſides of which and the ſtrong ligament that is ſtretched over from the *os ſacrum* to the ſharp-pointed proceſs of the *os iſchium* of the recent ſubject, a large hole is formed, through which the *muſculus pyriformis*, the great ſciatic nerve, and the poſterior crural veſſels, paſs, and are protected from compreſſion.

The external broad ſide or *dorſum* of the *os ilium* is a little hollow towards the fore-part; farther back, it is as much raiſed; then is conſiderably concave; and, laſtly, it is convex. Theſe inequalities are occaſioned by the actions of the muſcles that are ſituated on this ſurface. From behind the uppermoſt of the two anterior ſpinal proceſſes, in ſuch bones as are ſtrongly marked by the muſcles, a ſemicircular ridge is extended to the hollow paſſage of the ſciatic nerve. Between the ſpine and this ridge the *glutæus medius* takes its riſe. Immediately from above the loweſt of the anterior ſpinal proceſſes, a ſecond ridge is ſtretched to the niche. Between this and the former ridge the *glutæus minimus* has its origin. On the outſide of the poſterior ſpinal proceſſes, the *dorſum* of the *os ilium* is flat and rough, where part of the *muſculus glutæus maximus* and *pyriformis* riſes. The loweſt part of this bone is the thickeſt; and is formed into a large cavity with high brims, to aſſiſt in compoſing the great *acetabulum*; which ſhall be conſidered, after all the three bones that conſtitute the *os innominatum* are deſcribed.

The internal ſurface of the *os ilium* is concave in its broadeſt fore-part, where the internal iliac muſcle has its origin, and ſome ſhare of the *inteſtinum ilium* and *colon* is lodged.—From this large hollow a ſmall ſinuoſity is continued obliquely forwards, at the inſide of the anterior inferior ſpinal proceſs, where part of the *pſoas* and *iliacus* muſcles, with the crural veſſels and nerves, paſs. The large concavity is bounded below by a ſharp ridge, which runs from behind forwards; and, being continued with ſuch another ridge of the *os pubis*, forms a line of partition between the *abdomen* and *pelvis*. Into this ridge the broad tendon of the *pſoas parvus* is inſerted.

All

All the internal ſurface of the *os ilium*, behind this ridge, is very unequal: for the upper part is flat, but ſpongy, where the *ſacro-lumbalis* and *longiſſimus dorſi* riſe.——Lower down, there is a tranſverſe ridge, from which ligaments go out to the *os ſacrum*.—Immediately below this ridge, the rough unequal cavities and prominences are placed, which are exactly adapted to thoſe deſcribed on the ſide of the *os ſacrum*.——In the ſame manner, the upper part of this rough ſurface is porous, for the firmer adheſion of the ligamentous cellular ſubſtance; while the lower part is more ſolid, and covered with a thin cartilaginous ſkin, for its immoveable articulation with the *os ſacrum*.——From all the circumference of this large unequal ſurface, ligaments are extended to the *os ſacrum*, to ſecure more firmly the conjunction of theſe bones.

The paſſages of the medullary veſſels are very conſpicuous, both in the *dorſum* and *coſta* of many *oſſa ilium*; but in others they are inconſiderable.

The poſterior and lower parts of theſe bones are thick; but they are generally exceeding thin and compact at their middle, where they are expoſed to the actions of the *muſculi glutæi* and *iliacus internus*, and to the preſſure of the bowels contained in the belly.——The ſubſtance of the *oſſa ilium* is moſtly cellular, except a thin external table.

In a ripe child, the ſpine of the *os ilium* is cartilaginous, and is afterwards joined to the bone in form of an *epiphyſe*.——The large lower end of this bone is not completely oſſified.

Os ISCHIUM (*a*), or *hip-bone*, is of a middle bulk between the two other parts of the *os innominatum*, is ſituated loweſt of the three, and is of a very irregular figure.—Its extent might be marked by an horizontal line drawn near through the middle of the *acetabulum*; for the upper bulbous part of this bone forms ſome leſs than the lower half of that great cavity, and the ſmall leg of it riſes to much the ſame height on the other ſide of the great hole common to this bone and the *os pubis*.

From the upper thick part of the *os iſchium*, a ſharp proceſs, called by ſome *ſpinous*, ſtands out backwards, from which chiefly the *muſculus coccygæus* and *ſuperior gemellus*, and part of the *levator ani*, riſe; and the anterior or internal *ſacro-ſciatic* ligament is fixed to it.——Between the upper

(*a*) Coxæ, coxendicis, pixis.

upper part of this ligament and the bones, it was formerly obſerved that the *pyriform* muſcle, the poſterior crural veſſels, and the ſciatic nerve, paſs out of the *pelvis*.—Immediately below this proceſs, a ſinuoſity is formed for the tendon of the *muſculus obturator internus*.—In a recent ſubject, this part of the bone, which ſerves as a pulley on which the *obturator* muſcle plays, is covered with a ligamentous cartilage, that, by two or three ſmall ridges, points out the interſtices of the fibres in the tendon of this muſcle.——The outer ſurface of the bone at the root of this ſpinous proceſs is made hollow by the *pyriformis* or *iliacus externus* muſcle.

Below the ſinuoſity for the *obturator* muſcle, is the great knob or *tuberoſity*, covered with cartilage or tendon (*a*).——The upper part of the tuberoſity gives riſe to the inferior *gemellus* muſcle.——To a ridge at the inſide of this, the external or poſterior *ſacro-ſciatic* ligament is ſo fixed, that between it, the internal ligament, and the ſinuoſity of the *os iſchium*, a paſſage is left for the internal *obturator* muſcle.——The upper thick ſmooth part of the *tuber*, called by ſome its *dorſum*, has two oblique impreſſions on it. The inner one gives origin to the long head of the *biceps flexor tibiæ* and *ſeminervoſus* muſcles; and the *ſemimembranoſus* riſes from the exterior one, which reaches higher and nearer the *acetabulum* than the other.——The lower, thinner, more ſcabrous part of the knob which bends forwards, is alſo marked with two flat ſurfaces; whereof the internal is what we lean upon in ſitting, and the external gives riſe to the largeſt head of the *triceps adductor femoris*.——Between the external margin of the tuberoſity and the great hole of the *os innominatum*, there is frequently an obtuſe ridge extended down from the *acetabulum*, which gives origin to the *quadratus femoris*.—As the *tuber* advances forwards, it becomes ſmaller, and is rough, for the origin of the *muſculus tranſverſalis* and *erector penis*.—The ſmall leg of it, which mounts upwards to join the *os pubis*, is rough and prominent at its edge, where the two lower heads of the *triceps* or *quadriceps adductor femoris* take their riſe.

The upper and back part of the *os iſchium* is broad and thick; but its lower and fore part is narrower and thinner.—Its ſubſtance is of the ſtructure common to broad bones.

The *os ilium* and *pubis* of the ſame ſide are the only bones which are contiguous to the *os iſchium*.

The

(*a*) Winſlow, Expoſit. Anat. des Os Frais, § 96.

The part of the *os iſchium* which forms the *acetabulum*, the ſpinous proceſs, the great *tuber*, and the recurved leg, are all cartilaginous at birth. The *tuber*, with part of the leg or proceſs above it, becomes an epiphyſe before this bone is fully formed.

The OS PUBIS (*a*), or *ſhare-bone*, is the leaſt of the three parts of the *os innominatum*, and is placed at the upper fore-part of it.——The thick largeſt part of this bone is employed in forming the *acetabulum*; from which becoming much ſmaller, it is ſtretched inwards to its fellow of the other ſide, where again it grows larger, and ſends a ſmall branch downwards to join the end of the ſmall leg of the *os iſchium*.—The upper fore-part of each *os pubis* is tuberous and rough where the *muſculus rectus* and *pyramidalis* are inſerted.——From this a ridge is extended along the upper edge of the bone, in a continued line with ſuch another of the *os ilium*, which divides the *abdomen* and *pelvis*. The ligament of *Fallopius* is fixed to the internal end of this ridge, and the ſmooth hollow below it is made by the *pſoas* and *iliacus internus* muſcles paſſing with the anterior crural veſſels and nerves behind the ligament.—Some way below the former ridge another is extended from the tuberous part of the *os pubis* downwards and outwards towards the *acetabulum*; between theſe two ridges the bone is hollow and ſmooth, for lodging the head of the *pectineus* muſcle.—Immediately below, where the lower ridge is to take the turn downwards, a winding niche is made, which is comprehended in the great *foramen* of a ſkeleton, but is formed into a hole by a ſubtended ligament in the recent ſubject, for the paſſage of the poſterior crural nerve, an artery, and a vein.—The internal end of the *os pubis* is rough and unequal, for the firmer adheſion of the thick ligamentous cartilage that connects it to its fellow of the other ſide.—The proceſs which goes down from that to the *os iſchium* is broad and rough before, where the *gracilis* and upper heads of the *triceps*, or rather *quadriceps*, *adductor femoris* have their origin.

The ſubſtance of the *os pubis* is the ſame as of other broad bones.

Only a part of the large end of this bone is oſſified; and the whole leg is cartilaginous in a child born at the full time.

Betwixt the *os iſchium* and *pubis* a very large irregular hole is left, which

(*a*) Ἐβος, pectinis, penis, pudibundum, feneſtratum.

from its reſemblance to a door or ſhield, has been called *thyroides*. This hole is all, except the niche for the poſterior crural nerve, filled up in a recent ſubject with a ſtrong ligamentous membrane that adheres very firmly to its circumference. From this membrane chiefly the two *obturator* muſcles, external and internal, take their riſe.—The great deſign of this hole, beſides rendering the bone lighter, is to allow a ſtrong enough origin to the *obturator* muſcles, and ſufficient ſpace for lodging their bellies, that there may be no danger of diſturbing the functions of the contained *viſcera* of the *pelvis* by the actions of the internal, nor of the external being bruiſed by the thigh-bone, eſpecially by its leſſer *trochanter*, in the motions of the thigh inwards: Both which inconveniencies muſt have happened, had the *oſſa innominata* been complete here, and of ſufficient thickneſs and ſtrength to ſerve as the fixed point of theſe muſcles.—The bowels ſometimes make their way through the niche for the veſſels, at the upper part of this *thyroid* hole; and this cauſes a *hernia* in this place (*a*).

In the external ſurface of the *oſſa innominata*, near the outſide of the great hole, a large deep cavity is formed by all the three bones conjunctly: for the *os pubis* conſtitutes about one fifth, the *os ilium* makes ſomething leſs than two fifths, and the *os iſchium* as much more than two fifths. The brims of this cavity are very high, and ſtill much more enlarged by the ligamentous cartilage, with which they are tipped in a recent ſubject. From this form of the cavity it has been called *acetabulum;* and for a diſtinguiſhing character, the name of the bone that conſtitutes the largeſt ſhare of it is added: therefore *acetabulum oſſis iſchii* (*b*) is the name this cavity commonly bears.—Round the baſe of the *ſupercilia* the bone is rough and unequal, where the capſular ligament of the articulation is fixed. The brims at the upper and back part of the *acetabulum* are much larger and higher than any where elſe; which is very neceſſary to prevent the head of the *femur* from ſlipping out of its cavity at this place, where the whole weight of the body bears upon it, and conſequently would otherwiſe be conſtantly in danger of thruſting it out.—As theſe brims are extended downwards and forwards they become leſs; and at their internal lower part a breach is made in them; from the one ſide of which to the other a ligament is placed in the recent ſubject; under which a large hole

(*a*) Memoires de l'Acad. de Chirurgie, tom. 1. p. 709, &c. (*b*) Coxæ, coxendicis.

hole is left, which contains a fatty cellular ſubſtance and veſſels. The reaſon of which appearance has afforded matter of debate. To me it ſeems evidently contrived for allowing a larger motion to the thigh inwards: for if the bony brims had been here continued, the neck of the thigh-bone muſt have ſtruck upon them when the thighs were brought acroſs each other; which, in a large ſtrong motion this way, would have endangered the neck of the one bone, or brim of the other. Then the veſſels which are diſtributed to the joint may ſafely enter at the ſinuoſity in the bottom of the breach; which being, however, larger than is neceſſary for that purpoſe, allows the large mucilaginous gland of the joint to eſcape below the ligament, when the head of the thigh-bone is in hazard of preſſing too much upon it in the motions of the thigh outwards (*a*). Beſides this difference in the height of the brims, the *acetabulum* is otherwiſe unequal; for the lower internal part of it is depreſſed below the cartilaginous ſurface of the upper part, and is not covered with cartilage: into the upper part of this particular depreſſion, where it is deepeſt and of a ſemilunar form, the ligament of the thigh-bone, commonly, though improperly, called the *round* one, is inſerted; while in its more ſuperficial lower part the large mucilaginous gland of this joint is lodged. The largeſt ſhare of this ſeparate depreſſion is formed in the *os iſchium*.

From what has been ſaid of the condition of the three bones compoſing this *acetabulum* in new-born children, it muſt be evident, that a conſiderable part of this cavity is cartilaginous in them.

The *oſſa innominata* are joined at their back-part to each ſide of the *os ſacrum* by a ſort of ſuture, with a very thin intervening cartilage, which ſerves as ſo much glue to cement thoſe bones together; and ſtrong ligaments go from the circumference of this unequal ſurface to connect them more firmly. The *oſſa innominata* are connected together at their fore-part by the ligamentous cartilage interpoſed between the two *oſſa pubis*. Theſe bones can therefore have no motion in a natural ſtate, except what is common to the trunk of the body, or to the *os ſacrum*. But it has been diſputed, whether or not they looſen ſo much from each other and from the *os ſacrum* in child-birth, by the flow of *mucus* to the *pelvis*, and by the throes of the labour, as that the *oſſa pubis* recede from each other,

(*a*) Petit, Memoires de l'Acad. des Sciences, 1722.

and thereby allow the paſſage between the bones to be enlarged.—Several obſervations (*a*) ſhew that this relaxation ſometimes happens: but thoſe who had frequently opportunities of diſſecting the bodies of women who died immediately after being delivered of children, teach us to beware of regarding this as the common effect of child-birth; for they found ſuch a relaxation in very few of the bodies which they examined (*b*).

Conſidering what great weight is ſupported, in our erect poſture, by the articulation of the *oſſa innominata* with the *os ſacrum*; there is great reaſon to think, that, if the conglutinated ſurfaces of theſe bones were once ſeparated, (without which the *oſſa pubis* cannot ſhuffle on each other), the ligaments would be violently ſtretched, if not torn; from whence many diſorders would ariſe (*c*).

Each *os innominatum* affords a ſocket (the *acetabulum*) for the thigh-bones to move in; and the trunk of the body rolls here ſo much on the heads of the thigh-bones, as to allow the moſt conſpicuous motions of the *trunk*, which are commonly thought to be performed by the bones of the ſpine.—This articulation is to be more fully deſcribed after the *oſſa femoris* are examined.

The *pelvis*, then, has a large open above where it is continued with the *abdomen*; is ſtrongly fenced by bones on the ſides, back, and fore-part; and appears with a wide opening below in the ſkeleton: but in the recent ſubject, a conſiderable part of the opening is filled by the *ſacro-ſciatic* ligaments, *pyriform*, *internal obturator*, *levatores ani*, *gemini*, and *coccygæi* muſcles, which ſupport and protect the contained parts better than bones could have done; ſo that ſpace is only left at the loweſt part of it for the large excretories, the *veſica urinaria*, *inteſtinum rectum*, and in females the *uterus*, to diſcharge themſelves.

The THORAX (*d*), or *cheſt*, which is the only part of the trunk of the body which we have not yet deſcribed, reaches from below the neck to the belly; and, by means of the bones that guard it, is formed into a large cavity:

(*a*) Bauhin. Theat. Anat. lib. 1. cap. 49.—Spigel. Anat. lib. 2. cap. 24.—Riolan. Anthropog. lib. 6. cap. 12.—Diemerbroeck, Anat. lib. 9. cap. 16.

(*b*) Hildan. Epiſt. Cent. obſ. 46.—Dionis, Sixieme Demonſt. des Os.—Morgagn. Adverſ. 3. animad. 15.

(*c*) Ludov. in Ephem. German. dec. 1. ann. 3. obſ. 255.

(*d*) Pectus, caſſum.

cavity: The figure of which is ſomewhat conoidal; but its upper ſmaller end is not finiſhed, being left open for the paſſage of the wind-pipe, gullet, and large blood-veſſels; and its lower part, or baſe, has no bones, and is ſhorter before than behind; ſo that, to carry on our compariſon, it appears like an oblique ſection of the conoid. Beſides which, we ought alſo to remark, that the lower part of this cavity is narrower than ſome way above (*a*); and that the middle of its back-part is conſiderably diminiſhed by the bones ſtanding forwards into it.

The bones which form the *thorax* are the twelve dorſal *vertebræ* behind, the ribs on the ſides, and the *ſternum* before.

The *vertebræ* have already been deſcribed as part of the ſpine; and therefore are now to be paſſed.

The RIBS, or *coſtæ* (*b*), (as if they were *cuſtodes* or guards to thoſe principal organs of the animal-machine, the heart and lungs), are the long crooked bones placed at the ſide of the cheſt, in an oblique direction downwards in reſpect of the back-bone.—Their number is generally twelve on each ſide; though frequently eleven or thirteen have been found (*c*). Sometimes the ribs are found preternaturally conjoined or divided (*d*).

The ribs are all concave internally; where they are alſo made ſmooth by the action of the contained parts, which, on this account, are in no danger of being hurt by them; and they are convex externally, that they might reſiſt that part of the preſſure of the atmoſphere, which is not balanced by the air within the lungs during *inſpiration*.——The ends of the ribs next the *vertebræ* are rounder than they are after theſe bones have advanced forwards, when they become flatter and broader, and have an upper and lower edge; each of which is made rough by the action of the *intercoſtal* muſcles inſerted into them. Theſe muſcles, being all of nearly equal force, and equally ſtretched in the interſtices of the ribs, prevent the broken ends of theſe bones in a fracture from being removed far out of their natural place, to interrupt the motion of the vital organs. The upper edge of the ribs is more obtuſe and rounder than the lower, which

(*a*) Albin. de Oſſib. § 169. (*b*) Πλευραι, περισφυα, σπαδες.

(*c*) Riolan. Comment. de Oſſibus, cap. 19.—Marchetti, cap. 9. Cowper's Explicat. of tab. 93 & 94.—Morgagn. Adverſ. Anat. (*d*) Sue Trad. d'Oſteolog. p. 141.

which is depreſſed on its internal ſide by a long *foſſa* for lodging the intercoſtal veſſels and nerves; on each ſide of which there is a ridge, to which the intercoſtal muſcles are fixed. The *foſſa* is not obſervable, however, at either end of the ribs: for at the poſterior or root the veſſels have not yet reached the ribs; and at the fore-end they are ſplit away into branches, to ſerve the parts between the ribs: which plainly teaches ſurgeons one reaſon of the greater ſafety of performing the operation of the *empyema* towards the ſides of the *thorax*, than either near the back or the breaſt.

At the poſterior end (*a*) of each *rib* a little head is formed, which is divided by a middle ridge into two plain or hollow ſurfaces; the loweſt of which is the broadeſt and deepeſt in moſt of them. The two plains are joined to the bodies of two different *vertebræ*, and the ridge forces itſelf into the intervening cartilage.—A little way from this head, we find, on the external ſurface, a ſmall cavity, where mucilaginous glands are lodged; and round the head the bone appears ſpongy, where the capſular ligament of the articulation is fixed.—Immediately beyond this a flatted tubercle riſes, with a ſmall cavity at, and roughneſs about its root, for the articulation of the rib with the tranſverſe proceſs of the loweſt of the two *vertebræ*, with the bodies of which the head of the rib is joined.—Advancing farther on this external ſurface, we obſerve in moſt of the ribs another ſmaller tubercle; into which ligaments which connect the ribs to each other and to the tranſverſe proceſſes of the *vertebræ*, and portions of the *longiſſimus dorſi*, are inſerted.—Beyond this the ribs are made flat by the *ſacro-lumbalis* muſcle, which is inſerted into the part of this flat ſurface fartheſt from the ſpine, where each rib makes a conſiderable curve, called by ſome its *angle*.—Then the rib begins to turn broad, and continues ſo to its anterior end (*b*), which is hollow and ſpongy for the reception of, and firm coalition with, the cartilage that runs thence to be inſerted into the *ſternum*, or to be joined with ſome other cartilage.—In adults, generally the cavity at this end of the ribs is ſmooth and poliſhed on its ſurface; by which the articulation of the cartilage with it has the appearance of being deſigned for motion, but it has none.

The ſubſtance of the ribs is ſpongy, cellular, and only covered with a very

(*a*) Κωτιον, remulus. (*b*) Πλατη, palmula.

very thin external lamellated ſurface, which increaſes in thickneſs and ſtrength as it approaches the *vertebræ*.

To the fore-end of each rib a long broad and ſtrong cartilage is fixed, and reaches thence to the *ſternum*, or is joined to the cartilage of the next rib. This courſe, however, is not in a ſtraight line with the rib; for generally the cartilages make a conſiderable curve, the concave part of which is upwards: therefore at their inſertion into the *ſternum*, they make an obtuſe angle above, and an acute one below.—Theſe cartilages are of ſuch a length as never to allow the ribs to come to a right angle with the ſpine; but they keep them ſituated ſo obliquely, as to make an angle very conſiderably obtuſe above, till a force exceeding the elaſticity of the cartilages is applied. Theſe cartilages, as all others, are firmer and harder internally than they are on their external ſurface; and ſometimes, in old people, all their middle ſubſtance becomes bony, while a thin cartilaginous *lamella* appears externally (*a*). The oſſification, however, begins frequently at the external ſurface.—The greateſt alternate motions of the cartilages being made at their great curvature, that part remains frequently cartilaginous, after all the reſt is oſſified (*b*).

The ribs then are articulated at each end, of which the one behind is doubly joined to the *vertebræ*; for the head is received into the cavities of two bodies of the *vertebræ*, and the larger tubercle is received into the depreſſion in the tranſverſe proceſs of the lower *vertebra*.——When one examines the double articulation, he muſt immediately ſee, that no other motion can here be allowed than upwards and downwards; ſince the tranſverſe proceſs hinders the rib to be thruſt back; the reſiſtance on the other ſide of the *ſternum* prevents the ribs coming forward; and each of the two joints, with the other parts attached, oppoſe its turning round. But then it is likewiſe as evident, that even the motion upwards and downwards can be but ſmall, in any one rib, at the articulation itſelf. But as the ribs advance forwards, the diſtance from their centre of motion increaſing, the motion muſt be larger: and it would be very conſpicuous at their anterior ends, were they not reſiſted there by the cartilages; which yield ſo little, that the principal motion is performed by the middle part of the ribs, which turns outwards and upwards, and occaſions the twiſt

(*a*) Veſal. lib. 2. cap. 19. (*b*) Havers, Oſteolog. Nov. diſc. 5. p. 289.

twiſt remarkable in the long ribs at the place near their fore-end where they are moſt reſiſted (*a*).

Hitherto I have laid down the ſtructure and connection which moſt of the ribs enjoy, as belonging to all of them; but muſt now conſider the ſpecialities wherein any of them differ from the general deſcription given, or from each other.

In viewing the ribs from above downwards, their figure is ſtill ſtraighter; the uppermoſt being the moſt crooked of any.—Their obliquity, in reſpect of the ſpine, increaſes as they deſcend: ſo that though their diſtances from each other is very little different at their back-part, yet at their fore-ends the diſtances between the lower ones muſt increaſe.—In conſequence too of this increaſed obliquity of the lower ribs, each of their cartilages makes a greater curve in its progreſs from the rib towards the *ſternum*; and the tubercles that are articulated to the tranſverſe proceſſes of the *vertebræ*, have their ſmooth ſurfaces gradually facing more upwards.—The ribs becoming thus more oblique, while the *ſternum* advances forwards in its deſcent, makes the diſtance between the *ſternum* and the anterior end of the lower ribs greater than between the *ſternum* and the ribs above; conſequently the cartilages of thoſe ribs that are joined to the breaſt-bone are longer in the lower than in the higher ones.—— Theſe cartilages are placed nearer to each other as the ribs deſcend; which occaſions the curvature of the cartilages to be greater.

The length of the ribs increaſes from the firſt and uppermoſt rib as far down as the ſeventh; and from that to the twelfth as gradually diminiſhes.—The ſuperior of the two plain, or rather hollow ſurfaces, by which the ribs are articulated to the bodies of the *vertebræ*, gradually increaſes from the firſt to the fourth rib, and is diminiſhed after that in each lower rib.——The diſtance of their angles from the heads always increaſes as they deſcend to the ninth, becauſe of the greater breadth of the *ſacro-lumbalis* muſcle (*b*).

The ribs are commonly divided into *true* and *falſe*.

The *true* (*c*) *coſtæ* are the ſeven upper ones of each ſide, whoſe cartilages

(*a*) Winſlow, Memoires de l'Acad. des Sciences, 1720.

(*b*) Winſlow, Expoſition Anatomique des Os ſecs, § 643.

(*c*) γνήσιαι, germanæ, legitimæ.

ges are all gradually longer as the ribs deſcend, and are joined to the breaſt-bone: ſo that, being preſſed conſtantly between two bones, they are flatted at both ends; and are thicker, harder, and more liable to oſſify, than the other cartilages that are not ſubject to ſo much preſſure. Theſe ribs include the heart and lungs; and therefore are the proper or true *cuſtodes* of life.

The five inferior ribs of each ſide are the *falſe* or BASTARD (*a*), whoſe cartilages do not reach to the *ſternum*; and therefore wanting the reſiſtance at their fore-part, they are there pointed; and, on this account, having leſs preſſure, their ſubſtance is ſofter.——The cartilages of theſe *falſe ribs* are ſhorter as the ribs deſcend.—To all theſe five ribs the circular edge of the *diaphragm* is connected; and its fibres, inſtead of being ſtretched immediately tranſverſely, and ſo running perpendicular to the ribs, are preſſed ſo as to be often, eſpecially in exſpiration, parallel to the plane in which the ribs lie: Nay, one may judge by the attachments which theſe fibres have ſo frequently to the ſides of the *thorax*, a conſiderable way above where their extremities are inſerted into the ribs, and by the ſituation of the *viſcera*, always to be obſerved in a dead ſubject laid ſupine, that there is conſtantly a large concavity formed on each ſide by the *diaphragm* within theſe baſtard ribs, in which the ſtomach, liver, ſpleen, &c. are contained; which being only reckoned among the *viſcera naturalia*, have occaſioned the name of *baſtard cuſtodes* to theſe bones.

Hence in ſimple fractures of the falſe ribs, without fever, the ſtomach ought to be kept moderately filled with food, leſt the pendulous ribs falling inwards, ſhould thereby increaſe the pain, cough, &c. (*b*).—Hence likewiſe we may learn how to judge better of the ſeat of ſeveral diſeaſes, and to do the operation of the *empyema*, and ſome others, with more ſafety than we can do if we follow the common directions.

The eight upper ribs were formerly (*c*) claſſed into pairs, with particular names to each two, to wit, the *crooked*, the *ſolid*, the *pectoral*, the *twiſted*: But theſe names are of ſo little uſe, that they are now generally neglected.

(*a*) Μαλθακαι, χονδροειδεις, ακανθαι, νοθαι, ρεαι, adulterinæ, ſpuriæ, illegitimæ.

(*b*) Hippocrat. de Articulo, § 51.—Paré, lib. 15. cap. 11.

(*c*) Laurent. Hiſt. Anat. lib. 2. cap. 29.—Paaw, de Oſſibus, part 3. cap. 2.

The *firſt* rib of each ſide is ſo ſituated, that the flat ſides are above and below, while one edge is placed inwards, and the other outwards, or nearly ſo; therefore ſufficient ſpace is left above it for the ſubclavian veſſels and muſcle; and the broad concave ſurface is oppoſed to the lungs: But then, in conſequence of this ſituation, the channel for the intercoſtal veſſels is not to be found, and the edges are differently formed from all the other, except the ſecond; the lower one being rounded, and the other ſharp.—The head of this rib is not divided into two plain ſurfaces by a middle ridge, becauſe it is only articulated with the firſt *vertebra* of the *thorax*.—Its cartilage is oſſified in adults, and is united to the *ſternum* at right angles.—Frequently this firſt rib has a ridge riſing near the middle of its poſterior edge, where one of the heads of the *ſcalenus* muſcle riſes.——Farther forward it is flatted, or ſometimes depreſſed, by the clavicle.

The fifth, ſixth, and ſeventh, or rather the ſixth, ſeventh, eighth, and ſometimes the fifth, ſixth, ſeventh, eighth, ninth ribs, have their cartilages at leaſt contiguous; and frequently they are joined to each other by croſs cartilages; and moſt commonly the cartilages of the eighth, ninth, tenth, are connected to the former and to each other by firm ligaments.

The *eleventh*, and ſometimes the *tenth* rib, has no tubercle for its articulation with the tranſverſe proceſs of the *vertebra*, to which it is only looſely fixed by ligaments.—The *foſſa* in its lower edge is not ſo deep as in the upper ribs, becauſe the veſſels run more towards the interſtice between the ribs.—Its fore-end is ſmaller than its body, and its ſhort ſmall cartilage is but looſely connected to the cartilage of the rib above.

The *twelfth* rib is the ſhorteſt and ſtraighteſt.—Its head is only articulated with the laſt *vertebra* of the *thorax*; therefore is not divided into two ſurfaces.—This rib is not joined to the tranſverſe proceſs of the *vertebra*, and therefore has no tubercle, being often pulled neceſſarily inwards by the diaphragm, which an articulation with the tranſverſe proceſs would not have allowed.—The *foſſa* is not found at its under edge, becauſe the veſſels run below it.—The fore-part of this rib is ſmaller than its middle, and has only a very ſmall pointed cartilage fixed to it. To its whole internal ſide the diaphragm is connected.

The

The motions and uſes of the ribs ſhall be more particularly treated of after the deſcription of the *ſternum*.

The heads and tubercles of the ribs of a new-born child have cartilages on them; part of which becomes afterwards thin epiphyſes.—The bodies of the ribs encroach gradually after birth upon the cartilages; ſo that the latter are proportionally ſhorter, when compared to the ribs, in adults than in children.

Here I cannot help remarking the wiſe providence of our Creator, in preſerving us from periſhing as ſoon as we come into the world. The end of the bones of the limbs remain in a cartilaginous ſtate after birth, and are many years before they are entirely united to the main body of their ſeveral bones: whereas the condyles of the occipital bone, and of the lower jaw, are true original proceſſes, and oſſified before birth; and the heads and tubercles of the ribs are nearly in the ſame condition; and therefore the weight of the large head is firmly ſupported; the actions of ſucking, ſwallowing, reſpiration, &c. which are indiſpenſably neceſſary for us as ſoon as we come into the world, are performed without danger of ſeparating the parts of the bones that are moſt preſſed on in theſe motions: Whereas, had theſe proceſſes of the head, jaw, and ribs, been epiphyſes at birth, children muſt have been expoſed to danger of dying by ſuch a ſeparation; the immediate conſequences of which would be, the compreſſion of the beginning of the *ſpinal* marrow, or want of food, or a ſtop put to reſpiration.

The STERNUM (*a*), or *breaſt-bone*, is the broad flat bone, or pile of bones, at the fore-part of the *thorax*.——The number of bones which this ſhould be divided into, has occaſioned debates among anatomiſts, who have conſidered it in ſubjects of different ages.——In adults of a middle age, it is compoſed of three bones, which eaſily ſeparate after the cartilages connecting them are deſtroyed. Frequently the two lower bones are found intimately united; and very often, in old people, the *ſternum* is a continued bony ſubſtance from one end to the other; though we ſtill obſerve two, ſometimes three, tranſverſe lines on its ſurface; which are marks of the former diviſions.

When we conſider the *ſternum* as one bone, we find it broadeſt and

(*a*) Στηθος, os pectoris, enſiforme, ſcutum cordis.

thickeſt above, and becoming ſmaller as it deſcends. The internal ſurface of this bone is ſomewhat hollowed for enlarging the *thorax:* but the convexity on the external ſurface is not ſo conſpicuous, becauſe the ſides are preſſed outwards by the true ribs; the round heads of whoſe cartilages are received into ſeven ſmooth pits, formed in each ſide of the *ſternum*, and are kept firm there by ſtrong ligaments, which on the external ſurface have a particular radiated texture (*a*).—Frequently the cartilaginous fibres thruſt themſelves into the bony ſubſtance of the *ſternum*, and are joined by a ſort of ſuture.—The pits at the upper part of the *ſternum* are at the greateſt diſtance one from another, and, as they deſcend, are nearer; ſo that the two loweſt are contiguous.

The ſubſtance of the breaſt-bone is cellular, with a very thin external plate, eſpecially on its internal ſurface, where we may frequently obſerve a cartilaginous cruſt ſpread over it (*b*). On both ſurfaces, however, a ſtrong ligamentous membrane is cloſely braced; and the cells of this bone are ſo ſmall, that a conſiderable quantity of oſſeous fibres muſt be employed in the compoſition of it: Whence, with the defence which the muſcles give it, and the moveable ſupport it has from the cartilages, it is ſufficiently ſecured from being broken; for it is ſtrong by its quantity of bone, its parts are kept together by ligaments, and it yields enough to elude conſiderably the violence offered (*c*).

So far may be ſaid of this bone in general; but the three bones, of which, according to the common account, it is compoſed in adults, are each to be examined.

The *firſt*, all agree, is ſomewhat of the figure of a heart, as it is commonly painted; only it does not terminate in a ſharp point.—This is the uppermoſt thickeſt part of the *ſternum*.

The upper middle part of this firſt bone, where it is thickeſt, is hollowed, to make place for the *trachea arteria;* though this cavity (*d*) is principally formed by the bone being raiſed on each ſide of it, partly by the clavicles thruſting it inwards, and partly by the *ſterno-maſtoidei* muſcles pulling it upwards.—On the outſide of each tubercle, there is an

(*a*) Ruyſch. Catalog. Rar. fig. 9. (*b*) Jac. Sylv. in Galen. de Oſſibus, cap. 12.
(*b*) Senac. in Memoires de l'Acad. des Sciences, 1724.
(*c*) Χραγη, jugulum, furcula ſuperior.

an oblong cavity, that, in viewing it tranſverſely from before backwards, appears a little convex: Into theſe *glenæ* the ends of the clavicles are received.—Immediately below theſe, the ſides of this bone begin to turn thinner; and in each a ſuperficial cavity or a rough ſurface is to be ſeen, where the firſt ribs are received or joined to the *ſternum*.—In the ſide of the under-end of this firſt bone, the half of the pit for the ſecond rib on each ſide is formed.—The upper part of the ſurface behind is covered with a ſtrong ligament, which ſecures the clavicles; and is afterwards to be more particularly taken notice of.

The ſecond or middle diviſion of this bone, is much longer, narrower, and thinner, than the firſt; but, excepting that it is a little narrower above than below, it is nearly equal all over in its dimenſions of breadth or thickneſs.——In the ſides of it are complete pits for the third, fourth, fifth, and ſixth ribs, and an half of the pits for the ſecond and ſeventh; the lines, which are marks of the former diviſion of the bone, being extended from the middle of the pits of one ſide to the middle of the correſponding pits of the other ſide.—Near its middle an unoſſified part of the bone is ſometimes found, which, freed of the ligamentous membrane or cartilage that fills it, is deſcribed as a hole; and in this place, for the moſt part, we may obſerve a tranſverſe line, which has made authors divide this bone into two.—When the cartilage between this and the firſt bone is not oſſified, a manifeſt motion of this upon the firſt may be obſerved in reſpiration or in raiſing the *ſternum*, by pulling the ribs upwards or diſtending the lungs with air in a recent ſubject.

The third bone is much leſs than the other two, and has only one half of the pit for the ſeventh rib formed in it; wherefore it might be reckoned only an *appendix* of the *ſternum*.—In young ſubjects, it is always cartilaginous; and is better known by the name of *cartilago xiphoides*, or *enſiformis* (*a*), than any other: though the ancients often called the whole *ſternum*, *enſiforme*; comparing the two firſt bones to the handle, and this *appendix* to the blade, of a ſword.—This third bone is ſeldom of the ſame figure, magnitude, or ſituation, in any two ſubjects. For ſometimes it is a plain triangular bone, with one of the angles below, and perpendicular to

(*a*) Clypealis, gladialis, mucronata, malum granatum, ſcutum ſtomachi, epiglottalis, cultralis, medium furculæ inferioris, ſcutiformis, enſiculata.

to the middle of the upper ſide, by which it is connected to the ſecond bone.—In other people, the point is turned to one ſide, or obliquely forwards or backwards.—Frequently it is all nearly of an equal breadth; and in ſeveral ſubjects it is bifurcated, whence ſome writers give it the name of *furcella* or *furcula inferior*; or elſe it is unoſſified, in the middle.—In the greateſt number of adults it is oſſified, and tipped with a cartilage; in ſome, one half of it is cartilaginous; and in others, it is all in a cartilaginous ſtate.—Generally ſeveral oblique ligaments, fixed at one end to the cartilages of the ribs, and by the other to the outer ſurface of the *xiphoid* bone, connect it firmly to thoſe cartilages (*a*).

So many different ways this ſmall bone may be formed, without any inconvenience: But then ſome of theſe poſitions may be ſo directed, as to bring on a great train of ill conſequences; particularly, when the lower end is oſſified, and is too much turned outwards or inwards (*b*), or when the conjunction of this *appendix* with the ſecond bone is too weak (*c*).

The *ſternum* is joined by cartilages to the ſeven upper ribs, unleſs when the firſt coaleſces with it in an intimate union of ſubſtance; and its unequal cavity on each ſide of its upper end is fitted for the ends of the clavicles.

The *ſternum* moſt frequently has four round ſmall bones, ſurrounded with cartilage, in children born at the full time; the uppermoſt of theſe, which is the firſt bone, being the largeſt.—Two or three other very ſmall bony points are likewiſe to be ſeen in ſeveral children.—The number of bones increaſes for ſome years; and then diminiſhes, but uncertainly, till they are at laſt united into thoſe above deſcribed of an adult.

The uſes of this bone are, to afford origin and inſertion to ſeveral muſcles; to ſuſtain the *mediaſtinum*; to defend the vital organs, the heart and lungs, at the fore-part; and, laſtly, by ſerving as a moveable *fulcrum* of the ribs, to aſſiſt conſiderably in reſpiration: Which action, ſo far as it depends on the motion of the bones, we are now at liberty to explain.

When

(*a*) Weitbrecht, Syndeſmolog. p. 121.

(*b*) Rolfinc. Differt. Anat. lib. 2. cap. 41.——Paaw, de Oſſib. parte 1. cap. 3. & parte 3. cap. 3.—Codronchi de Prolapſu Cartilagin. Mucronat.

(*c*) Paaw, ibid.—Borrich. Act. Hafn. vol. 5. ob. 79.—Bonet. Sepulchret. Anat. tom. 2. lib. 3. § 5. append. ad obſ. 8.; et ibid. §. 7. obſ. 19.

When the ribs that are connected by their cartilages to the *ſternum*, or to the cartilages of the true ribs, are acted upon by the intercoſtal muſcles, they muſt all be pulled from the oblique poſition which their cartilages kept them in, nearer to right angles with the *vertebræ* and *ſternum*, becauſe the firſt or uppermoſt rib is by much the moſt fixed of any; and the cartilages making a great reſiſtance to raiſing the anterior ends of the ribs, their large arched middle parts turn outwards as well as upwards.—The *ſternum*, preſſed ſtrongly on both ſides by the cartilages of the ribs, is puſhed forwards; and that at its ſeveral parts, in proportion to the length and motion of its ſupporters, the ribs; that is, moſt at its lower end.—The *ſternum* and the cartilages, thus raiſed forwards, muſt draw the *diaphragm* connected to them; conſequently ſo far ſtretch it, and bring it nearer to a plane.—The power that raiſes this bone and the cartilages, fixes them ſufficiently to make them reſiſt the action of the *diaphragm*, whoſe fibres contract at the ſame time, and thruſt the *viſcera* of the *abdomen* downwards.—The arched part of the ribs being thus moved outwards, their anterior ends and the *ſternum* being advanced forwards, and the diaphragm being brought nearer to a plain ſurface, inſtead of being greatly convex on each ſide within each cavity of the *thorax*, it is evident how conſiderably the cavity, of which the nine or ten upper ribs are the ſides, muſt be widened, and made deeper and longer.—While this is doing in the upper ribs, the lower ones, whoſe cartilages are not joined to the *ſternum* or to other cartilages, move very differently, though they conſpire to the ſame intention, the enlargement of the *thorax*: For having no fixed point to which their anterior ends are faſtened, and the *diaphragm* being inſerted into them at the place where it runs pretty ſtraight upwards from its origin at the *vertebræ*, theſe ribs are drawn downwards by this ſtrong muſcle, and by the muſcles of the *abdomen*, which, at this time, are reſiſting the ſtretching force of the bowels; while the intercoſtal muſcles are pulling them in the contrary direction, to wit, upwards: The effect, therefore, of either of theſe powers, which are antagoniſts to each other, is very little, as to moving the ribs either up or down; but the muſcles of the *abdomen*, puſhed at this time outwards by the *viſcera*, carry theſe ribs along with them.—Thus the *thorax* is not only not allowed to be ſhortened, but is really widened at its lower

part,

part, to aſſiſt in making ſufficient ſpace for the due diſtenſion of the lungs.

As ſoon as the action of theſe ſeveral muſcles ceaſes, the elaſtic cartilages, extending themſelves to their natural ſituation, depreſs the upper ribs, and the *ſternum* ſubſides; the diaphragm is thruſt up by the *viſcera abdominalia*, and the oblique and tranſverſe muſcles of the belly ſerve to draw the inferior ribs inwards at the ſame time.——By theſe cauſes, the cavity of the breaſt is diminiſhed in all its dimenſions.

Though the motions above deſcribed of the ribs and *ſternum*, eſpecially of the latter bone, are ſo ſmall in the mild reſpiration of a healthy perſon, that we can ſcarce obſerve them; yet they are manifeſt whenever we deſignedly increaſe our reſpiration, or are obliged to do it after exerciſe, and in ſeveral diſeaſes.

OF THE SUPERIOR EXTREMITIES.

AUTHORS are much divided in their opinions about the number of bones which each *ſuperior extremity* (*a*) ſhould be ſaid to conſiſt of; ſome deſcribing the *clavicle* and *ſcapula* as part of it, others claſſing theſe two bones with thoſe of the *thorax*: But ſince moſt quadrupeds have no *clavicles*, and the human *thorax* can perform its functions right when the *ſcapula* is taken away (*b*), whereas it is impoſſible for us to have the right uſe of our arms without theſe bones; I muſt think that they belong to the *ſuperior extremities*; and therefore ſhall divide each of them into the *ſhoulder*, *arm*, *fore-arm*, and *hand*.

The SHOULDER conſiſts of the *clavicle* and *ſcapula*.

CLAVICULA, or *collar-bone* (*c*), is the long crooked bone, in figure like an *Italic ſ*, placed almoſt horizontally between the upper lateral part of the *ſternum*, and what is commonly called the top of the ſhoulder, which, as a *clavis* or beam, it bears off from the trunk of the body.

The *clavicle*, as well as other long round bones, is larger at its two ends,

(*a*) Κωλα, γυα, ιπρυαδις, enata, adnata, explanata membra, artus.

(*b*) Philoſoph. Tranſact. numb. 449. §. 5.

(*c*) Os jugulare, jugulum, furcula, ligula, clavis, humerus quibuſdam.

ends, than in the midle. The end next to the *ſternum* (*a*) is triangular: The angle behind is conſiderably produced, to form a ſharp ridge, to which the tranſverſe ligament extended from one clavicle to the other is fixed (*b*).—The ſide oppoſite to this is ſomewhat rounded.—The middle of this protuberant end is as irregularly hollowed, as the cavity in the *ſternum* for receiving it is raiſed: but in a recent ſubject, the irregular concavities of both are ſupplied by a moveable cartilage, which is not only much more cloſely connected every where by ligaments to the circumference of the articulation, than thoſe of the lower jaw are; but it grows to the two bones at both its internal and external end; its ſubſtance at the internal end being ſoft, but very ſtrong, and reſembling the intervertebral cartilages (*c*).

From this internal end, the *clavicle*, for about two fifths of its length, is bended obliquely forwards and downwards. On the upper and fore part of this curvature a ſmall ridge is ſeen, with a plain rough ſurface before it; whence the *muſculus ſterno-hyoideus* and *ſterno-maſtoideus* have in part their origin.—Near the lower angle a ſmall plain ſurface is often to be remarked, where the firſt rib and this bone are contiguous (*d*), and are connected by a firm ligament (*e*).—From this a rough plain ſurface is extended outwards, where the pectoral muſcle has part of its origin.——Behind, the bone is made flat and rough by the inſertion of the larger ſhare of the ſubclavian muſcle.—After the clavicle begins to be bended backwards, it is round, but ſoon after becomes broad and thin; which ſhape it retains to its external end.——Along the external concavity, a rough ſinuoſity runs, from which ſome part of the deltoid muſcle takes its riſe:—Oppoſite to this, on the convex edge, a ſcabrous ridge gives inſertion to a ſhare of the *cucullaris* muſcle. The upper ſurface of the clavicle here is flat; but the lower is hollow, for lodging the beginning of the *muſculus ſubclavius*; and towards its back part a tubercle riſes, to which, and a roughneſs near it, the ſtrong ſhort thick ligament connecting this bone to the *coracoid* proceſs of the *ſcapula* is fixed.

(*a*) Παραστατης.

(*b*) Riolan. Encheirid. Anat. lib. 6. cap. 13.—Winſlow, Expoſ. Anat. des os frais, § 248.—Weitbrecht, Act. Petropolit. tom. iv. p. 255. et Syndeſmolog. ſect. 2. I. §. 3.

(*c*) Weitbrecht, Syndeſmolog. ſect. 2. I. § 6. (*d*) Dionis, Sixieme Demonſt. des Os.

(*e*) Weitbrecht, Syndeſmolog. ſect. 2. I. § 7.

The external end (*a*) of this bone is horizontally oblong, ſmooth, ſloping at the poſterior ſide, and tipped in a recent ſubject with a cartilage, for its articulation with the *acromion ſcapulæ*.—Round this the bone is ſpongy, for the firmer connection of the ligaments.

The medullary arteries, having their direction obliquely outwards, enter the clavicles by one or more ſmall paſſages in the middle of their back-part.

The ſubſtance of this bone is the ſame as of the other round long bones.

The triangular unequal interior end of each *clavicle*, has the cartilage above deſcribed interpoſed betwixt it and the irregular cavity of the *ſternum*.—The ligaments, which ſurround this articulation to ſecure it, are ſo ſhort and ſtrong, that little motion can be allowed any way; and the ſtrong ligament that is ſtretched acroſs the upper *furcula* of the *ſternum*, from the poſterior prominent angle of the one clavicle, to the ſame place of the other clavicle, ſerves to keep each of theſe bones more firmly in their place.—By the aſſiſtance, however, of the moveable intervening cartilage, the clavicle can, at this joint, be raiſed or depreſſed, and moved backwards and forwards ſo much, as that the external end, which is at a great diſtance from that axis, enjoys very conſpicuous motions.—The articulation of the exterior end of the clavicle ſhall be conſidered after the deſcription of the *ſcapula*.

The clavicles of infants are not deficient in any of their parts: nor have they any epiphyſes at their extremities joined afterwards to their bodies, as moſt other ſuch long bones have; which preſerves them from being bended too much, and from the danger of any unoſſified parts being ſeparated by the force which pulls the arms forwards.

The uſes of the clavicles are, to keep the *ſcapulæ*, and conſequently all the *ſuperior extremities*, from falling in and forward upon the *thorax*; by which, as in moſt quadrupeds, the motions of the arms would be much confined, and the breaſt made too narrow.—The clavicles likewiſe afford origin to ſeveral muſcles, and a defence to large veſſels.

From the ſituation, figure, and uſe of the clavicles, it is evident, that they are much expoſed to fractures; that their broken parts muſt generally

(*a*) Ωμος.

rally go bye each other, and that they are difficultly kept in their place afterwards.

SCAPULA, or *ſhoulder-blade* (*a*), is the triangular bone ſituated on the outſide of the ribs, with its longeſt ſide, called its *baſe*, towards the ſpinal proceſſes of the *vertebræ*; and with the angle at the upper part of this ſide about three inches, and the lower angle at a greater diſtance, from theſe proceſſes.—The back-part of the *ſcapula* has nothing but the thin ends of the *ſerratus anticus major* and *ſubſcapularis* muſcles between it and the ribs: But as this bone advances forwards, its diſtance from the ribs increaſes.—The upper or ſhorteſt ſide, called the *ſuperior coſta* of the *ſcapula*, is nearly horizontal, and parallel with the ſecond rib.—The lower ſide, which is named the *inferior coſta*, is extended obliquely from the third to the eighth rib.——The ſituation of this bone here deſcribed, is when people are ſitting or ſtanding in a ſtate of inactivity, and allowing the members to remain in the moſt natural eaſy poſture.——The inferior angle of the *ſcapula* is very acute; the upper one is near to a right angle; and what is called the *anterior* does not deſerve the name, for the two ſides do not meet to form an angle.—The body of this bone is concave towards the ribs, and convex behind, where it has the name of *dorſum* (*b*). Three proceſſes are generally reckoned to proceed from the *ſcapula*.—The firſt is the large ſpine that riſes from its convex ſurface behind, and divides it unequally.—The ſecond proceſs ſtands out from the fore-part of the upper ſide; and from its imaginary reſemblance to a crow's beak, is named *coracoides* (*c*).——The third proceſs is the whole thick bulbous fore-part of the bone.

After thus naming the ſeveral conſtituent parts of the *ſcapula*, the particular deſcription will be more eaſily underſtood.

The *baſe*, which is tipped with cartilage in a young ſubject, is not all ſtraight. For above the ſpine, it runs obliquely forwards to the ſuperior angle, that here it might not be too protuberant backwards, and ſo bruiſe the muſcles and teguments: Into the oblique ſpace the *muſculus patientiæ* is inſerted.——At the root of the ſpine, on the back-part of the baſe, a

 triangular

(*a*) Ωμοπλατος, επιπωτιον, latitudo humeri, ſcoptulum vel ſcutulum opertum, ſpatula, ala, humerus, clypeus, ſcutum thoracis.

(*b*) Χειλυνιον. (*c*) Anchoroides, ſigmoides, digitalis, anciſtroides.

triangular plain ſurface is formed by the preſſure of the lower fibres of the *trapezius*.—Below this, the edge of the *ſcapula* is ſcabrous and rough, for the inſertion of the *ſerratus major anticus* and *rhomboid* muſcles.

The back-part of the inferior angle is made ſmooth by the *latiſſimus dorſi* paſſing over it. This muſcle alſo alters the direction of the *inferior coſta* ſome way forwards from this angle; and ſo far it is flatted behind by the origin of the *teres major*.—As the *inferior coſta* advances forward, it is of conſiderable thickneſs, is ſlightly hollowed and made ſmooth behind by the *teres minor*, while it has a *foſſa* formed into it below by part of the *ſubſcapularis*; and between the two, a ridge with a ſmall depreſſion appears, where the *longus extenſor cubiti* has its origin.

The *ſuperior coſta* is very thin; and near its fore-part there is a ſemilunar niche, from one end of which to the other a ligament is ſtretched; and ſometimes the bone is continued, to form one, or ſometimes two holes for the paſſage of the ſcapular blood-veſſels and nerves.—Immediately behind this *ſemilunar* cavity the *coraco-hyoid* muſcle has its riſe.—From the niche to the termination of the *foſſa* for the *teres minor*, the *ſcapula* is narrower than any where elſe, and ſupports the third proceſs. This part has the name of *cervix*.

The whole *dorſum* of the *ſcapula* is always ſaid to be convex; but by reaſon of the raiſed edges that ſurround it, it is divided into two cavities by the ſpine, which is ſtretched from behind forwards, much nearer to the ſuperior than to the inferior *coſta*.—The cavity above the ſpine is really concave where the *ſupra-ſpinatus* muſcle is lodged; while the ſurface of this bone below the ſpine, on which the *infra-ſpinatus* muſcle is placed, is convex, except a *foſſa* that runs at the ſide of the *inferior coſta*.

The internal or anterior ſurface of this bone is hollow, except in the part above the ſpine, which is convex.——The *ſubſcapularis* muſcle is extended over this ſurface, where it forms ſeveral ridges and intermediate depreſſions, commonly miſtaken for prints of the ribs; they point out the interſtices of the bundles of fibres of which the *ſubſcapularis* muſcle is compoſed (*a*).

The ſpine (*b*) riſes ſmall at the baſe of the *ſcapula*, and becomes higher and

(*a*) Winſlow, in Memoires de l'Acad. des Sciences, 1722.

(*b*) Ραχις, νωτοχη ωμοπλατων, eminentia ſcapularum.

and broader as it advances forwards.—On the ſides, it is unequally hollowed and crooked by the actions of the adjacent muſcles.—Its ridge (*a*) is divided into two rough flat ſurfaces: into the upper one, the *trapezius* muſcle is inſerted; and the lower one has part of the *deltoid* fixed to it.—The end of the ſpine, called *acromion* (*b*), or top of the ſhoulder, is broad and flat, and is ſometimes only joined to the ſpine by a cartilage (*c*).——The anterior edge of the *acromion* is flat, ſmooth, and covered with a cartilage, for its articulation with the external end of the clavicle; and it is hollowed below, to allow a paſſage to the *infra* and *ſupra ſpinati* muſcles, and free motion to the *os humeri*.

The *coracoid* (*d*) proceſs is crooked, with its point inclining forwards; ſo that a hollow is left at the lower ſide of its root, for the paſſage of the *infra-ſcapularis* muſcle.—The end of this proceſs is marked with three plain ſurfaces. Into the internal, the *ſerratus minor anticus* is inſerted; from the external, one head of the *biceps flexor cubiti* riſes; and from the lower one, the *coracobrachialis* has its origin.—At the upper part of the root of this proceſs, immediately before the *ſemilunar* cavity, a ſmooth tubercle appears, where a ligament from the *clavicle* is fixed. From all the external ſide of this coracoid *apophyſe*, a broad ligament goes out, which becomes narrower where it is fixed to the *acromion*.——The ſharp pain, violent inflammation, and tedious cure of contuſions in this part, are probably owing to theſe tendons and ligaments being hurt.

From the *cervix ſcapulæ* the third proceſs is produced. The fore-part of this is formed into a *glenoid* cavity (*e*), which is of the ſhape of the longitudinal ſection of an egg, being broad below and narrow above.—Between the brims of this hollow and the fore-part of the root of the ſpine, a large ſinuoſity is left for the tranſmiſſion of the *ſupra* and *infra ſpinati* muſcles; and on the upper part of theſe brims we may remark a ſmooth ſurface, where the ſecond head of the *biceps flexor cubiti* has its origin.—The root of the *ſupercilia* is rough all round, for the firmer adheſion of the capſular ligament of the articulation, and of the cartilage which is placed

(*a*) Pterigium, criſta.

(*b*) Ακρωμις αγκυροειδης, κορακοειδης, καταχλεις, acromii os, ſummus armus, roſtrum porcinum, proceſſus digitalis.

(*c*) Sue Trad. d'Oſteol. p. 160. (*d*) Αγκυροειδης, σιγμοειδης, roſtriformis. (*e*) Ωμοκοτυλις.

placed on theſe brims, where it is thick, but becomes very thin as it is continued towards the middle of the cavity, which it lines all over.

The medullary veſſels enter the *ſcapula* near the baſe of the ſpine.

The ſubſtance of the *ſcapula*, as in all other broad flat bones, is cellular, but of an unequal thickneſs; for the neck and third proceſs are thick and ſtrong. The inferior *coſta*, ſpine, and coracoid proceſs, are of a middle thickneſs; and the body is ſo preſſed by the muſcles, as to become thin and diaphanous.

The *ſcapula* and clavicle are joined by plain ſurfaces, tipped with cartilage (*a*): by which neither bone is allowed any conſiderable motion, being tightly tied down by the common capſular ligament, and by a very ſtrong one which proceeds from the coracoid proceſs; but divides into two before it is fixed into the *clavicle*, with ſuch a direction, as either can allow this bone to have a ſmall rotation, in which its poſterior edge turns more backwards, while the anterior one riſes farther forwards; or it can yield to the fore-part of the *ſcapula* moving downwards, while the back-part of it is drawn upwards: in both which caſes, the oblong ſmooth articulated ſurfaces of the *clavicle* and *ſcapula* are not in the ſame plane, but ſtand a little tranſverſely, or acroſs each other, and thereby preſerve this joint from luxations, to which it would be ſubject, if either of the bones was to move on the other perpendicularly up and down, without any rotation.—Sometimes a moveable ligamentous cartilage is found in this joint; otherwhiles ſuch a cartilage is only interpoſed at the anterior half of it; and in ſome old ſubjects I have found a ſeſamoid bone here (*b*).—The *ſcapula* is connected to the head, *os hyoides*, *vertebræ*, ribs, and arm-bone, by muſcles, that have one end faſtened to theſe bones, and the other to the *ſcapula*, which can move it upwards, downwards, backwards, or forwards; by the quick ſucceſſion of theſe motions, its whole body is carried in a circle: but being alſo often moved as upon an axis perpendicular to its plane, its circumference turns in a circle, whoſe centre this axis is (*c*). Whichever of theſe motions it performs, it always carries the outer end of the clavicle and the arm along with it.—The *glenoid* cavity

(*a*) Acromion, κατακλεις, clauſuræ.

(*b*) Jac. Sylv. Iſagog. Anat. lib. 1. cap. 2.

(*c*) See Winſlow, Memoires de l'Acad. des Sciences, 1726.

vity of this bone receives the *os humeri*, which plays in it as a ball in a ſocket, as will be explained more hereafter.

The uſe of the *ſcapula* is to ſerve as a *fulcrum* to the arm; and, by altering its poſition on different occaſions, to allow always the head of the *os humeri* a right ſituated ſocket to move in; and thereby to aſſiſt and to enlarge greatly the motions of the *ſuperior extremity*, and to afford the muſcles which riſe from it more advantageous actions, by altering their directions to the bone which they are to move.—This bone alſo ſerves to defend the back-part of the *thorax*; and is often employed to ſuſtain weights, or to reſiſt forces, too great for the arm to bear.

The baſe, *acromion*, coracoid proceſs, and head of the *ſcapula*, are all in a cartilaginous ſtate at birth; and the three firſt are joined as *epiphyſes*; while the head, with the *glenoid* cavity, is not formed into a diſtinct ſeparate bone, but is gradually produced by the oſſification of the body of this bone being continued forwards.

The ARM has only one bone, beſt known by the *Latin* name of *os humeri* (*a*); which is long, round, and nearly ſtraight.

The upper end of this bone (*b*) is formed into a large round ſmooth head, whoſe middle point is not in a ſtraight line with the axis of the bone, but ſtands obliquely backwards from it.—The extent of the head is diſtinguiſhed by a circular *foſſa* ſurrounding its baſe, where the head is united to the bone, and the capſular ligament of the joint is fixed.—Below the fore-part of its baſe two tubercles ſtand out: the ſmalleſt one, which is ſituated moſt to the inſide, has the tendon of the *ſubſcapularis* muſcle inſerted into it.——The larger more external protuberance is divided, at its upper part, into three ſmooth plain ſurfaces; into the anterior of which the *muſculus ſupra-ſpinatus*, into the middle or largeſt the *infra ſpinatus*, into the one behind the *teres minor*, is inſerted.——Between theſe two tubercles, exactly in the fore-part of the bone, a deep long *foſſa* is formed, for lodging the tendinous head of the *biceps flexor cubiti*; which, after paſſing, in a manner peculiar to itſelf, through the cavity of the articulation, is tied down by a tendinous ſheath extended acroſs the *foſſa*; in which, and in the neighbouring tubercles, are ſeveral

(*a*) Ακρολια, αλιτη, os brachii, armi, adjutorium, parvum brachium, canna brachii.

(*b*) Arocolium.

ral remarkable holes, which are penetrated by the tendinous and ligamentous fibres, and by veſſels.—On each ſide of this *foſſa*, as it deſcends in the *os humeri*, a rough ridge, gently flatted in the middle, runs from the roots of the tubercles.——The tendon of the *pectoral* muſcle is fixed into the anterior of theſe ridges, and the *latiſſimus dorſi* and *teres major* are inſerted into the internal one.—A little behind the lower end of this laſt, another rough ridge may be obſerved, where the *coraco-brachialis* is inſerted.—From the back-part of the root of the largeſt tubercle a ridge alſo is continued, from which the *brevis extenſor cubiti* riſes.—This bone is flatted on the inſide, about its middle, by the belly of the *biceps flexor cubiti*.——In the middle of this plain ſurface, the entry of the medullary artery is ſeen ſlanting obliquely downwards.—At the fore-ſide of this plane, the bone riſes in a ſort of ridge; which is rough, and often has a great many ſmall holes in it, where the tendon of the ſtrong *deltoid* muſcle is inſerted; on each ſide of which the bone is ſmooth and flat, where the *brachiæus internus* riſes. The exterior of theſe two flat ſurfaces is the largeſt; behind it a ſuperficial ſpiral channel, formed by the *muſcular* nerve and the veſſels that accompany it, runs from behind forwards and downwards.—The body of the *os humeri* is flatted behind by the extenſors of the fore-arm.—Near the lower end of this bone, a large ſharp ridge is extended on its outſide; from which the *muſculus ſpinator radii longus*, and the longeſt head of the *extenſor carpi radialis*, riſe.——Oppoſite to this, there is another ſmall ridge, to which the *aponeurotic* tendon, that gives origin to the fibres of the internal and external *brachiæi* muſcles, is fixed; and from a little depreſſion on the fore-ſide of it, the *pronator radii teres* riſes.

The body of the *os humeri* becomes gradually broader towards the lower end, where it has ſeveral proceſſes; at the roots of which there is a cavity before, and another behind (*a*). The anterior is divided by a ridge into two: the external, which is the leaſt, receives the end of the *radius*; and the internal receives the *coronoid* proceſs of the *ulna* in the flexions of the fore-arm, while the poſterior deep triangular cavity lodges the *olecranon* in the extenſions of that member.—The bone betwixt theſe two cavities is preſſed ſo thin by the proceſſes of the *ulna*, as to appear diaphanous in ſeveral

(*a*) Βαθμιδες.

ſeveral ſubjects.—The ſides of the poſterior cavity are ſtretched out into two proceſſes, one on each ſide: theſe are called *condyles*; from each of which a ſtrong ligament goes out to the bones of the *fore-arm*.—The external *condyle*, which has an oblique direction alſo forwards in reſpect of the internal, when the arm is in the moſt natural poſture (*a*), is equally broad, and has an obtuſe ſmooth head riſing from it forwards.—From the rough part of the *condyle*, the inferior head of the *bicornis*, the *extenſor digitorum communis*, *extenſor carpi ulnaris*, *anconæus*, and ſome part of the *ſupinator radii brevis*, take their riſe; and on the ſmooth head the upper end of the *radius* plays.—Immediately on the outſide of this there is a ſinuoſity made by the ſhorter head of the *bicornis* muſcle, upon which the *muſcular* nerve is placed.—The internal *condyle* is more pointed and protuberant than the external, to give origin to ſome part of the *flexor carpi radialis*, *pronator radii teres*, *palmaris longus*, *flexor digitorum ſublimis*, and *flexor carpi ulnaris*. Between the two *condyles* is the *trochlea*, or pully; which conſiſts of two lateral protuberances and a middle cavity, that are ſmooth and covered with cartilage.—When the fore-arm is extended, the tendon of the internal *brachiæus* muſcle is lodged in the fore-part of the cavity of this pully.—The external protuberance, which is leſs than the other, has a ſharp edge behind; but forwards, this ridge is o tuſe, and only ſeparated from the little head already deſcribed by a ſmall *foſſa*, in which the joined edges of the *ulna* and *radius* move.—The internal protuberance of the pully is largeſt and higheſt; and therefore in the motions of the *ulna* upon it, that bone would be inclined outwards, were it not ſupported by the *radius* on that ſide.—Between this internal protuberance and *condyle*, a ſinuoſity may be remarked where the *ulnar* nerve paſſes.

The ſubſtance and the internal ſtructure of the *os humeri* is the ſame, and diſpoſed in the ſame way, as in other long bones.

The round head at the upper end of this bone is articulated with the *glenoid* cavity of the *ſcapula*; which being ſuperficial, and having long ligaments, allows the arms a free and extenſive motion.—Theſe ligaments are, however, conſiderably ſtrong: for beſides the common capſular one, the tendons of the muſcles perform the office, and have been deſcribed under the name of *ligaments*.—Then the *acromion* and *coracoid* proceſs,

(*a*) Winſlow, Memoires de l'Acad. des Sciences, 1722.

with the ſtrong broad ligaments ſtretched betwixt them, ſecure the articulation above, where the greateſt and moſt frequent force is applied to thruſt the head of the bone out of its place. It is true, that there is not near ſo ſtrong a defence at the lower part of the articulation; but in the ordinary poſtures of the arm, that is, ſo long as it is at an acute angle with the trunk of the body, there cannot be any force applied at this place to occaſion a luxation, ſince the joint is protected ſo well above.

The motions which the arm enjoys by this articulation are to every ſide; and by the ſucceſſion of theſe different motions a circle may be deſcribed. Beſides which, the bone performs a ſmall rotation round its own *axis*. But though this can be performed with the round head in all poſitions; yet as theſe vary, the effects upon the body of the bone are very different: For if the middle of the head is the centre of rotation, as it is when the arm hangs down by the ſide, the body of the bone is only moved forwards and backwards; becauſe the *axis* of motion of the head is nearly at right angles with the length of the bone (*a*): whereas, when the arm is raiſed to right angles with the trunk of the body, the centre of motion, and the axis of the bone, come to be in the ſame ſtraight line; and therefore the body of the *os humeri* performs the ſame motion with its head.—Though the motions of the arm ſeem to be very extenſive, yet the larger ſhare of them depends on the motion of the *ſcapula*.—The lower end of the *os humeri* is articulated with the bones of the fore-arm, and carries them with it in all its motions, but ſerves as a baſe on which they perform the motions peculiar to themſelves; as ſhall be deſcribed afterwards.

Both the ends of this bone are cartilaginous in a new-born infant; and the large head with the two tubercles, and the *trochlea* with the two *condyles*, become *epiphyſes* before they are united to the body of the bone.

The FORE-ARM (*b*) conſiſts of two long bones, the *ulna* and *radius*; whoſe ſituation, in reſpect of each other, is oblique in the leaſt ſtraining or moſt natural poſture; that is, the *ulna* is not directly behind, nor on the outſide of the *radius*, but in a middle ſituation between theſe two, and the *radius* croſſes it.—The ſituation, however, of theſe two bones, and of all the other bones of the *ſuperior extremity* that are not yet deſcribed,

(*a*) Hippocrat. de Articul. § 1. (*b*) Cubitus, πηχυς, ωλινη, πυγων, ulna, lacertus.

bed, is frequently altered: and therefore, to ſhun repetitions, I deſire it may be now remarked, that in the remaining account of the *ſuperior extremity*, I underſtand by the term of *poſterior*, that part which is in the ſame direction with the back of the hand; by *anterior*, that anſwering to the palm; by *internal*, that on the ſame ſide with the thumb; by *external*, the ſide neareſt to the little finger; ſuppoſing the hand always to be in a middle poſition between *pronation* and *ſupination*.

ULNA (*a*), ſo named from its being uſed as a meaſure, is the longeſt of the two bones of the fore-arm, and ſituated on the outſide of the *radius*.

At the upper end of the *ulna* are two proceſſes.—The poſterior is the largeſt, and formed like a hook, whoſe concave ſurface moves upon the pully of the *os humeri*, and is called *olecranon* (*b*), or top of the cubit.—The convex back-part of it is rough and ſcabrous, where the *longus*, *brevis*, and *brachiæus externus*, are inſerted. The *olecranon* makes it unneceſſary that the tendons of the extenſor muſcles ſhould paſs over the end of the *os humeri*; which would have been of ill conſequence in the great flexions of this joint, or when any conſiderable external force is applied to this part (*c*).—The anterior proceſs is not ſo large, nor does it reach ſo high, as the one behind; but is ſharper at its end, and therefore is named *coronoid*.—Between theſe two proceſſes a large ſemicircular or *ſigmoid* concavity is left; the ſurface of which, on each ſide of a middle riſing, is ſlanting, and exactly adapted to the pully of the bone of the arm.—Acroſs the middle of it, there is a ſmall ſinuoſity for lodging mucilaginous glands; where, as well as in a ſmall hollow on the internal ſide of it, the cartilage that lines the reſt of its ſurface is wanting.——Round the brims of this concavity the bone is rough, where the capſular ligament of the joint is implanted.——Immediately below the *olecranon*, on the back-part of the *ulna*, a flat triangular ſpongy ſurface appears, on which we commonly lean.—At the internal ſide of this, there is a larger hollow ſurface, where the *muſculus anconæus* is lodged; and the ridge at the inſide of this gives riſe to the *muſculus ſupinator radii brevis*.——Between the top of the ridge

(*a*) Cubitus, πηχυς πρεσπηχυον. focile majus, canna vel arundo major, et inferior brachii.

(*b*) Αγκων, gibber, cubitus, additamentum necatum.

(*c*) Winſlow, Expoſition Anatomique du Corps Humain, Traité des Os Secs, § 979.

and the *coronoid* proceſs is the ſemilunated ſmooth cavity, lined with cartilage; in which, and a ligament extended from the one to the other end of this cavity, the round head of the *radius* plays.—Immediately below it, a rough hollow gives lodging to mucilaginous glands.—Below the root of the *coronoid* proceſs this bone is ſcabrous and unequal, where the *brachiæus internus* is inſerted.—On the outſide of that we obſerve a ſmooth concavity, where the beginning of the *flexor digitorum profundus* ſprouts out.

The body of the *ulna* is triangular.—The internal angle is very ſharp where the ligament that connects the two bones is fixed: the ſides which make this angle are flat and rough, by the action and adheſion of the many muſcles which are ſituated here.—At the diſtance of one third of the length of the *ulna* from the top, in its fore-part, the paſſage of the medullary veſſels is to be remarked ſlanting upwards.——The external ſide of this bone is ſmooth, ſomewhat convex; and the angles at each edge of it are blunted by the preſſure of the muſcles equally diſpoſed about them.

As this bone deſcends it becomes gradually ſmaller; ſo that its lower end terminates in a little head ſtanding on a ſmall neck.——Towards the fore but outer part of which laſt, an oblique ridge runs, that gives riſe to the *pronator radii quadratus*.—The head is round, ſmooth, and covered with a cartilage on its internal ſide, to be received into the ſemilunar cavity of the *radius*; while a *ſtyloid* proceſs (*a*) riſes from its outſide, to which is fixed a ſtrong ligament that is extended to the *os cuneiforme* and *piſiforme* of the wriſt.—Between the back-part of that internal ſmooth ſide and this proceſs, a ſinuoſity is left for the tendon of the *extenſor carpi ulnaris*.——On the fore-part of the root of the proceſs, ſuch another depreſſion may be remarked for the paſſage of the *ulnar* artery and nerve.—The end of the bone is ſmooth, and covered with a cartilage.—Between it and the bones of the wriſt, a doubly concave moveable cartilage is interpoſed; which is a continuation of the cartilage that covers the lower end of the *radius*, and is connected looſely to the root of the *ſtyloid* proceſs, and to the rough cavity there, in which mucilaginous glands are lodged.

The *ulna* is articulated above with the lower end of the *os humeri*, where theſe bones have depreſſions and protuberances correſponding to each other,

(*a*) ῥαφοειδὴς, malleolus externus.

other, ſo as to allow an eaſy and ſecure extenſion of the fore-arm to almoſt a ſtraight line with the arm, and flexion to a very acute angle; but by the ſlanting poſition of the pully, the lower part of the fore-arm is turned outwards in the extenſion, and inwards in the flexion (*a*); and a very ſmall kind of rotation is likewiſe allowed in all poſitions, eſpecially when the ligaments are moſt relaxed by the fore-arm being in a middle degree of flexion.—The *ulna* is alſo articulated with the *radius* and *carpus*, in a manner to be related afterwards.

RADIUS (*b*), ſo called from its imagined reſemblance to a ſpoke of a wheel, or to a weaver's beam, is the bone placed at the inſide of the fore-arm. Its upper end is formed into a circular little head, which is hollowed for an articulation with the tubercle at the ſide of the pully of the *os humeri*; and the half of the round circumference of the head next to the *ulna* is ſmooth, and covered with a cartilage, in order to be received into the ſemilunated cavity of that bone.—Below the head, the *radius* is much ſmaller; therefore this part is named its *cervix*, which is made round by the action of the *ſupinator radii brevis*.——At the external root of this neck a tuberous proceſs riſes; into the outer part of which the *biceps flexor cubiti* is inſerted.——From this a ridge runs downwards and inwards, where the *ſupinator radii brevis* is inſerted; and a little below, and behind this ridge, there is a rough ſcabrous ſurface, where the *pronator radii teres* is fixed.

The body of the *radius* is not ſtraight, but convex on its internal and poſterior ſurfaces; where it is alſo made round by the equal preſſure of the circumjacent muſcles, particularly of the *extenſors* of the thumb; but the ſurfaces next to the *ulna* are flatted and rough, for the origin of the muſcles of the hand; and both terminate in a common ſharp ſpine, to which the ſtrong ligament extended betwixt the two bones of the fore-arm is fixed.—A little below the beginning of the plain ſurface, on its fore-part, where the *flexor* muſcle of the laſt joint of the thumb takes its origin, the paſſage of the medullary veſſels is ſeen ſlanting upwards.—— The *radius* becomes broader and flatter towards the lower end, eſpecially on its fore-part, where its *pronator quadratus* muſcle is ſituated.

The

(*a*) Winſlow, Memoires de l'Acad. des Sciences, 1722.

(*b*) Κερκις, παραπηχιον, focile minus, canna minor, arundo minor.

The lower end of the *radius* is larger than the ſuperior; though not in ſuch a diſproportion as the upper end of the *ulna* is larger than its lower end.—Its back-part has a flat ſtrong ridge in the midle, and *foſſæ* on each ſide.—In a ſmall groove, immediately on the outſide of the ridge, the tendon of the *extenſor tertii internodii policis* plays.—In a large one beyond this, the tendons of the *indicator* and of the common *extenſor* muſcles of the fingers paſs.—Contiguous to the *ulna*, there is a ſmall depreſſion made by the *extenſor minimi digiti*.—On the inſide of the ridge there is a broad depreſſion, which ſeems again ſubdivided, where the two tendons of the *bicornis*, or *extenſor carpi radialis*, are lodged.—The internal ſide of this end of the *radius* is alſo hollowed by the extenſors of the firſt and ſecond joint of the thumb; immediately above which, a little rough ſurface ſhews where the *ſupinator radii longus* is inſerted.—The ridges at the ſides of the grooves, in which the tendons play, have an annular ligament fixed to them, by which the ſeveral ſheaths for the tendons are formed.——The fore-part of this end of the *radius* is alſo depreſſed, where the flexors of the fingers and *flexor carpi radialis* paſs.—The external ſide is formed into a ſemilunated ſmooth cavity, lined with a cartilage, for receiving the lower end of the *ulna*.——The loweſt part of the *radius* is formed into an oblong cavity: in the middle of which is a ſmall tranſverſe riſing, gently hollowed, for lodging mucilaginous glands; while the riſing itſelf is inſinuated into the conjunction of the two bones of the wriſt that are received into the cavity.——The internal ſide of this articulation is fenced by a remarkable proceſs (*a*) of the *radius*, from which a ligament goes out to the wriſt, as the *ſtyloid* proceſs of the *ulna* with its ligament guards it on the outſide.

The ends of both the bones of the fore-arm being thicker than the middle, there is a conſiderable diſtance between the bodies of theſe bones; in the larger part of which, a ſtrong tendinous, but thin ligament, is extended, to give a large enough ſurface for the origin of the numerous fibres of the muſcles ſituated here, that are ſo much ſunk between the bones, as to be protected from injuries, which they would otherwiſe be expoſed to. But this ligament is wanting near the upper end of the fore-arm,

(*a*) Malleolus internus, proceſſus ſtyloides.

arm, where the *ſupinator radii brevis* and *flexor digitorum profundus* are immediately connected (*a*).

Both ends of the bones of the fore-arm are firſt cartilages, and then *epiphyſes*, in children.

As the head of the *radius* receives the tubercle of the *os humeri*, it is not only bended and extended along with the *ulna*, but may be moved round its *axis* in any poſition; and that this motion round its *axis* may be ſufficiently large, the ligament of the articulation is extended farther down than ordinary on the neck of this bone, before it is connected to it; and it is very thin at its upper and lower part, but makes a firm ring in the middle.—This bone is alſo joined to the *ulna* by a double articulation: for above, a tubercle of the *radius* plays in a ſocket of the *ulna;* whilſt below, the *radius* gives the ſocket, and the *ulna* the tubercle. But then the motion performed in theſe two is very different: for, at the upper end, the radius does no more than turn round its axis; while, at the lower end, it moves in a ſort of *cycloid* upon the round part of the *ulna;* and as the hand is articulated and firmly connected here with the *radius*, they muſt move together.—When the palm is turned uppermoſt, the *radius* is ſaid to perform the *ſupination;* when the back of the hand is above, it is ſaid to be *prone*. But then the quickneſs and large extent of theſe two motions are aſſiſted by the *ulna*, which, as was before obſerved, can move with a kind of ſmall rotation on the ſloping ſides of the pulley. This lateral motion, though very inconſiderable in the joint itſelf, is conſpicuous at the lower end of ſuch a long bone; and the ſtrong ligament connecting this lower end to the *carpus*, makes the hand more readily to obey theſe motions.—When we deſign a large circular turn of our hand, we increaſe it by the rotation of the *os humeri*, and ſometimes employ the ſpine and *inferior extremities* to make theſe motions of pronation or ſupination of the hand large enough.

The HAND (*b*) comprehends all from the joint of the wriſt to the points of the fingers. Its back-part is convex, for greater firmneſs and ſtrength; and it is concave before, for containing more ſurely and conveniently ſuch bodies as we take hold of.—One half of the hand has an obſcure motion in compariſon of what the other has, and ſerves as a baſe to the moveable

(*a*) Weitbrecht, Syndeſmolog. fig. 10, 11. (*b*) Ἀκρωχειρ, ſumma manus.

moveable half; which can be extended back very little farther than to a ſtraight line with the fore-arm, but can be conſiderably bended forwards.

As the bones that compoſe the hand are of different ſhapes and uſes, while ſeveral of them that are contiguous agree in ſome general characters; the hand is, on this account, commonly divided into the *carpus*, *metacarpus*, and *fingers*; among which laſt the thumb is reckoned,

The CARPUS (*a*) is compoſed of eight ſmall ſpongy bones, ſituated at the upper part of the hand. I ſhall deſcribe each of theſe bones, under a proper name taken from their figure (*b*): becauſe the method of ranging them by numbers leaves anatomiſts too much at liberty to debate very idly, which ought to be preferred to the firſt number; or, which is worſe, ſeveral, without explaining the order they obſerve, differently apply the ſame numbers, and ſo confound their readers.——But, that the deſcription of theſe bones may be in the ſame order as they are found in the generality of anatomical books, I ſhall begin with the range of bones that are concerned in the moveable joint of the wriſt, or are connected to the fore-arm; and ſhall afterwards conſider the four that ſupport the thumb and *oſſa metacarpi* of the fingers.

The eight bones of the carpus are, *os ſcaphoides*, *lunare*, *cuneiforme*, *piſiforme*, *trapezium*, *trapezoides*, *magnum*, *unciforme*.

The *ſcaphoides* is ſituated moſt internally of thoſe that are articulated with the fore-arm.—The *lunare* is immediately on the outſide of the former.——The *cuneiforme* is placed ſtill more externally, but does not reach ſo high up as the other two.—The *piſiforme* ſtands forwards into the palm from the *cuneiforme*.—The *trapezium* is the firſt of the ſecond row, and is ſituated betwixt the *ſcaphoides* and firſt joint of the thumb.—The *trapezoides* is immediately on the outſide of the *trapezium*.——The *os magnum* is ſtill more external.—The *unciforme* is farther to the ſide of the little finger.

Os ſcaphoides (*c*) is the largeſt of the eight except one. It is convex above, concave and oblong below; from which ſmall reſemblance of a boat it has got its name.—Its ſmooth convex ſurface is divided by a rough middle *foſſa*, which runs obliquely croſs it.——The upper largeſt diviſion

(*a*) Καρπος, brachiale, prima palmæ pars, raſetta. (*b*) Lyſer. Cult. Anat. lib. 5. cap. 2.
(*c*) Κοτυλοειδης, naviculare.

diviſion is articulated with the *radius*.—Into the *foſſa* the common ligament of the joint of the wriſt is fixed; and the lower diviſion is joined to the *trapezium* and *trapezoides*.——The concavity receives more than an half of the round head of the *os magnum*.—The external ſide of this hollow is formed into a ſemilunar plane, to be articulated with the following bone.——The internal poſterior and anterior edges are rough, for fixing the ligaments that connect it to the ſurrounding bones.

Os lunare (*a*) has a ſmooth convex upper ſurface, by which it is articulated with the *radius*.——The internal ſide, which gives the name to the bone, is in the form of a creſcent, and is joined with the *ſcaphoid*;—the lower ſurface is hollow, for receiving part of the head of the *os magnum*.—On the outſide of this cavity is another ſmooth, but narrow oblong ſinuoſity, for receiving the upper end of the *os unciforme*:—On the outſide of which a ſmall round convexity is found, for its connection with the *os cuneiforme*.—Between the great convexity above, and the firſt deep inferior cavity, there is a rough *foſſa*, in which the circular ligament of the joint of the wriſt is fixed.

Os cuneiforme (*b*) is broader above, and towards the back of the hand, than it is below and forwards; which gives it the reſemblance of a wedge.——The ſuperior ſlightly convex ſurface is included in the joint of the wriſt, being oppoſed to the lower end of the *ulna*.—Below this the cuneiform bone has a rough *foſſa*, wherein the ligament of the articulation of the wriſt is fixed.—On the internal ſide of this bone, where it is contiguous to the *os lunare*, it is ſmooth and ſlightly concave.—Its lower ſurface, where it is contiguous to the *os unciforme*, is oblong, ſomewhat ſpiral, and concave.——Near the middle of its anterior ſurface a circular plane appears, where the *os piſiforme* is ſuſtained.

Os piſiforme (*c*) is almoſt ſpherical, except one circular plane, or ſlightly hollow ſurface, which is covered with cartilage for its motion on the cuneiform bone, from which its whole rough body is prominent forwards into the palm; having the tendon of the *flexor carpi ulnaris*, and a ligament from the *ſtyloid* proceſs of the *ulna*, fixed to its upper part; the *tranſverſe* ligament of the wriſt is connected to its internal ſide; ligaments

(*a*) Lunatum. (*b*) Triquetrum. (*c*) Cartilaginoſum, ſubrotundum, rectum.

extended to the *unciform* bone, and to the *os metacarpi* of the little finger, are attached to its lower part; the *abductor minimi digiti* has its origin from its fore-part; and, at the internal ſide of it, a ſmall depreſſion is formed, for the paſſage of the ulnar nerve.

Trapezium (*a*) has four unequal ſides and angles in its back-part, from which it has got its name.—Above, its ſurface is ſmooth, ſlightly hollowed, and ſemicircular, for its conjunction with the *os ſcaphoides*.—Its external ſide is an oblong concave ſquare, for receiving the following bone.——The inferior ſurface is formed into a pulley; the two protuberant ſides of which are external and internal. On this pulley the firſt bone of the thumb is moved.——At the external ſide of the external protuberance, a ſmall oblong ſmooth ſurface is formed by the *os metacarpi indicis*.—The fore-part of the *trapezium* is prominent in the palm; and, near to the external ſide, has a ſinuoſity in it, where the tendon of the *flexor carpi radialis* is lodged; on the ligamentous ſheath of which the tendon of the *flexor tertii internodii pollicis* plays: And ſtill more externally the bone is ſcabrous, where the *tranſverſe* ligament of the wriſt is connected, the *abductor* and *flexor primi internodii pollicis* have their origin, and ligaments go out to the firſt bone of the thumb.

Os trapezoides (*b*), ſo called from the irregular quadrangular figure of its back-part, is the ſmalleſt bone of the wriſt, except the *piſiforme*.—The figure of it is an irregular cube.—It has a ſmall hollow ſurface above, by which it joins the *ſcaphoides*; a long convex one internally, where it is contiguous to the *trapezium*; a ſmall external one, for its conjunction with the *os magnum*; and an inferior convex ſurface, the edges of which are however ſo raiſed before and behind, that a ſort of pulley is formed, where it ſuſtains the *os metacarpi indicis*.

Os magnum (*c*), ſo called becauſe it is the largeſt bone of the *carpus*, is oblong, having four quadrangular ſides, with a round upper end, and a triangular plain one below.—The round head is divided by a ſmall riſing, oppoſite to the connection of the *os ſcaphoides* and *lunare*, which together form the cavity for receiving it.—On the inſide a ſhort plain ſurface joins the *os magnum* to the *trapezoides*.—On the outſide is a long narrow concave

(*a*) Os cubiforme, trapezoides, multangulum majus.
(*b*) Trapezium, multangulum minus. (*c*) Maximum, capitatum.

cave ſurface, where it is contiguous to the *os unciforme*.—The lower end, which ſuſtains the metacarpal bone of the middle finger, is triangular, ſlightly hollowed, and farther advanced on the internal ſide than on the external, having a conſiderable oblong depreſſion made on the advanced inſide by the metacarpal bone of the fore-finger; and generally there is a ſmall mark of the *os metacarpi digiti annularis* on its external ſide.

Os unciforme (*a*) has got its name from a thin broad proceſs that ſtands out from it forwards into the palm, and is hollow on its inſide, for affording paſſage to the tendons of the flexors of the fingers. To this proceſs alſo the tranſverſe ligament is fixed, that binds down and defends theſe tendons; and the *flexor* and *abductor* muſcles of the little finger have part of their origin from it.——The upper plain ſurface is ſmall, convex, and joined with the *os lunare*:—The internal ſide is long, and ſlightly convex, adapted to the contiguous *os magnum*:—The external ſurface is oblique, and irregularly convex, to be articulated with the cuneiform bone:—The lower end is divided into two concave ſurfaces; the external is joined with the metacarpal bone of the little finger, and the internal one is fitted to the metacarpal bone of the ring-finger.

In the deſcription of the preceding eight bones, I have only mentioned thoſe plain ſurfaces covered with cartilage, by which they are articulated to each other, or to ſome other bones, except in ſome few caſes, where ſomething extraordinary was to be obſerved; and I have deſignedly omitted the other rough ſurfaces, leſt, by crowding too many words in the deſcription of ſuch ſmall bones, the whole ſhould be unintelligible: But theſe ſcabrous parts of the bones may eaſily be underſtood, after mentioning their figure, if it is obſerved, that they are generally found only towards the back or palm of the hand; that they are all plain, larger behind than before; and that they receive the different ligaments, by which they are either connected to neighbouring bones, or to one another; for theſe ligaments cover all the bones, and are ſo accurately applied to them, that, at firſt view, the whole *carpus* of a recent ſubject appears one ſmooth bone (*b*).

(*a*) Cuneiforme.

(*b*) Galen de Uſu Part. lib. 2. cap. 8. For a particular deſcription of theſe ligaments, ſee Weitbrecht, Syndeſmolog. p. 35,—68.

As the ſurfaces of theſe bones are largeſt behind, the figure of the whole conjoined muſt be convex there, and concave before; which concavity is ſtill more increaſed by the *os piſiforme*, and proceſs of the *os unciforme*, ſtanding forwards on one ſide, as the *trapezium* does on the other: And the bones are ſecurely kept in this form by the broad ſtrong tranſverſe ligament connected to thoſe parts of them that ſtand prominent into the palm of the hand.——The convexity behind renders the whole fabric ſtronger, where it is moſt expoſed to injuries; and the large anterior hollow is neceſſary for a ſafe paſſage to the numerous veſſels, nerves, and tendons of the fingers.

The ſubſtance of theſe bones is ſpongy and cellular, but ſtrong in reſpect of their bulk.

The three firſt bones of the *carpus* make an oblong head, by which they are articulated with the cavity at the lower ends of the bones of the fore-arm, ſo as to allow motion to all ſides; and, by a quick ſucceſſion of theſe motions, they may be moved in a circle. But as the joint is oblong, and therefore the two dimenſions are unequal, no motion is allowed to the *carpus* round its axis, except what it has in the pronation and ſupination along with the *radius*.——The articulation of the firſt three bones of the ſuperior row, with the bones of the inferior, is ſuch as allows of motion, eſpecially backwards and forwards; to the ſecurity and eaſineſs of which, the reception of the *os magnum* into the cavity formed by the *ſcaphoides* and *lunare* contributes conſiderably: And the greateſt number of the muſcles that ſerve for the motion of the wriſt on the *radius*, being inſerted beyond the conjunction of the firſt row of bones with the ſecond, act equally on this articulation as they do on the former; but the joint formed with the *radius* being the moſt eaſily moved, the firſt effect of theſe muſcles is on it, and the ſecond row of the *carpus* is only moved afterwards. By this means a larger motion of the wriſt is allowed than otherwiſe it could have had ſafely: for if as large motion had been given to one joint, the angle of flexion would have been very acute, and the ligaments muſt have been longer than was conſiſtent with the firmneſs and ſecurity of the joint.——The other articulations of the bones here being by nearly plain ſurfaces, ſcarce allow of any more motion, becauſe of the ſtrong connecting ligaments, than to yield a little, and ſo elude the force

force of any external power; and to render the back of the wriſt a little more flat, or the palm more hollow, on proper occaſions. The articulations of the thumb and metacarpal bones ſhall be examined afterwards.

The uſes of the *carpus* are to ſerve as a baſe to the hand, to protect its tendons, and to afford it a free large motion.

All the bones of the *carpus* are in a cartilaginous ſtate at the time of birth.

On account of the many tendons that paſs upon the lower end of the fore-arm and the *carpus*, and of the numerous ligaments of theſe tendons and of the bones, which have lubricating liquors ſupplied to them, the pain of ſprains here is acute, the parts take long time to recover their tone, and their ſwellings are very obſtinate.

METACARPUS (*a*) conſiſts of four bones which ſuſtain the fingers.—Each bone is long and round, with its ends larger than its body.—The upper end, which ſome call the baſe, is flat and oblong, without any conſiderable head or cavity; but it is, however, ſomewhat hollowed for the articulation with the *carpus:* It is made flat and ſmooth on the ſides where theſe bones are contiguous to each other.——Their bodies are flatted on their back-part by the tendons of the extenſors of the fingers.—The anterior ſurface of theſe bodies is a little concave, eſpecially in their middle; along which a ſharp ridge ſtands out, which ſeparates the *muſculi interoſſei* placed on each ſide of theſe bones, which are there made flat and plain by theſe muſcles.

Their lower ends are raiſed into large oblong ſmooth heads, whoſe greateſt extent is forwards from the axis of the bone.—At the fore-part of each ſide of the root of each of theſe heads, one or two tubercles ſtand out, for fixing the ligaments that go from one metacarpal bone to another, to preſerve them from being drawn aſunder.—Round the heads a rough ring may be remarked, for the capſular ligaments of the firſt joints of the fingers to be fixed to; and both ſides of theſe heads are flat, by preſſing on each other.

The ſubſtance of the metacarpal bones is the ſame with that of all long bones.

At

(*a*) Κτεις, μετακαρπιον, ταλος, κυδιφον, κτενιον, poſt brachiale, pectus, palma, pecten.

At the time of birth, theſe bones are cartilaginous at both ends, which afterwards become *epiphyſes*.

The metacarpal bones are joined above to the *oſſa carpi*, and to each other by nearly plain ſurfaces. Theſe connections are not fit for large motions.—The articulation of their round heads at the lower ends with the cavities of the firſt bones of the fingers, is to be taken notice of hereafter.

The concavity on the fore-part of theſe metacarpal bones, and the placing their baſes on the arched *carpus*, cauſe them to form a hollow in the palm of the hand, which is uſeful often to us.—The ſpaces between them lodge muſcles, and their ſmall motion makes them fit ſupporters for the fingers to play on.

Though the *oſſa metacarpi* ſo far agree, yet they may be diſtinguiſhed from each other by the following marks.

The *os metacarpi indicis* is generally the longeſt.—Its baſe, which is articulated with the *os trapezoides*, is hollow in the middle.—The ſmall ridge on the internal ſide of this oblong cavity is ſmaller than the one oppoſite to it, and is made flat on the ſide by the *trapezium*.—The exterior ridge is alſo ſmooth, and flat on its outſide, for its conjunction with the *os magnum*; immediately below which a ſemicircular ſmooth flat ſurface ſhows the articulation of this to the ſecond metacarpal bone.—The back-part of this baſe is flatted where the long head of the *extenſor carpi radialis* is inſerted; and its fore-part is prominent, where the tendon of the *flexor carpi radialis* is fixed.—The external ſide of the body of this bone is more hollowed by the action of muſcles than the internal.—The tubercle at the internal root of its head is larger than the external.—Its baſe is ſo firmly fixed to the bone it is connected with, that it has no motion.

Os metacarpi medii digiti is generally the ſecond in length: but often it is as long as the former; ſometimes it is longer; and frequently it appears only to equal the firſt by the *os magnum* being farther advanced downwards than any other bone of the wriſt—Its baſe is a broad ſuperficial cavity, ſlanting outwards; the internal poſterior angle of which is ſo prominent, as to have the appearance of a proceſs.—The internal ſide of this baſe is made plain in the ſame way as the external ſide of the former bone, while its external ſide has two hollow circular ſurfaces, for joining

the

the third metacarpal bone; and between theſe ſurfaces there is a rough *foſſa*, for the adheſion of a ligament, and lodging mucilaginous glands.—The ſhorter head of the *bicornis* is inſerted into the back-part of this baſe. The two ſides of this bone are almoſt equally flatted; only the ridge on the fore-part of the body inclines outwards. The tubercles at the fore-part of the root of the head are equal. The motion of this bone is very little more than the firſt metacarpal one has; and therefore theſe two firmly reſiſt bodies preſſed againſt them by the thumb, or fingers, or both.

Os metacarpi digiti annularis is ſhorter than the ſecond metacarpal bone. Its baſe is ſemicircular and convex, for its conjunction with the *os unciforme*.—On its internal ſide are two ſmooth convexities, and a middle *foſſa*, adapted to the ſecond metacarpal bone.—The external ſide has a triangular ſmooth concave ſurface to join it with the fourth one. The anterior ridge of its body is ſituated more to the out than the inſide.—The tubercles near the head are equal.—The motion of this third metacarpal bone is greater than the motion of the ſecond.

Os metacarpi minimi digiti is the ſmalleſt and ſharpeſt.—Its baſe is irregularly convex, and riſes ſlanting outwards.—Its internal ſide is exactly adapted to the third metacarpal bone.—The external has no ſmooth ſurface, becauſe it is not contiguous to any other bone; but it is prominent where the *extenſor carpi ulnaris* is inſerted.—As this *metacarpal* bone is furniſhed with a proper moving muſcle, has the plaineſt articulation, is moſt looſely connected and leaſt confined, it not only enjoys a much larger motion than any of the reſt, but draws the third bone with it, when the palm of the hand is to be made hollow by its advancement forwards, and by the prominence of the thumb oppoſite to it.

The THUMB and four FINGERS are each compoſed of three long bones.

The *thumb* (*a*) is ſituated obliquely in reſpect of the fingers, neither oppoſite directly to them, nor in the ſame plane with them.—All its bones are much thicker and ſtronger in proportion to their length, than the bones of the fingers are: which was extremely neceſſary, ſince the thumb counteracts all the fingers.

The firſt bone of the thumb has its baſe adapted to the double pulley of

(*a*) Αντιχειρ, διχοιδυλος, magnus digitus, promanus.

of the *trapezium:* for in viewing it from one ſide to the other, it appears convex in the middle; but when conſidered from behind forwards, it is concave there.—The edge at the fore-part of this baſe is produced farther than any other part; and round the back-part of the baſe a rough *foſſa* may be ſeen, for the connection of the ligaments of this joint.—The body and head of this bone are of the ſame ſhape as the *oſſa metacarpi;* only that the body is ſhorter, and the head flatter, with the tubercles at the fore-part of its root larger.

The articulation of the upper end of this bone is uncommon: for tho' it has protuberances and depreſſions adapted to the double pulley of the *trapezium*, yet it enjoys a circular motion, as the joints do where a round head of one bone plays in the orbicular ſocket of another; only it is ſomewhat more confined and leſs expeditious, but ſtronger and more ſecure, than ſuch joints generally are.

This bone of children is in the ſame ſtate with the metacarpal bones.

The ſecond bone of the thumb has a large baſe formed into an oblong cavity, whoſe greateſt length is from one ſide to the other.—Round it ſeveral tubercles may be remarked, for the inſertion of ligaments.—Its body is convex, or a half round behind; but flat before, for lodging the tendon of the long flexor of the thumb, which is tied down by ligamentous ſheaths that are fixed on each ſide to the angle at the edge of this flat ſurface. The lower end of this ſecond bone has two lateral round protuberances, and a middle cavity, whoſe greateſt extent of ſmooth ſurface is forwards.

The articulation and motion of the upper end of this ſecond bone is as ſingular as that of the former.—For its cavity being joined to the round head of the firſt bone, it would ſeem at firſt view to enjoy motion in all directions; yet becauſe of the ſtrength of its lateral ligaments, oblong figure of the joint itſelf, and mobility of the firſt joint, it only allows flexion and extenſion; and theſe are generally much confined.

The third bone of the thumb is the ſmalleſt, with a large baſe, whoſe greateſt extent is from one ſide to the other.——This baſe is formed into two cavities and a middle protuberance, to be adapted to the pulley of the former bone. Its body is rounded behind; but is flatter than in the former bone, for ſuſtaining the nail. It is flat and rough before, by the

inſertion

inſertion of the *flexor tertii internodii*. This bone becomes gradually ſmaller, till near the lower end, where it is a little enlarged, and has an oval ſcabrous edge.

The motion of this third bone is confined to flexion and extenſion.

The orderly diſpoſition of the bones of the *fingers* into three rows, has made them generally obtain the name of three *phalanges* (*a*). All of them have half-round convex ſurfaces, covered with an *aponeuroſis*, formed by the tendons of the *extenſors*, *lumbricales*, and *interoſſei*, and placed directly backwards, for their greater ſtrength; and their flat concave part is forwards, for taking hold more ſurely, and for lodging the tendons of the flexor muſcles. The ligaments for keeping down theſe tendons are fixed to the angles that are between the convex and concave ſides.

The bones of the firſt *phalanx* (*b*) of the fingers anſwer to the deſcription of the ſecond bone of the thumb; only that the cavity in their baſe is not ſo oblong, nor is their motion on the metacarpal bones ſo much confined: for they can be moved laterally or circularly; but have no rotation, or a very ſmall degree of it, round their axis.

Both the ends of this firſt *phalanx* are in a cartilaginous ſtate at the birth; and the upper one is afterwards affixed in form of an *epiphyſe*.

The ſecond bone (*c*) of the fingers has its baſe formed into two lateral cavities and a middle protuberance, while the lower end has two lateral protuberances and a middle cavity; therefore it is joined at both ends in the ſame manner, which none of the bones of the thumb are.

This bone is in the ſame condition with the former in children.

The third bone (*d*) differs nothing from the deſcription of the third bone of the thumb, excepting in the general diſtinguiſhing marks; and therefore the ſecond and third *phalanx* of the fingers enjoy only flexion and extenſion.

The upper end of this third *phalanx* is a cartilage in a ripe child; and is only an *epiphyſe* after, till the full growth of the body.

All the difference of the *phalanges* of the ſeveral fingers conſiſts in their magnitude.—The bones of the *middle finger* (*e*) being the longeſt and lar-

(*a*) Scytalidæ, internodia, ſcuticula, agmina, acies, condyli, articuli. (*b*) Προκονδυγοι.

(*c*) Κονδυλοι. (*d*) Μεταχονδυλες, ριζονυχια.

(*e*) Καταπυγων, εφαππιλες, infamis, impudicus, verpus, famoſus, obſcœnus.

geſt,—thoſe of the *fore-finger* (*a*) come next to that in thickneſs, but not in length; for thoſe of the *ring-finger* (*b*) are a little longer. The *little finger* (*c*) has the ſmalleſt bones: which diſpoſition is the beſt contrivance for holding the largeſt bodies; becauſe the longeſt fingers are applied to the middle largeſt periphery of ſuch ſubſtances as are of a ſpherical figure (*d*).

The uſes of all the parts of our *ſuperior extremities* are ſo evident in the common actions of life, that it is needleſs to enumerate them here; and therefore I ſhall proceed to the laſt part of the ſkeleton. Only, leſt I ſhould ſeem to have forgot the ſmall bones at the joints of the hand, I deſire now to refer to the deſcription of them, under the common title of *ſeſamoid bones*, which I have placed after the bones of the feet.

Of the INFERIOR EXTREMITIES.

THE INFERIOR EXTREMITIES depend from the *acetabula* of the *oſſa innominata*; and are commonly divided into three parts, viz. the thigh, leg, and foot.

The THIGH (*e*) has only one bone; which is the longeſt of the body, and the largeſt and ſtrongeſt of any of the cylindrical bones. The ſituation of it is not perpendicular; for the lower end is inclined conſiderably inwards: ſo that the knees are almoſt contiguous, while there is a conſiderable diſtance between the thigh-bones above; which is of good uſe to us, ſince ſufficient ſpace is thereby left for the external parts of generation, the two great *cloacæ* of urine and *fæces*, and for the large thick muſcles that move the thigh inwards. And at the ſame time this ſituation of the thigh-bones renders our progreſſion quicker, ſurer, ſtraighter, and in leſs room: for had the knees been at a greater diſtance from each other, we muſt have been obliged to deſcribe ſome part of a circle with the trunk

(*a*) Δειϰτιϰος, indicator, λιχανος, demonſtrativus, ſalutaris.

(*b*) Ἰατριϰος, παραμεσος, δαϰτυλιωτης, ἐπιβατις, annularis, medicus, cordis digitus.

(*c*) Μυωψ, ωτιτις, auricularis, minimus. (*d*) Galen de Uſu part. lib. 1. cap. 24.

(*e*) Μηρον, femen, coxa, agis, anchæ os, crus, femur.

trunk of our body in making a long ſtep; and when one leg was raiſed from the ground, our centre of gravity would have been too far from the baſe of the other, and we ſhould conſequently have been in hazard of falling: ſo that our ſteps would neither have been ſtraight nor firm; nor would it have been poſſible to walk in a narrow path, had our thigh-bones been otherwiſe placed. In conſequence, however, of the weight of the body bearing ſo obliquely on the joint of the knee, by this ſituation of the thigh-bones, weak rickety children become in-knee'd.

The upper end of the thigh-bone is not continued in a ſtraight line with the body of it, but is ſet off obliquely inwards and upwards; whereby the diſtance here between theſe two bones, at their upper part, is conſiderably increaſed.—This end is formed into a large ſmooth round head (*a*), which is the greater portion of a ſphere unequally divided.—Towards its lower internal part, a round rough ſpongy pit is obſervable, where the ſtrong ligament, commonly, but unjuſtly, called the *round* one, is fixed, to be extended from thence to the lower internal part of the receiving cavity; where it is conſiderably broader than near to the head of the thigh-bone.——The ſmall part below the head, called the *cervix*, of the *os femoris*, has a great many large holes, into which the fibres of the ſtrong ligament, continued from the capſular, enter, and are thereby ſurely united to it: and round the root of the neck, where it riſes from the bone, a rough ridge is found, where the capſular ligament of the articulation itſelf is connected.—Below the back-part of this root, the large unequal protuberance, called *trochanter major* (*b*), ſtands out: the external convex part of which is diſtinguiſhed into three different ſurfaces; whereof the one on the fore-part is ſcabrous and rough, for the inſertion of the *glutæus minimus*; the ſuperior one is ſmooth, and has the *glutæus medius* inſerted into it; and the one behind is made flat and ſmooth by the tendon of the *glutæus maximus* paſſing over it.—The upper edge of this proceſs is ſharp and pointed at its back-part, where the *glutæus medius* is fixed; but forwards it is more obtuſe, and has two ſuperficial pits formed in it: Into the ſuperior of theſe, the *pyriformis* is implanted; and the *obturator internus* and *gemini* are fixed into the lower one.—From the backmoſt prominent part of this great *trochanter*, a rough ridge runs

(*a*) Vertebrum. (*b*) τροχος, rotator natis, malum granatum teſticulorum.

backwards and downwards, into which the *quadratus* is inſerted.——In the deep hollow, at the internal upper ſide of this ridge, the *obturator externus* is implanted.—More internally, a conoid proceſs, called *trochanter minor* (*a*), riſes for the inſertion of the *muſculus pſoas* and *iliacus internus*; and the *pectineus* is implanted into a rough hollow below its internal root. The muſcles inſerted into theſe two proceſſes being the principal inſtruments of the rotatory motion of the thigh, have occaſioned the name of *trochanters* to the proceſſes.—The tendons that are fixed into or paſs over the great *trochanter*, cauſe bruiſes by falls on this part to be attended with great pain and weakneſs of the limb, which generally remain long.

The body of the *os femoris* is convex on the fore-part, and made hollow behind, by the action of the muſcles that move it and the leg, and for the conveniency of ſitting, without bearing too much on theſe muſcles; and probably the weight of the legs depending from the thighs in that poſture, contributes to this curvature.——The fore-part of the thigh-bone is a little flatted above by the beginning of the *cruræus* muſcle, as it is alſo below by the ſame muſcle and the *rectus*.—Its external ſurface is likewiſe made flat below by the *vaſtus externus*, where it is ſeparated from the former by an obtuſe ridge.—The *vaſtus internus* depreſſes a little the lower part of the internal ſurface.—The poſterior concave ſurface has a ridge riſing in its middle, commonly called *linea aſpera*, into which the *triceps* is inſerted; and the ſhort head of the *biceps flexor tibiæ* riſes from it.—At the upper part of it, the medullary veſſels enter by a ſmall hole that runs obliquely upwards.—A little above which there is a rough *foſſa* or two, where the tendon of the *glutæus maximus* is fixed—The lower end of the *linea aſpera* divides into two, which deſcend towards each ſide.—The two *vaſti* muſcles have part of their origin from theſe ridges; and the long tendon of the *triceps* is fixed to the internal by means of part of the *faſcia aponeurotica* of the thigh.—Near the beginning of the internal ridge, there is a diſcontinuation of the ridge, where the crural artery paſſes through the *aponeuroſis*.—Between theſe two rough lines, the bone is made flat by the large blood-veſſels and nerves which paſs upon it; and near the end of each of theſe ridges a ſmall ſmooth protuberance may often be remarked, where the two heads of the external *graſtrocnemius* muſcle take their

(*a*) Rotator minor.

their riſe, and where ſeſamoid bones are ſometimes found (*a*); and from the fore-part of the internal tubercle a ſtrong ligament is extended to the inſide of the *tibia*.

The lower end of the *os femoris* is larger than any other part of it, and is formed into a great protuberance on each ſide, called its *condyles;* between which a conſiderable cavity is found, eſpecially at the back-part, in which the crural veſſels and nerves lie immerſed in fat.—The internal condyle is longer than the external, which muſt happen from the oblique poſition of this bone, to give leſs obliquity to the leg. Each of theſe proceſſes ſeems to be divided in its plain ſmooth ſurface. The mark of diviſion on the external is a notch, and on the internal a ſmall protuberance. The fore-part of this diviſion, on which the *rotula* moves, is formed like a pulley, the external ſide of which is higheſt. Behind, there are two oblong large heads, whoſe greateſt extent is backwards, for the motion of the *tibia:* And from the rough cavity between them, but near to the baſe of the internal condyle, the ſtrong ligament, commonly called the *croſs* one, has its riſe; a little above which, a rough protuberance gives inſertion to the tendon of the *triceps*.——The condyles, both on the outer and inner ſide of the knee, are made flat by the muſcles paſſing along them.—On the back-part of the internal, a ſlight depreſſion is made by the tendons of the *gracilis* and *ſartorius:* And, on the external, ſuch another is formed by the *biceps flexor cruris;* behind which, a deep *foſſa* is to be obſerved, where the *poplitæus* muſcle has its origin.—From the tubercle immediately before this cavity, a ſtrong round ligament goes out to the upper part of the *fibula*.—Round this lower end of the thigh-bone, large holes are found, into which the ligaments for the ſecurity of the joint are fixed, and blood-veſſels paſs to the internal ſubſtance of the bone.

All the proceſſes of the *femur* are cartilaginous in new-born children, and afterwards become ſmall *apophyſes*, with large *epiphyſes*.

The thigh-bone being articulated above with the *acetabulum* of the *oſſa innominata*, which affords its round head a ſecure and extenſive play, can be moved to every ſide; but is reſtrained in its motion outwards, by the high brims of the cavity, and by the *round* ligament; for otherwiſe the head of the bone would have been frequently thruſt out at the breach of the

(*a*) Veſal. lib. 1. cap. 28. & 30.

the brims on the inſide, which allows the thigh to move conſiderably inwards.——The body of this bone enjoys little or no rotatory motion, though the head moſt commonly moves round its own axis; becauſe the oblique progreſs of the neck and head from the bone is ſuch, that the rotatory motion of the head can only bring the body of the bone forwards and backwards: Nor is this head, as in the arm, ever capable of being brought to a ſtraight direction with its body; ſo far, however, as the head can move within the cavity backwards and forwards, the reſt of the bone may have a partial rotation.——When the thigh-bone reſiſts the actions of its muſcles more than the trunk of the body can then do, as in ſtanding, theſe muſcles have their effect on the trunk, cauſing it to bend forward, raiſing it up, inclining it to the one or the other ſide, twiſting it obliquely, &c. which the rolling of the *acetabula* of the *oſſa innominata* on the round heads of the thigh-bones is well fitted for.——The *os femoris* is articulated below to the *tibia* and *rotula* in the manner afterwards to be deſcribed.

The nearneſs of the ſmall neck to the round head of the thigh-bone, and its upper end being covered with very thick muſcles, make greater difficulty in diſtinguiſhing between a luxation and fracture here, than in any other part of the body.

The LEG (*a*) is compoſed, according to the common account, of two bones, *tibia* and *fibula*: though it ſeems to have a very good title to a third, the *rotula*; which bears a ſtrong analogy to the *olecranon* of the *ulna*, and moves always with the other two.

TIBIA (*b*), ſo called from its reſemblance to an old muſical pipe or flute, is the long thick triangular bone, ſituated at the internal part of the leg, and continued in almoſt a ſtraight line from the thigh-bone.

The upper end of the *tibia* is large, bulbous, and ſpongy; and is divided into two cavities, by a rough irregular protuberance (*a*), which is hollow at its moſt prominent part, as well as before and behind. The anterior of the two ligaments that compoſe the great *croſs* one, is inſerted into the middle cavity, and the depreſſion behind receives the poſterior ligament.

(*a*) Κνημη, crus, tibia.

(*b*) Προκνημιον, οπτικνημιον, focile majus, arundo major, canna major, canna domeſtica cruris.

(*c*) Διαφυσις, εξοχη κυρτοχοικρωδης, tuber, tuberculum.

ligament.——The two broad cavities at the ſides of this protuberance are not equal: for the internal is oblong and deep, to receive the internal *condyle* of the thigh-bone; while the external is more ſuperficial and rounder, for the external *condyle*.——In each of theſe two cavities of a recent ſubject, a ſemilunar cartilage is placed, which is thick at its convex edge, and becomes gradually thinner towards the concave or interior edge.—The middle of each of theſe cartilages is broad, and the ends of them turn narrower and thinner as they approach the middle protuberance of the *tibia*.——The thick convex edge of each cartilage is connected to the capſular and other ligaments of the articulation; but ſo near to their riſe from the *tibia*, that the cartilages are not allowed to change place far; while the narrow ends of the cartilages, becoming almoſt ligaments, are fixed at the inſertion of the ſtrong croſs ligament into the *tibia*, and ſeem to have their ſubſtance united with it; therefore a circular hole is left between each cartilage and the ligament, in which the moſt prominent convex part of each condyle of the thigh-bone moves.—The circumference of theſe cavities is rough and unequal, for the firm connection of the ligaments of the joint.—Immediately below the edge, at its back-part, two rough flatted protuberances ſtand out: Into the internal, the tendon of the *ſemimembranoſus* muſcle is inſerted; and a part of the croſs ligament is fixed to the external.—On the outſide of this laſt tubercle, a ſmooth ſlightly hollowed ſurface is formed by the action of the *popliteæus* muſcle.

Below the fore-part of the upper end of the *tibia*, a conſiderable rough protuberance (*a*) riſes, to which the ſtrong tendinous ligament of the *rotula* is fixed.—On the internal ſide of this, there is a broad, ſcabrous, ſlightly hollowed ſurface, to which the internal long ligament of the joint, the *aponeuroſis* of the *vaſtus internus*, and the tendons of the *ſeminervoſus*, *gracilis*, and *ſartorius*, are fixed.—The loweſt part of this ſurface is therefore the place where the *tibia* ought to be ſawed through in an amputation, ſo as not to have too long and troubleſome a ſtump, and, at the ſame time, to preſerve its motions, by ſaving the proper muſcles.—— Below the external edge of the upper end of the *tibia*, there is a circular flat ſurface, covered in a recent ſubject with cartilage, for the articulation

(*a*) Ἀντικνημιον, anterior tuber.

tion of the *fibula*;——between which and the anterior knob, there is a rough hollow, from which the *tibialis anticus*, and *extenſor digitorum longus*, take their origin.—From the ſmooth flat ſurface, a ridge runs obliquely downwards and inwards, to give riſe to part of the *ſolæus*, *tibialis poſticus*, and *flexor digitorum longus*, and inſertion to the *aponeuroſis* of the *ſemimembranoſus* which covers the *poplitæus*, and to ſome of the external fibres of this laſt named muſcle.—At the inſide of this ridge an oblique plain ſurface is left, where the greateſt part of the *muſculus poplitæus* is inſerted.—The remaining body of the *tibia* is triangular.—The anterior angle is very ſharp, and is commonly called the *ſpine* or *ſhin* (*a*). This ridge is not ſtraight; but turns firſt inwards, then outwards, and laſtly inwards again.—The plain internal ſide is ſmooth and equal, being little ſubjected to the actions of muſcles; but the external ſide is hollowed above by the *tibialis anticus*, and below by the *extenſor digitorum longus* and *extenſor pollicis longus*.—The two angles behind theſe ſides are rounded by the action of the muſcles;—the poſterior ſide comprehended between them is not ſo broad as thoſe already mentioned, but is more oblique and flatted by the action of the *tibialis poſticus* and *flexor digitorum longus*. Some way above the middle of the bone, the internal angle terminates, and the bone is made round by the preſſure of the *muſculus ſolæus*. Near to this, the paſſage of the medullary veſſels is ſeen ſlanting obliquely downwards.

The lower end of the *tibia* is made hollow, but ſo as a ſmall protuberance riſes in the middle.—The internal ſide of this cavity, which is ſmooth, and in a recent ſubject is covered with cartilage, is produced into a conſiderable proceſs, commonly named *malleolus internus* (*b*); the point of which is divided by a notch, and from it ligaments are ſent out to the foot.—We ought to obſerve here, that this internal *malleolus* is ſituated more forwards than the internal condyle of the upper end of this bone; which is neceſſary to be remembered in reducing a fracture of the leg (*c*).—The external ſide of this end of the *tibia* has a rough irregular ſemilunar cavity formed in it, for receiving the lower end of the *fibula*.—The poſterior ſide has two lateral grooves, and a ſmall middle protuberance.

(*a*) Ακανθα, ſpina, crea, linea prima tibiæ, angulus acutus.

(*b*) Σφυρον, malleus, talus, clavicula, clavilla interior, clavilla domeſtica.

(*c*) Winſlow, Expoſition Anatomique des Os ſecs, ſect. 865.

rance. In the internal depreſſion, the tendons of the *muſculus tibialis poſticus* and *flexor digitorum longus* are lodged; and in the external, the tendon of the *flexor longus pollicis* plays.—From the middle protuberance, ligamentous ſheaths go out, for tying down theſe tendons.

The articulations and motions of the *tibia* ſhall be explained after all the three bones of the leg are deſcribed.

Both the ends of the *tibia* are cartilages at birth, and become afterwards *epiphyſes*.

FIBULA (*a*) is the ſmall long bone, placed on the outſide of the leg, oppoſite to the external angle of the *tibia*; the ſhape of it is irregularly triangular.

The head of the *fibula* has a ſuperficial circular cavity formed on its inſide, which, in a recent ſubject, is covered with a cartilage, but ſo cloſely connected to the *tibia* by ligaments, as to allow only a ſmall motion backwards and forwards.—This head is protuberant and rough on its outſide, where a ſtrong round ligament and the *muſculus biceps* are inſerted; and, below the back-part of its internal ſide, a tubercle may be remarked, that gives riſe to the ſtrong tendinous part of the *ſolæus* muſcle.

The body of this bone is a little crooked inwards and backwards, which figure is owing to the actions of the muſcles; but is ſtill further increaſed by nurſes, who often hold children careleſsly by the legs.—The ſharpeſt angle of the *fibula* is forwards, on each ſide of which the bone is conſiderably, but unequally, depreſſed by the bellies of the ſeveral muſcles that riſe from or act upon it; and, in old people, theſe muſcles make diſtinct ſinuoſities for themſelves. The external ſurface of the *fibula* is depreſſed obliquely from above downwards and backwards, by the two *peronæi*.—Its internal ſurface is unequally divided into two narrow longitudinal planes, by an oblique ridge extended from the upper part of the anterior angle, to join with the lower end of the internal angle. To this ridge the ligament ſtretched between the two bones of the leg is connected.—The anterior of the two planes is very narrow above, where the *extenſor longus digitorum* and *extenſor longus pollicis* ariſe from it; but is broader below, where it has the print of the *nonus Veſalii*.—The poſterior plane is broad and hollow, giving origin to the larger ſhare of the *tibialis poſticus*.

(*a*) Περόνη, perone, focile minus, arundo minor, canna minor cruris, fura, radius.

The internal angle of this bone has a tendinous membrane fixed to it, from which fibres of the *flexor digitorum longus* take their riſe.—The poſterior ſurface of the *fibula* is the plaineſt and ſmootheſt; but is made flat above by the *ſolæus*, and is hollowed below by the *flexor pollicis longus*.—In the middle of this ſurface the canal for the medullary veſſels may be ſeen ſlanting downwards.

I have taken particular notice of the entry and direction of the medullary veſſels of the large bones of the extremities (*a*); becauſe, in ſeveral chirurgical caſes, a ſurgeon who is ignorant of this may do miſchief to his patient. Thus, for example, if theſe veſſels are opened very near to their entry into the bone, or while they are in the oblique paſſage through it, an obſtinate hæmorrhagy may enſue: For the arteries being connected to the bony paſſage, ſtyptics, and other like corrugators, are vainly applied; compreſſing inſtruments can do no ſervice, and ligatures cannot be employed.—There ſeems to be a particular deſign in the contrivance of theſe canals; thoſe in the *os humeri*, *tibia*, and *fibula*, running obliquely downwards from their external entry; whereas in the *radius*, *ulna*, and *os femoris*, they ſlant upwards, whereby the arteries and nerves which are ſent into theſe three laſt bones muſt ſuffer a conſiderable reflection before they come at the *cancelli*. The reaſon of this diverſity may perhaps be, that the arteries, which are ſo ſmall within the bones as to have no ſtrong contractile propelling force in their coats, and where they are not aſſiſted by the action of any moving neighbouring organ, ſhould have, at leaſt in their paſſage through the bone, a favourable deſcent for their liquids: Which, it is evident, they have in the deſcending oblique paſſages formed for them in the firſt claſs of bones, to wit, the *os humeri*, *tibia*, and *fibula*, which are generally depending: And they alſo moſt frequently acquire the like advantage in the *radius*, *ulna*, and *os femoris*; becauſe the hand, in the moſt natural poſture, is higher than the elbow; and when we ſit or lie, the lower end of the thigh-bone comes to be at leaſt as high raiſed as the upper. In ſtanding and walking, or when the arms are moved, the blood muſt indeed aſcend as it paſſes through the bones of the forearm and thigh; but the preſſure of the muſcles, then in action, on the veſſels, before they enter the bones, is ſufficient to compenſate the diſadvantage

(*a*) Havers, Oſteolog. Nov. diſc. 1. p. 59.

vantage of their courſe. This reaſoning ſeems to be ſtill enforced, by obſerving, that this paſſage is always nearer the upper than the lower ends of theſe bones.

The lower end of the *fibula* is extended into a ſpongy oblong head, on the inſide of which is a convex, irregular, and frequently a ſcabrous ſurface, that is received by the external hollow of the *tibia*, and ſo firmly joined to it by a very thin intermediate cartilage and ſtrong ligaments, that it ſcarce can move.—Below this, the *fibula* is ſtretched out into a coronoid proceſs, that is ſmooth, covered with cartilage on its internal ſide, and is there contiguous to the outſide of the firſt bone of the foot, the *aſtragalus*, to ſecure the articulation. This proceſs, named *malleolus externus*, being ſituated farther back than the internal *malleolus*, and in an oblique direction, obliges us naturally to turn the fore-part of the foot outwards (*a*). At the lower internal part of this proceſs, a ſpongy cavity for mucilaginous glands may be remarked; from its point ligaments are extended to the *aſtragalus*, *os calcis*, and *os naviculare*, bones of the foot; and, from its inſide, ſhort ſtrong ones go out to the *aſtragalus*. On the back-part of it, a ſinuoſity is made by the tendons of the *peronæi* muſcles. ——When the ligament extended over theſe tendons from the one ſide of the depreſſion to the other is broke, ſtretched too much, or made weak by a ſprain, the tendons frequently ſtart forwards to the outſide of the *fibula*.

The conjunction of the upper end of the *fibula* with the *tibia* is by plain ſurfaces tipped with cartilage; and, at its lower end, the cartilage ſeems to glue the two bones together, not, however, ſo firmly in young people, but that the motion at the other end of ſuch a long *radius* is very obſervable.—In old ſubjects I often ſee the two bones of the leg grown together at their lower ends.

The principal uſe of this bone is to afford origin and inſertion to muſcles; the direction of which may be a little altered on proper occaſions, by its upper part ſhuffling backwards and forwards.—It likewiſe helps to make the articulation of the foot more ſecure and firm.—The ends of the *tibia* and *fibula* being larger than their middle, a ſpace is here left, which is filled up with ſuch another ligament as I deſcribed, extended

(*a*) Winſlow, Memoires de l'Acad. des Sciences, 1722.

between the bones of the fore-arm; and which is alſo diſcontinued at its upper part, where the *tibialis anticus* immediately adheres to the *ſolæus* and *tibialis poſticus*; but every where elſe it gives origin to muſcular fibres (*a*).

Both the ends of this bone are cartilaginous in a ripe child, and aſſume the form of *appendices* before they are united to its body.

ROTULA (*b*) is the ſmall flat bone ſituated at the fore-part of the joint of the knee.—Its ſhape reſembles the common figure of the heart with its point downwards.—The anterior convex ſurface of the *rotula* is pierced by a great number of holes, into which fibres of the ſtrong ligament that is ſpread over it enter.—Behind, its ſurface is ſmooth, covered with cartilage, and divided by a middle convex ridge into two cavities, of which the external is largeſt; and both are exactly adapted to the pulley of the *os femoris*, on which they are placed in the moſt ordinary unſtraining poſtures of the leg; but when the leg is much bended, the *rotula* deſcends far down on the condyles; and when the leg is fully extended, the *rotula* riſes higher, in its upper part, than the pulley of the thigh-bone.—The plain ſmooth ſurface is ſurrounded by a rough prominent edge, to which the capſular ligament adheres:—Below, the point of the bone is ſcabrous, where the ſtrong tendinous ligament from the tubercle of the *tibia* is fixed. The upper horizontal part of this bone is flatted and unequal, where the tendons of the extenſors of the leg are inſerted.

The ſubſtance of the *rotula* is cellular, with very thin external firm plates: But then theſe *cells* are ſo ſmall, and ſuch a quantity of bone is employed in their formation, that ſcarce any bone of its bulk is ſo ſtrong. Beſides, it is covered all over with a thick ligament, (as it was obſerved, that this ſort of bones generally is), to connect its ſubſtance, and is moveable to one ſide or other; therefore is ſufficiently ſtrong to reſiſt the ordinary actions of the large muſcles that are inſerted into it, or any common external force applied to it; while a fixed proceſs, ſuch as the *olecranon*, would not have been ſufficient to bear the whole weight of our bodies, which frequently falls on it, and would have hindered the rotatory motion

(*a*) Weitbrecht, Syndeſmolog. p. 156.

(*b*) Ἐπιμυλὶς, μυλακρὶς, κογχὶς, ἐπιγονατὶς, πλανησιδρον, patella, mola, genu, ſcutiforme os, cartilaginoſum, diſciforme, oculus genu.

motion of the leg. Notwithſtanding theſe precautions to preſerve this bone from ſuch injuries, yet I have ſeen a tranſverſe fracture in it, when by the report of the patient, and of the people about him, and by the want of ſwelling, diſcolouring, or other mark of bruiſe or contuſion, it was plain the bone was broken by the violent ſtraining effort of the muſcles (*a*). Though my patient recovered the uſe of the joint of the knee, yet I think it reaſonable to believe, that this ſort of fracture is commonly attended with difficulty of motion after the broken parts of the *rotula* are re-united; becauſe the callous matter probably extends itſelf into the cavity of the joint, where it either grows to ſome of the parts, or makes ſuch an inequality on the ſurface of this bone, as does not allow it to perform the neceſſary motions on the condyles of the *femur* (*b*).

At the ordinary time of birth, the *rotula* is entirely cartilaginous, and ſcarcely aſſumes a bony nature ſo ſoon as moſt *epiphyſes do.*

The parts which conſtitute the joint of the knee being now deſcribed, let us examine what are its motions, and how performed.—The two principal motions are flexion and extenſion.——In the former of theſe, the leg may be brought to a very acute angle with the thigh, by the condyles of the thigh-bones being round and made ſmooth far backwards. In performing this, the *rotula* is pulled down by the *tibia*.—When the leg is to be extended, the *rotula* is drawn upwards, conſequently the *tibia* forwards, by the extenſor muſcles: which, by means of the protuberant joint, and of this thick bone with its ligament, have in effect the chord with which they act fixed to the *tibia* at a conſiderable angle; therefore act with advantage: but are reſtrained from pulling the leg farther than to a ſtraight line with the thigh, by the poſterior part of the *croſs* ligament, that the body might be ſupported by a firm perpendicular column; for at this time the thigh and leg are as little moveable in a rotatory way, or to either ſide, as if they were one continued bone.—But when the joint is a little bended, the *rotula* is not tightly braced, and the poſterior ligament is relaxed: therefore this bone may be moved a little to either ſide, or with a ſmall rotation in the ſuperficial cavities of the *tibia;* which is done by the motion of the external cavity backwards and forwards, the

(*a*) See Ruyſch, Obſerv. Anat. Chirurg. obſ. 3. (*b*) Parè, liv. 15. chap. 22.

the internal ſerving as a ſort of axis (*a*). Seeing, then, one part of the *croſs* ligament is ſituated perpendicularly, and the poſterior part is ſtretched obliquely from the internal condyle of the thigh outwards, that poſterior part of the *croſs* ligament prevents the leg's being turned at all inwards; but it could not hinder it from turning outwards almoſt round, were not that motion confined by the lateral ligaments of this joint, which can yield little. This rotation of the leg outwards is of good advantage to us in croſſing our legs, and turning our feet outwards, on ſeveral neceſſary occaſions; though it is altogether fit this motion ſhould not be very large, to prevent frequent luxations here.——While all theſe motions are performing, the part of the *tibia* that moves immediately on the condyles is only ſo much as is within the cartilaginous rings; which, by the thickneſs on their outſides, make the cavities of the *tibia* more horizontal, by raiſing their external ſide where the ſurface of the *tibia* ſlants downwards. By this means the motions of this joint are more equal and ſteady than otherwiſe they would have been. The cartilages, being capable of changing a little their ſituation, are fit for doing this good office in the different motions and poſtures of the member, and likewiſe contribute to make the motions larger and quicker.

On account of the very large ſurface of the bones forming the joint of the knee, and the many ſtrong ligaments connecting them, luxations ſeldom happen here. But theſe very ligaments, the *aponeuroſis* paſſing over this joint, the quantity of fat and mucilaginous glands neceſſary for lubricating it, make it more ſubject to *white ſwellings*, dropſies, and ſuch other diſorders, than any other joint of the body.

The FOOT is divided, as well as the hand, into three parts, viz. *tarſus*, *metatarſus*, and *toes*: In the deſcription of which, the ſeveral ſurfaces ſhall be named, according to their natural ſituation, viz. the *broad* of the foot, ſhall be called ſuperior; the ſole, inferior; the ſide on which the great toe is, internal; that where the little toe is, external.

The *tarſus* (*a*) conſiſts of ſeven ſpongy bones; to wit, the *aſtragalus*, *os calcis*, *naviculare*, *cuboides*. *cuneiforme externum*, *cuneiforme medium*, and *cuneiforme internum*.

The

(*a*) Winſlow, Expoſition Anatomique du Corps Humain, traité des Os ſecs, § 976.
(*b*) Raſſetta.

The *aſtragalus* is the uppermoſt of theſe bones.—The *os calcis* is below the *aſtragalus*; and is conſiderably prominent backwards beyond the other bones, to form the heel.—The *os naviculare* is in the middle of the internal ſide of the *tarſus*.—The *os cuboides* is the moſt external of the row of four bones at its fore-part.—The *os cuneiforme externum* is placed at the inſide of the *cuboid*; the *cuneiforme medium* is between the *external* and *internal cuneiform* bones; and the *internal cuneiform* is put at the internal ſide of the foot.

That the deſcription of theſe bones may not be immoderately ſwelled with repetition, I deſire, once for all, to obſerve, That wherever a ridge is mentioned, without a particular uſe aſſigned, a ligament is underſtood to be fixed to it; or where a ſpongy rough cavity, depreſſion, or *foſſa*, is remarked, without naming its uſe, a ligament is inſerted, and mucilaginous glands are lodged: for ſuch will occur in the detail of each of theſe bones.

The upper part of the *aſtragalus* (*a*) is formed into a large ſmooth head (*b*), which is ſlightly hollowed in the middle; and therefore reſembles a ſuperficial pulley, by which it is fitted to the lower end of the *tibia*.—The internal ſide of this head is flat and ſmooth, to play on the internal *malleolus*.—The external ſide has alſo ſuch a ſurface, but larger, for its articulation with the external *malleolus*.—Round the baſe of this head there is a rough *foſſa*; and, immediately before the head, as alſo below its internal ſmooth ſurface, we find a conſiderable rough cavity.

The lower ſurface of the *aſtragalus* is divided by an irregular deep rough *foſſa*; which at its internal end is narrow, but gradually widens as it ſtretches obliquely outwards and forwards.—The ſmooth ſurface, covered with cartilage, behind this *foſſa*, is large, oblong, extended in the ſame oblique ſituation with the *foſſa*, and concave for its conjunction with the *os calcis*.—The back-part of the edge of this cavity is produced into two ſharp-pointed rough proceſſes; between which is a depreſſion made by the tendon of the *flexor pollicis longus*.—The lower ſurface before the *foſſa* is convex, and compoſed of three diſtinct ſmooth planes. The long one behind, and the exterior or ſhorteſt, are articulated with the heel-

(*a*) Ἀστραγος talus, baliſtæ os, malleolus, chaib, quatrio, os teſſare, claviculæ, nuciforme.
(*b*) Τετραγωνος.

heel-bone; while the internal, which is the moſt convex of the three, reſts and moves upon a cartilaginous ligament, that is continued from the *calcaneum* to the *os ſcaphoides*. Without which ligament, the *aſtralagus* could not be ſuſtained, but would be preſſed out of its place by the great weight it ſupports, and the other bones of the *tarſus* would be ſeparated. Nor would a bone be fit here, becauſe it muſt have been thicker than could conveniently be allowed; otherwiſe it would break, and would not prove ſuch an eaſy bending baſe, to leſſen the ſhock which is given to the body in leaping, running, &c.

The fore-part of this bone is formed into a convex oblong ſmooth head, called by ſome its proceſs, which is received by the *os naviculare*. Round the root of this head, eſpecially on the upper ſurface, a rough *foſſa* may be remarked.

The *aſtragalus* is articulated above to the *tibia* and *fibula*; which together form one cavity. Though, in this articulation, the bones have prominencies and cavities ſo ſmall, as might allow motions in all directions; yet the flexion and extenſion are the moſt conſiderable, the other motions being confined by the *malleoli*, and by the ſtrong ligaments which go out from the points of theſe proceſſes to the *aſtragalus* and *os calcis*.—When the foot is bended, ſo far as it is commonly when we ſtand, no lateral or rotatory motion is allowed in this joint; for then the head of the *aſtragalus* is ſunk deep between the *malleoli*, and the ligaments are tenſe: but when the foot is extended, the *aſtragalus* can move a little to either ſide, and with a ſmall rotation. By this contrivance, the foot is firm, when the weight of the body is to be ſupported on it; and when a foot is raiſed, we are at liberty to direct it more exactly to the place we intend next to ſtep upon.—The *aſtragalus* is joined below to the *os calcis*, and before to the *os naviculare*, in the manner to be explained when theſe bones are deſcribed.

A conſiderable ſhare of this bone is oſſified in a new-born infant.

Calcaneum (*a*) is the largeſt bone of the ſeven.—Behind, it is formed into a large knob, commonly called the *heel*: the ſurface of which is rough behind, where the *tendo Achillis* is inſerted into it; and above, it is hollow and ſpongy: Farther forwards, on the upper ſurface of the *calcaneum*,

(*a*) Os calcis, πτερνα, calcar pedis.

calcaneum, there is an irregular oblong ſmooth convexity, adapted to the concavity at the back-part of the *aſtragalus*; and beyond this a narrow *foſſa* is ſeen, which divides it from two ſmall concave ſmooth ſurfaces, that are joined to the fore-part of the *aſtragalus*.—Behind the poſterior of theſe ſmooth ſurfaces, which is the largeſt, a ſmall ſinuoſity is made by the tendon of the *flexor digitorum longus*; at the fore-part of which a ſmall rough protuberance appears, that gives riſe to the *muſculus extenſor digitorum brevis*.

The external ſide of this bone is flat, with a ſuperficial *foſſa* running horizontally, in which the tendon of the *muſculus peronæus longus* is lodged.—The internal ſide of the heel-bone is hollowed, for lodging the origin of the *maſſa cornea Jac. Sylvii*, and for the ſafe paſſage of tendons, nerves, and arteries.—Under the ſide of the internal ſmooth concavity, a particular groove is made by the tendon of the *flexor pollicis longus*; and from the thin protuberance on this internal ſide, the cartilaginous ligament that ſupports the *aſtragalus*, goes out to the *os naviculare*; on which ligament, and on the edge of this bone to which it is fixed, the groove is formed for the tendon of the *flexor digitorum profundus*.

The lower ſurface of this bone is preſſed flat at the back-part, by the weight of our bodies; and immediately before this plane there are two tubercles, from the internal of which the *muſculus abductor pollicis*, *flexor digitorum ſublimis*, as alſo part of the *aponeuroſis plantaris*, and of the *abductor minimi digiti*, have their origin; and the other part of the *abductor minimi digiti* and *aponeuroſis plantaris* riſes from the external.—Before theſe protuberances this bone is concave, for lodging the flexor muſcles: and at its fore-part we may obſerve a rough depreſſion; from which, and a tubercle behind it, the ligament goes out that prevents this bone to be ſeparated from the *os cuboides*.

The fore-part of the *os calcis* is formed into an oblong pulley-like ſmooth ſurface, which is circular at its upper external end, but is pointed below. This ſmooth ſurface is fitted to the *os cuboides*.

Though the ſurfaces by which the *aſtragalus* and *os calcis* are articulated, ſeem fit enough for motion; yet the very ſtrong ligaments by which theſe bones are connected, prevent it, and render this principal part of our baſe, which reſts on the ground, to wit, the *os calcis*, firm.

A large ſhare of the heel-bone is oſſified at the ordinary time of birth; and the large knob appears afterwards in form of an *epiphyſe*.

Os naviculare (*a*) is ſomewhat circular.—It is formed into an oblong concavity behind, for receiving the anterior head of the *aſtragalus*.—On the upper ſurface there is a rough *foſſa*.—Below, the *os naviculare* is very unequal and rough; but hollow, for the ſafety of the muſcles.—On its inſide a large knob riſes out, from which the *abductor pollicis* takes in part its origin, the tendon of the *tibialis poſticus* is inſerted into it, and to it two remarkable ligaments are fixed: the firſt is the ſtrong one, formerly mentioned, which ſupports the *aſtragalus*; the ſecond is ſtretched from this bone obliquely croſs the foot, to the metatarſal bones of the middle toe, and of the toe next to the little one.—On the outſide of the *os naviculare* there is a ſemicircular ſmooth ſurface, where it is joined to the *os cuboides*.—The fore-part of this bone is all covered with cartilage, and is divided into three ſmooth planes, fitted to the three *oſſa cuneiformia*.

The *os naviculare* and *aſtragalus* are joined as a ball and ſocket; and the *naviculare* moves in all directions in turning the toes inwards, or in raiſing or depreſſing either ſide of the foot, though the motions are greatly reſtrained by the ligaments which connect this to the other bones of the *tarſus*.—A weakneſs of theſe ligaments cauſes ſometimes an unnatural turn of the fore-part of the foot inwards.

The *os naviculare* is wholly cartilaginous in a new-born infant.

Os CUBOIDES (*a*) is a very irregular cube.—Behind, it is formed into an oblong unequal concavity, adapted to the fore-part of the *os calcis*.—On its internal ſide, there is a ſmall ſemicircular ſmooth cavity, to join the *os naviculare*.—Immediately before which, an oblong ſmooth plane is made by the *os cuneiforme externum*.—Below this, the bone is hollow and rough. On the internal ſide of the lower ſurface, a round protuberance and *foſſa* are found, where the *muſculus adductor pollicis* has its origin. On the external ſide of this ſame ſurface, there is a round knob covered with cartilage; immediately before which, a ſmooth *foſſa* may be obſerved, in which the tendon of the *peronæus primus* runs obliquely croſs the foot; and on the knob, the thin flat cartilage proper to this muſcle plays; in place

(*a*) Σκαφοειδης, os cymbæ.

(*b*) Πολυμορφον, cubiforme, quadratum, grandinoſum, varium, teſſaræ, multiforme.

place of which ſometimes a bone is found.—More externally than the knob, a rough hollow is made, for the ſtrong ligaments ſtretched betwixt this bone and the *os calcis*.—Before, the ſurface of the *os cuboides* is flat, ſmooth, and ſlightly divided into two planes, for ſuſtaining the *os metatarſi* of the little toe, and of the toe next to it.

The form of the back-part of the *os cuboides*, and the ligaments connecting the joint there with the *os calcis*, both concur in allowing little motion in this part.

The oſſification of this bone is ſcarcely begun at the birth.

Os cuneiforme externum (*a*), if we regard its ſituation or *medium* by its bulk, is much of the ſhape of a wedge, being broad and flat above, with long ſides running obliquely downwards, and terminating in a ſharp edge.—The upper ſurface of this bone is an oblong ſquare.—The one behind is nearly a triangle, but not complete at the inferior angle, and is joined to the *os naviculare*.—The external ſide is an oblong ſquare, divided as it were by a diagonal: the upper half of it is ſmooth, for its conjunction with the *os cuboides:* the other is a ſcabrous hollow, and in its ſuperior anterior angle a ſmall ſmooth impreſſion is made by the *os metatarſi* of the toe next to the little one.—The internal ſide of this bone is alſo quadrangular, with the fore-part of its edge made flat and ſmooth by the *os metatarſi* of the toe next to the great one; and the back-part is alſo flat and ſmooth where the *os cuneiforme medium* is contiguous to it.——The fore-part of this bone is an oblong triangle, for ſuſtaining the *os metatarſi* of the middle toe.

Os cuneiforme medium, or *minimum*, is ſtill more exactly the ſhape of a wedge than the former.—Its upper part is ſquare:—its internal ſide has a flat ſmooth ſurface above and behind, for its conjunction with the following bone, with a ſmall rough *foſſa* below; and a conſiderable ſhare of it is rough and hollow.—The external ſide is ſmooth, and a little hollowed, where it is contiguous to the laſt deſcribed bone.——Behind, this bone is triangular, where it is articulated with the *os naviculare*; and it is alſo triangular at its fore-part, where it is contiguous to the *os metatarſi* of the toe next to the great one.

Os cuneiforme maximum, or *internum*, differs from the two former in its

(*a*) Chalcoideum externum.

ſituation. which is more oblique than theirs.—Beſides, its broad thick part is placed below, and the ſmall thin point is above and outwards; while its under broad ſurface is concave, for allowing a ſafe paſſage to the flexors of the great toe.——The ſurface of this *os cuneiforme* behind, where it is joined to the *os naviculare*, is hollow, ſmooth, and of a circular figure below, but pointed above.—The external ſide conſiſts of two ſmooth and flat ſurfaces, whoſe direction is nearly at right angles with each other. With the poſterior, that runs obliquely from below forwards and upwards, the *os cuneiforme minimum* is joined; and with the anterior, whoſe direction is longitudinal, the *os metatarſi* of the toe next to the great one is connected.——The fore-part of this bone is ſemilunar, but flat and ſmooth, for ſuſtaining the *os metatarſi* of the great toe.——The internal ſide is ſcabrous, with two remarkable tubercles below, from which the *muſculus abductor pollicis* riſes; and the *tibialis anticus* is inſerted into its upper part.

The three cuneiform bones are all ſo ſecured by ligaments, that very little motion is allowed in any of them; and they are cartilaginous in a *fœtus* of nine months.

Theſe ſeven bones of the *tarſus*, when joined, are convex above; and leave a concavity below, for lodging ſafely the ſeveral muſcles, tendons, veſſels, and nerves, that lie in the ſole of the foot.—In the recent ſubject, their upper and lower ſurfaces are covered with ſtrong ligaments, which adhere firmly to them: and all the bones are ſo tightly connected by theſe and the other ligaments, which are fixed to the rough ridges and *foſſæ*, mentioned in the preceding deſcription of the particular bones, that, notwithſtanding the many ſurfaces covered with cartilage, ſome of which are of the form of the very moveable articulations, no more motion is here allowed, than only to prevent too great a ſhock of the fabric of the body in walking, leaping, &c. by falling on too ſolid a baſe; which, if it was one continued bone, would likewiſe be much more liable to be broken; and in order to make our foot accommodate itſelf to the ſurfaces we tread on, by becoming more or leſs hollow, or by raiſing or depreſſing either ſide of it, as might be judged by what was ſaid of the particular bones.

Sprains

Sprains here occaſion, as in the wriſt, great pain and obſtinate tumours, which too often cauſe carious bones.

METATARSUS (*a*) is compoſed of five bones, which, in their general characters, agree with the metacarpal bones; but may be diſtinguiſhed from them by the following marks: 1. They are longer, thicker, and ſtronger. 2. Their anterior round ends are not ſo broad, and are leſs in proportion to their baſes. 3. Their bodies are ſharper above and flatter on their ſides, with their inferior ridge inclined more to the outſide. 4. The tubercles at the lower parts of the round head are larger.

The firſt or internal metatarſal bone is eaſily diſtinguiſhed from the reſt by its thickneſs.—The one next to it is the longeſt, and with its ſharp edge almoſt perpendicular.—The others are ſhorter and more oblique, as their ſituation is more external. Which general remarks, with the deſcription I am now to give of each, may teach us to diſtinguiſh them from each other.

Os metatarſi pollicis is by far the thickeſt and ſtrongeſt, as having much the greateſt weight to ſuſtain. Its baſe is oblong, irregularly concave, and of a ſemilunar figure, to be adapted to the *os cuneiforme maximum*.—The inferior edge of this baſe is a little prominent and rough, where the tendon of the *peronæus primus* muſcle is inſerted.—On its outſide an oblique circular depreſſion is made by the ſecond metatarſal bone.—Its round head has generally on its fore-part a middle ridge, and two oblong cavities, for the *oſſa ſeſamoidea*; and on the external ſide a depreſſion is made by the following bone.

Os metatarſi of the ſecond toe, is the longeſt of the five, with a triangular baſe ſupported by the *os cuneiforme medium*, and the external ſide produced into a proceſs; the end of which is an oblique ſmooth plane, joined to the *os cuneiforme externum*.——Near the internal edge of the baſe, this bone has two ſmall depreſſions made by the *os cuneiforme maximum*, between which is a rough cavity.—Farther forwards we may obſerve a ſmooth protuberance, which is joined to the foregoing bone.—On the outſide of the baſe are two oblong ſmooth ſurfaces, for its articulation with the following bone; the ſuperior ſmooth ſurface being extended longi-

(*a*) Ταρσος, πεδιον, planta, planum, veſtigium, ſolium, pectus, præcordium, pectuſculum.

longitudinally, and the inferior perpendicularly; between which there is a rough *foſſa*.

Os metatarſi of the middle toe, is the ſecond in length.—Its baſe, ſupported by the *os cuneiforme externum*, is triangular, but ſlanting outwards, where it ends in a ſharp-pointed little proceſs; and the angle below is not compleated.

The internal ſide of this baſe is adapted to the preceding bone; and the external ſide has alſo two ſmooth ſurfaces covered with cartilage, but of a different figure; for the upper one is concave, and, being round behind, turns ſmaller as it advances forwards; and the lower ſurface is little, ſmooth, convex, and very near the edge of the baſe.

Os metatarſi of the fourth toe, is near as long as the former, with a triangular ſlanting baſe joined to the *os cuboides*, and made round at its external angle, having one hollow ſmooth ſurface on the outſide, where it is preſſed upon by the following bone, and two on the internal ſide, correſponding to the former bone; behind which is a long narrow ſurface impreſſed by the *os cuneiforme externum*.

Os metatarſi of the little toe, is the ſhorteſt, ſituated with its too flat ſides above and below, and with the ridges laterally.—The baſe of it, part of which reſts on the *os cuboides*, is very large, tuberous, and produced into a long pointed proceſs externally, where part of the *abductor minimi digiti* is fixed; and into its upper part the *peronæus ſecundus* is inſerted.—Its inſide has a flat conoidal ſurface, where it is contiguous to the preceding bone.

When we ſtand, the fore-ends of theſe metatarſal bones, and the *os calcis*, are our only ſupporters; and therefore it is neceſſary they ſhould be ſtrong, and ſhould have a confined motion.

The bones of the TOES are much a-kin to thoſe of the thumb and fingers; particularly the two of the great toe are preciſely formed as the two laſt of the thumb: only their poſition, in reſpect of the other toes, is not oblique; and they are proportionally much ſtronger, becauſe they are ſubjected to a greater force; for they ſuſtain the force with which our bodies are puſhed forwards by the foot behind at every ſtep we make, and on them principally the weight of the body is ſupported when we are raiſed on our tiptoes.

The

The three bones in each of the other four toes, compared to thoſe of the fingers, differ from them in theſe particulars.—They are leſs, and ſmaller in proportion to their lengths:—Their baſes are much larger than their anterior ends: Their bodies are more narrow above and below, and flatter on the ſides.—The firſt *phalanx* is proportionally much longer than the bones of the ſecond and third, which are very ſhort.

Of the four, the toe next to the great one, has the largeſt bones in all dimenſions, and more externally the toes are leſs. The little toe, and frequently that next to it, have the ſecond and third bones intimately united into one; which may be owing to their little motion, and the great preſſure they are ſubjected to.

The toes are of good uſe to us in walking; for, when the ſole is raiſed, they bring our body, with its centre of gravity, perpendicular to the advanced foot.

The bones of the *metatarſus* and toes, are in the ſame condition in children as thoſe of the *metacarpus* and fingers.

The only bones now remaining to complete the deſcription of the ſkeleton, are the ſmall ones, which are found at the joints of the fingers and toes, and in ſome other parts, called

OSSA SESAMOIDEA, which are of very different figures and ſizes though they are generally ſaid to reſemble the ſeed of the *ſeſamum*.—They ſeem to me nothing elſe than the ligaments of the articulations or the firm tendons of ſtrong muſcles, or both, become bony, by the compreſſion which they ſuffer. Thus the *ſeſamoid* bones at the beginning of the *gaſtrocnemii* muſcles, are evidently compoſed of the tendinous fibres only.—Theſe, at the firſt joint of the great toe, are as plainly the ſame continued ſubſtance with the ligaments and the tendons of the *adductor*, *flexor*, *brevis*, and *abductor*.—That which is ſometiemes double at the ſecond joint of that toe, is part of the capſular ligament; and if we may enumerate the other *ſeſamoid* bones that are at any time found, we obſerve all of them formed in this manner.—Their number, figure, ſituation, and magnitude, are ſo uncertain, that it were in vain to inſiſt on the differences of each; and therefore I ſhall only in general remark,

1. That wherever the tendons and ligaments are firmeſt, the actions of

of the muſcles ſtrongeſt, and the compreſſion greateſt, there ſuch bones are moſt commonly found.

2. That, *cæteris paribus*, the older the ſubject is in which they are ſought, their number is greater, and their ſize is larger.

3. The more labour any perſon is inured to, he has, *cæteris paribus*, the moſt numerous and largeſt *oſſa ſeſamoidea*.

However, as the two at the firſt joint of the great toe are much larger than any other, are early formed, and are ſeldom wanting in an adult, we may judge, that, beſides the more forcible cauſe of their formation, there ſhould alſo be ſome particular advantage neceſſary at this place, rather than elſewhere, which may poſſibly be, to allow the *flexor* muſcles to ſend their tendons along this joint, ſecure from compreſſion in the hollow between the two oblong ſeſamoid bones; while, by removing theſe tendons from the centre of motion, and giving them the advantage of an angle at their inſertion, the force of the muſcles is increaſed, and therefore the great ſuperincumbent weight of our body in progreſſion is more eaſily raiſed.

APPEN-

APPENDIX.

Of the MARKS of a FEMALE SKELETON.

TO finiſh the deſcription of the bones, is generally to conclude the *oſteology*: but, that no part of the ſubject may be left untouched, I think it neceſſary to ſubjoin the diſtinguiſhing marks of the male and female ſkeletons; and have choſen to illuſtrate them principally in the latter; becauſe women having a more delicate conſtitution, and affording lodging and nouriſhment to their tender *fœtuſes* till they have ſufficient ſtrength and firmneſs to bear the injuries of the atmoſphere and contact of other more ſolid ſubſtances, their bones are frequently incomplete, and always of a make in ſome parts of the body different from thoſe of the robuſt male; which agree to the deſcription already given, unleſs where the proper ſpecialities of the female were particularly remarked; which could not be doue in all places where they occur, without perplexing the order of this treatiſe: Therefore I choſe rather to ſum them up here by way of *appendix*.

The cauſes of the following ſpecialities of the female bones may be reduced to theſe three: 1. A weak lax conſtitution. 2. A ſedentary unactive life, increaſing that conſtitution. 3. A proper frame for being mothers.

The bones of women are ſmaller in proportion to their length than thoſe of men; becauſe the force of their muſcles is not ſo great, nor is ſuch ſtrong external force applied to them to prevent their ſtretching out in length.

The depreſſions, ridges, ſcabrous ſurfaces, and other inequalities made by the muſcles, are not ſo conſpicuous in them; becauſe their muſcles are neither ſo thick nor ſtrong, nor ſo much employed, to make ſo ſtrong prints on their bones.

Their *os frontis* is more frequently divided by a continuation of the

ſagittal ſuture, which depends on the firſt and ſecond general cauſes aſſigned above for the ſpecialities in their bones, as will appear after reflecting on the account given formerly of the middle internal ſpine of this bone.

Their *clavicles* are leſs crooked; becauſe their arms have been leſs forcibly pulled forwards, which, in our *European* women, eſpecially thoſe of diſtinction, is more hindered by their garb.

Their *ſternum* is more raiſed by long cartilages below, that the *thorax* might be there widened in ſome proportion to what it is ſhortened by the preſſure upon the *diaphragm* when they are with child.

The defect of bone, or the hole in the middle of the *ſternum*, is oftenеſt found in them; to allow the paſſage of the mammary veſſels, ſay ſome. But, in my opinion, this is owing to a lax conſtitution, by which the oſſification is not ſo ſoon completed as in men, where the action of the ſolids is vigorous, and the circulation of the fluids is briſk: for a much ſmaller hole might have ſerved this purpoſe; and the branches of the internal mammary veſſels which are ſent to the external parts of the *thorax*, do not paſs here, but between the cartilages of the ribs, before theſe are joined to the *ſternum*.

The *cartilago xiphoides*, is oftener bifurcated in women than in men, for the reaſon aſſigned in the preceding paragraph, viz. a leſs forcible power of oſſification.

The ſuperior cartilages of the ribs ſooner oſſify, to ſupport the weight of the *mammæ*.

The middle cartilages are more flat and broad by the weight of the breaſts.

The inferior cartilages are longer, for enlarging the cheſt.

Weak women, who have born many children when young, often have the *vertebræ* of their back bended forwards, and their *ſternum* depreſſed, or become round-ſhouldered and flat-breaſted (*a*) by the preſſure and weight of the impregnated *uterus*, and by the ſtrong action of the abdominal muſcles.

The *os ſacrum* is broader, and turned much more backwards, for enlarging the *pelvis*.

The

(*a*) Cheſelden's Anatomy, book 1. chap. 3.

The *os coccygis* is more moveable, and much leſs bended forwards, to facilitate the birth.

The *oſſa ilium* are more hollow, and more reflected outwards, and conſequently further removed from each other, in order to widen the lower part of the *abdomen*, and for the better ſupport of the impregnated *uterus*.

The ridge on the upper part of the *os pubis* is larger in ſuch women as have born children, being extended by the ſtrong action of the *muſculi recti abdominis*.

The cartilage between the two *oſſa pubis*, eſpecially in women who have born children, is thicker than in men, by which the *pelvis* is more capacious in females.

The conjoined furfaces of the *oſſa pubis*, and of the *oſſa innominata* and *ſacrum*, are leſs; the angle under the *ſymphyſis* of the *oſſa pubis* is much larger; and the arches formed below and behind by the *oſſa ilium* and *iſchium* are wider; which, with the ſtraighter *os ſacrum*, and more diſtant *tubera iſchii*, leave a larger paſſage for the excluſion of the child in birth.

The great tuberoſity of the *oſſa iſchium*, is flatter in women than in men, becauſe it is more preſſed upon in the ſedentary life which females enjoy.

In conſequence of the *pelvis* of women being wider, the articulations of their thigh-bones muſt be farther removed from each other; and therefore a larger ſpace is left for the procreation and birth of children (*a*): which diſtance of the thighs, may be one reaſon why women in running generally ſhuffle more from one ſide to the other than men, to preſerve the centre of gravity of their bodies from falling too far to a ſide of the joint of the thigh that ſupports them when the other is raiſed, which would endanger their tumbling to the ground.

(*a*) Albin. de Oſſib. § 339.

N° 4.

DESCRIPTION

OF A

SKULL uncommon for the Number and Size of the Ossa Triquetra.

IT is my buſineſs, in teaching, to ſhow the young gentlemen, my pupils, not only the ſtructure which generally obtains, but likewiſe as many of the uſeful *luſus naturæ* as I can. By uſeful, I mean all ſuch as can aſſiſt them in explaining the animal-œconomy and diſeaſes, or can prevent their committing miſtakes in practice. Among theſe deviations from the ordinary ſtructure, I reckon the *oſſa triquetra*, which are ſometimes ſeen in the ſeveral ſutures of the cranium, but more frequently in the lambdoid than in any other; for, without being acquainted with them, one may judge a ſlight wound of a perſon who had ſuch bones, to be a violent fracture of theſkull.

Among the different ſkulls in my poſſeſſion, there is one which has theſe bones more remarkable than any I have ſeen.

Fig. 3. of Plate I. repreſents the poſterior view of the cranium, where the ſeveral pricked lines from AA terminate in *oſſa triquetra*, placed in the upper part of the lamboid ſuture. BB are the holes of the parietal bones, much larger than in moſt ſkulls.

On the ſame Plate,

Fig. 4. is the vomer of a young child, in nearly the natural ſituation; *a* is the lower part, which reſts on the palate-plates of the palate and maxillary bones; *b* the poſterior edge between the back-part of the palate

late and the baſe of the ſkull; *c* the wide hollow for receiving the thick ſpongy *proceſſus azygos* of the *os ſphenoides*; *d*, *e*, the ſerrated ſuperior edges receiving the cartilaginous *naſal plate* of the *os ethmoides*: From *e*, to the point *f*, this plate is cartilaginous even in adults.

Fig. 5. is another view of the ſame vomer, where the ſame letters point to the ſame things; only the inferior ſide *a* is put uppermoſt, and brought in view to ſhow the little riſing in its middle *z*, which enters between the palate-plates, while the ſides are depreſſed.

REMARKS

N° 5.

REMARKS

ON THE

Articulation, Muſcles, and Luxation, of the LOWER JAW.

IT is now near two centuries ſince anatomiſts have been univerſally acquainted with all the principal parts belonging to the lower jaw: They have known, that the condyles are covered with a ſmooth cartilage; that the jaw moves on theſe proceſſes, which are received into a cavity of each temporal bone, immediately behind the root of the zygomatic proceſs: And ſome have ſaid, that the condyle of each ſide moves on the root of the zygoma. Nor have they been ignorant of the oblong moveable cartilage, which is concave in the middle on both ſides, and is interpoſed between each condyle and the temporal bone with which it is articulated, nor of the ligament that connects the parts of this articulation. They have likewiſe deſcribed eight muſcles that ſerve to raiſe the lower jaw, and all the other muſcles which are ſo fixed to this bone as to be capable of pulling it down.

Though this account ſeems to comprehend all the parts that deſerve to enter into a deſcription; yet I imagine the mechaniſm of theſe parts is not hitherto ſufficiently explained, authors having either overlooked ſome neceſſary circumſtances of the ſtructure, or obſerving too negligently the actions and motions performed here, and miſtaking the proper organs of them: I therefore ſubmit to your jugments to determine, whether the following remarks on the articulation and motion of the condyles, and on the actions of ſome of the muſcles of the lower jaw, with a ſhort obſerva-

tion

tion or two on the luxation of that bone, and the manner of reducing it, deſerve a place in your Collection *.

Each condyle of the lower jaw is not articulated only with the cavity behind the zygoma, or only with the root of that proceſs; but both the anterior part of the cavity, and the poſterior part of the tubercle at the root of the zygoma, are covered with ſmooth cartilage for the jaw to move on; and the ligament of this joint is fixed into the circumference of theſe two ſurfaces. The ſhare of the cavity covered with cartilage is ſmall, but the ligament generally is ſpread over, and looſely connected by cellular membranes to a larger ſhare of it backwards; and the large part, which ſtill remains behind this, is filled externally with the parotid gland, which I have ſeen frequently reſemble, at this place, the glands commonly called *conglobate*, in its firmneſs and ſmoothneſs; but never could ſeparate this part from the reſt of the gland without violence. In the remaining ſhare of the cavity, immediately before the ſtyloid proceſs, a fat cellular ſubſtance is lodged.

The exterior extremity of this oblong poſterior cavity is made very narrow by the *meatus auditorius externus* being conſiderably advanced forwards here; which again prevents the condyle ever to be puſhed ſo far back, as to be in hazard of doing any injury to the gland ſituated in the more internal part of the cavity.

The ligament which riſes from the circumference of the ſmooth ſurface of the temporal bone, is conſiderably long and wide, and is inſerted into the edge of the concave moveable cartilage; from which edge another ligament goes out to ſurround the condyle of the jaw, and to be inſerted into the neck of that bone. This laſt ligament is more tightly connected to the cartilage and bone than the former.

Each condyle of the jaw-bone ſtands with its greateſt length tranſverſely, but with a ſmall degree of obliquity, the external extremity being a little farther advanced forwards than the other. It is alſo worth while to obſerve, that the convexity of this proceſs is not perpendicular to the neck of the bone, but is almoſt turned entirely forwards, where it is covered with cartilage for the articulation; while the neck and poſterior ſurface

* The Edinburgh Medical Eſſays; where this Paper was originally inſerted.

ſurface of the condyle appear in one ſtraight flat ſurface, with very little cartilage covering the upper part of it.

Into the anterior edge of the moveable cartilage interpoſed between each condyle and temporal bone, a conſiderable ſhare of the external pterygoid muſcle is ſtrongly inſerted, and ſome few fibres of the temporal and maſſeter muſcles are alſo fixed to the external and ſuperior part of this cartilage. Dr Douglas (*a*) is the only author I know who has ſo much as hinted this inſertion of theſe muſcles.

For better underſtanding the preceding deſcriptions, the parts deſcribed, in their natural ſituation and magnitude, are repreſented on Plate II. fig. 1.

When the teeth of both jaws are oppoſite, each to thoſe of the ſame claſs, the condyles of the lower jaw are, in moſt men, placed in the cavity of each temporal bone; but as ſoon as the teeth of the lower jaw are advanced forward beyond the range of the ſuperior, the condyles deſcend on the tubercles. This any one can be ſenſible of in himſelf, by laying his fingers on the angles of his own jaw while he performs theſe motions; and it is obvious to the ſight when the articulation is laid bare by diſſection, and the bone is moved in the manner mentioned.

The condyles can be moved laterally when they are lodged in the cavities or on the tubercles; but theſe lateral motions are much more confined in the cavities, becauſe of the ſurrounding brims. Theſe facts are to be examined in the ſame way as the former.

The lateral motions, and thoſe backwards and forwards, of the lower jaw, being exceedingly neceſſary for us in chewing, this mechaniſm of a double ſort of articulation in a cavity, and on a protuberance, anſwers the deſign much more effectually than any one uniform ſurface could have done, whether we ſuppoſe it plain, convex, or concave; for in any of theſe, the motion neither could have been ſo gradual nor ſo ſteady, and at the ſame time ſo free and large. But without the interpoſition of a double concave cartilage, the motion of the condyle on the tubercle would have been vacillating, and often dangerous, ſeeing the two convexities could only touch each other in one ſtraight line; and therefore the condyle would have ſlid off, either back to the cavity again, or for-

(*a*) Myograph. chap. 20. and Append. p. 8.

ward to occaſion a luxation: whereas the cartilage, when placed on the tubercle, renders the ſurface on which the condyle is to reſt really concave, and exactly fitted to the convexity of that proceſs. If, however, this cartilage were to remain always in the ſame ſituation in reſpect of the condyle, it would be unneceſſary, if not inconvenient, when this proceſs is lodged in the cavity: therefore the cartilage is never preſſed farther back than the poſterior ſurface of the tubercle, and there it receives the anterior convex ſurface of the condyle: but while the cartilage is on the lower part of the tubercle, only the ſuperior ſtraight part of the condyle is joined to it. This is evident on performing theſe motions, after the joint is laid bare, and part of the ligament which goes between the condyle and the moveable cartilage is cut.

The ſurface of both condyle and cartilage is ſo ſlippery, the anterior edge of the cartilage is ſo little prominent, and the anterior part of the ligament connecting the two is ſo looſe, that the preſſure of the condyle on the cartilage would not be ſufficient to bring the cartilage as quickly forward as the condyle; which, however, I have endeavoured to prove is neceſſary: to prevent, therefore, the inconveniencies that might ariſe from the condyle's being immediately contiguous to the tubercle, ſome of the muſcles which ſerve to move the condyle forwards are alſo inſerted into the cartilage, and will equally advance both; and as the *external pterygoid* muſcle has the moſt direct action this way, and indeed the largeſt ſhare in performing this motion, it has the greateſt number of fibres inſerted into the edge of the cartilage.

If the mouth were opened while the condyle ſtands on the tubercle, the flat back-part of the condyle would be applied to the cartilage; the anterior prominence of which would conſequently have little effect in preventing the condyle to ſlip forward: So that, if the leaſt force was employed at the ſame time to pull or puſh the jaw forward, a diſlocation would inevitably happen. To prevent which, the muſcles that open the mouth are ſo ſituated, that when they act, they muſt alſo pull the jaw backward: Hence when one attempts to open his mouth, while the under teeth are advanced beyond the upper, he immediately is ſenſible of the jaw's ſliding back; and no diſlocation does happen, without an external force applied, unleſs when the raiſers of the jaw, by a convulſive contraction,

traction, as in yawning or violent vomiting, do forcibly keep the jaw forwards, in the time that the depreſſors are acting.

All the forces ſaid to be employed to bring the lower jaw down in opening of the mouth, are the weight of the jaw itſelf, the action of the *platyſma myoides*, and of the digaſtric muſcles; but as the two firſt are commonly allowed to be of little account, authors generally mention the digaſtric muſcles to be the ſole antagoniſts to the eight muſcles that raiſe the jaw: which I have long ſuſpected to have been aſſumed without ſufficient examination, there being ſome obvious appearances that would ſeem to infer an incapacity in theſe digaſtric muſcles, to open the mouth ſo wide, and with ſuch force, as we really ſee it is; ſuch as,

1. The fleſhy bellies of the digaſtric muſcles would appear too ſhort for performing ſuch a large contraction as is often required, whether we allow, according to the common way of reckoning, each fleſhy fibre to contract one third of its length; and ſtill leſs, if, with Bernouilli (*a*), we reſtrict ſuch contraction to one third of the length of the fibre.

2. The proportional force of the digaſtrics to that of the levators of the jaw, is conſiderably leſs than what is commonly obſerved in other parts of the body, where antagoniſt muſcles are; which proportional force of theſe muſcles is, on ſome occaſions, greatly leſſened by the angle of inſertion of theſe digaſtric muſcles into the jaw, decreaſing as the mouth is opened.

Theſe ſuſpicions made me to inquire more exactly into the ſtructure of the parts; and to try ſome experiments, which ſeem all to contradict the common opinion. For,

3. There is no pulley the leaſt a-kin to that of the larger oblique muſcle of the eye, through which the tendon of each digaſtric muſcle paſſes: but what is commonly called the ligament connecting the tendon of the digaſtrics to the *os hyoides*, is nothing elſe than part of the proper tendinous fibres of the digaſtric muſcle, ſent off from the reſt in form of an aponeuroſis (*b*), which is faſtened to the *os hyoides*, and is in part ſpread over the inferior extremity of the mylo-hyoideus muſcle, to be united to ſuch another aponeuroſis of the other ſide; and the connexion of this aponeuroſis, as it comes off from the round tendon, is ſo firm,

(*a*) Act. Petropolit. tom. i.

(*b*) See Cowper's Myot. Tab. xxiii.

that the leaſt ſhuffling or motion of the round tendon within this ligamentous ſheath, as it is commonly called, is not allowed: But this aponeuroſis being of ſome length, it can yield a little backward or forward, when one or t'other of the fleſhy bellies of the digaſtric muſcle is ſhortened. Since, then, there is no ſheath in which the middle tendon can ſlide, but that, on the contrary, it is connected to the *os hyoides*, we may ſee the unfitneſs of the poſterior heads of the two digaſtric muſcles for pulling the jaw down.

4. That we may have ocular conviction of the poſterior belly of the digaſtric having no effect on the lower jaw, let it be laid bare in a dead body, whoſe head muſt be reclined back for this purpoſe, and then pull this muſcle in the direction of its fibres, while the *os hyoides* is kept firm, or a little brought down, (which this bone evidently is when the mouth is opened), the jaw will not in the leaſt be moved. If the *os hyoides* is left unfixed while the muſcle is pulled, that bone is brought upwards, till the two heads of the digaſtric are brought to form a ſtraight line; after which, indeed, the force applied to the poſterior belly of the muſcle begins to depreſs the jaw. But as the firſt caſe of the *os hyoides* being kept firm, is the only ſuppoſition to be allowed in the preſent queſtion, I preſume this concluſion, from the foregoing obſervations, will ſcarce be refuſed: That the common account of the action of the digaſtric muſcles is not altogether ſo unexceptionable as it has hitherto paſſed for.

Having undone the mechaniſm of a pulley, through which the middle tendon of each digaſtric is ſaid to paſs; and having excluded the poſterior head of that muſcle from its office of pulling the jaw-bone down; I am almoſt induced to think, that, in the ordinary depreſſions of the lower-jaw, the anterior bellies of the digaſtric muſcles are as little employed as the poſterior. For,

5. When the two extremities of this anterior head are pulled towards the middle, by the help of a thread paſſed through the firm tendinous part near each extremity, the ends of which are croſſed, and equally drawn in the direction of the fibres, which is the faireſt way of knowing the action of any muſcle, both whoſe extremities are moveable; when, I ſay, the anterior head of the digaſtric muſcle is pulled in this manner, we obſerve the tendinous aponeuroſis yield near as much forwards as one

would

would expect the natural contraction of this fleſhy belly would require. When the aponeuroſis is fully ſtretched, the *os hyoides* is brought upwards, and then the jaw-bone is pulled down. If the *os hyoides* is kept firm, while this muſcle is thus drawn, its effects on the lower jaw will be greater and more obſervable: and if the poſterior head is alſo pulled at the ſame time, the whole effort of the force wherewith the anterior belly is drawn, is employed in opening the mouth. From which it would appear, that, in order to apply the power of this anterior muſcular head to the jaw-bone, it is neceſſary to ſuppoſe the poſterior belly to act at the ſame time with it, that the aponeuroſis may be kept ſtretched; which is all the ſervice this poſterior head does: and in performing this, it muſt exert a force equal to the contraction of the anterior belly; and that force muſt be employed in the direction of its muſcular fibres on the *os hyoides*, and therefore muſt counteract the muſcles which pull the *os hyoides* down: but I ſhall afterwards prove, that the action of theſe laſt muſcles is conſtant and neceſſary in opening of the mouth; conſequently the jaw gains nothing on this ſuppoſition of the anterior belly of the digaſtric aſſiſting the depreſſion of it, ſince an equal power is loſt by the action of the poſterior head. From all which there is at leaſt a ſeeming improbability of any part of the digaſtric muſcle acting in the depreſſion of the jaw, when nothing is to be gained by it.

6. To confirm what has been argued for in the preceding paragraph, let any one whoſe *tunica celluloſa* is not too well filled, apply his fingers to the teguments that cover the anterior heads of the digaſtric muſcles, while the mouth is opened ever ſo wide, quickly, or ſtrongly, he will indeed feel theſe muſcles protruded a little outwards, by the ſwelling of thoſe above them; but will not be ſenſible of their becoming either harder or ſhorter; which, however, is plainly to be felt at this ſame time in much thinner muſcles, the ſterno-hyoidei and ſterno-thyroidei, by placing another finger on the fore-part of the *trachea arteria*; and is manifeſt in theſe ſame anterior heads of the digaſtrics, when deglutition is performed.

The office I would aſſign to the digaſtric muſcles is to be principal inſtruments in the compound action of deglutition; one part of which they are exceedingly well adapted to perform, which is to pull the *os hyoides* upwards,

upwards, and thereby to preſs the root of the tongue, &c. to the *velum pendulum palati*; for which purpoſe, the only organs commonly mentioned, the *ſtylo-hyoidei*, *ſtylo-gloſſi*, and perhaps the *ſtylo-pharyngei*, muſcles are too weak, conſidering the reſiſtance they muſt meet with in raiſing ſo many parts, viz. the tongue, *os hyoides*, *larynx*, &c. whoſe muſcles are to be ſtretched far beyond their natural tone. The fitneſs of theſe digaſtrics for ſuch an office, is pretty evident from a view of theſe muſcles in their natural ſituation, and only applying the univerſally acknowledged effort of all muſcles, to bring themſelves in their contractions from a crooked to a ſtraight ſtate. For further evidence, let both heads of either one or both digaſtric muſcles be pulled in the manner formerly mentioned, and the raiſing of the *os hyoides* will be ſeen: or, what may perhaps be as convincing, let any one ſwallow either ſolids or fluids, while his fingers are applied below his chin, and he will feel the ſwelling, hardneſs, and ſhortening of theſe muſcles then in action.

Mr George Lauder, ſurgeon in this place, having diſſected away a tumour covering one of the digaſtric muſcles, cauſed the patient to drink while the muſcle was laid bare; when he, and a numerous crowd of ſtudents in medicine, ſaw the muſcle perform its contractions violently every time that the patient ſwallowed the liquor: unluckily, he neglected to deſire him to open his mouth wide and quickly.

This being granted to be the proper action of the two digaſtrics, we may readily aſſign ſeveral reaſons why one can ſcarce ſwallow any with his mouth open. Firſt, The lower jaw being then unſtable and moving, theſe muſcles have not ſuch a fixed point to reſiſt their actions. Next, The jaw and *os hyoides* being brought nearer, the curve made by the tendon of each digaſtric muſcle muſt be diminiſhed; conſequently the effect the muſcle would have on the *os hyoides* is alſo leſſened; whereas it ought rather to have been increaſed, beeauſe the ſpace between the *velum pendulum palati* and the *os hyoides* is increaſed, by this bone's being brought down at this time. Laſtly, The muſcles which ſerve to draw down the *os hyoides* being now in contraction, they muſt prevent the action of the digaſtrici.

We may here alſo obſerve how advantageouſly the tendinous aponeuroſes of the digaſtric muſcles are ſtretched over the mylo-hyoidei muſcles,

for

for raiſing the root of the tongue along with the *os hyoides*; and how the ſtylo-hyoidei and digaſtric muſcles may act more uniformly and in more convenient direction, by the tendons of the latter paſſing through the ſubſtance of the former.

I come now to ſupply the function which I have endeavoured to deprive the digaſtric muſcles of; but muſt previouſly remark, that the opening of the mouth does not only depend on the motion of the lower jaw downwards, but alſo on the ſuperior jaw being raiſed up by the muſcles which extend the head back. This fact is ſtrongly denied by the generality of anatomiſts; and really paſſed unobſerved by me, till my ingenious friend, and *quondam* pupil, Dr John Pringle, made me remark it: and any one may convince himſelf of the truth of it, by putting the blade of a knife, or his own nail, oppoſite to the conjoined edges of the teeth when the mouth is ſhut; which knife being held unmoved while the mouth is opened, he may, by the help of a mirror, ſee the upper teeth raiſed remarkably at every aperture he performs. The larger ſhare, however, of the mouth's aperture is, in the ordinary erect poſition of the head, made by the lower jaw's being brought down by muſcles that are commonly appropriated to the tongue, *os hyoides*, and larynx; which are capable, in my opinion, of being applied not only to this uſe, but to ſome others that are generally overlooked.

In conſidering theſe muſcles in reſpect of the lower jaw, imagine the *ſterno-hyoidei* and *genio-hyoidei*, or the *coraco-hyoidei* and *mylo-hyoidei*, to act at the ſame time; it is evident, that the *ſternum* and *ſcapula* being fixed in compariſon of the jaw, theſe muſcles may be looked on as digaſtrics, whoſe middle interſection is the *os hyoides*, and whoſe moveable inſertion is the lower jaw. Imagine in the ſame manner the *ſterno-thyroidei*, *thyro-hyoidei*, *hyogloſſi*, and *geniogloſſi*, to act all together, they may be conſidered as two many-bellied muſcles acting on the lower jaw, which they will be ſufficient depreſſors of in length, ſtrength, and manner of inſertion, without ſtanding in need of aſſiſtance from any other muſcles. Beſides what might reaſonably be deduced from viewing theſe muſcles, and from pulling them in the direction of their fibres in a dead body, in proof of their being employed in depreſſing the jaw, we can be abundantly ſenſible

fible of moſt of them acting when the mouth is opened, by laying our fingers on the teguments that cover them.

Theſe muſcles do, by the jaw's deſcending, loſe ſomewhat of the advantageous inſertion which they have when the mouth is ſhut; for the *os hyoides* will deſcend ſo much leſs than the jaw-bone, as the contraction of the muſcles ſituated below the *os hyoides* is leſs than the joint contraction of theſe muſcles, and of the others that go from that bone to the jaw. To mention an example: Suppoſe the *ſterno-hyoidei* and *genio-hyoidei* only to act, the chin will be brought proportionally ſo much farther down than the *os hyoides* deſcends, as the quantity of contraction of both *ſterno-hyoidei* and *genio-hyoidei* is greater than the contraction of the *ſterno-hyoidei* alone; in conſequence, then, of the chin being brought nearer to the *os hyoides*, the muſcles between theſe two bones come to have a more oblique direction to the jaw, or to have their angles of inſertion diminiſhed, and their force in pulling the jaw down leſſened, on that account. One advantage, however, is hereby obtained, that the root of of the tongue, *larynx*, *&c.* are not removed too far out of their place; and that loſs of advantageous inſertion is compenſated another way: for, when the muſcles above and below the *os hyoides* are conſidered as digaſtrics, it is evident that this bone being placed farther back than the inſertion of the muſcles into the jaw, a conſiderable curve muſt be made at this bony interſection of theſe muſcles; and therefore, by becoming ſtraighter in their contraction, they muſt draw the *os hyoides* forward, by which this bone becomes more perpendicular to the jaw, and the muſcles obtain neceſſarily a more favourable direction. But, in all poſitions of the *os hyoides* in reſpect of the jaw, the obliquity of the muſcles backward is great enough to oblige the condyles of the lower jaw, when advanced on the tubercles, to ſlide back into the cavities in the time of their action; by which, as I hinted formerly, luxations are prevented.

This motion of the *os hyoides* forwards and downwards, which can be felt by laying a finger on this bone when the mouth is opened, leads us naturally to account for the uſe of the ligament which is ſent out from the ſtyloid proceſs of each temporal bone to be fixed to each appendix of the *os hyoides*: for its direction is exactly ſuch as prevents this bone from being drawn too far out of its place by the muſcles that open the mouth;

whereas

whereas it can be of little effect towards ſupporting the *os hyoides* and other parts connected to it, unleſs it had been more perpendicular. I imagine the reſiſtance which theſe ligaments make to the muſcles below the *os hyoides*, to be one reaſon why theſe muſcles do not bring the *os hyoides* ſo far down proportionally to their lengths, as the others above it ſeem to depreſs the jaw, in opening the mouth: Which action I found to be performed by the ſeveral parts concerned, in the following proportion; by ſtraining, I can open my mouth, when the head is in the moſt natural eaſy poſition, till the diſtance between my anterior *dentes inciſores* is $1\frac{1}{2}$ inch, to which the extenſor muſcles of the head contributed ſomewhat leſs than half an inch by raiſing the upper jaw, the *os hyoides* deſcended about as much more than half an inch as the upper jaw wanted of it, and conſequently the muſcles between the lower jaw and *os hyoides* contracted one third of the whole ſpace. I choſe this ſtraining poſture, becauſe any other degree of opening the mouth cannot well be determined: but I am at the ſame time ſenſible, that, where no ſuch violent contraction of muſcles is required, the proportional motions of theſe parts will be different from what I have juſt now deſcribed them; and, when the head is extended very far back, the lower jaw only is moved in opening the mouth, whereas this action is chiefly performed by raiſing the upper jaw when the head is bended much forward.

Suppoſing, then, the *mylo-hyoidei*, *genio-hyoidei*, *genio-gloſſi*, *hyo-gloſſi*, *ſterno-hyoidei*, *coraco-hyoidei*, *thyro-hyoidei* and *ſterno-thyroidei* muſcles always to be employed in drawing down the jaw conjunctly, (whereof however in ordinary occaſions ſome may be unactive), the force they are capable of exerting will be conſiderably leſs than that of the levators. From thence we may learn, how the whole parts being left to their natural action, the lower jaw may be ſupported and the mouth kept ſhut by the ſuperior power in the levators; whereas the depreſſors in their voluntary contraction (which is vaſtly greater in all muſcles than the natural) may be capable of overcoming the natural force of the levators. Hence alſo we may ſee the reaſon of the jaw's falling down by its own weight, when the natural contraction of all the muſcles is weakened by palſy, drunkenneſs, or ſleep; or how, on the contrary, the mouth is violently kept ſhut,

when the muſcles are preternaturally contracted, as in convulſions, inflammations, &c.

Theſe muſcles, which are ſo well adapted for depreſſing the lower jaw, are capable of performing very different functions when the lower jaw is kept firm by the muſcles which raiſe it. If they act at different times, the moſt remarkable of their actions will be theſe; the *genio-gloſſi*, *hyo-gloſſi*, *genio-hyoidei*, and *mylo-hyoides*, will pull the *os hyoides* and tongue upwards and forwards. If with theſe the thyro-hyoidei act, the larynx will alſo be brought along with the other parts; if with all yet mentioned the ſterno-hyoidei and coraco-hyoidei act, the larynx only will be brought nearer to the *os hyoides*. If the thyro-hyoidei alone act, the *os hyoides* and thyroid cartilage will approach each other proportionally to their mobility. If the ſterno-hyoidei and coraco-hyoidei act with the former, the *os hyoides* will deſcend to the cartilage. If to theſe the ſterno-thyroidei are joined, then the tongue, *os hyoides*, and larynx, will be brought down. All the other combined actions of theſe parts are eaſily deducible from thoſe mentioned. If theſe muſcles act all together, and the jaw is kept firm at the ſame time by its levators, they have an effect not ſo generally remarked; which is, the bending of the head forward, the articulations of the head and of the ſuperior vertebræ being the neareſt moveable joints: And, in this action, theſe muſcles muſt have very great advantage by the great diſtance of their inſertion from the centre of motion; or, in other words, by the length of the vectis they act with. As an evidence of the fact, let any one's head be pulled or puſhed violently backward, his jaws are preſſed ſtrongly together, and his throat is tenſe with his larynx advanced, while he ſtrains to reſiſt the force applied: This the painters ſeem to have been abundantly more ſenſible of than the anatomiſts.

The ſum of all I have argued for, concerning theſe muſcles, may be deduced in theſe few propoſitions.

The digaſtric muſcles ſerve to draw up the *os hyoides* and parts annexed to it in deglutition.

In opening the mouth, the head is extended, and the whole muſcles of any conſiderable length and bigneſs ſituated betwixt the ſternum and chin (except the digaſtrici) are put into action, the *os hyoides*, &c. are drawn

drawn down and advanced forward; if the jaw-bone was brought forward, it is made to ſlide back.

When the mouth is kept ſhut, or the jaw-bone is made firm by its levators in any degree of the aperture of the mouth, that range of muſcles juſt now mentioned may either contract ſucceſſively, and then they act as commonly deſcribed; unleſs that, by being variouſly combined, they may be differently determined to pull up one part, or to depreſs another: Or, if all the muſcles act together, they conſpire to bend the head forward.

When the condyles of the lower jaw are luxated, the mouth ſtands open, and cannot be ſhut. This Mr Petit (*a*) aſcribes to the direction of the fibres of the muſcles that raiſe this bone, being ſo altered in reſpect of the condyles, that theſe proceſſes come to be ſituated in a ſtraight line drawn from the origin to the inſertion of the muſcles; and therefore theſe muſcles can have no other effect than to preſs the condyles cloſer to the temporal bones. It is evident, however, that this cannot obtain in moſt of theſe muſcles; as, for inſtance, in the maſſeter and internal pterygoid: nay, the external pterygoid would ſeem to gain as much more in this morbid ſituation as the temporal loſe; and I have ſeen people labouring under a luxation of the lower jaw, whoſe mouth ſtood open to a certain degree, but they could ſtill open it farther, and bring it back again by the elevator muſcles of the jaw. The plain cauſe of the mouth's not ſhutting in the luxation is the ſlipping of the coronoid proceſſes under the anterior root of the zygoma, and their being preſſed on that bone: which is, I ſuppoſe, one reaſon why, after attempting the reduction of ſuch a luxation, by ſimply preſſing or ſtriking the fore-part of the jaw upwards; or, after applying any other force that preſſes the coronoid proceſſes violently upon the bones of the upper jaw; a tenſion and inflammation may be brought on the parts hereabouts, and particularly on the temporal muſcles; which afterwards may be followed by all the other ſymptoms of a pricked, bruiſed, or wounded tendon, taken notice of by Hippocrates; becauſe the tendon of the temporal muſcle of the luxated ſide muſt ſuffer theſe very injuries, by being intercepted betwixt the corone and the *os maxillare* or *maxillarum*.

(*a*) Maladies des Os, liv. 1. chap. 2.

This cauſe of the mouth's remaining open in a luxation which I have aſſigned, was the common reaſon given for it before Mr Petit, and is ſtrenuouſly defended by one of his critics (*a*) : therefore I needed not have mentioned it, if Mr Petit's book was not in the hands of a great many young ſtudents here, and the other known to few ; and I hope the other circumſtances added, which are at leaſt not ſo commonly remarked, will plead my excuſe.

I HAVE more than once found Mr Petit's method of reducing the luxated jaw-bone ineffectual, after the muſcles had been ſwelled by unartful attempts of reduction ; but have ſucceeded by a very ſmall improvement on that excellent method : which was, to wrap linen ſo thick round my two thumbs, that I could ſcarce introduce them betwixt the poſterior grinders ; then taking hold of the baſe of the jaw with my fingers, and applying my palms under the chin, I preſſed down and pulled forward the poſterior part of the jaw with my fingers and the points of my thumbs, which is the whole of Mr Petit's method ; and at the ſame time, I thruſt the anterior part of the jaw upwards with my palms, ſo that, the jaw being made uſe of as a lever to which the laſt joint of the thumbs ſerved as a prop, I acquired a conſiderable additional force, to which the muſcles were obliged to yield, and the condyles were diſengaged entirely from the zygoma, and brought down, after which they ſlide backwards with the leaſt aſſiſtance, and the reduction is fully made.

When the thumbs employed, as juſt now deſcribed, have not force enough to make the reduction, my friend Dr Simpſon, profeſſor of medicine at St Andrew's, makes uſe of a round piece of wood eight or nine inches long, one end of which is cut into the form of a wedge, to introduce it between the teeth of the luxated ſide, with the thinneſt part as far back as the poſterior grinders ; when, having the head ſecured, and raiſing the chin, he puſhes the other end of the wood upwards to depreſs the back part of the jaw with the thin end, by which the force is much greater than the thumbs can exert.

THE origin and courſe of the CHORDA TYMPANI being deſcribed by

(*a*) Diſſertation au ſujet des ouvrages de l'auteur du livre ſur les maladies des os.

by few authors, and ſcarce delineated by any in the natural poſition, and the figure eaſily admitting of the repreſentation of the inferior maxillary branch of the fifth pair of nerves, as it comes out of the ſkull, and divides into its branches, I have cauſed that nerve and the *chorda tympani* to be painted, which I ſhall ſay, with the generality of anatomiſts, proceeds or is ſent off from that nerve, though I rather incline to think it a branch of the *portio dura* of the ſeventh pair united to the fifth. The *chorda tympani* takes its origin moſt frequently from that branch of the fifth pair that is beſtowed on the tongue; but I have ſeen it ſometimes riſe from the trunk which furniſhes the branch given to the tongue, and the other that enters the poſterior hole of the lower jaw. The chorda immediately after its riſe runs backwards and outwards, involved in a cellular ſubſtance, till it ſinks within the bony part of the *tuba Euſtachiana*. The ſituation of the ſkull in drawing this figure would not allow me to delineate more of this chord, without deſtroying ſome parts that were chiefly deſigned to be illuſtrated here: wherefore I ſhall refer to *Tab.* xiii. and vii. of Du Verney's *Traitè de l'organe de l'ouie* for what remains of it; and ſeeing our common ſyſtems, nay the authors who have expreſsly treated of the nerves, paſs the deſcription of this nerve generally very ſlightly, I ſhall tranſlate Mr Du Verney's deſcription, which is the fulleſt and moſt exact I know.

" The little nerve (ſays he, page 51.) that croſſes the tympanum, has " its origin immediately from the branch of the fifth pair of nerves, " which deſcends to be diſtributed to the ſide of the tongue. This little " nerve aſcends to the exterior ſide of the bony part of the *tuba Euſta-* " *chiana;* and, following the courſe of the external (commonly called now " the oblique) muſcle of the malleus over which it lies, it enters by the " ſame aperture into the tympanum: then it paſſes under the tendon of " the internal muſcle, and, deſcending obliquely from before backwards, " it lies upon the membrane of the tympanum; and, paſſing before the " long leg of the incus, it at laſt eſcapes out of the cavity of the tympa- " num, to enter into a ſmall canal formed in the *os petroſum*, and is joined " to the *portio dura* of the auditory nerve, a little before the *portio dura* " makes its exit from its canal."

The only remark I have to make on this deſcription is, That I am at a loſs

loſs how to underſtand the words, *It lies upon the membrana tympani* (*a*); for it does not appear to be immediately contiguous to that membrane.

I have alſo cauſed the *Tubæ Euſtachianæ* to be repreſented in this figure, in full view, that one, by ſupplying in his imagination the *velum pendulum palati* and *uvula* depending obliquely from the edge of the palate-bones, or by conſulting Du Verney's *tab.* ix. *fig.* 2. may eaſily underſtand the true ſituation of the orifices of the tubæ, which ſome anatomiſts ſeem not to be entirely well acquainted with, though it is an anatomical fact neceſſary to be exactly underſtood; eſpecially if it ſhall be found, that the method of injecting medicines by this canal for curing deafneſs in ſeveral caſes ſhall prove ſucceſsful, which there is a great probability it ſhould, and of which Mr Guyot gives a good inſtance by relating his own cure (*b*). The inſtrument he made uſe of for injecting the medicines is deſcribed at great length by Mr Garengeot, in his treatiſe of *chirurgical inſtruments*.

By authors neglecting to explain the method they took to repreſent the parts delineated in their figures, diſengaged from all the others to which they are naturally contiguous and adherent in the body, I have often obſerved younger anatomiſts utterly at a loſs to ſearch out the parts, which they imagined they underſtood exactly the ſituation and ſtructure of, from the repreſentation authors had made of them. To prevent ſuch an inconvenience in the preſent caſe, I ſhall inform the reader how the bones appear ſo bare, and yet the ſofter parts which were deſigned to be repreſented are preſerved entire.

Mr Cowper, who both drew and engraved the following figure, not having been formerly in uſe to work upon anatomical ſubjects, I put a ſkull perfectly cleaned in the proper attitude, and let him draw it at his leiſure; then I cauſed him to ſupply the other parts painted from the firſt recent ſubject I had afterwards, whoſe ſkull was very near of the ſame dimenſions, having previouſly made the bones as bare as I could without boiling or macerating, and without injuring the ſoft parts deſigned to be illuſtrated; which method has had a good effect, by making the whole figure more ſimple and beautiful.

EXPLI-

(*a*) Il ſe couche ſur la peau de tambour. (*b*) Hiſt. de l'Acad. des Sciences. 1724.

EXPLICATION of PLATE II. Fig. 1.

A, The occipital bone.

B, The lamboid future.

C, The great hole of the occipital bone through which the *medulla ſpinalis* paſſes.

D D, The condyles of the *os occipitis*.

E E, The maſtoid proceſſes of the temporal bones.

F F, The ſtyloid proceſſes.

G G, The zygomatic proceſſes.

H H, The holes through which the lateral ſinuſes and eight pair of nerves paſs.

I I, The paſſages of the carotid arteries.

K K, The external wings of the pterygoid proceſſes of the ſphenoid bone.

L L. The internal alæ.

M M, The external ears.

N, The left temporal proceſs of the ſphenoid bone.

O, The back part of the vomer.

P P, The part of the parotid glands lodged in the back-part of the cavities which receive the condyles of the lower jaw.

Q Q, The *tubæ Euſtachianæ*.

a, The tubercle of the left temporal bone on which the condyle of the lower jaw moves when the maxilla is drawn forwards.

b, The cavity behind that tubercle wherein the condyle is commonly lodged. The ſurrounding ligaments hinder this cavity from being fully repreſented.

c, The ligament which connects the moveable cartilage to the temporal bone.

d, The moveable cartilage of the right ſide brought forwards on the tubercle that it might be fully ſeen.

e, The circular ligament which connects the cartilage to the condyle of the jaw.

f, That

f, That part of the external pterygoid muſcle which is inſerted into the moveable cartilage, and ſerves to pull it forwards.

gg, The third branch of the fifth pair of nerves coming out of the ſkull.

hh, The branches of that nerve given to the temporal and maſſeter muſcles.

ii, The *chorda tympani* ſent off from the branch of that nerve which is diſtributed to the tongue.

For the ſake of young anatomiſts, whoſe imagination might not be able to ſupply the want of figures to explain what is above written, thoſe on Plate I. are given: Where,

Fig. 6. is a copy of as much of Cowper's tab. xxiii. *Myotom.* as relates to the parts in queſtion, with the addition of two or three pricked lines; the view here repreſented being a direct one of the left ſide, with the head reclined towards the right, and the muſcles in an unactive ſtate.

A, Denotes the baſe of the lower jaw, to which the anterior head of the digaſtric muſcle is fixed.

B, the part of the temporal bone from which the other head of the digaſtric riſes.

C, The *os hyoides*.

D, The internal jugular vein filled with wax.

E, The anterior head of the digaſtric muſcle.

F, The poſterior fleſhy belly of the ſame muſcle.

G*g*, The middle tendon common to both theſe heads.

H, A ſtrong aponeuroſis ſent from that tendon to the *os hyoides*.

i, Part of that tendon raiſed into a convexity forwards, by the over-diſtended jugular vein.

K, The *ſtylo-hyoid* muſcle, through which the tendon of the digaſtric paſſes.

L, The extremity of the *ſtylo-hyoid* muſcle, that is fixed to the *os hyoides*.

Fig. 7. Repreſents the direct anterior view of the *ſtylo-hyoid* and digaſtric muſcles, with the *os hyoides*, when the head is drawn much back.

The letters common to this figure, with the former, denoting the ſame parts,

parts, a compariſon of the two figures will ſhew what the effect of the different attitudes is.

Beſides what is common to both, *q q* here point out the great curve of the round tendons to be at the ſame part where the ſtrong aponeuroſis H goes off to the *os hyoides*.

P is the thin aponeuroſis of the digaſtric muſcle, ſpread upon the mylo-hyoid muſcles.

You ſee, then, that Mr Cowper paints no ligamentous pulley here for the round tendon of the digaſtric muſcle to move in; nor has he any in tab. 31. *Myotom.* where the digaſtric is again repreſented: but in both he delineates the aponeuroſis fixed to the *os hyoides*, which he mentions in his deſcription, num. 68. as a conſtant thing, as I always find it. But he is obliged to acknowledge (notwithſtanding the fondneſs he expreſſes for being the firſt who ſhewed the mechaniſm by which the digaſtrics act on the lower jaw) that the tendon paſſes through the ſtylo-hyoideus, and an annular ligament, or ſometimes a membranous incloſure. I ſtill affirm, that I never ſaw any ligament, ſuch as ties down the muſcles of the hand, fingers, foot, toes, or any other muſcle, whoſe action is determined by a band, or ligament, to any direction different from the ſtraight courſe of its fleſhy fibres; and that what is called the annular ligament of the tendon of the digaſtric muſcle, is no other than the common cellular membrane, which ſtretches with the leaſt force drawing it, and readily riſes into cells upon blowing air into it.

Some have fancied that the ſtylo-hyoideus muſcle ſerves as a pulley to the tendon of the digaſtric: but any who have ever diſſected muſcles, muſt know, that their fleſhy fibres are connected to each other by ſuch weak fibres as can make very little reſiſtance; and, in diſſecting this part of the ſtylo-hyoideus muſcle, we ſcarce can hold it with a hook or forceps ſo tenſe as to diſſect it clean, without the riſk of tearing its fibres aſunder; which plainly ſhows it to be too weak for the uſe they aſſign it. They ought to have alſo conſidered, that the tendon has no curve where it paſſes through this muſcle; which is a ſure ſign that the muſcle does not ſerve as a pulley to it.

Though there were a pulley through which this tendon paſſed, it could be of no uſe, ſo long as the tendon is tied to the *os hyoides*; for the apo-

neuroſis H hinders its play, in the ſame way as threads tied to a cord laid over a pulley, and to the ſcrew or ropes by which the pulley is ſuſpended, prevent the motion of the cord.

It has been ſaid, that though there is a great curve in the middle of each digaſtric muſcle when the head is extended backwards, yet it becomes ſtraight when the head is bended forwards; and that, when theſe muſcles are ſtraight, they may bring the lower jaw down.——To this it may be replied, 1. That the digaſtric muſcles never are ſtraight; there is a curve in them when the chin touches the breaſt. 2. If they were to pull the jaw down, they muſt draw the *os hyoides* upwards and backwards; whereas this bone deſcends and advances forwards when the mouth is opened. 3. In this ſituation of the head, bended ſo greatly forwards, which is ſuppoſed to be the proper one for the action of the digaſtric muſcles, the mouth is not opened by the deſcent of the lower jaw, but by the upper one only being raiſed.

One may readily judge from the figures what the action of this digaſtric muſcle muſt be. If the poſterior head, F, alone act, the middle tendon will be drawn backwards till the aponeuroſis ſhuffles from *m* to *o*; which is a very ſmall ſpace in Mr Cowper's figure, and muſt be much leſs in mine; after which, this head acts on the *os hyoides*.

The anterior belly, E, acting alone, the extremity of the aponeuroſis, H, is brought from *m* to *n*; which is as much as this head could be expected to contract.

If both heads act while the *os hyoides* is not kept down, the muſcle becomes ſtraighter, approaching the line *r*, till its axis is placed in that line; which I have endeavoured to prove is the proper office of this muſcle in deglutition, in which it is aſſiſted by the ſtylo-hyoideus, K.

If both heads contract while the muſcles which pull the *os hyoides* down are in action, the tendon G will be raiſed towards *r*, till the aponeuroſis H is made ſtraight and tenſe. Both bellies then continuing to contract in this ſituation, they will conſpire in their efforts to draw the *os hyoides* upwards; beſides which, the anterior head pulls alſo the jaw A. Before the jaw can be depreſſed, the *os hyoides* C muſt be ſo firmly kept down by its muſcles, that it ſhall be more difficultly raiſed than the jaw can be depreſſed; otherwiſe E would move the *os hyoides* upwards, without

out any effect on the jaw. Since therefore the jaw can be depreſſed with no greater force than what is employed to pull the *os hyoides* down, it will neceſſarily follow, that whatever diminiſhes the force pulling the *os hyoides* down, muſt hinder, inſtead of aſſiſting, the depreſſion of the jaw. But in the preſent ſuppoſition, of both heads of the digaſtric muſcle contracting in the ſituation above deſcribed, it is evident, that the poſterior head can have no effect on the jaw, but exerts its whole force in pulling the *os hyoides* upwards, by which it counteracts the muſcles, i. e. diminiſhes the force that draws the *os hyoides* down, (which the anterior head cannot increaſe), and conſequently the jaw is depreſſed, or the mouth is opened with leſs force, when the digaſtric muſcle contracts, than when it is unactive. From all which, eſpecially if joined to the experiments mentioned in the article to which this is a ſupplement, it appears evident to me, that the depreſſion of the jaw is no more the office of the digraſtic than the extenſion of the fore-arm is the office of the *brachiæus internus*.

THE preceding article * having been ſeverely criticiſed, without convincing me that I am in the errors imputed to me, I think myſelf obliged to offer what arguments I can in ſupport of theſe articles.

My firſt critic is the famous Mr Winſlow, one of the greateſt maſters in anatomy, to whom the world is infinitely obliged for numerous improvements and diſcoveries, and who appears, from his writings, to be a ſcrupulouſly honeſt man.

The ſecond is Mr Ferrein, who has given ſeveral ſpecimens of his accuracy and ingenuity, publiſhed among the memoirs of the French academy of ſciences, and in his other writings.

The third is Profeſſor Walther of Leipſic, who is author of numerous anatomical, phyſiological, and medical tracts, which ſhew him induſtrious and learned.

Theſe gentlemen have argued ſo differently, that I muſt conſider each by himſelf.

* When firſt publiſhed in the Edinburgh Medical Eſſays; being Art. xi. of Vol. I. and Art. xiii. of Vol. III.

ANSWER to Mr WINSLOW.

MR WINSLOW (*a*) obſerves, 1. That at the end of Vol. I. of the Medical Eſſays, &c. publiſhed in 1733, notice is taken of his *Expoſition Anatomique*, publiſhed in the year 1732. 2. That Dr Douglas's tranſlation of the expoſition was publiſhed in 1732. 3. That the 3d volume of Eſſays was publiſhed in 1735.

I fancy the meaning of theſe obſervations is to inſinuate, that I was the firſt aggreſſor; and therefore, to ſet this matter in its true light, I muſt remark,

1. That our Vol. I. which is properly for June 1731—May 1732, was publiſhed in 1732, notwithſtanding the bookſellers having put 1733 upon its title-page, according to the common practice of people of that buſineſs when they publiſh books near the end of a year; and that this volume was ſtopped ſeveral weeks at the preſs, after more than two thirds of the ſheets were caſt off.—When my remarks on the articulation, &c. of the lower jaw, were read to the Society in 1731, and when they were printed, I knew no more of the expoſition, than that a ſyſtem of anatomy was long and impatiently expected from Mr Winſlow.

2. There muſt be a typographical error in the ſecond obſervation; for 1734 is on the title-page of Dr Douglas's tranſlation of the expoſition; nor could a tranſlation of ſuch a book have well been publiſhed ſooner after the original.

3. When vol. iii. of Eſſays was publiſhed, I did not know Mr Winſlow's opinion concerning the point now in diſpute, but did not ſee reaſon to embrace it.

The obſervations are followed by an accurate account of Mr Winſlow's doctrine, and then mine is attacked.

On my argument of the digaſtric muſcles being too ſhort for drawing down the lower jaw in opening the mouth (*b*), it is remarked, (p. 185, 4to. p. 259, 12mo.) that the lower jaw being a crooked lever, a ſmall motion at its angles

(*a*) Mem. de l'Acad. des Sciences, 1742, p. 178 of 4to edit. or p. 239 of 12mo.

(*b*) See p. 235, *ſupra*.

angles muſt make a conſiderable one at the chin; and that the digaſtric muſcles may be regarded as if their inſertion was towards its angles, therefore a ſmall quantity of contraction of the fibres of theſe muſcles is only required.

All will agree, that the motions of the ſeveral parts of the lower jaw, and of every other bone, are in proportion to their diſtances from their common centre of motion; and therefore the angles of the jaw move much leſs than the chin does. But this is no reaſon why the digaſtric muſcles ſhould be regarded as if they were inſerted into the angles, when they are inſerted into a part of the jaw which has a much larger motion than the angles have, in proportion to which motion they muſt contract; and the quantity of this contraction muſt be according to the length of their fibres, which I ſtill think are too ſhort for ſuch an office. This is confirmed by the diſſection of quadrupeds and birds, whoſe digaſtric muſcles depreſs the lower jaw; for in them theſe muſcles are not inſerted into the fore-part of the jaw, but much nearer to its centre of motion.

In ſtating my ſecond objection, Mr Winſlow has twice omitted the word *proportional*, and from thence is led to criticiſe me (p. 187, 4to. 251, 12mo.) for what I have not ſaid.

I have ſo good an opinion of Mr Winſlow's integrity, that I ſhall give this hint, without entering into any argument, believing that it will be ſufficient to make him wiſh theſe remarks had been omitted.

In anſwer to this 2d objection, (p. 187,—252), and in ſome other parts of his *Memoire*, Mr Winſlow alſo interprets what I called the angle of inſertion of the digaſtric muſcles, as if I meant by it the curvature of the tendons of theſe muſcles.

What has occaſioned this miſtake, I cannot tell; for I have always named them differently: and I thought every one had known what is meant by the angle of inſertion of a muſcle into a bone, to wit, the angle between the muſcle and the bone; and that the nearer this angle is to a right one, the muſcle always acted, *cæteris paribus*, with greater advantage.——In the preſent queſtion, it might be eaſily demonſtrated, that the nearer perpendicular a muſcle fixed at one end to the *os hyoides*, and to the chin at the other end, is to a line drawn from the axis of the jaw through

through the part of the *os hyoides* where the muſcle is fixed, the larger angle it muſt act with in drawing the jaw down: conſequently the digaſtric muſcles act with a larger angle when the head is reclined back, and with a leſs one as the chin is depreſſed; that is, theſe muſcles have a leſs angle of inſertion as they continue to act; whereas moſt other muſcles obtain a larger angle of inſertion as they act. Thus when the fore-arm is extended, the *biceps* and *brachiæus internus* are inſerted at a very acute angle; but as the fore-arm bends, the angle of their inſertion increaſes.

Whether the aponeuroſis of the digaſtric muſcles is long and looſe enough, to ſhuffle as much as is ſufficient for their action, if they were depreſſors of the jaw, is the next point in which Mr Winſlow and I differ, and which other anatomiſts inſpecting the parts muſt determine.

After this I am blamed (*Mem.* p. 189—254) for conſidering the actions of each head of the digraſtic muſcles ſeparately; and, by repeating this critical remark afterwards, Mr Winſlow ſeems to think that theſe muſcles always act ſimultaneouſly, or at the ſame time.

If I had neglected to conſider the ſimultaneous action, I had been to blame: but as this was done, there could be no fault in examining what each head can do; becauſe I have no doubt of their often acting ſeparately, as I ſee different parts of other muſcles act, which ſeem to be more made for co-operation than theſe two parts of the digaſtric muſcles. Thus, for example, when the arm hanging by the ſide is to be raiſed by the deltoid muſcle, its middle part only can act at firſt, becauſe the fore and back parts of this muſcle being then placed below the centre of motion of the joint of the arm, might, if they acted, pull down the arm with as much force as the middle part could exert to raiſe it: and, on the contrary, when the arm is to be preſſed to the ribs, the lateral parts of the deltoid muſcle contract, while the middle part is inactive.

In relating my 4th objection (*Mem.* p. 189—254), there are two miſtakes in tranſlating my words, which have given ground for criticiſm. Where I ſay the *os hyoides* is kept firm, or a little brought down, *brought down* is tranſlated *pouſſé en embas*, puſhed down; whereas the evident meaning in French is *abaiſſé*, or *tiré en embas*.—Inſtead of tranſlating the Engliſh words, *is the only ſuppoſition to be allowed*, by the French words *eſt la ſeule choſe que je ſuppoſe*, the tranſlation ought to have been *qu'on doit toujours ſuppoſer*.

After

After Mr Winſlow has mentioned how people may be deceived in making trials of the actions of the muſcles in dead bodies, he blames me (*Mem.* p. 190—256) for reclining the head backwards when I was to examine the digaſtric muſcles, and ſays that I ought to have made the diſſection with the head in the ordinary erect poſture.

In making theſe experiments, I did not free the muſcles from any attachment which could have effect on their actions: I did no more than lay their external ſide ſo far bare as I could take hold of it with a hook, or put a needle into it. And I ſtill think the experiments ought to be made with the head reclined backwards, rather than in any other poſture; for this obvious reaſon, that it is in the reclined poſture only that living people, evidently and without a diſpute, cauſe their lower jaw to deſcend in opening the mouth; and therefore, if the digaſtric muſcles ever have any effect in pulling down the jaw, it muſt be in this attitude. I made the trials in all the poſtures; but mentioned this one particularly, as being the moſt deciſive of the queſtion in diſpute.

I know not what uſe Mr Winſlow intends ſhould be made of his obſervation, That, in the moſt erect poſture, " the middle curvature of the " digaſtric muſcles, called their *angle* by Mr Monro, is much leſs than " the ordinary manner of diſſecting has given occaſion to attribute to " them." It is certain that theſe muſcles never are ſtraight in any poſture, and that Mr Monro never gave the name of *angle* to their curvature; and, in the erect poſture, I ſee nothing in theſe muſcles to perſuade me they are fit for pulling down the jaw, unleſs the experiment is made, as Mr Winſlow has ſometimes done, after taking away the adheſion of the middle tendon of a digaſtric muſcle to the *os hyoides*, (*Mem.* p. 180—242).

I am alſo at a loſs to know, what advantage Mr Winſlow can have in the preſent argument, by conſidering the lower jaw as a crooked lever, as he has done (p. 185 & 191, 4to. 249, 357, 12mo.): For a power acting on or drawing one end of a beam, the other end of which is the centre of motion, has the ſame force or effect, whether the beam is ſtraight or crooked, provided the power acts in both with the ſame angle of inſertion, and ſame diſtance from the centre of motion.

It is acknowledged (p. 192—258,) that, when the head is reclined back, and the *os hyoides* is kept firm, " it is certain the poſterior heads of " the

" the digaſtric muſcles cannot act, and conſequently can do nothing for " the motion of the lower jaw:" But then, as the keeping firm or bringing down, or, as Mr Winſlow is pleaſed to quote me, the *puſhing down*, the lower jaw, is ſaid to be only a ſuppoſition which is not to be found in a natural ſtate, as is afterwards to be demonſtrated, the concluſion which might otherwiſe be drawn cannot, it is ſaid, be made.

There is no ſuch demonſtration as Mr Winſlow here promiſes, to be met with in this Memoir; and the keeping firm or bringing down the *os hyoides*, when the mouth is opening, is ſo far from an imaginary ſuppoſition, that every perſon, putting a finger on the *os hyoides* while he opens his mouth, can be certain of its being a conſtant evident fact; and therefore Mr Winſlow himſelf is here excluding the poſterior heads of the digaſtric muſcles from any ſhare in the motion of the lower jaw downwards.

Unleſs the keeping the *os hyoides* down is again mentioned as an objection to my 5th ſection, there is none made (p. 192—258).

When Mr Winſlow knows, that, in the original of my 6th objection, the perſon endeavouring to feel whether the anterior heads of the digaſtric muſcles are in action, is deſired to do it while the mouth is opened ever ſo wide, quickly or *ſtrongly*, which laſt word is omitted in his quotation of this objection, he will wiſh ſome of his reflections, which depend on his omiſſion of this word, had not been inſerted.

It is admitted (p. 195—262), that the action of other muſcles beſides the digaſtric, is to be felt while the mouth is opened; and (p. 196—264) that there is a difficulty in feeling the action of the digaſtric muſcles, though, it is alledged, it may be felt when the points of the two thumbs are put at the internal or poſterior ſide of the bone of the chin, and reſiſtance is made by the thumbs to the depreſſion of the jaw.

In ſwallowing, any perſon may feel the anterior heads of the digaſtric muſcles in action, without having accurate knowledge in anatomy: I deſire only a compariſon to be made, between the feeling of theſe muſcles when even the leaſt forcible deglutition is performed, and when the moſt ſtraining effort is made to open the mouth. In deglutition, theſe muſcles are tenſe, hard, and ſwelled; in opening the mouth, their action cannot be diſtinguiſhed: They then feel no more tenſe than the traction of the

os hyoides, then drawn downwards, would make them; nor more protruded outwards, than the ſwelling and riſing outwards of the muſcles above them could cauſe.

In proof of the poſterior heads of the digaſtric muſcles acting in opening the mouth, it is ſaid (p. 196—265), that, " when the fore-finger is " puſhed between the lower part of the maſtoid proceſs and the angle " of the lower jaw (as alſo a little more forwards), and then the finger is " preſſed ſtrongly, while the jaw is drawn down with effort to the laſt " degree, the belly of the digaſtric muſcle of that ſide may be felt very " diſtinctly as a kind of ſtretched cord, eſpecially, if at the ſame time, the " chin is borne up by the thumb of the other hand, to reſiſt the effort of " drawing down the jaw."

I did not expect Mr Winſlow would have inſiſted on this poſterior head acting in opening the mouth, after acknowledging it certain, that, " if " the *os hyoides* is kept firm, (which it moſt undoubtedly is), this poſterior " head can do nothing for opening the mouth in the reclined or extended " attitude of the head, in which the mouth is only opened by the de- " ſcent of the lower jaw;" and when there cannot be ſo much as a pretence for the favourite baſcule, or reverſion of the upper part of the head upon the condyles of the maxilla. Since, however, he appeals to this trial, I muſt obſerve, that, in making it, no tenſe cord is felt in ſome people: in many, it is felt; but in theſe it is very different from what is felt when deglutition is performed, both in its form and ſituation. In this latter action, one can diſtinguiſh the tenſion of the tendon, and the ſwelling of the belly of the muſcle: In opening the mouth, the cord is higher, deeper, and without any perceivable ſwelling in one part more than another: and, therefore, I underſtand it to be the ligament extended from the ſtyloid proceſs of the temporal bone to the *os hyoides* (*a*), ſuſtaining the *os hyoides;* or that it is the ſtylo-hyoideus muſcle performing that office, when there is no ſuch ligament, as frequently is the caſe (*b*).

The laſt argument in the *Memoire* for the digaſtric muſcles drawing down the lower jaw in opening the mouth, is (p. 182—245, p. 191—257, p. 197—265), the diſſection of quadrupeds and birds, in whom the

(*a*) Ruyſch Adverſ. dec. 3. § 9. Cowper Myot. in fol. Tab. 24. *c*. Tab. 27. fig. 1. DD.

(*b*) Weitbrecht, Syndeſmolog. ſect. vi. § 15.

muſcles analogous to the human digaſtric, are not connected to the *os hyoides*, but are extended in a ſtraight courſe to the lower jaw, to the middle or back part of each ſide of which they are fixed, and evidently draw it down.

I agree with Mr Winſlow both in the anatomy and uſes of theſe muſcles in quadrupeds and birds; but will not admit his concluſion, that the human digaſtric muſcles have the ſame office: for theſe muſcles of theſe creatures have not the curvature in the middle, nor the connection to the *os hyoides*, nor the inſertion into the chin, which the human digaſtric muſcles have, and which are the circumſtances upon which my objections to the common account of the action of theſe human muſcles are founded. —If any perſon was to argue thus, The human digaſtric muſcles are principal inſtruments in deglutition, therefore the analogous muſcles of quadrupeds and birds are alſo organs of deglutition; Mr Winſlow would refuſe this concluſion to be juſt, for the ſame reaſons as make me not to admit his concluſion.

After objecting to the common doctrine concerning the digaſtric muſcles, I took notice of both jaws contributing to the opening of the mouth; the upper part of the head only moving when the chin is near the breaſt; the lower jaw only moving while the head is extended fully back; and both jaws moving in all the intermediate ſituations of the head, each of them moving nearly proportionally to the greater or leſſer flexion or extenſion of the head. In proof of this, I deſire any perſon to put a knife, or his nail, oppoſite to the conjoined edges of the teeth, before the mouth is opened, to hold the knife or nail unmoved, while, ſtanding before a mirror, he opened his mouth in all theſe different attitudes of the head, and then he might ſee theſe motions of the jaws.

In the reflection on theſe experiments (*Mem.* p. 198—267), Mr Winſlow ſeems to think, that, "when there is not ſpace enough to make a "large opening of the mouth by the deſcent of the lower jaw, one is na- "turally prompted to raiſe or recline the head backwards proportionally "to the extent of ſpace neceſſary to make the opening of the mouth by "the ordinary depreſſion of the lower jaw; and that it is thus that cro- "codiles raiſe the head to make a large throat, according to the obſerva- "tions on three crocodiles related in the Collection of old Memoirs."

If,

If, in opening the mouth, while the chin is near the breaſt, all the head was firſt raiſed, and then the lower jaw deſcended, there would be ſome reaſon for this reflection: but, as the lower jaw is not in the leaſt raiſed, but keeps its ſituation, while the upper part of the head only moves, it cannot invalidate what I have ſaid; and there cannot be any intention of making ſpace for the deſcent of the lower jaw, when this jaw is not to deſcend.—The Academicians, whom Mr Winſlow quotes, evidently thought of crocodiles raiſing their upper jaw and cranium by the muſcles placed on the back-part of the vertebræ of their back and neck.

In the ſame reflection (p. 199—268) it is ſaid, That, in the experiment I propoſed for ſeeing the motion of the jaws in a mirror, the perſon extends his head, that he may look into his throat:—Whereas the experiment ſucceeds, whether the perſon ſees, or is blind; whether he knows for what purpoſe it is made, or is ignorant of it; whether he holds the knife himſelf, or another does it without his knowledge. In ſhort, whoever makes the trials, or ſees another do them, with a mirror, or without one, muſt be convinced I have deſcribed what really is done in opening the mouth.

I am ſurpriſed the reflections above mentioned were inſiſted on, ſince they contradict the baſcule, or reverſion of the upper part of the head upon the condyles of the lower jaw, argued for (p. 181—243, p. 184—247); which I would next examine, if it were not more proper to conſider it in my remarks on Mr Ferrein's *Memoire*, where it is more fully treated than in Mr Winſlow's.

Whether the uſes I have mentioned of the muſcles below the *os hyoides*, to wit, the ſterno-hyoidei, coraco-hyoidei, &c. are aſſented to or denied, (p. 195—262), I cannot ſay: for though it is admitted, that, "in great "efforts to bring the lower jaw down to the laſt degree, and by this to "open the mouth greatly, the tenſion, and a kind of hardneſs from this "tenſion, of theſe muſcles, are felt; yet it is ſaid, that one ſhall not diſ-"tinguiſh any hardneſs by the contraction of their fleſhy fibres, nor any "ſhortening by that contraction."

Any perſon putting his finger on the ſkin which covers theſe muſcles, while he moves his lower jaw, can determine as well as the moſt accurate anatomiſt what theſe muſcles then do; and therefore I ſhall appeal to

every one's feeling for determining this part of the debate. My colleague Dr Rutherford, Mr Gibſon ſurgeon at Leith, and I, were conſulted about a tumor in the thyroid gland of a very lean lady, in whom the coraco-hyoid, ſterno-hyoid, and ſterno-thyroid muſcles raiſed the ſkin covering them, on even the leaſt motion made by her lower jaw in ſpeaking to us, and then felt as firm hard cords under our fingers.

After Mr Winſlow has finiſhed his reflections on the article in general, he criticiſes the illuſtration (*a*); but has nothing new in his remarks, except blaming me, (p. 202—272) for making uſe of figures of the parts put in a wrong attitude, and particularly the one I had cauſed to be drawn of theſe parts as they appear when the head is reclined back.

I have already ſaid, and beg leave to repeat, that this is the moſt proper attitude in which the digaſtric muſcles can be examined in order to paſs judgment on the diſpute between us, becauſe it is in this poſture that the opening of the mouth is ſolely made by the deſcent of the lower jaw; and therefore, if the digaſtric muſcles are the organs which pull down this bone, then it is that their action muſt be greateſt, and conſequently moſt manifeſt.

I ſhould have thought myſelf very happy in being prevented from cauſing any original anatomical figures to be drawn, which I probably would have been, had Mr Winſlow given us the figures of all the parts of the body, as he intended; for, had the painters and engravers executed their parts with the ſame accuracy and candour, as he would have diſſected and preſented the originals to them, we ſhould have had by far the moſt complete ſyſtem of anatomy ever yet has appeared, though, as frailties muſt attend human nature, even a Winſlow might have erred. Long may he live to do ſtill more ſervice to mankind; but I am afraid his great age will not bear the fatigue of ſuch laborious work as theſe plates would require.

ANSWER to Mr FERREIN.

THE Academy of Sciences at Paris has publiſhed two Memoirs of Mr Ferrein, relating to the motions of the jaws, in their Tranſactions for

(*a*) P. 248, *ſupra*; or Art. xiii. of Vol. III. of Med. Eſſays, &c.

for the year 1744. In the firſt of which there is (p. 427, &c.—579, &c.) a deſcription of the articulation of the lower jaw agreeing with mine; except that, 1. (p. 427—579) The ſubſtance interpoſed between the two pieces of which the lower jaw conſiſts in infants, and between moſt other bones of the head, ought, it is ſaid, not to be called a cartilage, as is commonly done, but a continuation of the perioſteum.——2. (p. 329—580), The ſubſtance which lines the cavity that receives the condyle of the lower jaw, is likewiſe ſaid to be no cartilage but a ſimple membrane.——3. (p. 430—582), The elaſtic *meniſcoid interarticular* cartilages are affirmed to be ligamentous bodies.——4. (p. 430—582). The external and internal parts of the articular ligaments, which are thicker than the fore and back parts of theſe ligaments, according to the common rule, of the ligaments of the articulations by ginglimus being thicker at the ſides to which leaſt motion is allowed, are here eſteemed four ligamentous cords.

Seeing ſelf-defence alone obliges me to take up the pen at preſent, and none of theſe four ſpecialities are particularly deſigned to criticiſe me, I ſhall enter into no diſpute about them.

The motion of the jaw forwards, or its horizontal motion, is deſcribed in the *Memoir*, (p. 431—584), in the ſame manner as in my eſſay; but (p. 431—584, p. 432—586) it is aſſerted, that authors have expreſſed themſelves ſo obſcurely concerning the motions of the jaw backwards, that it was impoſſible to know what they thought.

Whether is it impoſſible to underſtand the following words, (p. 232, *ſupra*)? "The exterior extremity of this oblong poſterior cavity is "made very narrow by the *meatus auditorius externus* being conſiderably "advanced forwards here, which again prevents the condyle ever to "be puſhed ſo far back as to be in hazard of doing any injury to "the gland ſituated in the more internal part of the cavity." Whether is not this a more particular account of the non-receſſion of the lower jaw, than to ſay in general, as is done in *Memoires* 1744, (p. 433—586) that, it is owing to the conſtruction of the parts, and the oppoſition of the ligamentous cords?

Mr Ferrein, obſerving that the condyles are too much ſtraitened in the glenoid cavities for performing the large motions which the lower jaw makes

makes to each ſide, (p. 434—588), is aſtoniſhed, " that an obſervation " ſo ſimple, and a truth ſo ſtriking, has eſcaped the eyes of ſo many ana- " tomiſts."——Has he not overlooked the following words of the Eſſay, (p. 233, *ſupra*)? " The condyles can be moved laterally when they are lodged " in the cavities, or on the tubercles; but theſe lateral motions are much " more confined in the cavities, becauſe of the ſurrounding brims."

Both anatomiſts and ſurgeons knew that the condyles of the lower jaw did not always advance and recede together, but were capable of being moved forwards or backwards, ſeparately or alternately. They are, however, obliged to Mr Ferrein for his minute deſcription of theſe motions, and their effects on the different parts of the jaw, (p. 435—588; p. 443—599.)

In p. 439—594, Mr Ferrein has made a very pretty diſcovery, and has corrected an error into which all the anatomiſts had fallen, concerning the manner of the motion of the lower jaw in its depreſſion and elevation. The condyles had always been thought the axes upon which the lower jaw moved, as moſt other bones do upon their articulated ends; but Mr Ferrein has demonſtrated the axis of motion of the lower jaw, in its motions upwards and downwards, to be a little above its angles: ſo that when the body of the bone moves downwards, its condyles advance forwards; and when its body is raiſed up, the condyles recede back: by which, ſays he, the parotid glands are ſafe from compreſſion, as the muſcles which raiſe the jaw are far from being overſtretched; and it may be added, that the nerves and blood-veſſels which enter the internal poſterior hole of the jaw, are likewiſe ſaved from being twiſted, overſtretched, or torn, in the motions of this bone.

I ſhall conclude my remarks on this firſt memoir of Mr Ferrein, by obſerving, that his account of the aperture of the mouth, and experience, confirm what I have ſaid (p. 234) of the danger of a luxation of the lower jaw when the mouth is opened, and the condyles are on the tubercles of the temporal bones. It is in vomiting, coughing, yawning, &c. that theſe luxations ever happen: ſo that he ſhould not have quoted this opinion as erroneous, p. 444—602.).

THE firſt thing Mr Ferrein undertakes to prove, in his ſecond memoir, is,

is, (p. 511—687), "That the head contributes to make the opening of "the mouth, and that it even contributes conſiderably; but by a motion "independent of the will, and of the contraction of the ſplenius, com-"plexus, and other muſcles which raiſe the head; in a word, by a mo-"tion reciprocal to that of the lower jaw, reſulting from the effort that is "made to depreſs the lower jaw, and occaſioned by the reſiſtance which "it oppoſes to its depreſſion."

I ſuſpect I do not rightly underſtand this propoſition: for I am at a loſs to know what motion can be independent of the will, which reſults from an effort, and which is ſaid (p. 540—729) to be an effect of the act of the will; and I am not certain whether the reciprocal motion here mentioned is Mr Winſlow's baſcule, or reverſion of the head upon the condyles of the lower jaw. I ſuppoſe it is; and therefore am now to perform the promiſe I made in my anſwer to him.

As an introduction to Mr Ferrein's demonſtration of the foregoing doctrine, he mentions the following law in mechanics: "I ſuppoſe two bo-"dies, A and B, faſtened to the two ends of a cord which ſhortens itſelf; "it is evident that the cord draws theſe two bodies, the one towards the "other, in making them paſs over ſpaces reciprocal to their maſſes; and "that if the maſs A is double or triple of the maſs B, the ſpace which the "maſs B moves ſhall be double or triple of what A moves."

If the force with which the cord ſhortens itſelf is leſs than the reſiſtance of the maſs A, how much ſpace would that maſs A move? None ſurely. This is the caſe of muſcles, which almoſt perpetually act with a force which moves only the more moveable of the two parts to which their ends are connected. In proof of this I ſhall take Mr Ferrein's own examples of the fore-arm and leg, which he has brought (p. 512—688) to prove his mechanic law.——When the leg or the fore-arm alone is to be extended, its muſcles move it only; ſo far is according to the rule I juſt now ſaid is generally obſerved: But, ſays Mr Ferrein, the reaſon why the thigh or arm do not move at the ſame time, is the reſiſtance made to the motion of the thigh and arm by the almoſt enormous maſs of the trunk, &c. which muſt be moved with them.—Let us ſuppoſe this a good reaſon; then obſerve what happens when one riſes from a chair, if it is even on one foot. The extenſor muſcles of that leg raiſe the enormous

maſs

maſs above it, and leave the leg immoveable; and in the ſame way one having his hands on a table with his fore-arms bended, can raiſe his body from the ground by the action of the extenſors of the fore-arms, raiſing the arms, and all the enormous weight of the body, the fore-arms remaining unmoved. If Mr Ferrein's law obtained in the action of muſcles, and if a leg and foot, or the two fore-arms and hands, are one tenth or eighth of the weight of the whole body; then, in theſe caſes of riſing from a chair, or raiſing our weight on our hands, the leg or fore-arms ought to move only one tenth or eighth leſs ſpace than the thigh or arms move; whereas they move none. Thus muſcles move only the leaſt reſiſting part of the two they are connected to, though the difference of the reſiſtance is but one eighth or tenth; nay, if a man riſes with a weight in his arms, or on his back, the difference may not be one twentieth or thirtieth.

After aſſuming this mechanic law of muſcles moving both the parts they are connected to, it is inferred, (p. 502—689), that "the principles "which are eſtabliſhed, are certainly ſufficient to demonſtrate, that the "effort which one makes to open the mouth, ought to tend at the ſame "time to depreſs the lower jaw, and to raiſe the upper one."

Admitting the law in mechanics to have been demonſtrated, and juſtly applied to the action of muſcles, and granting every thing yet mentioned in this memoir, this conſequence would not follow; becauſe there has yet been no proof brought of a contractile cord extended from the head to the lower jaw.

In applying the law we have been diſputing about, "Mr Ferrein ſays, (p. 513—689), "I have diſcovered, that, notwithſtanding the head's be-"ing nearer the trunk than the lower jaw, yet the reſiſtance which the "head makes to its elevation is extremely little, and ſuch nearly as it "would be if the head was wholly ſeparated from the ſpine. I have alſo "found, that the reſiſtance of the lower jaw, though really leſs, (mean-"ing, I ſuppoſe, than that of the head), is however conſiderable enough "to occaſion in the head the motion which I have attributed to it," to wit, the elevation.

One muſt read the ſubſequent page of the memoir before he can underſtand what the reſiſtance of the head wholly ſeparated from the ſpine is, which

which is here intended. It is, I ſuppoſe, the reſiſtance to elevation which the head makes, when its upper part is made to move on the condyles of the lower jaw.

The heads of people falling aſleep, or of children and of weak perſons, when they are in an erect poſture, bend down on their breaſts; and whoever raiſes the head of a man in a faint, may find, that, in doing it, he muſt employ a conſiderable force. So that the reſiſtance to the elevation of the head is not extremely little: And ſeeing it is here acknowledged, that the reſiſtance of the lower jaw is leſs than that of the head, it will be concluded, from the foregoing experiments with the legs and forearms, and many more ſuch might have been named, that, ſuppoſing a contractile cord to be extended from the back-part of the head to the lower jaw, this cord would only move the lower jaw, which is confeſſed to give the leſſer reſiſtance.

In the ſubſequent paragraph, there is an acknowledgment which I heartily wiſh had been more attended to. The words of it are, "In "truth, the reciprocal motion of the head upon the lower jaw cannot be "made, if the proceſſes articulated with the ſpine (theſe muſt be the con-"dyles of the occipital bone) do not follow the determination which the "motion of the head gives them."

The condyles of the occipital bone are the fulcra on which the head reſts, and on which the motions of the cranium and upper jaw, independent of the ſpine and lower extremities, muſt always be performed. Whoever affirms, that the condyles of the lower jaw can be the fulcra and axis of theſe motions, might as well ſay, that a beam, AB, placed on the rigid pillar C, could ever have its axis of motion on the end D of another beam DE, joined to AB by a hinge; where it is evident, that, on raiſing the end A upon the axis D, the other end B of the beam muſt make its way down through the ſubſtance of the pillar C, as the pricked line *a b* does in fig. 9. (Plate I.):——Or, if we would ſuppoſe, as in fig. 10. that the beam FG, ſupported by the pillar H, is to have its end F moved downwards upon the axis I, the end of a beam KI fixed to FG by a hinge; then it is evident, that FG muſt riſe greatly from the end of the pillar, as the pricked line *f g* does in the figure. It is almoſt needleſs to add, that the cranium and upper jaw are here repreſented by the lines

AB, *ab*, FG, *fg*. The pillars C and H are inſtead of the ſpine; and the crooked lines DE and IK are in place of the lower jaw; on the ſuppoſition of whoſe condyles being the axes of motion of the head, the ſpine muſt be immenſely compreſſible and elaſtic, to be lengthened and ſhortened ſo greatly in the opening and ſhutting the mouth.

It is in vain to endeavour to elude the force of this objection to the reverſion of the head upon the condyles of the lower jaw, by ſaying, as Mr Ferrein does, (p. 514—690), That "the motion of the head on the firſt "vertebra of the neck, and on the lower jaw, has nearly the ſame axis." —— Mr Ferrein knows very well how much farther back the condyles of the occiput are than either the glenoid cavities, or tubercles of the temporal bones, with which the lower jaw is articulated: for, of the ſpace between the occipital condyles and the fore-part of the jaws, the diſtance between theſe condyles and the middle of each cavity, at the back-part of the tubercle, is about one fifth; and the diſtance between theſe condyles and the middle of the tubercle, is more than one fourth: But if the occipital condyles are at all behind theſe parts of the temporal bones, it is abſolutely impoſſible, that while the head and ſpine are kept together, the fulcrum, or axis of the head, can be on the condyles of the lower jaw, or indeed any where but on the occipital condyles or ſpine. And Mr Ferrein ſeems conſcious of this: for he does not affirm, that the axes are preciſely the ſame, which they ought to be, in his and Mr Winſlow's opinion of the motions being performed on the condyles of the lower jaw; but only affirms here and afterwards (p. 517—695), that they are nearly the ſame.

The only way to make the head move on the lower jaw, would be, to take away its ſupporting pillar the ſpine, that the back-part of the head might be left looſe and free; and then to hold the lower jaw firm. Upon comparing the axis of motion, in theſe motions performed by the head in this ſituation, it may be ſeen very different from what it is while the ſpine ſupports the head; whether the vertebræ are put on a table, as Mr Ferrein (p. 514—690) propoſes; or whether no part of the ſpine is ſeparated from the body, which is much the better way of making this experiment: The axis of motion of the head is therefore the ſame, whether it moves with or without the opening of the mouth.

Mr

Plate I.

Fig. 8.

Fig. 3.

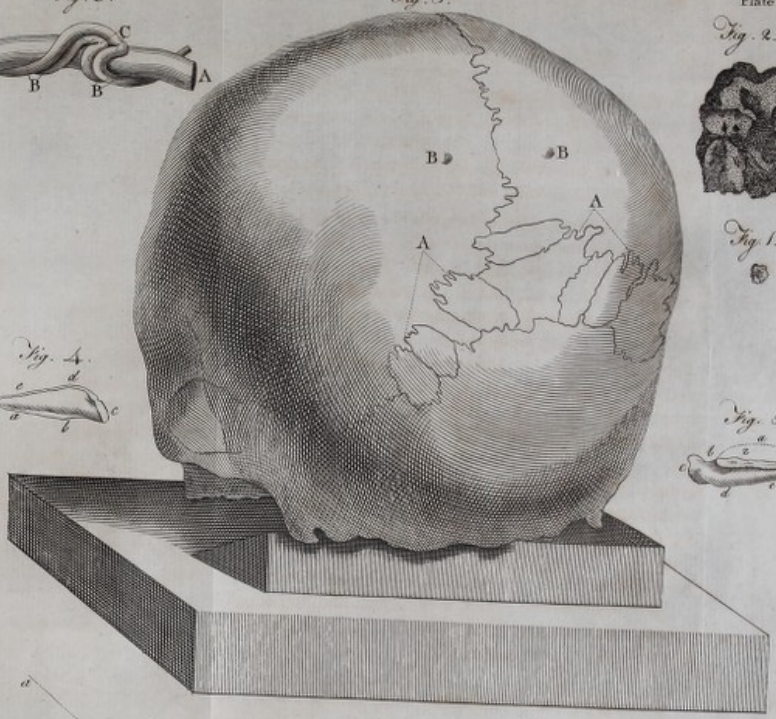

Fig. 2.

Fig. 1.

Fig. 4.

Fig. 5.

Fig. 9.

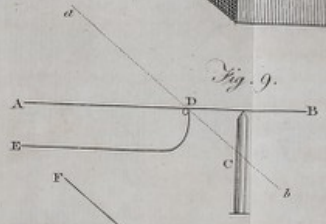

Fig. 10.

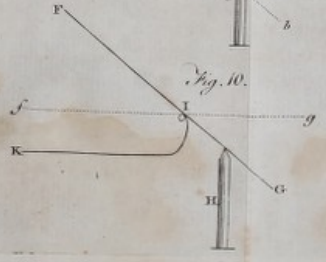

Fig. 6.

Fig. 7.

A. Bell Sculp.

Mr Ferrein, aware that, though all his preliminary propoſitions were granted, yet the lower jaw muſt make a conſiderable reſiſtance before the head could be raiſed, mentions (p. 515—692) four cauſes which conſpire to make this reſiſtance, to wit, 1. The inertia of the parts, which, as in all matter, makes them reſiſt motion.——2. The *ployement* of the parts which compoſe the fore-part of the neck.——3. The connections of the lower jaw with the upper part of the neck.——4. The fleſhy body of the pharynx, which is connected to the neck and lower jaw.

I am ſurpriſed that the firſt of theſe cauſes is mentioned to prevail in a pendulous member, whoſe gravity is making it tend downwards.—I did not tranſlate *ployement* in the account of the ſecond cauſe, becauſe I cannot think this word is here taken in the common ſignification of bending, ſinking, ſhrivelling, or ſhortening, which would all contribute to bring down the lower jaw: and if I was to take any notice of the 1ſt, or of this 2d, and the 3d and 4th cauſes, it would have been to enumerate them as cauſes which draw the lower jaw down; for they have not only gravity to cauſe them to deſcend, but the muſcular contractile organs, on the fore-part of the neck, being connected below to parts which are much more difficultly moved than the lower jaw, to wit, the ſternum, clavicles, ſcapulæ, diaphragm, whatever power of contraction they have, muſt be a niſus to draw down the jaw.

It is, however, needleſs, in the preſent argument, to inſiſt on a minute claſſing of the cauſes, when we every day ſee the jaw falling, and the mouth open, in drunken, paralytic, dying perſons, or whenever the levators of the jaw become weak; nay, whenever the attention of the mind is taken off from the office of ſuſtaining the jaw, it falls. Thus people in profound meditation generally have their mouths open; and a country-fellow ſtands gaping while he is gazing at the novelties of a town.——When the cheeks and the muſcles, which are levators of the lower jaw, are cut in a dead body, the mouth remains open, while the head is in the erect poſture.

I ſhall make no remark on Mr Ferrein's proof of the poſſibility and reality of the motion of the upper jaw in opening the mouth, (contained in Mem. p. 515, 516, 517,—693, 694, 695), but beg the reader to compare them with a few lines in p. 239, *ſupra*.

This ſection of Mr Ferrein's memoir is concluded (p. 516—695) with five remarks.

" 1. The axis of motion in the depreſſion of the lower jaw is, according " to him, nearly the ſame with the axis in the elevation of the upper jaw.

" 2. Theſe axes are both very different from the axis of the natural mo- " tion of the head, ſuch as is made naturally, and without conſtraint, by " means of the ſplenius and complexus."

Of the doctrine in theſe remarks, enough is already ſaid.

" 3. The reciprocal motion of the upper jaw is independent of the con- " traction of the ſplenius, complexus, and other levator muſcles of the " head: This is demonſtrated by reaſon and experience."

I ſee no reaſon for this in the memoir; but I ſhall take one againſt it from Mr Ferrein's own doctrine, which is uſing what is commonly called *argumentum ad hominem*. In p. 541—730, he gives it as a maxim, " That " every muſcle being connected at its two ends to two different bones, " every motion of the one or of the other of theſe two bones, which " makes one of theſe ends to come nearer to the other, depends, at leaſt " in part, upon the contraction of that muſcle." Now, whatever axis the upper part of the head has in its elevation, Mr Ferrein will certainly grant, that the back-part of the head deſcends during the elevation of the fore-part of it; and this back-part cannot deſcend without the end of the ſplenius and complexus inſerted into it coming nearer to their other end, which riſes from the vertebra: and therefore, by his own maxim, theſe muſcles, at leaſt in part, ſerve to bring down the back-part of the head, and thereby raiſe the fore-part of it.

The experience he appeals to is, to apply the fingers upon the teguments covering the ſplenius and complexus when the mouth is opening; when, he affirms, theſe muſcles are not felt hard or tenſe, unleſs when the ſeparation of the two jaws being come to the laſt degree, one endeavours to force further the opening of the mouth.

The anſwer to this experience is, That in every perſon, blind or ſeeing, ignorant or acquainted of the intention, the action of theſe muſcles is always felt in opening the mouth, eſpecially when done quickly, ſtrongly, and with repeated jerks, the perſon who makes the trial remembering that they are thin broad muſcles covered with thick ſkin and fat,

fat, and with the cucullaris muſcle; ſo that they cannot be expected to ſwell ſo much outwards during their contraction, as a maſſeter, gaſtrocnemius, or ſuch other thick muſcle which is little covered.

" 4. The upper and lower jaws concur in the ſame manner to open the " mouth, ſince they divide the motion which produces this effect."

Is not this the doctrine of the eſſay-writer ?

" 5. It is probably the ſame in the crocodile, as well as in a great num- " ber of other animals. It is known that the crocodile, in opening its " throat, raiſes the upper jaw conſiderably. We are aſſured, in the old " memoirs of the academy, that this elevation is greater than the depreſ- " ſion of the lower jaw: there ſix muſcles are deſcribed, which are in " place of the ſplenius, complexus, &c. and which are there ſaid to pro- " duce the motion of the upper jaw."

This is ſuch an explicite declaration of theſe ſix muſcles ſerving to open the throat, that I cannot imagine how it came to be brought as an argument againſt me, unleſs the remark which follows is thought to explain this declaration to the reverſe of its obvious meaning. The remark is, " All the muſcles of which we have ſpoke, are only appointed to raiſe or " bring down the head: and thus, when it is ſaid that thoſe which are " placed upon the back-part of the back and neck ſerve to raiſe the jaw, " it is not properly the jaw which is raiſed—but the upper jaw and the " cranium; for the bones which compoſe theſe two parts are firmly con- " nected to each other."

In this the Academicians are guarding againſt their readers believing that they joined in the common opinion, which prevailed at that time, of a crocodile's upper jaw having a moveable articulation, and moving independent of the motions of the cranium, in the ſame way as the upper beaks of parrots move, without any intention of contradicting what they had ſaid of the muſcles analogous to the ſplenius and complexus raiſing the upper jaw.—Nay, Mr Ferrein's introducing his explication of the words of the Academicians, with *apparemment*, and afterwards with *il eſt à preſumer*, "probably," and "it is to be preſumed," ſhews that he was not convinced his explication was juſt, but rather that he gave it in complaiſance to Mr Winſlow.

In the ſecond article or ſection of the memoir I am examining, Mr Ferrein

Ferrein treats of the muſcles which produce the motions of the one or the other jaw; in which, to ſhun digreſſions, he premiſes ſome preliminary obſervations, which I ſhall conſider in the ſame order he has put them.

1. (P. 519—698) " In polygaſtric muſcles, the contraction of one belly " is independent of the contraction of another."

I agree to this, but don't chooſe to adopt all the reaſoning in proof of it; which, however, not relating to the ſubject in diſpute, I ſhall paſs without further notice.

2. (P. 521—701.) " The inflexion of the tendon of the digaſtric muſcle " is produced by an annular ligament, and by an aponeuroſis which is " fixed to the *os hyoides*."

I have deſcribed and painted the aponeuroſis. Cowper (*a*) mentioned an annular ligament; and it is painted by Courcelles (*b*), who ſays, " In " omnibus ſubjectis non tam diſtincte conſpicitur annulus:" and Mr Ferrein admits, that it is inconſtant in its appearance; varying in its thickneſs and breadth, and being (p. 529—712.) frequently enough, and (p. 531—715.) very often, entirely wanting.

In the comment on this ſecond obſerv. (p. 513—783), there is a little miſtake committed, when it ſaid, that my article is accompanied with two figures of Cowper, there being but one figure of Cowper's. And, immediately after, by beginning a quotation from that article in the middle of a ſentence, I am made to ſay what I never intended, to wit, that this ring of his is nothing but a cellular membrane; whereas, by beginning the quotation five lines higher, or reading the 3d objection in p. 235, *ſupra*, every one may ſee that I denied ſuch a pulley to the tendon of the digaſtric muſcle, as the ſuperior oblique muſcle of the eye, or the muſcles of the fingers, have to play in; unleſs the cellular membrane had been miſtaken for a pulley. Mr Ferrein agrees with me, that there is no ſuch pulley; though he is pleaſed to give the name of annular ligament to ſome fibres of the aponeuroſis, which, riſing in greater or ſmaller number in ſome ſubjects, muſt paſs over the tendon, to join others which are extended from the inſide of that tendon.—Whether do ſuch uncertain fibres warrant one to lay down a general maxim, " That " the

(*a*) Anat. explicat. of tab. 15. et Myot.

(*b*) Icon. Muſc. capit. 4. Lugd. Bat. 1743. tab. 4.

" the inflexion of the tendon of the digaſtric muſcle is produced by an " annular ligament," eſpecially ſeeing the inflexion is always made whether there is or is not ſuch a ligament?

The third and fourth obſervations in the Memoir being approbations of my doctrine concerning the curvature or tendon of the digaſtric, which cannot be raiſed without the *os hyoides*, and its want of a pulley, I ſhall make no remarks on the explications of them, that I may avoid more diſpute than is neceſſary for my own defence.

Mr Ferrein, obſerving ſome fibres of the ſtylo-hyoid muſcles joined with the digaſtric, concludes, in his 5th obſervation (p. 531—715), that " the ſtylo-hyoideus muſcle, and the poſterior belly of the digaſtric, may " be conſidered as one and the ſame muſcle with two heads."

If the connexion of the aponeurotic fibres of muſcles ſhould give the name of *digaſtric*, *trigaſtric*, &c. to all the muſcles which have ſuch connexion, the number of the many-bellied muſcles muſt be greatly increaſed.

(P. 535—720), it is ſaid, " The ſtylo-hyoideus, and poſterior belly of " the digaſtric, are appointed to act together, and to produce nearly the " ſame effects."—How does this agree with the firſt obſervation, (p. 515—648), " In polygaſtric muſcles the contraction of one belly is independent " of the contraction of another?"

The 6th obſerv. is (p. 335—721), " The *os hyoides* departing from its " natural ſituation cannot be moved from before backwards." The reaſon for which is ſaid to be, the ends of the cornua of the *os hyoides* then reſting upon, or being ſupported by, the tendinous parts of the *muſculi recti anteriores majores* of the head, which are ſituated immediately upon the vertebræ.

One would think, that, as muſcles have a conſtant niſus to ſhorten themſelves, the curve which the muſcles above and below the *os hyoides* make was intended to keep the points of its cornua from reſting on the vertebræ, to prevent the parts there from being hurt by the preſſure of theſe points. And, when one is directing no effort in theſe muſcles, but they are left to their natural action, a finger on the baſe of the *os hyoides* can puſh it back; and, when we obſerve the motion of this bone in deglutition, we ſee it recede farther back than its natural ſituation.

The 7th obſervation is to confirm what I had ſaid concerning the keeping

keeping firm or bringing down the *os hyoides* in opening the mouth. But, in the account of the diſpute about the digaſtric muſcles, the word *uniquement* (p. 537—723) and the word *ſeul* (p. 550—743) ought not to have been put; for I never ſaid that the digaſtric ſerved only for deglutition.

I am here in an unlucky ſituation between the Academicians. Mr Winſlow, as I obſerved formerly, blames me for conſidering other actions of the two heads of the digaſtric muſcles than the ſimultaneous one; and here Mr Ferrein blames me as much for conſidering only the ſimultaneous one. Whoever reads my article will find Mr Winſlow has underſtood me beſt.

After what I have ſaid concerning the impoſſibility of the condyles of the lower jaw ever being the fulcra or axis of the head in its motions, it is needleſs to ſhow Mr Ferrein's miſapplication of his obſervation of the maxillary condyles advancing forwards in opening the mouth, which (p. 538—725) he would have us to believe is the head ſhuffling back. He will ſee the miſtake, by only trying whether he feels this ſhuffling backwards in the maſtoid proceſs, and whether the ligaments which join the occipital condyles to the vertebræ are long enough to allow this ſhuffling back of the head.

The uſe of the external pterygoid muſcles, in bringing forwards the condyles and meniſcoid cartilages of the lower jaw, is next deſcribed in nearly the ſame manner as in my eſſay; and (p. 539—727) the ſame action of bringing down the lower jaw is aſcribed to the mylo and genio hyoidei muſcles: but, in proof of this laſt propoſition, I am made to ſay, that the *os hyoides* moves towards the lower jaw, when the jaw is brought down; or at leaſt I muſt be inferred to ſay ſo from my aſſerting that the muſcles above and below the *os hyoides*, having a conſiderable curve at this bone, muſt draw it forwards when they are acting.

If I had not ſaid that the *os hyoides* is brought down and reſtrained from coming too far forwards in opening the mouth, there might have been ſome grounds for the inference above mentioned; but, as I affirm both thoſe facts, the inference ought not to have been made from one circumſtance without mentioning the other two.

The ſecond propoſition (p. 540—729) is, " The ſtylo-hyoideus muſcle

ſerves

" ſerves to raiſe the upper jaw ;" the proof of which is the motion of the two jaws upon the ſame axis : the motion of the upper jaw is very different from the natural motion of the head, and altogether independent of the contraction of the ſplenius, complexus, or its other elevators ; and therefore, the raiſing of the upper jaw muſt be by the action of the ſtylo-hyoideus and poſterior head of the digaſtric.

If the reader is convinced that the circumſtances in the antecedent propoſition are diſproved, as I have endeavoured to do, he will reject the conſequence here drawn.

Though we follow Mr Ferrein in his ſuppoſition (p. 541—729) of the ſtylo-hyoideus muſcle being extended to the chin inſtead of being fixed to the *os hyoides*, we would not find this muſcle could make any effort to raiſe the upper jaw: For the head always performing its motions on the ſpine, and the ſtyloid proceſs, which is the part of the head to which this muſcle is fixed, being farther forward than the axis of the head's motion, the muſcle never can draw down the back-part of the head to raiſe the fore-part.

The 1ſt proof of the ſtylo-hyoideus raiſing the upper jaw is founded on the following general rule: " Every muſcle being connected at its two " ends to two different bones, all motion of one or the other of theſe bones, " which cauſes one of theſe ends to come nearer to the other end, depends, " at leaſt in part, on the contraction of that muſcle. The rule, it is added, " is perhaps new."

Is it new to you, gentlemen, that muſcles ſhorten, or endeavour to ſhorten themſelves, when they act, and that they muſt be ſhorter when their ends come nearer each other ? And, if the rule is true, does it not prove what I formerly inferred from it concerning the action of the ſplenius and complexus ?

Whoever lays it down as an univerſal principle, that every muſcle becomes ſhorter when it acts, or that every muſcle which ſhortens itſelf is exerting its force, is in a miſtake, as is evident in numerous examples. Thus, when one ſits down on a ſeat, the extenſor muſcles of the legs, and the retractors of the thighs, are in ſtrong action, yet are lengthened; while the flexors of the legs and thighs are ſhortened, but unactive.— The extenſors of the ſpine are the acting but elongated muſcles, when

we bow forwards. Nay, of two muſcles which ſeem to have nearly the ſame direction and uſe, the one may act without the other. Thus the *biceps flexor cubiti* and *brachiæus internus* generally act together in bending the fore-arm: but, if the fore-arm is to remain extended, or is to be kept fixed in any degree of flexion, while the arm is to be ſtrongly raiſed and drawn forwards, the biceps contracts ſtrongly, and the brachiæus is unactive; or if the fore-arm is to perform ſtrongly the action of pronation, while it is to be bended with little force, the brachiæus may act while the biceps is unactive, leſt this latter muſcle counteract the pronators, whoſe force is then principally required.

I hope the feeble criſpation of the muſcles which I have ſaid to be unactive in the foregoing caſes will not be called their action, in order to find a contradiction in my words. Every one ſurely knows the difference between the weak natural curtation of muſcles and their ſtrong voluntary contraction.

If the rule is faulty, the example of the ſtylo-hyoideus, as here applied to illuſtrate it, is one of the moſt unfavourable in the body, becauſe, this muſcle being fixed to a part of the head farther forward than its axis of motion, it is impoſſible ſuch a muſcle ever can raiſe the head. But, ſuppoſing the connection of this muſcle to the head to be farther back than its axis, and ſuppoſing the cornua of the *os hyoides* to reſt with their points on the vertebræ of the neck, can it be imagined that ſuch ſlippery round points could poſſibly ſtand ſo firm on the ſlippery vertebræ as to be a fulcrum to the head in its elevation, eſpecially too while the traction is at the other end of the cornua, and in a very oblique direction? or could ſuch points be preſſed with ſo much force upon the muſcles covering the vertebræ without hurting them?

In my anſwer to Mr Winſlow, I mentioned what I thought the uſe of the ſtylo-hyoideus muſcle in opening the mouth: and therefore may paſs Mr Ferrein's ſecond propoſition, which treats of that ſubject, without examination; as I may alſo do to his third propoſition, wherein he aſſigns the ſame uſe to the *mylo, genio, ſterno, coraco hyoidei* muſcles, as I had done.

In his fourth propoſition, (p. 543—732) he undertakes to prove, "that "the mylo and genio hyoidei aſſiſt in certain caſes the ſtylo-hyoidei to "raiſe

" raiſe the upper jaw, but that the ſtylo-hyoidei never can aſſiſt the for-
" mer to bring down the lower jaw."

The power of the ſtylo-hyoidei to raiſe the upper jaw, and the cornua of the *os hyoides* ſerving as fulcra to the head in its elevation, being the foundations on which the proof of this propoſition is laid, I need not do more than mention it, and refer to what has been ſaid againſt theſe foundations of it, which may alſo ſerve as an anſwer to what is ſaid of the poſterior head of the digaſtric muſcle (p. 544, 545,—734 736), where the ſame principles are made uſe of.

What is ſaid (p. 544, 545—734, 735), of the anterior head of the digaſtric, is appealing to his general principle about the ſhortening of muſcles, and repeating what Mr Winſlow had ſaid; which, being already examined, need not now be conſidered.

Had not Meſſrs Winſlow and Ferrein been ſo fond of the impoſſible reverſion of the head upon the condyles of the lower jaw, they might have had a better argument than any they have employed for the action of the digaſtric muſcle in opening the mouth: They might have obſerved, that the poſterior belly of the digaſtric is fixed to the ſkull, at leaſt as far back as the condyles of the occiput, where the axis of the motion of the head is; and therefore, when that muſcle acted, it might draw down the back-part of the head, and ſo raiſe the fore-part, while the anterior belly brought the lower jaw down.

Leſt ſome other make uſe of this argument againſt me, I muſt obſerve, that the axis of the head is much farther back than its centre of gravity; on which account the head falls forward on the breaſt, whenever the organs that ſupport it are weak and unactive, as in infants, ſleeping, drunken, fainting, apoplectic people, whenever they are put in an erect poſture. The organs which ſupport the head from falling forwards are the ſplenius, complexus, and other muſcles placed on the back-part of the neck, as is evident from the head's bending forward when theſe muſcles are cut tranſverſely, from the retraction of the head when they are convulſed or inflamed; and many more ſuch proofs might be named. Theſe muſcles are not only ſtrong by their number of fibres, but they are inſerted into the head in a much more advantageous way than moſt

muſcles of the body are in their reſpective bones: for they are fixed into the head nearly at right angles, and at a conſiderable diſtance from the axis, that they may have a long lever to act with; and their other end is fixed to the vertebræ, where little motion in the direction of their traction can be allowed: whereas the digaſtric muſcles have few fibres, are fixed very near the axis, at a very acute angle, and are connected at their other end to a very looſe moveable part; and therefore can never officiate inſtead of the other powerful organs. Nor would the fixing of the *os hyoides* by the muſcles below it render the digaſtric any way equal to the office of raiſing the head, while the action of the poſterior head of the digaſtric would diminiſh the force by which the lower jaw is drawn down juſt as much as the power of its own action: for it muſt be evident, that the lower jaw can be drawn down with no greater force by muſcles fixed to the *os hyoides*, than what is exerted to keep that bone down. Whenever the power is greater that draws the *os hyoides* up, than what pulls it down, it muſt be moved towards the jaw, which it never is in opening the mouth.

P. 547, 548—739, it is granted, according to what is in the Eſſay, that the mylo and genio hyoidei muſcles draw the jaw backwards.

I paſs ſeveral little things which may be criticiſed in the four following pages, to come to the concluſion of this memoir; where it is aſſerted, "That Bidloo, Cowper, and Monro, conclude it impoſſible to ſwallow "while the mouth is open; which reaſoning is deſtroyed by experience, as "may be obſerved in thoſe who drink, pouring the liquor from above "into the mouth."

I can ſee no ſuch aſſertion in Bidloo, either where, in tab. xv. of his *Anat. Corp. Hum.* he has painted the digaſtric muſcle, nor where the lower jaw is delineated in tab. xcii.: nor is it to be expected any where in his large anatomy, becauſe, in the preface to it, he declares, he is not to give the hiſtory of the uſes of the parts; nor have I obſerved it in his *Exercitationes*.

Cowper, in the explication of Bidloo's tab. xv. and in both the editions of his Myotomy, ſays, "When we ſwallow our aliment, we ſhut

"our

" our mouth;" which is true: but he mentions nothing of the impoſſibility of doing otherwiſe.

Monro's words are, (Eſſays, vol. i. p. 114 *), " One can ſcarce ſwal-" low any with his mouth open:" which might be tranſlated into French, " C'eſt avec beaucoup de difficulté qu' on peut avaler quand la bouche eſt " ouverte;" which, I ſuppoſe, Mr Ferrein will allow.——The experiment of ſwallowing when liquor is poured into the mouth from above, does not prove it not difficult to ſwallow with the mouth open; and in this ſituation, the weight of the liquor ſupplies, in a great meaſure, the office of the digaſtric muſcles.

The challenge of the accuracy of quotations, puts me in mind to remark, that Mr Platner, whoſe pen is ſaid (p. 427—578) to have been employed about the uſe of one of the muſcles of the lower jaw, does no more than relate ſome of the things which authors, and particularly Mr Winſlow and I, had ſaid, declaring, p. 14. *Nec in has lites ire, nec eas componere auſim:* " He will neither enter into nor determine this diſputed que-" ſtion."

ANSWER to Profeſſor WALTHER.

IN a diſſertation *de Oſcitatione*, publiſhed at Leipſic in 1738, the profeſſor, p. 12. criticiſes my fourth objection to the office commonly aſcribed to the digaſtric muſcles. The character which a very good judge † gives of this gentleman's writings, obliges me to tranſcribe his own words, that others may know whether I do him juſtice.

After giving a tranſlation of my objection, he ſays, " Itaque, ut lucu-" lenter adpareat, quomodo ille ſcriptor, hac doctrinæ ſuæ parte, motus " componat, qui aliter a ſe diſtingui debent, hinc ita arguendo rem de-" claramus: Caput reclinare eundem affectum habet ac ſi in vivo homine " id extendatur. Hinc idem erit, atque maxillam inferiorem ab infe-" riore, præſertim in cadavere, ubi hæc per ſe ſtupida cernitur, diſcedere " jubere,

* Or p. 238, *ſupra*.

† Haller, Method. ſtud. Medic. p. 548, dictione paulum obſcuriore uſus eſt.

" jubere, et ita os aperire. Porro, caput reclinare, idem erit, ac diga-
" ſtrici originis locum demittere, et, ſi manſores muſculi maxillam in
" vivis fixerint, hanc capitis reclinationem, contractione digaſtrici juvare;
" ſed præter hunc caſum, eundem muſculum debilitare, et pro maxilla
" deducenda inertem reddere: nihilo minus tamen eundem, tanquam ſi
" ligamentum eſſet, longiorem facere, et ita intendere, ſimul, os hyoides
" non propria, naturali, ac facillima contractione muſculi, ſed plurium
" partium communi tenſione ac motu, levare. Nam omni occaſione, os
" ipſum quoque tollitur, etiamſi maxillæ committantur, et tantum caput
" reclinetur; ſicut, quod inter pomum Adami et os hyoides ſpatium eſt,
" ac illo tempore admodum augetur, etiam in vivis hanc rem probavit.
" Eadem fallacia communis atque proprii motus adſertio nititur, cum cl.
" Monro præſumit; toties os hyoides deorſum duci, quoties maxilla vivi
" hominis deſcendit. Verum, ubi caput erigitur, et binæ maxillæ com-
" mittuntur, quin et deglutitione accidit, ut priores hyoidei muſculi et pars
" ſtylo-pharyngæi os bicorne aliquantum tollant, aut alium membranarum
" nexum hoc os ſequatur, ut, digito altero ad mediam baſin, et altero
" ad cornu admoto, facile percipitur. Sed, quando jam maxilla move-
" tur, tum hoc fere leviſſimo modo os hyoides demittitur: imo, eo tem-
" pore, ſterno-hyoideos aut ſterno-thyroideos muſculos non contrahi, vel
" exinde judicare Monro potuiſſet, quod hic maxillæ motus, et oris hia-
" tus, motus proportionem, quo os hyoides deſcendit, creberrime ſupe-
" ret; et maxime, quod, ore clauſo, perinde ac aperto, ſcutiformis carti-
" lago, ſub oſſe hyoideo, in alterutrum latus, pari facilitate converti
" poſſit."

The objection here, I imagine, is, that the *os hyoides* riſes when the head is extended, and deſcends when the head is bended, though the mouth is ſhut all the time; the riſing of the *os hyoides* in the former caſe being owing to the ſtretching of the parts, without any contraction of the muſcles which are connected to the *os hyoides*, as the deſcent of this bone in the flexion of the head depends on the natural elaſticity or reſtitution of the overſtretched parts ſtretched beyond their tone.

If I had propoſed no more to be done, than to obſerve what happened to the *os hyoides* when the head was alternately bended and extended, the objection would have been reaſonable; but as I deſired muſcles to be drawn

drawn with hooks and threads, while the poſture of the head remained the ſame, and appealed to the feeling of muſcles hard, ſwelled, and tenſe, while the different actions were performed by a living perſon, this objection can have no force.

It is to be wiſhed, too, we had been here told, how a muſcle becomes weaker and unfit to do its office, by ſtretching it, and making it tenſe, as ſeems to be affirmed in regard to that digaſtric muſcle; for, on the contrary, it is a doctrine generally received, that muſcles exert moſt force when they are tenſe.

The particular objection to the ſterno-hyoidei and ſterno-thyroidei muſcles acting in opening the mouth, to wit, that very frequently, in this action, the lower jaw moves proportionally more, and the mouth is wider opened, than the *os hyoides* deſcends, will not be inſiſted on by any who conſider, 1. That ſuppoſing theſe muſcles to be the only depreſſors of the jaw, the chin would move downwards much more than the ſpace which theſe muſcles contract, or than the *os hyoides* deſcends. 2. That muſcles placed between the *os hyoides* and chin, contribute to the opening of their mouth by the contraction; the quantity of which is not ſo great as the defect of the chin occaſioned by this very contraction is.

To illuſtrate theſe propoſitions, and ſome others mentioned in my reply to the two learned academicians, and to ſhow ſome other things not generally attended to in conſidering the motions of the jaw, I ſhall make uſe of a little figure, repreſenting theſe parts in their motions.

Let A, fig. 2. (Plate II.) be the axis of motion of the lower jaw;—— B, C, D, the chin. AB, then, is the jaw in the reclined or extended ſtate of the head; AC is the jaw in the middle or erect ſituation; AD is the jaw fully depreſſed.—Let E be the *os hyoides*; EB a muſcle fixed to the *os hyoides* and chin; AC, ED, the ſame muſcle ſhortened as the jaw deſcends; ED being in the ſame plane with the jaw, and EB perpendicular to that plane.—Let EF be a muſcle extended between the ſternum and *os hyoides*.

Hence it appears, 1. That the depreſſors of the jaw, being fixed at a greater diſtance from the centre of motion, than moſt other muſcles are fixed to their reſpective bones, have a longer lever to act with.

2. Suppoſing the *os hyoides* E unmoved, while BE acts, the ſpace which

EB

EB contracts, is ſo much leſs than the chin deſcends, as B*g*, the difference between B*e* and CE, is leſs than the ſpace between B and C.

3. Leſs ſhortening of the muſcle EB is required as the chin deſcends, to make the chin move equal ſpaces; for C*h* or *g i* is leſs than B*g*, though the ſpace between B and C and between C and D are equal.

4. The angle ABE is larger than ACE, or any angle which could be between the muſcle and the chin, moving from B to D; and the farther EB recedes from being perpendicular to AD, the angle between the bone and muſcle always becomes leſs; that is, the angle of inſertion of this muſcle is decreaſing as it continues to act.

5. If ever the muſcle and jaw are in the ſame plane, as AE and ED here coincide, the muſcle may draw the bone back, but can no longer depreſs it; and if the bone was brought lower down by any other power, this muſcle would raiſe it, inſtead of drawing it down.

6. The muſcle EF acting, may be conſidered as fixed to the point E, *e*, *e*, of the jaw; and therefore this muſcle ſhortens itſelf ſo much leſs than the chin moves, as the ſpaces between *e* and *e*, or *e* and E, are leſs than the ſpaces between B and C or C and D.

7. If the *os hyoides* E moves downwards at the ſame time that the jaw deſcends, then the muſcle EB requires to have a leſs quantity of contraction, than when E is fixed, to move the jaw through the ſame ſpace; from C to *k*, is longer than EC, and the angle of inſertion does not decreaſe ſo much, the angle AC*k* would be larger than ACE.

8. If E moves only forwards while the jaw deſcends, the muſcle EB requires to ſhorten itſelf more than when E remains fixed. A line drawn from C to *l*, is ſhorter than CE, but the angle of inſertion does not decreaſe ſo much; AC*l* is larger than ACE, and EF acquires a longer lever.

9. When the *os hyoides* is moved forwards and downwards while the jaw deſcends, the angle of inſertion of EB decreaſes leſs than when it is fixed, and EF acquires a longer lever; but the quantity of contraction of EB may be more or leſs, or the ſame, according to the proportion of the advancement forwards and of the depreſſion of E.

No 6.

THE

MECHANISM

OF THE

CARTILAGES between the TRUE VERTEBRÆ (*a*).

SEVERAL of you, Gentlemen, ſaw what was ſhewed here laſt winter, as a ſtrange uncommon fiſh, by a ſoldier. It conſiſted of two round plates of bone, with a flexible tough ſubſtance, about 1½ inch thick, interpoſed between them and connecting them. No preſſure could force the middle centrical part of the plates nearer: but upon preſſing any ſide of either of the plates, they approached each other, the intervening ſubſtance at the preſſed part riſing outwards into a convexity, while the oppoſite ſide, where the plates were ſeparated, ſtretched conſiderably; all theſe motions ſeeming to be performed upon a ſolid firm ſubſtance placed in the centre.

Some of the young gentlemen who ſtudied under my care, ſearched along the ſea-ſhore, till, near to Granton, where a young whale was caſt aſhore a few years ago, they found ſuch another body; and, ſeeing the vertebræ of the whale near to it, they were ſo obliging as to bring it, with one of the vertebræ, to me.

Upon comparing the ſurfaces of the plates with the flat ſurfaces of the body of the vertebra, it was at firſt ſight obvious, that the plates were no other than epiphyſes ſeparated from two adjacent vertebræ, and the intermediate ſubſtance was the cartilage interpoſed between the vertebræ. Upon cutting the ſoft ligamentous ſubſtance, its concentrical fibres ſhewed

(*a*) Edin. Med. Eſſays, Vol. V. No xviii.

themſelves; and it became ſofter gradually, till in the centre, where it had reſiſted all preſſure formerly, it was altogether in a liquid form.

The view of the play of theſe two plates, by means of the interpoſed ligament, with a liquor in the middle of it, ſerved to explain to me the deſign of the ſtructure of the cartilages between our vertebræ, which I was at a loſs to underſtand before, though it is of the greateſt advantage.

The mucous part of this ligamentous cartilage in the human body is placed near to the poſterior part of the bodies of the vertebræ; and therefore is nearly in the middle between the anterior part of the bodies and the oblique proceſſes of the vertebræ: ſo that, when we ſtand erect, each vertebra reſts upon a fluid fulcrum or ſort of pivot, the motion upon which to any ſide is eaſily and quickly performed, and, at the ſame time, is not too haſty or unequal; for the compreſſibility of the cartilages gradually increaſes from the liquid central incompreſſible part towards the circumference. Without this central pivot, in moving the ſpine from any reclined poſture to the oppoſite one, particularly in moving forwards a ſpine that was reclined far back, there would often be the greateſt danger of a moſt violent ſhock of one vertebra upon another, and, indeed, of all the parts of the body ſupported by them; whereas this contrivance allows a very gradual change of the centre of motion of each vertebra, accommodated to the bearing of the ſuperincumbent weight in the different deflections of the ſpine from an erect poſture, or in raiſing it to ſuch a poſture.

This liquid fulcrum, too, will bear off the great preſſure which the veſſels of the ligamento-cartilaginous ſubſtance would ſuffer in our erect poſture, that might be of ill conſequence; while the abſorption of this liquor, increaſed by ſtrong preſſure, will ſerve to account in part for the difference of ſtature at night and in the morning.

AN

No 7.

AN

ESSAY

ON

The CARIES of BONES.

THE nature and ſeat of a diſeaſe being known, there is no difficulty in underſtanding what chirurgical operation ought to be performed, and the effects of every part of the operation can be demonſtrated; ſo that ſurgeons are inexcuſable if they do not reform what is faulty in the manual part of their buſineſs. The effects of medicines not being near ſo evident, but requiring long and accurate obſervation to diſcover them fully, are much more liable to be miſtaken. People are too haſty in making concluſions; a ſingle caſe or two has too often been the occaſion of fixing a general rule for the cure of diſeaſes.—The different circumſtances of diſeaſes and patients are not ſufficiently regarded, medicines being often ordered more for the name of the diſeaſe than for the ſymptoms of the patient.—If a cure is made, the ſucceſs is attributed to the medicines, without any examination whether nature has not made it in oppoſition to medicines very improper to aſſiſt her.—Men of great fame have been ſubject to ſuch errors, and they have been followed by the generality of practiſers.—What people have embraced for truths in their youth they are unwilling to contradict afterwards, and the early impreſſions which our mind receives are with difficulty effaced; the human mind is the ſame it was in Horace's days, the *Quo ſemel eſt imbuta recens* is ſtill true.—In ſo many different ways may people, acting with the utmoſt

ſincerity and *bona fides*, be led into error about the medicines they employ in diſeaſes.

If gentlemen would patiently and aſſiduouſly obſerve the circumſtances of their patients, and the operation and effects of medicines:—If, after remarking the evident ſenſible effects of medicines, they would reaſon from one caſe to another, by obſerving the analogy between them; they would be convinced, that the common routine is often not to be followed, but that a more ſafe and effectual method of cure ought to be purſued.—If no more credit were to be given to writers than what is ſupported by not only their multiplicity of practice, but by their accuracy in relating circumſtances, and by the reaſonable indications on which their practice appears to have been founded:—If, inſtead of taking one or two of our cotemporaries as our conſtant guides, we would compare ſeveral writers of different ages, to diſcover whoſe practice was moſt on a rational foundation:—If theſe methods were purſued, I am perſuaded the common practice, in a great many caſes, would ſoon be changed.

General ſchemes of this kind are, I know, commonly looked upon as words of courſe, and as little regarded as if one was propoſing a project impoſſible to be executed. An example of the practice in a particular diſeaſe, varied hitherto in many different ways, and moſt of it founded on very little reaſon, with a propoſal of reforming it according to the plan above mentioned, may poſſibly have greater influence, which I ſhall therefore now lay before you.

In complaiſance to the deſire of ſeveral of my pupils, I have choſen for this example, that corrupted ſtate of bones which ſurgeons name *caries*, *ſphacelus*, *teredon* or *tredon*: In treating which, I ſhall give, in the hiſtorical way, a ſhort ſketch of what ſome of the moſt eminent writers have ſaid upon it; next, I ſhall deſcribe the different appearances I have had occaſion to obſerve of this diſeaſe; then I ſhall examine the manifeſt effects of the different medicines which have been uſed or propoſed for it; and, laſtly, I ſhall conſider what method of cure appears moſt reaſonable according to the various circumſtances.

In the works commonly aſcribed to Hippocrates, the caries is ſaid to be a dried pituit between the laminæ of the bones (*a*), or earth dried by heat

(*a*) De Morb. lib. 2.

heat (*a*), or a defect of the mucus (*b*).—The account of the ſymptoms is very incomplete (*c*). The prognoſis is as ſuperficial; for I ſee no more than that in tedious ulcers the bones are affected, and the cicatrices are hollow (*d*), and livid fleſh in a diſeaſed bone is a bad ſign (*e*). As to the cure; cold is ſaid to be hurtful to bones (*f*), and this diſeaſe is to be treated as a fracture (*g*).

Celſus gives no opinion of the cauſe of the caries, and deſcribes very few of its ſymptoms, but is very particular in his directions concerning the cure.

His application to bones laid bare in a compound fracture is wine, oil, and ſuppurants (*h*). In a fiſſure or fracture, where it is not neceſſary to take out the bone, he orders a cephalic plaſter, ſoftened with vinegar, to be applied; and propoſes that the ſame plaſter, ſoftened with a cerate of roſes, ſhould be uſed afterwards as an incarner (*i*). His medicine for ſtopping the hemorrhagy, which ſometimes happens in cutting the teguments to lay the ſkull bare, and after raiſing pieces of it from the *dura mater*, is vinegar (*k*).

In the caries of bones, Celſus's method (*l*) is to lay all the carious part bare; and, if it is then doubtful how deep the caries goes, to pierce with the tereba (or pyramidal perforative) till the raſpings are no more black. ——If the caries is ſuperficial, he orders it to be burnt once and again with a hot iron, that a ſcale may ſeparate from it; or to raſp it till either drops of blood ouzing out, or the white ſurface of the bone, ſhow all the carious part to be taken away, when nitre (*m*) well pounded is to be ſprinkled on the bone.——When the caries is deep, he adviſes a great many holes to be made through it with the perforative, into each of which a red-hot iron is to be put, till the bone is quite dry; for thus, adds he, the corrupted part will be brought off.—When the caries penetrates to the other ſide of the bone, it muſt be cut out.—When the extent of this deep caries is not larger than what the head of the trepan will cover, he employs this inſtrument

(*a*) De Carnibus. (*b*) De Articul. (*c*) De Morb. lib. 2.
(*d*) Aphoriſm. § 6. aph. 45. (*e*) Ibid. § 7. aph. 2. (*f*) Ibid. § 5. aph. 18.
(*g*) De Morb. lib. 2. (*h*) Lib. 8. cap. 8. & 10. (*i*) Ibid. cap. 4.
(*k*) Ibid. (*l*) Ibid. cap. 2. & 3.
(*m*) Dioſcorid. lib. 3. cap. 8. ſays, Nitre and its ſpuma is biting, and has the force and burning of ſalt.

inſtrument to take it out.—If the caries is large, he orders holes to be made round the edges of it with a perforative; and then, cutting the bridges between theſe holes through with a ſtrong knife ſtruck with a hammer, he takes away all the carious part.

The medicines which Dioſcorides chiefly recommends for bringing away the ſcales of bones, or for what is now called their exfoliation, is the powder of the root of the peucedanum (*a*), and the juice of euphorbium; deſiring the teguments to be defended with liniments or cerates, when the euphorbium is to be applied (*b*).

Galen defines bones to be the hardeſt, moſt dry and terreſtrious parts of the body (*c*), whoſe qualities are cold and dry (*d*). He thought a caries in a bone analogous to an ulcer in a ſoft part (*e*); and that it was occaſioned either by the adjacent fleſh generating a bad ſanies, with which the bones being moiſtened were corrupted (*f*); or that it was owing to a mucous humour drove to the bones (*g*).

In conſequence of this general doctrine concerning bones and their eroſion, with the general axiom, that contraries are the remedies of contraries (*h*), Galen muſt neceſſarily have been led to diſcharge all things which he eſteemed cold (*i*), and to recommend driers (*k*) in a caries. He is very ſparing in his recommendations of particular medicines for this diſeaſe; opoponax in ulcers of bones, and *rad. peucedani* for exfoliation (*l*), with ſome compounded plaſters (*m*), are all he mentions.

The Greek phyſicians after Galen have added little concerning this diſeaſe, except ſome few medicines, anſwering Galen's intentions of cure. Paulus Ægineta (*n*) has ſomething of a different formula for making the affected part of a bone ſeparate; it is a cataplaſm made of the leaves of the wild poppy and of the fig-tree, with barley-flour and wine; or, inſtead of it, he recommends equal parts of the *ſem. hyoſciami* and of vitriol.

The

(*a*) Dioſcorid. lib. 3. cap. 77. (*b*) Ibid. cap. 8. (*c*) De Oſſib. in proœm.
(*d*) De Element. lib. 1. cap. 6. (*e*) De Cauſis Morb. cap. 11. De Medic. Art. Conſt. cap. 6.
(*f*) Comment. in Hippocrat. de Fract. lib. 2. § 20. (*g*) Ibid. de Articul. lib. 3.
(*h*) Comment. in Hippocrat. Aphoriſm. § 5. aph. 18. (*i*) Ibid.
(*k*) Ibid. § 6. aph. 45. (*l*) De Simpl. Medicam. Facult. lib. 8.
(*m*) De Compoſ. Pharmac. ſ. Loc. lib. 10. De Comp. Medic. per Genera, lib. 4. cap. 13. & lib. 5. cap. 2.
(*n*) Lib. 4. cap. 50.

The Arabians added greatly to the liſt of drying medicines: Moſt of them actually ſo; that is, in the form of powders: and the greater number potentially ſo too; that is, ſuch as, when taſted or applied to ſores, ſtimulate, raiſe heat and ſome degree of inflammation. They alſo reſtored the Celſian practice of burning and raſping diſeaſed bones (*a*), which had been neglected by the Greek phyſicians, but has been generally mentioned by writers after the Arabians.

One of the Arabians, Albucaſis (*b*), adviſes, in a compound fracture, where a bone is bare, to put a cloth dipped in black ſtyptic wine into the wound; but not to make uſe of a cerate, or any thing in which there is oil, leſt it make corruption happen to it.

Thoſe who wrote on ſurgery, when learning began to be reſtored in Europe, in the 14th and 15th centuries, copied moſtly the Arabians; but after burning the bone, which is the method of cure in the caries which the moſt eminent of them are fondeſt of, they applied oily medicines to the cauterized bone (*c*).

After chemie came to be cultivated in the 16th century, other methods of cauterizing were introduced.

Angelus Bologninus (*d*) tells us, that ſome in his time made uſe of ſcalding hot oil, heated roots of the aſphodelus, kindled brimſtone, and the water by which gold is ſeparated from ſilver.

Joannes de Vigo (*e*), beſides *aqua regia*, mentions oil of vitriol, *unguentum Egyptiacum*, and vitriol burnt and mixed with aquavitæ, as cauteries. After cauterizing, he dreſſed with *ung. abſterſivum de apio*; and ſays, that, by this method, the ſeparation of the diſeaſed part is made in forty days after cauterizing.

Veſalius (*f*) mentions *ol. ſulphuris* and euphorbium for the caries; but prefers a preparation of antimony, which he does not deſcribe.

Fallopius (*g*) agrees with Veſalius in the form of the drying medicines to be applied, and in the management of a bone after it is burnt. The place, ſay they, immediately after being burnt, is to be frequently moiſtened

(*a*) Avicen. Tract. iv. lib. 4. Fen. iv. cap. 11. (*b*) Chirurg. pars iii. cap. 20.
(*c*) Guy de Chauliac. traité iv. (*d*) De Cura Ulcer. lib. 2.
(*e*) Pract. Medic. ſecunda pars, lib. 3. De Ulcere cum Oſſe corrupto.
(*f*) Chirurg. Magn. lib. 4. cap. 14. (*g*) De Ulcerib. cap. 22.

ened with roſe water and the white of an egg, that inflammation and other ſymptoms may be prevented; afterwards the eſcar is to be ripened with butter or *ung. tetrapharmacum.*

Ambroſe Parè (*a*) ſays more explicitely than Albucaſis, that the application of unctuous and oily, or of moiſt and ſuppurating medicines, corrupts bones: Parè ſeems alſo fonder of the ſimple driers, that is, the abſorbent powders, than thoſe who went before him, whoſe driers were as much potentially ſo, as actually.

Fabricius ab Aquapendente (*b*) reckons aquavitæ among the ſtronger driers; and recommends the juice of leeks, with ſalt, for drying bones further after they are burnt.

Gulielmus Fabricius Hildanus (*c*) is rather more poſitive than Paré in forbidding the application of all moiſt and oily medicines to bones laid bare; he ſeems in one part of his writings (*d*) to expect always an exfoliation from bones laid bare, though in other places (*e*) he relates examples of bones laid bare being cured without any deſquamation.

Hildanus (*f*) introduced the free uſe of euphorbium and its tincture in ſpirit of wine; the acrimony of which the writers before him had warned their readers to guard againſt.

Marcus Aurelius Severinus (*g*) takes notice of the ſhrill ſound, as if a void was below, which a piece of bone has when ſtruck after its exfoliation begins. He recommends oil of euphorbium and of lime, as a proper application to corrupted bones (*h*).

Soon after Severinus's time, that is, about the middle of the 17th century, the eſſential aromatic oils of vegetables were introduced.

Nicolaus Tulpius's (*i*) favourite medicine for exfoliation, was oil of cinnamon with oil of ſublimate.

In the latter part of the laſt century, not only variety of theſe oils were uſed, and different tinctures in ardent ſpirits, and other compoſitions of the

(*a*) Livre 19. chap. 31. & 32. (*b*) Pentateuch. Chirurg. lib. 3. cap. 10.
(*c*) De Gangræn. et Sphacel. cap. 19. (*d*) De Ulcerib. cap. 22.
(*e*) Obſerv. cent. iv. obſerv. 95. & 96..
(*f*) De Gangr. et Sphac. cap. 19. Obſerv. cent. i. obſ. 92.—Cent. iv. obſ. 21. & 95.—Cent. v. obſ. 21.
(*g*) De efficaci Chirurg. pars ii. cap. 11. (*h*) Pyrotechn. Chirurg. lib. 2. pars i. cap. 4.
(*i*) Obſervat. lib. 1. obſ. 31.

the driers of the ancients, and of the aromatic oils, were contrived; but the alkaline ſalts, both fixed and volatile, ſuch as *ſal tartari*, *ſp. ſal. ammoniaci*, *&c.* came to be employed, as well as the acid ſpirits *ol. ſulphur. vitriol. &c.* (*a*).

While the generality of writers at this time were ſo fond of the aromata, tinctures, elixirs, ſpirits, &c. ſome mention their having cured carious bones by perforating, trepanning, and cutting them out (*b*), or by burning and deſtroying them with cauſtics (*c*). Others ſucceſsfully employed watery medicines (*d*), and dry lint (*e*).

Among the writers of this time, Wiſeman (*f*) is more accurate in relating the appearances of carious bones than former authors. They generally remarked only the black colour, greaſineſs, roughneſs, ſpongy ſoftneſs, ſtinking ſmell, and thin brown ichor, of bones when carious, with the ſpongy fleſh growing out from them. Wiſeman obſerves, that carious bones may be of a white, brown, or black colour; and adds, "If the white be pory, the caries may be deeper and more dangerous "than if it were black and hard."

His method of cure is like to Celſus's in ſeveral particulars. He orders all the carious part to be laid bare, with cauſtic applied to the teguments; then to ſcrape the rotten fleſh away, or to conſume it with eſcharotics: where that cannot be done, becauſe of large veſſels, nerves, or tendons, in the way, he deſires the orifices of the ulcer to be dilated with ſponge tent, gentian root, &c. But if the cure of the caries is of greater conſequence to the patient than theſe parts are, and they are ſo ſituated that the cure cannot be made without deſtroying them, he adviſes to cut them through to come at the bone. When the carious bone is laid bare, if the caries is ſuperficial, he would have it raſped, and then to be dreſſed with the milder ſarcotics, or digeſting ointment; in a few days after the application of which, he ſays, you may ſee the fleſh thruſt forth in ſmall

(*a*) See Barbette Chirurg. lib. 3. cap. 8.—Verduc Patholog. de Chirurgie, chap. 1. des Fractures.—Car. Muſitan. Chirurg. tom. ii. cap. 19.

(*b*) Scultet. Armament. Chirurg. tab. 27. explic. & obſ. 65.—Zodiac. Medico-gallic. anni 1679, menſ. Decemb.—an. 1681, menſ. Novembris.

(*c*) Lamzweerd, Obſerv. 90. (*d*) Scultet. Armam. obſ. 42. Ruyſch, obſ. 48.

(*e*) Ruyſch, obſ. 5. (*f*) Surgery, book ii. chap. 7.

grains, which is callus.—Burning with a hot iron he frequently uſed with ſucceſs for haſtening the exfoliation.——At other times he pinched away or broke off the caries.——His medicines are the driers, chemical oils, and eſcharotics; only that, in ſeveral caſes, where the bone lay deep, he uſed injections compoſed of the vulnerary plants boiled in watery liquors, with ſome ardent ſpirit, and a little *ſp. vitrioli dulc.*

I took notice formerly, that Hildanus expreſſed himſelf as if he thought bones laid bare muſt exfoliate: This came to be a general opinion, as is evident from the directions which moſt chirurgical authors give for treating wounds where bones were laid bare; and Belloſte (*a*) tells us, it was the univerſal practice in his time to dilate ſuch wounds, and to keep them open in expectation of the exfoliation. He endeavours to ſhow the abſurdity of this practice, and recommends to ſurgeons to endeavour to prevent exfoliation in ſuch caſes; and for this purpoſe, he not only adviſed what Fælix Wurtz and Cæſar Magatus had done before him, to wit, to bring the lips of the wound near together, and to dreſs ſeldom; but alſo propoſed, that when a conſiderable ſpace of the ſurface of ſmooth firm bones is laid bare, there ſhould be a great number of ſmall holes, made with a perforative of a trepan as deep as the diploë or cancelli of the bones; after which, he ſays, fleſhy papillæ riſe out from theſe holes, and extend themſelves all over the bared ſurface of the bones, and the wound is ſoon cured without any exfoliation. This practice has been approved by ſome conſiderable men, though, ſo far as I know, it has not been general among ſurgeons.—Belloſte condemns the application of acid ſpirits to bones, as increaſing the caries; and being of opinion that the air acts by its acid on bones, he inſiſts, in rather ſtronger terms than moſt former writers had done, that bones ſhould be well defended from the air.

Mr Petit (*b*) is the only author of this preſent eighteenth century, whom I need to mention. He names the ſeveral diſeaſes in which caries moſt frequently happens; and relates the ſymptoms by which it may be judged that a bone is corrupted: ſuch are, the deep-ſeated pains preceding an abſceſs forming near a bone, with a livid colour and ſpongineſs in the teguments; an ulcer continuing long near a bone; the ſprouting fleſh of ſuch ulcer appearing ſpongy, of a pale colour, eaſily penetrated by a probe, and bleeding

(*a*) Chirurgien d'Hopital, chap. 12. (*b*) Maladies des Os, tom. ii. chap. 16.

bleeding readily without giving pain; the quantity of matter being larger than commonly comes from an ulcer of that extent; the thin conſiſtence, browniſh colour, and ſtinking ſmell, of the matter; its appearing black on the plaſters, though there is no lead in their compoſition; feeling the bone ſcabrous and unequal.

Petit obſerves ſeveral appearances rotten bones have, which may make ſo many ſpecies of caries. 1. The ſurface of a bone may be corrupted, and may notwithſtanding be pretty firm and ſmooth, without throwing out much matter: he calls this a *dry caries*. 2. If the ſurface of a bone is very unequal, with a number of ſmall holes diſcharging large quantities of ſanies, he names the caries *vermouillé* or *worm-eaten*, from the reſemblance it has to wood eroded by ſmall inſects. 3. Fleſh may grow in the interſtices of the corrupted bony fibres, and may fill up the cavernulæ. 4. Sometimes the bones are imperceptibly waſted in the cancers.

Mr Petit ſays, the dry caries is generally the moſt ſuperficial, and cures more eaſily by exfoliation than the other kinds; which has made him think, "that the exfoliation of bones is only made readily when the carious part "has no more communication with the veſſels of the ſound bone. This "communication entirely ſtopt gives ground to believe, that the juices "which move in the veſſels of the ſound part make an effort againſt the "corrupted part; and that theſe efforts, redoubled by the reſiſtance, and "repeated every moment of life, are the cauſe which inſenſibly ſeparates "the corrupted part of the bone.

"I perceive ſoon, (ſays he), fleſh riſing in the circumference of the cor-"rupted piece, which grows more and more. I have reaſon to believe, "that, proportionally as the firſt efforts of the liquors make the ſepara-"tion, theſe nutritive juices congeal, and form fleſh; and that it is the "inſenſible growth of this fleſh which completes the ſeparation of the "piece of the diſeaſed bone, and thruſts it outwards. I am more certain "nature acts thus, becauſe I find this granulated fleſh in the place where "the ſeparated piece of bone was; and that the good qualities of this "fleſh make me certain that the bone is ſound below."

The motion of the corrupted piece of bone, and the blood coming out below it, are the ſymptoms by which Mr Petit tells us the exfoliation may be known to begin.

Our author remarks, that the worm-eaten caries, and that where fleſh riſes in the cavernulæ, may be of different depths in the bone, and are more difficult to cure than the dry caries.—When the quantity of ſanies (which is generally bloody in the latter ſpecies of caries) is very large, there is reaſon, ſays he, to ſuſpect it comes from the cancelli, where the marrow is contained, and where the diſeaſe frequently begins; from which, if it does not find an exit, it will kill the patient.

Mr Petit's methods of cure are theſe. When the caries is very ſuperficial, and of the dry kind, he dreſſes it with doſſils dipt in ſpirit of wine, as he would do a ſound bone laid bare; which he affirms does not always exfoliate.—If the caries is deeper, and an exfoliation muſt be haſtened, he applies to it *aqua fortis*, or ſpirit of nitre in which quickſilver has been diſſolved, which he recommends as a favourite medicine, and afterwards he makes uſe of ſpirit of wine.——He diſcharges the exfoliating part to be taken away till it is quite looſe.—If the carious part cannot be ſeparated by theſe means, he recommends the red-hot iron, raſping, the perforative, and trepan, as Celſus orders.

After the caries is thus removed, Mr Petit judges by the white, thick, mild matter, firm fleſh, and hollow hard cicatrix, that the bone is ſound; or he dreads a relapſe if the appearances are otherwiſe.

The general practice of our ſurgeons is to keep ulcers with carious bones as much dilated as they can by doſſils, ſponge-tent, &c. to deſtroy the ſpongy fleſh with eſcharotics, to apply ſpirit of wine, tincture of myrrh and aloes, tincture of euphorbium, and ſuch like, to the bone, and frequently to all the ſore.—As theſe ardent ſpirits are applied to haſten the exfoliation in a caries, they are applied, for moſt part, alſo to ſound bones laid bare, as preſervatives, it is ſaid, againſt their corruption, and to prevent exfoliation.

From this hiſtorical ſketch of what authors have ſaid of the caries, it is evident how little the circumſtances of this diſeaſe have been conſidered, and what a contradictory odd medley of practice has been followed; ſurely all of it could not have been ſupported by obſervations tolerably made. Of late, indeed, ſome ſpecies of this diſeaſe have been diſtinguiſhed, but the practice is too uniform in all of them. To reform this, it will be neceſſary to examine more accurately the appearances of this diſeaſe.

Previous to any account of the caries, it will be neceſſary to remark, that bones have their veſſels and circulating fluids, and in ſhort the ſame general texture which other parts have; ſo that ſolidity and ſtronger coheſion of parts are the only evident diſtinguiſhing characters of the compoſition of bones. Of this truth there are many proofs; ſuch as,

1. Bones are in the ſtate of membranes and cartilages before they oſſify.

2. The hardeſt bones have ſometimes changed back again into a ſoft ſtate.

3. The granulated fleſh which riſes out from bones after fractures, amputations, the trepan, or in exfoliation, differs nothing from what would come from any ſoft part, yet in ſeveral caſes becomes ſound ſolid bone.

4. When the texture of bones is unravelled artfully, and compared with the texture of the ſofter parts, it appears alike in each.

5. By a chemical analyſis, the ſame principles are obtained from bones as other parts, the proportion of theſe principles being different in different parts.

6. By comparing the diſeaſes of bones with ſimilar ones in ſofter parts, as I ſhall do in conſidering the different ſpecies of caries, the general propoſition, of bones differing only in ſolidity and coheſion of parts from the other ſofter organs of the body, will be further confirmed.

The ſpecies of caries which I have had occaſion to ſee, are,

I. What Mr Petit calls the *dry caries*, where the bone is pretty ſmooth and firm, and throws out little matter. Though the ſurface of the carious part of a bone, in this ſpecies, is not of a very dark colour at firſt, yet before exfoliation it becomes of a dark brown or black colour. An exfoliation is more eaſily obtained here than in any other kind. Before the corrupted part can otherwiſe be obſerved to ſeparate, one will hear, as Severinus remarks, a ſhrill ſound when it is ſtruck with a probe, as if it was hollow: ſoon after this, the edges of the carious part riſe a little, and pus, or, if preſſed, blood is ſeen coming out below them; granulated fleſh then appears at theſe edges; the bone is more raiſed gradually towards the middle, till all the carious part is ſeparated from the new ſprouting fleſh, which riſes upon the whole ſurface of the bone below, and ſeems to puſh off the carious ſquama, ſo that it becomes quite looſe, and can be taken away without any violence. The ulcer is then in a fair way of curing;

and

and though a conſiderable thickneſs of bone has come away, yet, in ſome time after, little depreſſion is to be felt on the ſurface of the bone, the new fleſh having gradually become harder, till it ſupplies in a good meaſure what was taken away.

Whoever has ſeen the ſeparation of a gangrened piece of ſkin, or of the eſchar of a cauſtic applied to the ſkin, where a fiſſure firſt appears in the margin of the mortified part, pus begins to ooze out there, the diviſion between the ſound and mortified part becomes larger, new fleſh riſes, the ſeparation goes on from the circumference to the centre, till the mortified part drops off, and the new fleſh ſupplies its place: whoever, I ſay, has ſeen this, and compares it with the phænomena of the dry caries, will judge, that, allowance only being made for the rigidity of the bony fibres, which cannot contract as the fibres of the ſkin do, the appearances are the ſame in both caſes; and therefore I would call the ſtate of bones deſcribed above, the *gangrenous caries*.

II. The ſecond kind of this diſeaſe is Mr Petit's worm-eaten caries, in which the ſpongy or cavernulous texture is evident. It has not ſuch a dark colour as the former; the quantity of matter ſent out from the cellules of the bones is greater than in the former kind, and is vaſtly increaſed when the corrupted ſanies comes out from the marrow in the cancelli. Pieces of the rotten bone may be broken off here, or they may fall away; but no regular exfoliation is to be expected, unleſs when by art it is reduced to the former ſpecies. The gradual waſting of the bony fibres by the ſuppuration is often very remarkable in this caries; a piece of bone which appeared as large as the end of one's thumb, and of a ſolid ſubſtance, ſhall become leſs than the point of the little finger, and ſo ſpongy that it can ſcarce be touched without breaking.

The worm-eaten caries, where the ſubſtance of the bone only is affected, may be compared to an ulcer of the ſoft parts, which has a number of little ſinuſes in its ſides, ſuch as I have frequently ſeen when hard tumors had only in part ſuppurated, and were not all melted down into pus; drops of matter could be ſeen drilling out from the numerous orifices of the ſmall caverns in its ſides.—When the ſanies comes from the corrupted marrow in the cancelli, the diſeaſe is analogous to an abſceſs, the matter of which has eroded a number of ſmall holes in the ſkin.

III.

III. Frequently a ſpongy, bleeding, fleſhy ſubſtance riſes in all the little caverns of the worm-eaten caries; when it may be called *carnous*, and is much a-kin to ulcers with hyperſarcoſis.

IV. As the ſoft parts are diſſolved down into a mucaginous ſubſtance, which deſtroys their original form and texture, in the *white ſwellings*, as they are called; ſo in this diſeaſe, and ſome others, the perioſteum becomes thicker, the bone turns ſofter, its ſurface is eroded, a yellow red ſpongy ſubſtance ſprouts out, and, proceeding deeper into their ſubſtance, waſtes the bony fibres.

The difference of the appearance of this kind from what I call the carnous is, that in the carnous the ſpongy fleſh grows out of the caverns, while the grey or brown-coloured ſpongy bony ſides of them ſtill remain; whereas in the other, the bony fibres diſappear wherever the ſpongy fleſh comes, ſo that one can ſcarce determine by the probe whether or not the bone is carious. Upon ſcraping away this bone-conſuming fleſh, the ſurface of the bone appears rough indeed, but not much eroded nor greatly altered in its colour.

I have ſeen ſome ulcers in ſoft parts, where ſuch a conſuming ſpongy fleſh roſe.

V. Frequently, upon opening an abſceſs, one ſhall ſee at the bottom of it a white ſmooth bone, without its perioſteum or connection to any of the neighbouring parts, except by its ligaments at its extremities. By any trials we can make, and by what we can judge from the conſequence of the bone's changing its colour gradually as it continues expoſed to the air, and the neceſſity of its coming all away before any cure can be made of the ulcer, it appears, that there is no circulation of liquors in ſuch bones before the abſceſs was opened.

This way of bones mortifying happens moſt commonly in ſcrophulous patients, in whom ſomething analogous to this is likewiſe often to be obſerved in the glands, round which a ſlow ſuppuration is made, which leaves them almoſt entirely ſeparated from the ſurrounding parts.

VI. In one ſpecies of exoſtoſis, the tumefied part of the bone is ſofter than the reſt of it; and is not compoſed of regular fibres, nor cavernous, but as if the oſſifying juice had been thrown out irregularly; over which a cartilaginous or tendinous ſubſtance is ſpread; and from this a firm, ſhining,

ſhining, ſmooth fleſh grows out, which, after the teguments are removed, ſends forth a thin, ſtinking, acrid ſanies; the patient complains often of throbbing pains in it, and ſometimes conſiderable hæmorrhages are made from imperceptible veſſels in its ſurface. May not this be compared to ulcerated cancers of glands?

VII. In the ſpreading, eating cancers, which all practiſers know the ſymptoms of, the bones are waſted as well as the ſoft parts; and the appearances are the ſame in both, unleſs that the bones do not conſume quite ſo faſt.

Having mentioned from Wiſeman and Petit the general ſymptoms by which we may ſuſpect or know that a bone is carious, and having deſcribed what different appearances I have ſeen in corrupted bones, I ſhould, if I intended a regular treatiſe, proceed to the ætiology and prognoſis of each: but the former would lead me into too large a field of diſpute; and the latter would require ſo many ſuppoſitions as would be tedious, or would be ſo general as to be of little more uſe than the common directions laid down by practical authors eaſily guide one to: I ſhall therefore proceed directly to the therapeuſis.

In treating any caries, it is altogether neceſſary to examine ſtrictly all circumſtances; and to diſcover, if poſſible, what cauſe, either general or topical, may have made the corruption of the bones, that endeavours may be uſed to remove it, if it ſtill ſubſiſts. Seeing it would be very improper to pretend to give here directions for the cure of the lues venerea, ſcrophula, ſcurvy, gangrenes, abſceſſes, wounds, contuſions, and all the other diſeaſes which may occaſion caries, I muſt confine myſelf to the topical management of the caries, without any regard to the habit of the patient, or to any other diſeaſe.

A ſpeedy and ſafe ſeparation of all the corrupted part is then the principal indication to be purſued; for executing which, you have ſeen from the hiſtory very many means have been propoſed. To know which of theſe are preferable in the different caſes which may be under our care, it will be neceſſary to conſider the evident operation and effects of the ſeveral medicines propoſed, which may be reduced to the following claſſes:

1. The inſipid, terreſtrious abſorbents, ſuch as powder of coral, crabs eyes, &c. put into an ulcer, where a bone is carious, can have little other

effect

effect than to imbibe the matter of the ulcer; if they fall into any cavernulæ of the corrupted bone, they may remain ſo long there as that the matter that they imbibe may become acrid. Charpie lint is an abſorbent which has not this diſadvantage.

2. The powders which have aromatic or other acrid particles in them, ſuch as *pulv. rad. ariſtoloch. bryon. peucedan. aloe, myrrh, euphorbium*, not only abſorb liquors, but give more or leſs ſtimulus in proportion to their acrimony; and as the effect of all irritation is ſome degree of inflammation, which in ſores is principally removed by a ſubſequent increaſed ſuppuration, theſe powders may aſſiſt to ſeparate corrupted from ſound parts.—Such of them as have balſamic particles in their compoſition encourage the ſuppuration moſt.—Several of them reſiſt the putrefaction of animal-ſubſtances; and therefore may preſerve a carious bone, or the matter coming from it, from ſuch a high degree of putrefaction as they might otherwiſe go to.—Beſides theſe effects on the ſore, regard muſt always be had to their operation, if any of their particles are abſorbed into the blood-veſſels; for ſome of them produce more or leſs of fever, others become purgatives, &c. according to their different powers, which are known to thoſe who are acquainted with the virtues of drugs.

3. Ardent ſpirits, ſuch as *aqua vitæ, ſp. v.* being liquid, can be introduced further into a carious bone than powders can; they ſtimulate ſores, reſiſt putrefaction, harden the fibres, coagulate the liquors, hinder ſuppuration, and quicken the pulſe when abſorbed.

4. The tinctures of the powders N° 2. in the ſpirits N° 3. partake of the nature of both; but principally of the ſpirit, of which the larger ſhare of the compoſition conſiſts.

5. The eſſential oils, *ol. cinnamom. cariophyll. &c.* ſtimulate, erode, reſiſt putrefaction, and, mixed with the blood, raiſe ſome degree of fever.

6. Common oils, balſams, reſins, relax, increaſe the putrefaction, and are allowed univerſally to be the moſt effectual ſuppurants and incarners.

7. Water relaxes the ſolids and dilutes the fluids, when nearly of the ſame heat with animals.

8. Vinegar ſtimulates and reſiſts putrefaction; when weak, enjoys alſo the virtues of water; when ſtrong, approaches to the 10th claſs.

9. The natural ſalts, nitre, ſea-ſalt, alum, the vitriols, have different degrees of pungency, and proportionally ſtimulate or erode, otherwiſe they preſerve animal-ſubſtances from putrefaction.

10. Acid ſpirits extracted from foſſils by the force of fire, ſuch as *ſp. nitr. ſal marin. ol. ſulphur. vitrioli*, &c. coagulate the liquids, and mortify the ſolids: by being diluted with water, they approach to vinegar.

11. By diſſolving metallic ſubſtances in thoſe acid ſpirits, generally their corroding ſphacelating power is increaſed, and ſome of them give ſuch violent pain as frequently to bring on convulſions.

12. Metallic bodies corroded by acids generally erode when applied to ſores; ſome of theſe, for example ſublimate mercury, and ſome other mineral ſubſtances, particularly arſenic, have ſhaken the whole frame of the body when applied externally, and the mercurial preparations do ſometimes enter the blood to produce a ſalivation.

13. Alkaline ſalts and ſpirits, *ſal et ſp. c. c. ſal et ſp. ſal. ammoniaci, cineres clavellat. ſal tartar. ol. tartar.* &c. ſtimulate, erode, and increaſe putrefaction: when abſorbed, as the volatile ones very readily are, they quicken the pulſe. The eroding power of theſe ſalts is greatly increaſed in their preparations with quicklime, as in the common cauſtic; which mortifies any part of a living animal it is applied to, but with remarkably leſs pain than what the acids or their preparations with metals give.

14. All bodies heated beyond a certain degree, and applied to our bodies, give us pain, ſtimulate, and inflame; when greatly heated, they mortify whatever part of an animal they touch.

15. The effects of raſping, cutting, breaking, and trepanning bones, are altogether evident.

16. In every wound or ulcer, the matter diſcharged into it muſt be the moſt conſtant application to the ſides of the ſore: when this matter is laudable mild pus, it is one of the moſt powerful good digeſters, ſuppurants, and incarners; when it ſtagnates too long, or when the liquors or veſſels are faulty, it may become an acrid, ſtimulating, eroding ſanies; when abſorbed into the blood, it infects all the liquors, ſtimulates the veſſels, and is capable of producing violent diſorders.

The effects I have attributed to theſe medicines are ſuch as are evident to the ſenſes, andwhat all who practiſe know, but do not always conſider when

when they make uſe of them, otherwiſe they would have adapted them better to the ſeveral ſpecies of caries, and to the different ſtadia of each; to the cure of which I now proceed.

Of the Dry *or* Gangrenous Caries.

When the dark colour and dry ſurface of a carious piece of bone ſhow it to be fully mortified; eſpecially if the ſhrill ſound and riſing edges of it, with pus coming out below them, diſcover the exfoliation to be begun; nature, of herſelf, or with very little aſſiſtance, will make the cure.

If the pus is mild and in due quantity, it will prove the beſt ſuppurant and incarner for making the new fleſh thruſt off the carious piece of bone; care only being taken not to remove it too frequently, nor to allow it to remain ſo long as to become too acrid.

If the quantity of pus is too little, it is to be ſupplied by the medicines whoſe effects are neareſt to it, ſo that thoſe of the ſixth claſs are proper, *ung. baſilic. liniment. arcæi*, or ſuch like, every ſurgeon employs to haſten the falling out of a piece of ſkin mortified by a cauſtic. I have often employed them with equal ſucceſs in bringing away a ſquama of a carious bone, the ſeparation of which would neceſſarily be retarded by every thing which checks ſuppuration and the growth of new fleſh, as the common favourite medicines comprehended under claſs third and fourth neceſſarily do; though it muſt be acknowledged, nature, with the aſſiſtance of the balſam of her own preparing, pus, will often get the better of all that ſurgeons do againſt her.

While the exfoliation is making, the external opening in the teguments is large enough if the pus is ſo evacuated, that it neither forms ſinuous ulcers, nor is abſorbed to taint the blood; for otherwiſe it haſtens the ſeparation of the carious part of the bone more by being collected upon it, than when it has a free exit.

If, by the external orifice being ſmall, either of the bad conſequences juſt now mentioned happens, the aperture ought to be enlarged, either by filling it with prepared ſponge, which expanding itſelf ſtretches the orifice; or it may be enlarged by cutting with a knife, or eroding with cauſtic, the teguments which cover the caries; and they are afterwards to be

kept aſunder by filling the ſore with ſoft doſſils, and preſſing them in gently by a proper bandage.

When the colour of a part of bone is conſiderably altered from what it ſhould be in a ſound ſtate, but is not ſo dark as it can be judged to be entirely mortified; while there are no ſigns of its ſeparation, it may prove a very tedious taſk to truſt the exfoliation only to nature: and therefore, after laying all the altered part of it bare, if it can be done by the methods propoſed in the preceding ſuppoſition, the ſurgeon ought to try with the perforative, or with the raſper, how deep the diſeaſe goes. If it is only ſuperficial, a complete mortification is to be made, by applying a red-hot iron or potential cautery; after which, the caſe and its management is the ſame as was mentioned already.

If the alteration in the bone is deeper than the action of the iron or cauſtic can reach, the ſurgeon may cut off all that is ſuſpicious with a very ſharp inſtrument ſtruck with a wooden mallet, which gives little ſhock to the member; after which, he is to promote as much as poſſible the ſprouting of granulated fleſh, ſuch as riſes in exfoliations, from the whole ſurface of the bone, without which no cure is made, but the ſurface anew alters its colour and corrupts. If it was aſked ſurgeons, what the medicines are which would moſt readily procure the growth of fleſh, they would readily anſwer in general, pus and balſamic or unctuous medicines; and ſuch they would apply in all ſuch caſes except where bones are bare. For what reaſon this exception ſhould be made, I underſtand not. The parts which yield new ſprouting fleſh with the greateſt difficulty ought, one would think, to have the moſt powerful incarners applied to them: and now, after a great many trials, I can aſſure you, that no medicines ſo effectually prevent the corruption of bones laid bare, and aſſiſt to cover them ſo ſoon with fleſh, as ointments, balſams, and dreſſing ſeldom, to have the aſſiſtance of the moſt effectual balſam of all, pus. With theſe we ſee daily the extremities of amputated bones covered over with fleſh; and by this method I have had the pleaſure to ſee large parts of the ſkull, tibia, and other ſuch very ſolid bones, covered in a little time with granulated fleſh, after they had been laid quite bare by wounds made even with bruiſing inſtruments, and likewiſe after their

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exterior carious ſurface had been cut off as directed a little above, and a complete cure was made without the leaſt obſervable exfoliation.

It is plain, that, in the caſe I now treat of, where the corrupted part of a bone has been all cut away, or when ſound bones have been laid bare, and we wiſh to make a cure without deſquamation, that all medicines which can mortify the exterior fibres, ſuch are all eroding medicines, are to be ſhunned; as are alſo all ſuch as harden and dry fibres they are applied to, ſo as to prevent the growing of fleſh, which ardent ſpirits moſt effectually do: and therefore, of all the claſſes of medicines which I mentioned, there are none, except the abſorbents N° 1. and 2. the unctuous and balſamic N° 6. and water N° 7. which are not oppoſite to the indications of cure. The terreſtrious abſorbents are of no uſe; water dilutes and waſhes away the pus, ſo that ſome of the more active or balſamic powders and the unctuous medicines can only be the proper remedies here.

Whoever has taken notice of the progreſs of the exfoliation of a bone, or of the cure of a bone laid bare without exfoliation, muſt have ſeen the granulated fleſh riſing from every part of the ſurface of the bone to cover it; and that what fleſh grew out from any neighbouring part, though it may lie over the bone and hide it from one's ſight, yet it does not grow to the bone, and no cure is made unleſs by what riſes from every point of the bone; nay, very often ſurgeons are obliged to deſtroy ſuch overlopping ſpongy fleſh, to promote the cure: from which it is reaſonable to conclude, that Belloſte's dreſſing ſeldom contributed much more to the cures he performed without exfoliation of bones laid bare, than the holes he propoſes to be made with a perforative into the diploë or cancelli; the fleſh riſing from that ſofter ſubſtance, overſpreading the ſurface in the circumference of the holes, can be no better than the ſpongy fleſh which hangs over the bone from the ſides of the ſore.

If, notwithſtanding our endeavours to make fleſh riſe from the ſurface of a ſound bone laid bare, or of one that has had its mortified ſurface cut off, we cannot obtain this wiſhed for incarnation, and the ſurface of the bone ſhews its beginning corruption by a change of colour, it muſt be treated as above directed in the caſe where we ſuppoſed a ſuperficial caries; it muſt be completely mortified.

When

When the carious part of a bone is too thick for being ſeparated either by the raſper or chiſel, it is to be taken out with the exfoliating trepan, or by making a great many holes in the circumference of the caries; and then, cutting the bridges between them through, the middle of it is raiſed or cut off; after which, the management is the ſame as in the preceding caſe.

Very often there is not ſpace enough in the ſore to apply right the inſtruments proper for cutting away the carious part of a bone, and it cannot be ſafely enlarged. When this is the caſe, we can only haſten the exfoliation by fully mortifying all that is ſpoiled, by repeated applications of a red-hot iron or of potential cauteries. When the hot iron is to be uſed, the bone ought to be previouſly well dried, that the iron may not be extinguiſhed by the moiſture; and we are commonly deſired to guard the ſides of the ſore with wet rags: whereas, when either the iron is to be applied from time to time, or we can judge that the exfoliation cannot be ſpeedily made, while we wiſh to continue a larger external opening, the reaſonable practice is of deſign to burn the ſides of the ſore into a fully mortified eſchar, if ſome part is not to be hurt, the burning of which might be of very ill conſequence; for while this dead eſchar remains, leſs moiſture will be thrown out to prevent the effect of the cautery; and the ſubſequent applications of the hot iron can be made with little or no pain to the patient, and the orifice does not contract.—If a carious bone, which is to be burnt, lies deep, the hot iron ought to be introduced through a canula placed upon the bone, that the iron may be rightly directed.

If the potential cauteries are choſen rather than the actual, the common cauſtic, prepared of quicklime and ſoap-lees, deſerves the preference to any of thoſe compoſed of the acid ſpirits. For it gives not near ſo much pain, and is not ſo apt to occaſion convulſions: it penetrates better than the dry forms of eroded metals, and does not run ſo much when it melts as the more liquid acids do: it either is not abſorbed, or its effects are not obſerved in the blood; whereas the mercurial preparations frequently raiſe an unexpected ſalivation.—The reaſons given for burning the ſides of ſuch a ſore as I now treat of, are equally good for forming an eſchar all round the ſides with the potential cauteries.—This eſchar ought to be

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kept from ſeparating as long as the ſurgeon can. The moſt effectual way of doing this is to ſoak it frequently with ardent ſpirits; by which management the exfoliation of the ſides (pardon the expreſſion which I uſe to ſhow the analogy) may ſometimes be near as long in making as the exfoliation of the bone, if the ſuppurants, pus, and digeſting balſams, are rightly applied to it.

When the affected part of the bone is fully mortified either of theſe ways, the caſe is reduced to the ſuppoſition I firſt made, and is to be treated in the ſame way.

Though neceſſity obliges us to uſe cauſtics in the very deep dry caries, yet becauſe they require ſo much time, and ſo frequent applications, before they can pierce through any conſiderable thickneſs of a ſolid bone, I would prefer the chirurgical inſtruments, with which the whole corrupted part can be taken away at once, wherever they can be conveniently made uſe of.

After an exfoliating piece of bone is moveable, the orifice of the ſore ought to be made ſo large, by the methods formerly propoſed for enlarging orifices of ſores, as the ſeparated piece can eaſily be brought out, and without leaving any conſiderable hollow ulcer under the ſkin: for thus the pricking pain, which a looſe piece of rotten bone frequently occaſions when left to work its way through a ſmall paſſage, and the ſuppurations which may be occaſioned by its remaining under the teguments, may be prevented; and there is no danger of leaving a ſinuous ulcer, which may require more time and labour than is otherwiſe neceſſary for a complete cure of the ſore, which needs no other treatment, after all the corrupted bone is brought away, and the ſound part is covered with firm fleſh, than what any common ulcer does.

The caſes I have ſuppoſed may ſerve for underſtanding the different ſtadia of this dry caries, with the management neceſſary in each; and therefore I proceed to the ſecond ſpecies of caries which was mentioned.

Of the Worm-eaten Caries, *or* Ulcer *of the* Bones.

The cells formed in the eroded bone in this ſpecies of caries lodging and retaining the acrid putrid ſanies, which increaſes the diſeaſe, it is neceſſary

neceſſary to deſtroy all the affected part of the bone as ſoon as can conveniently be done.——Wherever the proper inſtruments can be applied, raſping, chiſeling, or trepanning, according to the depth or extent of the caries, will moſt ſpeedily anſwer the intention. After any of theſe operations are performed, the method of cure is the ſame as was propoſed when we ſuppoſed theſe operations to have been performed in the dry caries.

When the ſanies comes from the cancelli of the bones, the corrupted ſides ought to be taken out by one or more applications of the trepan.—If the carious part is of a large extent, the trepan is to be applied all round the circumference of it; and the bridges being cut through, it is to be all raiſed up. Robert Watſon was received into the Infirmary for a ſwelled carious tibia: the teguments were all mortified by cauſtic, and then cut away; the operation of the trepan was performed fourteen times in the circumference of the corrupted part, and all the anterior internal ſide of the middle of the tibia was taken out; new fleſh roſe from the cancelli, and became firm bone before he went from the hoſpital.

If leſs of the firm ſides of the bone are found to be corrupted than what, upon opening the cancelli, we diſcover them affected, care muſt be taken that the matter within the bone ſhould be eaſily diſcharged.

When, by the orifice through the ſides of the bone being in the lower part of the putrid cancelli, the matter eaſily flows out, or all the affected cavity can be filled with proper dreſſings, the cure may be made without taking any more off the ſolid ſides of the bone. The late Mr Macgill and I were conſulted about a girl who, after the ſmall-pox, had an ulcer very near the internal malleolus; a hole was eroded by the matter through the bone, large enough to let one's finger enter: a probe was introduced three inches upwards within the tibia, without meeting any reſiſtance; but, on directing the probe downwards, we felt the bone full of firm fleſh. A paſtil, made of myrrh, aloes, and honey, had been put every day into the bone; and the girl had a conſtant purging, which ceaſed a day after I ordered the aloes to be omitted in the dreſſing of the ſore. An injection, compoſed of digeſtive and melroſe diſſolved in water with ſome vinegar, was thrown every day into the bone, the paſtil of myrrh

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and honey was introduced a little way, the cavity of the bone gradually filled up with new fleſh, and a complete cure was made.

When the ſanies ſtagnates becauſe of the unfavourable ſituation of the aperture in the ſides of the bone, one or more new openings muſt be made with the trepan, till either the ſanies has a free exit, or all the part of the bone covering the putrid cancelli is taken away, when the common cures for other ulcers are to be employed.

If we cannot perform the neceſſary operations for removing a worm-eaten caries, we muſt burn it frequently with a red-hot iron; the directions for which operation were already given in treating of the dry caries. The hot iron ſeems to be preferable here to the potential cauteries; becauſe theſe may ſink into the cells, and erode deeper than we incline, while they might not deſtroy the exterior part.

When in this ſpecies of caries the ſanies is in great quantity and very fœtid, and the bone cannot be come at to do what is neceſſary for a free diſcharge, ſo that there is reaſon to be afraid, that not only the bone may be further eroded, but that the ſanies may be abſorbed to occaſion hectic fever and all its fatal conſequences, it will be fit to encourage the diſcharge of the matter as much as poſſible, and to apply ſuch medicines as blunt or deſtroy its acrimony. It is therefore neceſſary to dreſs frequently in this caſe, and to waſh out the ſanies at each dreſſing with a proper liquor. Ardent ſpirits, the tinctures made with them, and eſſential oils, do indeed deſtroy or confound the putrid ſmell of ſuch ſanies, and, by contracting the veſſels of any ſore they are put into, leſſen the diſcharge of the ſanies: which makes them anſwer the old theory of their being proper medicines for the caries of bones; which diſeaſe was ſuppoſed to be owing to too much moiſture thrown upon the bones, whoſe natural quality is dry, and therefore required drying medicines to cure them. Theſe, I am perſuaded, have been the reaſons why thoſe medicines came to be employed for carious bones. But from what has been obſerved of the different circumſtances of caries, it is evident, that theſe reaſons cannot be alleged for employing them in all caries: And in the very caſe which we now conſider, and which is the moſt favourable for uſing them, there are objections to them, which make others appear more reaſonable to be employed, and which, upon trial, I have found more

ſucceſsful. The objections are, That ardent ſpirits, and eſſential oils, in very ſmall quantity, or diluted, (for when pure and in large quantity they are cauſtic and penetrate too deep), retard the ſeparation of the corrupted parts: they render all the ulcer callous; which is indeed of ſome advantage to prevent proud fleſh while the bone is not ſeparated, but is troubleſome to remove afterwards: they are very readily abſorbed, and produce more or leſs fever, which hurts the patient. Some of the moſt common tinctures employed, that of aloes particularly, frequently bring on a conſtant purging. Common digeſtive or honey, or both, diſſolved in water, with which vinegar or ſome drops of an acid ſpirit have been mixed, more effectually correct the putrid ſanies, and can be uſed in any quantity to waſh it out of the ſore, without either retarding the ſeparation of the ſpoiled bone, or raiſing the leaſt diſorder if abſorbed; but, on the contrary, preventing the miſchief which the abſorbed ſanies would otherwiſe produce.—When the ulcer is deep, this medicine ought to be thrown into it from a ſyringe, that it may penetrate every where, and may bring the ſanies away with it when it recoils.

Of the CARNOUS CARIES, *or* ULCER *of* BONES *with* HYPERSARCOSIS.

THIS diſeaſe differing only from the immediately preceding in the addition of ſpongy fleſh growing in the cells of the bone, the general indications of cure alter very little: only, as this fleeſh bleeds eaſily, and obſtructs the ſurgeon's view, the raſping, chiſelling, and trepanning, cannot be ſo proper here as the cauteries for deſtroying the corrupted part; and ſeeing the liquors conſtantly oozing from the ſpongy fleſh ſoon extinguiſh the hot iron, the potential cauteries are preferable to the actual cautery. The application of the cauſtic will require to be frequently repeated, becauſe this kind of caries is generally very deep; and therefore it will be convenient to make an eſchar round all the ſides of the ulcer at the firſt application of the cauſtic, and to keep it as long on as we can, by ſoaking in ardent ſpirits, that it may ſerve as a fence for preventing the future cauſtics from ſpreading too far, or giving pain. The moiſture which the ſpongy fleſh in this diſeaſe ſpues out, eſpecially when irritated, is ſo great, that I have daily dreſſed ſuch ſores with powder of common

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mon cauſtic, removing a conſiderable quantity of gelatinous ſtuff which collected on the ſurface, where the cauſtic had been applied inſtead of the eſchar, which uſes to be made in drier parts.—If the cauſtic makes an adhering eſchar, it is in vain to apply any more cauſtic till that eſchar ſeparates; which is to be haſtened by ſuppurant ointments.—By ſuch repeated applications of common cauſtic, I have in a very ſhort time conſumed a whole metatarſal bone of the great toe of an adult, and have penetrated into the cancelli in the middle of a tibia, the leſſer and more ſpongy bones conſuming ſooner.

What has been ſaid of the two former ſpecies of caries, will readily make one know what further is to be done in managing the different ſtadia of this caries; it is ſufficient for my purpoſe to have mentioned what is peculiar to this diſeaſe.

Of the PHAGEDENIC CARIES *with* HYPERSARCOSIS.

THE management of this caries is nearly the ſame with the former: only one or two applications of the potential cauſtic are ſufficient to mortify ſome of the ſurface of the ſolid bone, which ſeems to reduce it to the dry caries. But I muſt obſerve, that when this caries is partial, I mean when it only ſeizes one part of a bone, which ſeldom is the caſe, the fleſh which thruſts off the mortified ſquama is for moſt part as phagedenic or bone-conſuming as what appeared at firſt; and therefore, even in this moſt favourable ſuppoſition, the ſurgeon ſhould not promiſe a cure, unleſs he has corrected the habit or topical indiſpoſition by internal remedies.

When this diſeaſe has taken firm roots, it will ſpread upon one end of a bone, which was in appearance ſound when the cure of the other end attacked by it was begun; and it will creep along from one bone to another; with this diſadvantage too, that it is far advanced before one can well diſcover it.

Of the Scrophulous Caries.

The ſpoiled bones here being principally retained by their ligaments, which we ſeldom can conveniently come at to cut through, and which are too ſenſible to be eroded, ſurgeons not only loſe their labour, but do conſiderable miſchief, when, in treating ſuch patients *ſecundum artem*, they forcibly keep open and dilate the orifices of ulcers where ſuch bones are, by cramming them with hard dreſſings kept in by a firm bandage, and by waſting down the ſpongy fleſh with eſcharotics, while they are forcibly endeavouring to make the bone come away. Such tender conſtitutions as theſe patients have, cannot bear ſuch rough treatment; they languiſh and decay under it. What I have always found of moſt ſervice, or rather that did the leaſt hurt, was to deſtroy fully the teguments covering the abſceſs formed in the bone with cauſtic, to cut the eſchar through the middle, to evacuate the collected matter, and to ſave the eſchar on the ſides as long as I could; to order very mild applications afterwards to the ſore, and to waſh it frequently with water for aſſiſtng the diſcharge of the matter; or, if the matter became fœtid, to mix a little vinegar with the water. Nature at laſt ſeparates the bone, which is to be taken out whenever it is quite looſe.

Of the Scirrho-cancrous Caries.

Actual and potential cauteries have the ſame effects here as in ulcerated cancers of glands; they do not diminiſh the tumour, create great pain, occaſion hæmorrhages when their eſchars ſeparate, &c. Moſt other medicines do miſchief, none of them do good: extirpation alone can make a cure; which may be done either by trepanning round the root of the excreſcence, cutting the bridges between the holes and bringing all away, or the member is to be amputated. All of them I have yet ſeen were ſo ſituated, that it was impoſſible to make the partial extirpation; ſo that I cannot ſay poſitively how it would ſucceed. After amputation of the member, the wound cures as well as in other diſeaſes; but ſome of the patients have ſince been ſeized with the ſame diſeaſe in another member.

Of the Spreading Cancrous Caries.

This ſort of cancer ſeldom cures; it will ſometimes get a ſkin upon it after cutting or burning, or with gentle drying medicines or dry lint, often breaks out again unexpectedly; in ſhort, it is one of the *opprobria medicorum* for which there is no certain cure yet found. I never ſaw this diſeaſe originally formed in the bones; they are only affected by being in the way of the diſeaſe; ſo that whatever change the original diſeaſe undergoes, the bones partake of it.

N° 8.

THE

DESCRIPTION

OF THE

HUMAN LACTEAL SAC and DUCT.

THE *receptaculum chyli* of *Pecquet*, or *ſaccus lacteus* of *Van Horne*, is a membranous ſomewhat pyriform bag, two thirds of an inch long, one third of an inch over in its largeſt part when collapſed; ſituated on the firſt *vertebra* of the loins to the right of the *aorta*, a little higher than the right emulgent artery, behind the right inferior muſcle of the diaphragm: it is formed by the union of three tubes, one from under the *aorta*, the ſecond from the interſtice of the *aorta* and *cava*, the third from under the emulgents of the right ſide. The *lacteal ſac*, becoming gradually ſmaller towards its upper part, is contracted into a ſlender membranous pipe of about a line diameter, which is generally named the *thoracic duct*. This paſſes betwixt the muſcular *appendices* or inferior muſcles of the diaphragm, on the right of and ſomewhat behind the *aorta:* then, being lodged in the cellular ſubſtance behind the *pleura*, it mounts between the *aorta* and the *vena azygos* as far as the fifth *vertebra* of the *thorax*, where it is hid by the *azygos*, as this vein riſes forwards to join the deſcending or ſuperior *cava*; after which, the duct paſſes obliquely over to the left ſide behind the *æſophagus*, *aorta deſcendens*, and the great curvature of the *aorta*, until it reaches the left carotid artery; behind which, on the left ſide of the *æſophagus*, it runs to the interſtice of the firſt and ſecond *vertebra* of the *thorax*, where it begins to ſeparate from the carotid, ſtretching farther towards the left internal jugular

gular vein by a circular turn, whoſe convex part is uppermoſt. At the top of this arch, it ſplits into two for a line and an half; the ſuperior branch receiving into it a large lymphatic veſſel from the cervical glands. This lymphatic appears, by blowing air and injecting liquors into it, to have few valves. When the two branches are again united, the duct continues its courſe towards the internal jugular vein, behind which it deſcends; and, immediately at the left ſide of the inſertion of this vein, enters the ſuperior poſterior part of the left ſubclavian vein, whoſe internal membrane duplicated forms a ſemilunar valve that is convex externally, and covers two thirds of the orifice of the duct: immediately below this orifice, a cervical vein from the *muſculi ſcaleni* enters the ſubclavian.

The coats of the *ſac* and *duct* are thin tranſparent membranes: from the inſide of which, in the duct, ſmall ſemilunar valves are produced, moſt commonly in pairs; which are ſo ſituated, as to allow the paſſage of liquors upwards, but oppoſe their return in an oppoſite courſe. The number of theſe is generally ten or twelve.

This is the moſt ſimple and common courſe, ſituation, and ſtructure, of the *receptaculum chyli* and *thoracic duct*; but having had occaſion to obſerve a variety in theſe parts in different ſubjects, I ſhall ſet down the moſt remarkable of them.

The ſac is ſometimes ſituated lower down than in the former deſcription; is not always of the ſame dimenſions; is not compoſed of the ſame number of ducts; and frequently appears to conſiſt of ſeveral ſmall cells or ducts, inſtead of being one ſimple cavity.

The diameter of the duct is various in moſt bodies; and is ſeldom uniform in the ſame ſubject, but frequently ſudden enlargements or *ſacculi* of it are obſervable.——The diviſions which authors mention of this duct are very uncertain. I have ſeen it divided into two; whereof one branch climbed over the forepart of the *aorta* at the eighth *vertebra* of the *thorax*, and at the fifth ſlipped behind that artery, to join the other branch which continued in the ordinary courſe.——The preciſe *vertebra* where it begins to turn to the left ſide, is alſo uncertain.—Frequently it does not ſplit at its ſuperior arch; in which caſe, a large ſac is found near its aperture into the ſubclavian vein.—Generally it has but one orifice; tho'

I have ſeen two in one body, and three in another: nay, ſometimes it divides into two, under the curvature of the great artery; one goes to the right, another to the left ſubclavian vein; and I have found this duct diſcharging itſelf entirely into the right ſubſclavian.——The lymphatic veſſel which enters its ſuperior arch, is often ſent from the *thyroid* gland.

Whether is not the ſituation of the *receptaculum chyli* ſo much nearer the muſcular *appendices* of the diaphragm in men than in brutes, deſigned to ſupply the diſadvantageous courſe the chyle muſt otherwiſe have in our erect poſture?

Does not the deſcent of the end of the duct to the ſubclavian vein, and the opening of the lymphatic into the top of the arch, contribute to the ready admiſſion of the chyle into that vein?

N° 9.

No 9.

HISTORIES

OF THE

CURE of LYMPHATICS opened in WOUNDS.

I Do not obſerve that chirurgical writers take notice of a phænomenon which I have ſeen ſeveral times in the cure of wounds, which poſſibly young ſurgeons may be at a loſs to underſtand, or to know how to remedy; it is the riſing of a fungous ſubſtance, from which there is a conſtant ſtillicidium of lymph, which prevents a cure, and weakens the patient if it is allowed to continue long. To aſſiſt them, I ſhall give two of the moſt remarkable examples that I have met with of ſuch a caſe.

In May 1726, I extirpated a very large ſteatom from the left arm of a ſervant of Mr Graham of Killearn. It had been occaſioned by a bite of a horſe about twenty years before: its baſe reached from the middle of the deltoid muſcle to near the elbow; ſo that the cephalic vein ran along the middle of it, and was neceſſarily to be cut through twice in amputating the tumour. The cure went on very ſucceſsfully, the wound contracting very faſt, till a yellowiſh white ſubſtance roſe up from a ſmall peduncle at the part where the under-part of the cephalic vein had been cut through. From this ſubſtance ſuch a quantity of lymph oozed out from imperceptible orifices, that the dreſſings were every day wet. I cut and eroded this ſubſtance away ſeveral times: but it quickly grew again, and the drilling of lymph became worſe and worſe; ſo that in a very little time it dropped ſo faſt, that I could have gathered a ſpoonful of it in a very ſhort time. What cured it at laſt was eating the fungous ſtuff, and a little of the wound about, with powder of Roman vitriol, and

dreſſing the eſchar with alcohol, which kept it from ſeparating two weeks; in which time the orifices of the ſmall pipes were ſoldered.

2. A gentlewoman having been let blood of in the baſilic vein in the country, ſoon perceived a tumour at the orifice. Several months after, ſhe came to town. When I ſaw it, it was as large as a walnut, beating violently: I could make it diſappear by preſſure; and as I kept my thumb on it, while I yielded to the influx of the blood, I had a feeling very like to hearing the ſound of water ruſhing into a pipe.

I tried firſt what preſſure would do in keeping the blood from ruſhing into it; but that being of no uſe, I was obliged to perform the operation of the aneuriſm, which I did in the way propoſed in the Medical Eſſays, Vol. IV. Art. xvii *. The ſac, in which nothing but liquid blood was contained, was as thick and ſtrong as the cyſtis of encyſted tumours commonly are; and was evidently formed in the ſame way, that is, by the ſtretching and thickening of a part of the cellular membrane. However, I cut none of it away, on purpoſe to ſee what change would come on it. As the tumour had extended itſelf principally outwards, it had raiſed both median and cephalic vein in the teguments upon it; and the cephalic lay ſo obliquely over it, that I could not evite it in cutting.

I had the pleaſure to ſee the hard firm bag become every day ſofter and thinner, with papillæ of granulated fleſh growing out from it, till it became all the ſame ſoft red fleſh as was in the reſt of the wound.

After a fortnight, ſuch a yellowiſh white fungus, with a drilling of lymph, as deſcribed in the former caſe, roſe out from the part of the wound where the extremity of the cut vein was. I burnt it with the lunar cauſtic, and dreſſed the eſchar with alcohol; which effectually cured it, and the ſore was ſkinned fully over in ſome leſs than ſix weeks, and my patient enjoyed then the full uſe and ſtrength of all parts of the member. The pulſe at the wriſt was plainly felt next day after the operation, and is now ſo ſtrong that nobody could know the artery was ever tied.

The operation of the aneuriſm has been ſix times more performed here; ſo that in few years there are nine examples of its ſucceſs in this place, all the patients who underwent it having been brought from the country.

Since 1747, the operation of the aneuriſm has been performed here ſucceſsfully on four more patients.

* Or, No XV. of this Collection.

No 10.

THE

ANATOMY

OF THE

HUMAN NERVES.

THE

ANATOMY

OF THE

HUMAN NERVES.

Of the NERVES in general.

1. THE numerous turns which the *carotid* and *vertebral* arteries make before they paſs through the *dura mater*, theſe arteries having neither ſwelling muſcles nor preſſure of the atmoſphere to aſſiſt the courſe of the blood in them after they enter the ſkull, and their diviſion into innumerable communicating branches in the *pia mater* and its proceſſes, ſhow, that the liquors muſt move more ſlowly and equally in them than in moſt other parts of the body.

2. By the aſſiſtance of injections and microſcopes, the very minute branches of theſe veſſels (§ 1.) are diſcovered to go from the *pia mater*, into the *cortex*, cineritious or aſhy-coloured part of the *cerebrum*, *cerebellum*, and *ſpinal marrow*; whereas we can only ſee longitudinal veſſels, without numerous ramifications or reticular plexuſes, in the white medullary ſubſtance of theſe parts.

3. The

3. The continuity of the *cortex* with the *medulla* of the *encephalon* and *ſpinal marrow*, is obſervable with the naked eye, and is more diſtinctly ſeen with the aſſiſtance of a microſcope.

4. In diſſecting the *brain* and *cerebellum*, we ſee the ſmall beginnings of the *medulla* proceeding from the *cortex*, and can trace its gradual increaſe by the addition of more ſuch white ſubſtance coming from the *cortex*.

5. Both theſe ſubſtances (§ 4.) are very ſucculent; for, being expoſed to the air to dry, they loſe more of their weight than moſt other parts of the body do.

6. In ſeveral places, we can obſerve the *medulla* to be compoſed of fibres laid at each others ſides.

7. The medullary ſubſtance is employed in forming the white fibrous cords, which have now the name of *nerves* appropriated to them. Within the ſkull we ſee the nerves to be the medullary ſubſtance continued; and the *ſpinal marrow* is all employed in forming nerves.

8. The common opinion concerning the riſe of the nerves, founded on a ſuperficial inſpection of thoſe parts, is, that the nerves are propagated from that ſide of the *encephalon* at which they go out of the ſkull. But it having been remarked, after a more ſtrict inquiry, and preparing the parts by maceration in water, that the medullary fibres decuſſate or croſs each other in ſome parts of the *medulla*, as for example at the *corpus annulare*, and beginning of the *ſpinal marrow*; and practical obſervators having related ſeveral examples of people whoſe brain was hurt on the ſide, while the morbid ſymptom, palſy, appeared on the other ſide of the body, of which I have ſeen ſome inſtances; and experiments made on brutes having confirmed theſe obſervations, it has been thought, that the nerves had their riſe from that ſide of the *encephalon* which is oppoſite to their egreſs from the ſkull. It may, however, ſtill be ſaid, that this laſt opinion is not fully demonſtrated, becauſe a decuſſation in ſome parts is is not a proof that it obtains univerſally; and if there are examples of palſy of the ſide oppoſite to where the leſion of the brain was, there are alſo others where the injury done to the brain and the palſy were both on the ſame ſide.

9. The

9. The nerves are compoſed of a great many threads lying parallel to each other, or nearly ſo, at their exit from the *medulla*.

This fibrous texture is evident at the origin of moſt of the nerves within the ſkull; and, in the *cauda equina* of the *ſpinal marrow*, we can divide them into ſuch ſmall threads, that a very good eye can ſcarce perceive them; but theſe threads, when looked at with a microſcope, appear each to be compoſed of a great number of ſmaller threads.

10. How ſmall one of theſe fibrils of the nerves is, we know not; but when we conſider, that every even the moſt minute part of the body is ſenſible, and that this muſt depend on the nerves (which all conjoined would not make a chord of an inch diameter) being divided into branches or filaments to be diſperſed through all theſe minute parts, we muſt be convinced, that the nervous fibrils are very ſmall. From the examination of the *minimum viſibile*, it is demonſtrated, that each fibre in the *retina* of the eye, or expanded optic nerve, cannot exceed the ſize of the 32,400th part of a hair.

11. The medullary ſubſtance, of which the nervous fibrils are compoſed, is very tender, and would not be able to reſiſt ſuch forces as the nerves are expoſed to within the bones, nor even the common force of the circulating fluids, were not the *pia mater* and *tunica arachnoides* continued upon them; the former giving them firmneſs and ſtrength, and the latter furniſhing a cellular coat to connect the threads of the nerves, to let them lie ſoft and moiſt, and to ſupport the veſſels which go with them.

It is this cellular ſubſtance that is diſtended when air is forced through a blow-pipe thruſt into a nerve, and that makes a nerve appear all ſpongy after being diſtended with air till it dries; the proper nervous fibrils ſhrivelling ſo in drying, that they ſcarce can be obſerved.

12. Theſe coats (§ 11.) would not make the nerves ſtrong enough to bear the ſtretching and preſſure they are expoſed to in their courſe to the different parts of the body: and therefore, where the nerves go out at the holes in the *cranium* and *ſpine*, the *dura mater* is generally wrapt cloſely round them, to collect their diſgregated fibres into tight firm cords; and that the tenſion which they may happen to be expoſed to may not injure them

them before they have got this additional coat, it is firmly fixed to the ſides of the holes in the bones through which they paſs.

13. The nervous cords thus compoſed of nervous fibrils, cellular coat, *pia* and *dura mater*, have ſuch numerous blood-veſſels, that, after their arteries only are injected, the whole cord is tinged of the colour of the injected liquor; and if the injection is puſhed violently, the cellular ſubſtance of the nerves is at laſt diſtended with it.

14. A nervous cord, ſuch as has been juſt now deſcribed (§ 13.) has very little elaſticity, compared with ſeveral other parts of the body. When cut out of the body, it does not become obſervably ſhorter, while the blood-veſſels contract three eighths of their length.

15. Nerves are generally lodged in a cellular or fatty ſubſtance; and have their courſe in the interſtices of muſcles, and other active organs, where they are guarded from preſſure: but in ſeveral parts they are ſo placed, as if it was intended that they ſhould there ſuffer the vibrating force of arteries, or the preſſure of the contracting fibres of muſcles.

16. The larger cords of the nerves divide into branches as they go off to the different parts; the branches being ſmaller than the trunk from which they come, and making generally an acute angle where they ſeparate.

17. In ſeveral places, different nerves unite into one cord, which is commonly larger than any of the nerves which form it.

18. Several nerves, particularly thoſe which are diſtributed to the bowels, after ſuch union (§ 17.), ſuddenly form a hard knot conſiderably larger than all the nerves of which it is made. Theſe knots were called *corpora olivaria*, and are now generally named *ganglions*.

19. The *ganglions* have thicker coats, more numerous and larger blood-veſſels, than the nerves; ſo that they appear more red and muſcular. On diſſecting the *ganglions*, fibres are ſeen running longitudinally in their axes, and other fibres are derived from their ſides in an oblique direction to the longitudinal ones.

20. Commonly numerous ſmall nerves, which conjunctly are not equal to the ſize of the *ganglion*, are ſent out from it, but with a ſtructure no way different from that of other nerves.

21. The nerves ſent to the organs of the ſenſes, loſe their firm coats, and terminate in a pulpy ſubſtance. The *optic nerves* are expanded into the

the ſoft tender webs, the *retinæ*. The *auditory nerve* has ſcarce the conſiſtence of *mucus* in the *veſtibulum*, *cochlea*, and *ſemicircular canals* of each ear. The *papillæ* of the noſe, tongue, and ſkin, are very ſoft.

22. The nerves of muſcles can likewiſe be traced till they ſeem to loſe their coats by becoming very ſoft; from which, and what we obſerved of the ſenſatory nerves (§ 21.), there is reaſon to conclude, that the muſcular nerves are alſo pulpy at their terminations, which we cannot indeed proſecute by diſſection.

23. It would ſeem neceſſary that the extremities of the nerves ſhould continue in this ſoft flexible ſtate (§ 21. 22.), in order to perform their functions right: For, in proportion as parts become rigid and firm by age, or any other cauſe, they loſe of their ſenſibility, and the motions are more difficultly performed.

24. Though the fibres in a nervous cord are firmly connected, and frequently different nerves join into one trunk, or into the ſame *ganglion*; yet the ſenſation of each part of the body is ſo very diſtinct, and we have ſo much the power of moving the muſcles ſeparately, that if the nerves are principal agents in theſe two functions, which I ſhall endeavour to prove they are, we have reaſon to believe that there is no union, confuſion, or immediate communication of the proper nervous fibrils, but that each fibre remains diſtinct from its origin to its termination.

25. Changes produced any way upon the coats of the nerves, cannot however miſs to affect the nervous fibrils. The cellular ſubſtance may be too full of liquor, or may not ſupply enough; the liquor may not be of a due conſiſtence, or it may be preternaturally obſtructed and collected. The *pia* or *dura mater* may be too tenſe or too lax; their veſſels may be obſtructed; their proper nerves may be violently irritated, or loſe their power of acting; and a great many other ſuch changes may happen, which will not only occaſion diſorders in particular nerves, but may be a cauſe of the *ſympathy* ſo frequently obſerved among the nerves; which is ſo neceſſary to be attentively regarded in a great many diſeaſes, in order to diſcover their true ſtate and nature, that without this knowledge, very dangerous miſtakes in the practice of phyſic and ſurgery may be committed.

26. Many experiments and obſervations concur in proving, that, when

nerves are compreſſed, cut, or any other way deſtroyed, the parts ſerved by ſuch nerves, farther from the head or ſpine than where the injuring cauſe has been applied, have their ſenſations, motions, and nouriſhment, weakened or loſt, while no ſuch effects are ſeen in the parts nearer to the origin of thoſe nerves: and in ſuch experiments where the cauſe impeding the nerves to exert themſelves could be removed, and the ſtructure of the nerves not injured; as for example, when a ligature made upon a nerve, and ſtopping its influence, has been taken away; the motion and ſenſation of the parts ſoon were reſtored. From which it would appear, that the nerves are principal inſtruments in our ſenſations, motions, and nouriſhment; and that this influence of the nerves is not inherent in them, without the communication between theſe cords and their origin is preſerved.

This concluſion is juſt, notwithſtanding that ſometimes, upon cutting a nerve, the effects above mentioned have been felt for a ſhort time; but afterwards the perſon was ſenſible of no numbneſs or immobility: for, where-ever this is ſaid to have happened, the cut nerve was only one of ſeveral which were ſent to the member; the want of whoſe influence was felt no longer, than till the habit was acquired of performing the functions eaſily by the other nerves.

Nor is it of greater weight as an objection, that ſometimes when a ligature is drawn very hard upon a nerve, and then is taken away, the nerve never again recovers its influence upon the parts it is diſtributed to beyond the ligature, but is of as little effect as if it had been cut through; which is to ſay, that its texture has been altered beyond recovery. The ſame thing is to be ſeen by tying a thread tight round a tender twig of any vegetable; it decays.

27. Experiments and obſervations ſhow too, that when the parts of the *encephalon* or *ſpinal marrow* have been irritated, compreſſed, or deſtroyed, the parts of the body, whoſe nerves had their origin from ſuch affected parts of the *encephalon* or *ſpinal marrow*, became convulſed, paralytic, inſenſible, or waſted; and in ſuch caſes where the injuring cauſe could be removed from the origin of the nerves, the morbid ſymptoms obſerved in the parts to which theſe nerves were diſtributed went off upon the removal of that cauſe. From which it is thought reaſonable to conclude, that the

nerves

nerves muſt not only have a communication with their origin, but that the influence they have upon the parts they are diſtributed to, depends on the influence which they derive from the *medulla encephali* and *ſpinalis*.

28. Though the *ſpinal marrow* has its own veſſels and cineritious ſubſtance which aſſiſts to form its *medulla*; yet a very large ſhare of the medullary ſubſtance within the ſpine is derived from the *encephalon*, whoſe *medulla oblongata* deſcends from the head, and the influence of the *ſpinal marrow* on its nerves depends in a great meaſure on this *medulla oblongata* of the head. Hence an injury done to any part of the *ſpinal marrow*, immediately affects all the parts whoſe nerves have their origin below where the injuring cauſe is applied. A luxation of a *vertebra* in the loins makes the lower extremities ſoon paralytic; a tranſverſe ſection of the *medulla* at the firſt *vertebra* of the neck, ſoon puts an end to life.

29. If ſuch cauſes produce conſtantly ſuch effects (§ 26. 27. 28.) in us, and other creatures living in nearly the ſame circumſtances as we do, the concluſions already made muſt be good; notwithſtanding examples of children and other creatures being born without *brains* or *ſpinal marrow*; or notwithſtanding that the brains of adult creatures can be much changed in their texture by diſeaſes; and that *tortoiſes*, and ſome other animals, continue to move a conſiderable time after their heads are cut off. We may be ignorant of the particular circumſtances requiſite or neceſſary to the being or well-being of this or that particular creature, and we may be unable to account for a great many phænomena: but we muſt believe our eyes in the examination of facts; and if we ſee conſtantly ſuch conſequences from ſuch actions, we cannot but conclude the one to be the cauſe and the other the effect. It would be as unjuſt to deny the concluſions made in the three preceding articles becauſe of the ſeemingly preternatural phænomena mentioned at the beginning of this, as it would be to deny the neceſſity of the circulation of the blood in us and moſt quadrupeds, becauſe a frog can jump about, or a tortoiſe can walk long after all the bowels of its thorax and abdomen are taken out, or becauſe the different parts of a worm crawl after it has been cut into a great many pieces. It is therefore almoſt univerſally allowed, that the nerves are *principal* inſtruments in our ſenſations, motion, and nouriſhment; and that the influence which they have is communicated from their origin, the *encephalon* and *medulla ſpinalis*. But authors are far

from agreeing about the manner in which this influence is communicated, or in what way nerves act to produce these effects.

30. Some allege, that the *nervous fibres are all solid cords acting by elasticity or vibration*; others maintain, that *those fibres are small pipes conveying liquors, by means of which their effects are produced.*

31. The gentlemen who think the nervous fibres solid raise several objections to the other doctrine, which I shall consider afterwards; and endeavour to shew the fitness of their own doctrine to account for the effects commonly observed to be produced by the nerves.

The objects of the senses plainly (say they) make impulses on the nerves of the proper organs, which must shake the nervous fibrils; and this vibration must be propagated along the whole cord to its other extremity or origin, as happens in other tense strings; and these vibrations being differently modified, according to the difference of the object and its different application, produce the different ideas we have of objects.

32. To this account of sensation, it is objected, *first*, That nerves are unfit for vibrations, because their extremities where objects are applied to them are quite soft and pappy (§ 21.), and therefore not susceptible of the vibrations supposed; and if there could be any little tremor made here by the impulse of objects, it could not be continued along the nervous cord, because the cellular substance by which each particular fibre is connected to the neighbouring ones (§ 11.), and the fatty substance in which the nervous cord is immersed (§ 15.), would soon stifle any such vibratory motion.

A *second* objection to this doctrine is, That supposing the nerves capable of vibrations by the impressions of objects, these vibrations would not answer the design. For if what we know of other vibrating strings, to wit, that their tone remains the same, unless their texture, length, or tension is altered, and that different substances striking them do no more than make the sound higher or lower; if these properties are to be applied to nerves, then it will follow, that the same nerve would constantly convey the same idea, with no other variety than of its being weaker and stronger, whatever different objects were applied to it: unless we supposed the nerve changed in its texture, length, or tension, each time

time a different object is applied; which, it is presumed, nobody will undertake to prove does happen.

Nay, 3*dly*, If ever such a variety of vibrations could be made, our sensations would notwithstanding be confused and indistinct, because the tremulous nervous fibre being firmly connected and contiguous to several other fibres of the same cord, would necessarily shake them too, by which we should have the notion of the object as applied at all the different parts where the extremities of these fibres terminate.

33. In whatever way the favourers of the doctrine of solid nerves please to apply the elasticity of nerves to the contraction of muscles, their adversaries insist that nerves are too weak to resist such weights as the muscles sustain; they would surely break, especially as they are in a great measure, if not wholly, deprived of their strong coats before they come to the part of the muscle they are immediately to act upon (§ 22.) The nerves being found to have little or no elasticity to shorten themselves (§ 14.), shows them altogether unfit for such an office as this of contracting muscles in the way proposed of their acting by elasticity; and when a nerve is viewed with a microscope while the muscles it serves are in action, no contraction or motion is observed in it.——Nay, if they were elastic, they would equally exert their power of contracting muscles nearer to their origin as well as farther from it, when they were put into contraction or vibration, by irritation of any part of them. The former, however, does not happen.

34. As a further objection against either motion or sensation being owing to the elasticity of the nerves, it is said, that if this doctrine was true, the sensations would be more acute, and the contractions of muscles would be greater and stronger, when the parts become firmer and more rigid by age; for then their elasticity is increased: Whereas, on the contrary, it appears (§ 23.) that then the sensations are blunted, and muscular contraction becomes less and weaker.

35. If the nerves were granted to be elastic, and to communicate a springy force to all the parts they are distributed to, they might appear necessary in this view to assist the application of the nutritious particles of the fluids to the sides of the vessels which these particles were to repair; and so far might well enough account for the share which nerves are thought

thought to have in nutrition: But, if we cannot make uſe of elaſticity in the other two functions, ſenſation and motion, we muſt alſo endeavour to find out ſome other way for the nerves to act in nutrition; which will be done afterwards.

36. Having thus ſtated the reaſons for and againſt the nerves acting as ſolid ſtrings, let us likewiſe relate the arguments for nerves being pipes, and the objections to this doctrine.

A great argument of thoſe who think the nerves to be tubes conveying liquors, is the ſtrong analogy of the brain and nerves to other glands of the body and their excretories, where a manifeſt ſecretion of liquor is made in the glands, to be conveyed by the excretories to the proper places in which it ought to be depoſited. They think that the vaſcular texture of the *cortex* of the *encephalon* and *ſpinal marrow* (§ 2.), the continuation of the *cortex* in forming the medullary ſubſtance (§ 3. 4.), the fibrous texture (§ 6.) and ſucculent ſtate of this *medulla* (§ 5.), and its being wholly employed to form the nerves (§ 7.), where the fibrous texture is evident (§ 9.); all theſe things, ſay they, conſpire to ſhow ſuch a ſtrong analogy between theſe parts and the other glands of the body, as carries a conviction that there is a liquor ſecreted in the *encephalon* and *ſpinal marrow*, to be ſent out by the nerves to the different parts of the body.

37. The following objections are raiſed to this argument in favour of liquor conveyed in the nerves from the analogy of the glands. 1*ſt*, Other glands, it is ſaid, have their excretories collected into a few large pipes, and not continued in ſuch a great number of ſeparate pipes as far as the places where the liquors are depoſited; which laſt muſt be the caſe, if the nerves are the excretories of the glandular brain. 2*dly*, We ſee the cavities, and can examine the liquors in the excretories of other glands much ſmaller than the brain; which cannot be done in the nerves. 3*dly*, If the nerves were pipes, they would be ſo ſmall, that the attraction of the liquors to their ſides would prevent that celerity in the motion of the liquors, which is requiſite to ſenſations and motions. 4*thly*, If the nerves were pipes, they would be cylindrical ones, and conſequently not ſubject to diſeaſes, or at leaſt we could have no comprehenſion of the diſeaſes in them.

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38. The anſwer to the *1ſt* of theſe objections is, That there are other glands where there is a manifeſt ſecretion, and in which the diſpoſition of the excretories is in much the ſame way as in the *encephalon*. The kidneys, for example, have a reticulated *cortex* of veſſels, from which the *Euſtachian* or *Bellinian medulla*, conſiſting of longitudinal fibres and a few blood-veſſels in the ſame direction, proceeds; and this *medulla* is collected into ten, twelve, or more *papillæ*, each of which is formed of numerous ſmall ſeparate pipes, which ſingly diſcharge the urine into the large membranous tubes; and theſe united form the *pelvis*. Upon comparing this texture of the kidneys with that of the *encephalon* (§ 2. 3. 4. 5. 6. 7. 9.) the analogy will be found very ſtrong.

39. In anſwer to the *2d* objection, in § 37. it is granted, that microſcopes, injections, and all the other arts hitherto employed, have not ſhown the cavities of the nervous fibrils, or the liquors contained in them; and from what was ſaid (§ 10.) of the ſmallneſs of the nervous fibrils, it is not to be expected that ever they ſhould be ſeen. But, ſo long as ſuch a number of little animals can every hour be brought to the objectors, in which they can as little demonſtrate the veſſels or contained fluids, it will not be allowed to be concluſive reaſoning, that, becauſe ocular demonſtration cannot be given of either the tubes or their contents, therefore they do not exiſt. For if we have any notion of an animal, it is its being an hydraulic machine, which has liquors moving in it as long as it has life; if therefore ſuch little animals have veſſels and liquors which we cannot ſee, why may not ſome of the veſſels and liquors of the human body be alſo inviſible to us?

To avoid this anſwer to the objection, it is further urged, That, though we might not ſee the nervous tubes or the liquors they contain, as they naturally flow; yet if ſuch liquors really exiſt, they ought to diſcover themſelves, either by a nerve's ſwelling when it is firmly tied; or that, however ſubtile their fluids are, they might be collected in ſome drops, at leaſt, when the cut end of a nerve of a living animal is kept ſome time in the exhauſted receiver of an air-pump. It is affirmed, that neither did the tied nerve ſwell between the brain and ligature, nor was there any liquor collected in the receiver of the air-pump; from which it is concluded, that there is no liquor in the nerves.

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Some who ſay they have tried theſe experiments, affirm, that in young animals the nerve does ſwell above the ligature, and that a liquor does drill out upon cutting a nerve.——Whether ſwelling or liquor is ſeen or is not ſeen in theſe experiments, no concluſion for or againſt a nervous fluid can be made from them; for the ſwelling of the nerve after it is tied, or the efflux of liquors from its extremity, will never prove either to be the effect of the fluid in the proper nervous fibrils, ſo long as they might be occaſioned by the liquors in the larger veſſels of the cellular ſubſtance of the nerves; and if theſe ſame veſſels of the coats of the nerves do not diſcover their liquors by theſe experiments, it is far leſs to be expected that the much more ſubtile nerves will diſcover theirs.

40. The *3d* objection to the doctrine of the brain being a gland, and the nerves its excretories, ſuppoſes a more rapid motion neceſſary in the fluid of the nerves, than what moſt of the defenders of the nervous fluid will now allow; and is afterwards to be conſidered particularly in a more proper place.

41. The *4th* objection being, That if nerves are excretories of a gland, they muſt be cylindrical pipes, in which no obſtructions or diſeaſes would happen; but ſince we daily ſee diſeaſes in the nerves, they muſt therefore not be ſuch excretories. The anſwer is, That diſeaſes happen often in the excretories of other glands, as of the liver, kidneys, &c. notwithſtanding their cylindrical form, and their much ſhorter and leſs expoſed courſe. When we conſider the very tender ſubſtance of the brain, the vaſt complication of veſſels there, the prodigious ſmallneſs of the pipes going out from it, the many moving powers which the nerves are to undergo the ſhock of, and the many chances which the veſſels, membranes, and cellular ſubſtance accompanying the nerves, have of being diſordered, and then affecting the nervous fibrils, we have very great reaſon to be ſurpriſed, that theſe cylindrical pipes are not much more frequently put out of order, by too great or too ſmall a quantity of liquors; by too viſcid or too thin fluids; by liquors conſiſting of too mild and ſluggiſh particles, or of too acrid pungent ones; by too great or too little motion given to the liquors; by the diameters of the pipes being too much ſtraitened, or too much enlarged; and by a great many other varieties of circumſtances which might be thought capable of diſturbing the functions

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of the nerves, ſuppoſing them to be cylindrical excretories of the gland, the brain.

42. The numerous veſſels of the *encephalon* have brought ſome of the gentlemen who aſſert the nerves to be ſolid, to acknowledge, that there is a liquor ſecreted in the brain: but then they will not allow that this liquor is ſent out by the proper nervous fibrils; but that it is poured into the cellular ſubſtance in which the nerves lie, to keep them moiſt and ſupple, and therefore fit for exerting their elaſticity, vibration, &c. by which, in their opinion, the effects commonly aſcribed to nerves are produced.

43. Beſides the objections already mentioned (§ 32. 33.) againſt the nerves acting as elaſtic ſtrings, this opinion has ſome other difficulties which may be objected to it: for inſtance, there is not one analogous example in the whole body of liquors ſecreted in a large gland, to be poured into a cellular ſubſtance, as is here ſuppoſed; the liquors in the cells of the *tela cellularis* of other parts are ſeparated from the little arteries which are diſtributed to theſe cells.

Further, it cannot be imagined, how a liquor ſecreted in the *cortex* of the brain ſhould make its way through the *medulla*, to come out into the cellular membranes on the ſurface of that *medulla*.

Laſtly, A very ſimple experiment, of injecting water by the artery of any member, and thereby filling the cellular ſubſtance of the nerves of that member, ſhows evidently, that the liquor of the *cellular* ſubſtance of the nerves has the ſame fountain as the liquor has in the *tela cellularis* any where elſe, that is, from the little arteries diſperſed upon it.

44. The doctrine of a fluid in the nerves, is not only thus ſupported by the analogy of the brain and nerves to the other glands and their excretories, but thoſe who maintain this doctrine mention an experiment which they think directly proves a fluid in the nerves. It is this: After opening the thorax of a living dog, catch hold of and preſs one or both the *phrenic* nerves with the fingers, the *diaphragm* immediately ceaſes to contract: Ceaſe to compreſs the nerves, and the muſcle acts again. A ſecond time, lay hold of the nerve or nerves ſome way above the *diaphragm*, its motion ſtops: Keep firm the hold of the nerve, and, with the fingers of the other hand ſtrip it down from the fingers which make the com-

preſſion towards the *diaphragm*; and it again contracts. A repetition of this part of the experiment three or four times, is always attended with the ſame effects: but it then contracts no more, ſtrip as you will, unleſs you remove the preſſure, to take hold of the nerves above the place firſt pinched; when the muſcle may again be made to contract, by ſtripping the nerve down towards it. This experiment I have done with the ſucceſs here mentioned. Let any one try if he can imagine any other reaſonable account of theſe appearances, than that the preſſure by the fingers ſtopped the courſe of a fluid in the nerve; that ſo much of this fluid as remained in the nerve, betwixt the fingers and *diaphragm*, was forced into that muſcle by ſtripping; and when it was all preſſed away, the fingers above preventing a ſupply, the muſcle contracted no more till the fingers were removed, and a freſh flow by that means was received from the ſpinal marrow, or from that part of the nerve which had not yet been ſo ſtripped.

It has been objected to the concluſions from this experiment, *1ſt*, That the *diaphragm* is ſet in motion by ſtripping the nerve from, as well as towards, this muſcle. And this may be well expected; for a liquor, in ſuch ſmall pipes, hindered to flow backwards by ligature, pinching fingers, or even the flow of their liquors from the fountain, will regurgitate forwards with velocity when preſſed backwards. We ſee it happen in the ſtalks of tender ſucculent plants.

2dly, It is ſaid, that muſcles ceaſe to act when their veins are tied, as well as when their arteries or nerves are tied or cut; but that muſcles continue to act when their veins are cut: by which it would appear, that the overloading of the veſſels is an impediment to the action of muſcles; and therefore the ceaſing of their action, when their arteries or nerves are tied or cut, may alſo be owing to the liquor in the branches of theſe pipes of muſcles ſtagnating when it is not propelled by the flow of more liquor from their trunks, and not to any influence or moving power, which now ceaſes to be conveyed to them.

It is to be obſerved in making the experiments juſt now mentioned, that the contraction of the muſcles ceaſes ſooneſt when the nerves, and lateſt when the veins, are tied.——That when veins are tied, not only are the veſſels overloaded, but all the cellular ſubſtance of the muſcles is filled

filled with coagulated blood; whereas when the arteries and nerves are tied, the reverſe is ſeen, the muſcles are lax and of leſs bulk. So that in theſe caſes, the ceaſing of the contraction of the muſcles ſeems to depend on very different cauſes, to wit, a deprivation of neceſſary liquors in the one, and a redundancy of ſuperfluous blood in the other. An elaſtic ſtick may be deprived of its elaſticity by being made either too dry or too wet.

45. Some gentlemen, convinced of the reaſonableneſs of the ſecretion of a liquor in the brain to be ſent out by the nerves, but not comprehending how a fluid could have ſuch a rapid retrograde motion as they imagined was neceſſary for conveying the impreſſions of objects made on the extremities of nerves to the *ſenſorium*, ſuppoſed two ſorts of nerves; one that conveyed a liquor for muſcular motion and nutrition; the other compoſed of ſolid nerves, that were to ſerve for organs of the ſenſes, to convey the vibrations communicated from objects to the *ſenſorium*.

46. To this opinion (§ 45.) the objections againſt the ſenſatory nerves acting by vibration (§ 32.) may be made; and there is ſo little reaſon to ſuſpect any difference in the texture of the different parts of the brain or nerves, that, on the contrary, the ſtructure is every where ſimilar, and branches of the ſame nerve often ſerve both for ſenſation and motion.

How little neceſſity there is for ſuppoſing extremely rapid motions of the nervous fluid, is to be examined ſoon.

47. The hypotheſis of great celerity in the motion of the fluid of the nerves being neceſſary, gave alſo riſe to another diviſion of the nerves into *arterious* or *effluent*, and *venous* or *refluent*. It was ſaid, that muſcular motion and nutrition depended on the arterious nerves; and that the ſenſations depended on an accelerated motion of the nervous fluid towards the brain, by the impreſſions which the objects of the ſenſes make upon the venous nerves. By this ſuppoſition, the abſurdity of rapid fluxes and refluxes in the ſame canal was prevented, and an advantage was thought to be gained by it, of ſaving too great a waſte of the fluid of the nerves, which otherwiſe the *encephalon* and *ſpinal marrow* could not ſupply in ſufficient quantity to anſwer all the exigencies of life.

48. To this opinion (§ 47.) it has been objected, 1*ſt*, That there is no example in the body of a ſecreted liquor being returned immediately and

unmixed to the gland by which it was originally ſeparated from the maſs of blood; which would be the caſe, were there venous nerves. 2*dly*, There is no occaſion for ſaving the fluid of the nerves in the way propoſed; the organs for ſecreting that fluid being large enough to ſupply all that is neceſſary of it in the common functions of life.——3*dly*, If the fluid of the nerves was to be thus kept in a perpetual circulation, it would ſoon become too acrid for continuing with ſafety in ſuch ſenſible tender veſſels as the brain and nerves are compoſed of. 4*thly*, This hypotheſis will not anſwer the deſign for which it was propoſed: For though the momentary application of an object might cauſe an acceleration in the fluid of venous nerves, yet if the object was kept applied to the nerves, it would ſtop their fluid, ſo that it could not go forward to the brain; and therefore, according to this doctrine, we ſhould be ſenſible of no objects, except thoſe whoſe application to the organs of the ſenſes was momentary.

49. Let us now ſuppoſe it probable, that the *encephalon* and *ſpinal marrow* ſecern a liquor from the blood which is ſent into all the nerves, and that by the means of this liquor the nerves perform the offices commonly aſſigned to them; it is next neceſſary to inquire, what kind of liquor this is, and how it moves, in order to determine how well its nature and motion are fitted for performing what is expected from it.

50. The liquor of the nerves has been fancied by ſome to be of a very ſtrong acid or alkaline nature: but ſince none of our juices appear to be of this ſort, and ſince ſuch liquors irritate and deſtroy the parts of the body which they are applied to, we cannot conceive how the brain can ſeparate, or the nerves could bear, any thing of ſuch an acrid nature. This tenderneſs and ſenſibility of theſe organs muſt hinder us abſolutely from ſuppoſing that the liquor of the nerves can be acrid or pungent, or of the nature of ſpirit of wine, hartſhorn, &c.

51. Some have imagined the liquor of the nerves to be capable of vaſt exploſion like gun-powder, or of violent ſudden rarefaction like air, or of ſtrong ebullition like boiling water, or the mixture of acids with alkaline liquors. But as the maſs of blood from which this fluid is derived, is not poſſeſſed of any ſuch properties, we cannot ſuppoſe the blood to furniſh what it has not in itſelf. Beſides, all theſe operations are too violent

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for the brain or nerves to bear; and when once they are begun, they are not ſo quickly controlled or reſtrained, as experience teaches us the nerves can be made to ceaſe from acting.

52. We are not ſufficiently acquainted with the properties of an *æther* or *electrical effluvia* pervading every thing, to apply them juſtly in the animal œconomy; and it is as difficult to conceive how they ſhould be retained or conducted in a long nervous cord. Theſe are difficulties not to be ſurmounted.

53. The ſureſt way of judging what kind of liquor this of the nerves muſt be, is to examine the liquors of ſimilar parts of the body. All the glands ſeparate liquors from the blood much thinner than the compound maſs itſelf; ſuch is the *liquor* poured into the cavity of the *abdomen*, *thorax*, *ventricles of the brain*, the *ſaliva*, *pancreatic juice*, *lymph*, &c. Whereever there is occaſion for ſecreted liquors being thick and viſcid, in order to anſwer better the uſes they are intended for, nature has provided reſervoirs for them to ſtagnate in, where their thinner parts may be carried off by the numerous abſorbent veins diſperſed on the ſides of thoſe cavities, or they may exhale where they are expoſed to the open air. The *mucus of the noſe* becomes viſcid by ſtagnation; for when it is immediately ſecreted, it is thin and watery, as appears from the application of ſternutatories, &c. The *cerumen* of the ears is of a watery conſiſtence, when juſt ſqueezing out. The *mucus* of the alimentary canal grows thick in the *lacunæ*. The *bile* in the hepatic duct has little more conſiſtence than lymph; *that* in the gall-bladder is viſcid and ſtrong. The *urine* is much more watery as it flows from the kidneys than when it is excreted from the bladder. The *ſeed* is thin as it comes from the teſticles, and is concocted in the *veſiculæ ſeminales*, &c.

54. Hence (§ 53.) we may ſafely conclude, that a thin liquor is ſecreted in the *cortex encephali* and *ſpinal marrow*; and ſeeing the thinneſs of ſecreted liquors is generally, as the diviſions of the veſſels, into ſmall ſubtile branches, and that the ramifications within the ſkull are almoſt infinitely ſubtile, the liquor ſecreted in the *encephalon* may be determined to be among the fineſt or thinneſt fluids.

55. Seeing alſo that we can obſerve no large reſervoir, where the liquor ſecerned in the *cortical ſubſtance* is depoſited, to have its finer parts taken of,

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we have reaſon to think that it goes forward into the nerves in the ſame condition in which it is ſecerned.

56. By fine or ſubtile animal-liquors, is meant no more than thoſe which are very fluid, and which ſeem to conſiſt of a large proportion of watery particles, and a leſſer one of the oily, ſaline, and terreſtrious particles. Some of the liquors which we can have in ſufficient quantity to make experiments with, are ſo fluid, and have ſo little viſcidity or coheſion of parts, that, when laid upon a piece of clean mirror, they evaporate without leaving a ſtain; ſuch is the liqour oozing out from the ſurface of the *pleura*, the lymph, and ſeveral others.

If then theſe liquors, which are ſubject to our examination, the ſecerning veſſels of which are ſo large that we can ſee them, have ſuch a ſmall coheſion of parts, it might not be unreaſonable to ſay, that the liquor of the nerves is as much more fine and fluid than lymph, as the veſſels ſeparating it are ſmaller; and therefore, that the fluid of the nerves is a defecated water, with a very ſmall proportion of the other principles extremely ſubtilized.

57. Two experiments are ſaid to contradict this opinion of the liquor of the nerves being ſo fluid and ſubtile. One is, that upon cutting the *cauda equina* of a living animal, a liquor as viſcid as the white of an egg drops out: the other is, that a wounded nerve yields a *glairy ſanies*. But theſe do not appear to be the proper fluid of the nerves; ſince it is evident, that what is diſcharged in both theſe caſes, comes out of the cellular ſubſtance involving the nervous fibrils.

58. Conſidering how many experiments make it evident, that there is a conſtant uninterrupted ſtream of liquors flowing through all the canals of animals, which convey liquors compoſed of particles ſmaller than the diameter of their canal, which is always the caſe of the nerves in a natural ſtate; it is ſurpriſing how it ever could be thought that the liquid of the nerves ſhould be obliged to flow from the brain to each muſcle the moment we will, or that this liquor ſhould flow back with the like ſwiftneſs from the extremity of each nerve to which an object of ſenſation is applied. The nerves, as well as the other excretories of the glands, always are full of liquor; the degree of diſtenſion of the canals not being at all times alike even in a ſound ſtate. But this happens without inconvenience,

venience, as the ſides of the canals have a power of accommodating themſelves to the preſent quantity; unleſs it is very much above or below the natural ſtandard, in both which caſes diſeaſes enſue.

59. The motion of the fluid in the nerves is therefore not only conſtant, but it is alſo equal, or nearly ſo: for though the blood in the larger arteries is moved unequally by the unequal forces, the contraction of the ventricle of the heart, and the weaker power, the *ſyſtole* of the arteries; yet the difference between theſe two moving powers comes to be leſs and leſs perceptible, as the arteries divide into ſmaller branches, becauſe of the numerous reſiſtances which the liquors meet with, and becauſe the canals they move in become larger, till, in the very ſmall arterious branches, there is no ſenſible difference in the velocity of the liquors from the effect of the heart or arteries. The motion of the fluids muſt ſtill be more equal in the excretories of glands, and particularly in thoſe where the veſſels have divided into very minute branches, and the liquors have no other propelling force but the heart and arteries (ſee § 1.); therefore the nervous fluid moves conſtantly, equally, and ſlowly, unleſs when its courſe is altered by the influence of the mind, or by the preſſure of ſome neighbouring active organ.

60. As there is neither proof nor probability of the *valves* ſuppoſed by ſome in nerves, we are not to aſſume them in accounting for any *phænomena*.

61. We have not, and perhaps cannot have, any idea of the manner in which mind and body act upon each other; but if we allow that the one is affected by the other, which none deny, and that the fluid of the nerves (whatever name people pleaſe to give it) is a principal inſtrument which the mind makes uſe of to influence the actions of the body, or to inform itſelf of the impreſſions made on the body, we muſt allow that the mind can direct this inſtrument differently, particularly as to quantity and celerity, though we muſt remain ignorant of the manner how many *phænomena*, depending on this connection of mind and body, are produced. Thus we would in vain attempt to account for animals continuing, after their heads were ſtruck off, or their hearts were cut out, to perform actions begun before they ſuffered any injury.

62. Let us now ſuppoſe the nervous fluid ſuch as has been argued for,

to wit, a very fluid ſaponaceous water, moving in a conſtant, equal, ſlow ſtream, from the *encephalon* and *ſpinal marrow*, in each of the proper nervous fibres, except when the motion is changed by ſome acceſſory cauſe, ſuch as the mind, preſſure of other parts, &c.; and let us examine how well ſuch a ſuppoſition will agree with the *phænomena* of the three great functions, nutrition, ſenſation, and muſcular motion, which the nerves are principal inſtruments of.

63. In general, we may ſay, that nerves can carry fluids to the moſt minute part of the body, to ſupply what is waſted in any of the ſolids; that the impreſſion made by the objects of the ſenſes on the very ſoft pulpy extremities of the nerves of the organs of the ſenſes, muſt make ſuch a ſtop in the equal-flowing nervous fluid, as muſt inſtantaneouſly be perceptible at the fountain-head from which the pipes affected ariſe; that the conſtant flow of the liquor of the nerves into the cavities of the *muſcular fibrillæ*, occaſions the natural contraction of the muſcles, by the as conſtant *niſus* it makes to increaſe the tranſverſe and to ſhorten the longitudinal diameter of each fibre; and that it is only to allow the mind a power of determining a greater quantity of this ſame fluid with a greater velocity into what muſcular fibres it pleaſes, to account for the voluntary ſtrong action of the muſcles.

64. But, ſince ſuch a ſuperficial account would not be ſatisfactory, it will be expected, that the principal *phænomena* of theſe three functions ſhould be explained by the means of ſuch a fluid as has been ſuppoſed; and that the ſeveral objections againſt this doctrine ſhould be anſwered. Let us attempt this; and, where we cannot extricate ourſelves from difficulties which may be thrown in, let us honeſtly acknowledge ignorance.

65. A, If water, with a very ſmall proportion of oils and ſalts from the earth, proves a fit nouriſhment for vegetables, ſuch a liquor as the fluid of the nerves has been deſcribed (§ 56.) may not be unfit for reparing the waſte in animals.

B, The ſlow continual motion of this nervous fluid (§ 58. 59.) to the moſt minute parts of the body (§ 10.), is well enough calculated to ſupply the particles that are conſtantly worn off from the ſolids by the circulation of the liquors and neceſſary actions of life.

C, The greater proportional ſize of the *encephalon* in young creatures than

than in adults, ſeems calculated for their greater proportional growth: For the younger the animal is, the larger *encephalon* and ſpeedier growth it has.

D, A palſy and atrophy of the members generally accompanying each other, ſhow, that nouriſhment, ſenſation, and motion, depend on the ſame cauſe.

E, It was ſaid (§ 26.), that the nerves were *principal* inſtruments in nutrition: It was not affirmed, that they were the *ſole* inſtruments; and therefore an *atrophy* may proceed from the compreſſion or other leſion of an artery, without being an objection to the doctrine here laid down.

66. *a.* All objects of ſenſe, when applied to their proper organs, act by impulſe; and this action is capable of being increaſed by increaſing the impelling force. In tangible objects, that is clearly evident; the cloſer they are preſſed to a certain degree, the more diſtinct perception enſues. Odorous particles need the aſſiſtance of air moved rapidly, to affect our noſe: Sapid ſubſtances, that are ſcarce ſufficient to give us an idea of their taſte by their own weight, are aſſiſted by the preſſure of the tongue upon the palate: The rays of light collected drive light bodies before them: Sound communicates a vibration to all bodies in harmonic proportion with it.

The impulſes made thus by any of theſe objects on the ſoft pulpy nerves (§ 21.), which are full of liquor, preſſes their ſides or extremities, and their liquor is hindered from flowing ſo freely as it did. The canals being all full (§ 58.) this reſiſtance muſt inſtantaneouſly affect the whole column of fluids in the canals that are preſſed, and their origins, and have the ſame effect as if the impulſe had been made upon the origin itſelf. To illuſtrate this by a groſs compariſon: Let any one puſh water out of a ſyringe, through a long flexible pipe fixed to the ſyringe, and he is ſenſible of reſiſtance or a puſh backwards, the moment any one ſtops the orifice of the pipe, or cloſes the ſides of it with his fingers. This impulſe made on the nerves, and thus communicated to their origin, varies according to the ſtrength or weakneſs, the quickneſs or ſlowneſs, the continuation or ſpeedy removal, the uniformity or irregularity, the conſtancy or alternation, &c. with which objects are applied to the nerves.

b. Whenever any object is regularly applied with due force to a nerve,

rightly diſpoſed to be impreſſed by it, and is communicated, as juſt now explained, to the *ſenſorium*, it gives a true and juſt idea of the object to the mind.

c. The various kinds of impulſes which the different claſſes of objects make, occaſion in animals, which ought to have accurate perceptions of each object, a neceſſity of having the different organs of the ſenſes variouſly modified, ſo that the ſeveral impulſes may be regularly applied to the nerves in each organ; or, in other words, we muſt have different organs of the ſenſes fitted to the different claſſes of objects.

d. As the objects have one common property of impulſe, ſo all the organs have moſt of the properties of the organ of touching in common with the *papillæ* of the ſkin. In the noſe and tongue, this is evident: In ſome operations of the eyes we can alſo perceive this; as we may likewiſe do in ſome caſes where matter is collected in the internal ear.

e. Theſe properties common to the different objects and organs, occaſion frequently uncommon effects in the application of an object to an organ proper to another object of ſenſation. For ſometimes we have the ſame idea as if the object had been applied to its own proper organ. At other times the object is as it were changed, and we have the idea as if the organ had had its own proper object applied to it. Thus, for example, light is the proper object to be applied to the eye, to give us any idea of colours; yet when all light is excluded from the eyes, an idea of light and colours may be excited in us by couching, ſneezing, rubbing, or ſtriking the eye-ball.——A cane vibrating, ſo as not to excite ſound perceptible to the ear, applied to the teeth, raiſes a ſtrong idea of ſound; as a little inſect creeping in the *meatus auditorius* alſo does.—The fingers applied to two rough ſurfaces, rubbing on each other, are ſenſible of the ſound they make; ſurgeons of any practice in the cure of fractured bones can bear witneſs to the truth of this.—The fingers dipped in acid and ſeveral other acrid liquors, have a ſenſation very like to taſting.—— Smelling and taſting, every body knows, are ſubſervient and aſſiſting to each other. From ſuch examples, we have further proof of one general cauſe of our ſenſations, to wit, impulſe from the objects; and of ſuch a ſimilarity and relation in the organs, as might give reaſon for imagining that any one of them would be capable of producing the effect of another,

another, if the impulſes of the different objects could be regularly applied to each.—Hence light and ſound may affect inſects and other animals that have not eyes or ears.

f. If the impulſe of an object is applied with due force, but irregularly, a confuſed idea of the object is raiſed. Diſtant objects are confuſed to *myopes*, as very near ones are to *preſbytæ*.

g. If the application of the impulſe is regular, but the force with which it is applied is too weak, our perception of the object is too faint. One may whiſper ſo low as not to be heard.

h. If the application of objects is too violent, and there is any danger of the tender organs of our ſenſes being hurt or deſtroyed, an uneaſy ſenſation we call *pain* is raiſed, whatever the organ thus injured is. The object of feeling affects every organ: Thus preſſure, ſtretching, cutting, pricking, acrid ſalts, pungent oils, great heat, violent cold, &c. occaſion pain, wherever they are applied. Beſides, every particular organ can be affected with pain by the too violent application of its own proper object. Too much light pains the eyes; very loud ſound ſtuns the ears; very odorous bodies and too ſapid objects hurt the noſe and tongue. A pretty ſure proof this, that the objects of our ſenſes all act, and that the organs are all impreſſed, in nearly the ſame way.

i. Since a middle impulſe, neither too ſmall nor too great, is neceſſary for a clear perception of objects, we would often be in danger of not diſtinguiſhing them, if we were not ſubjected to another law, to wit, that numerous impulſes made at once, or in a quick ſucceſſion to each other, increaſe our perceptions of objects. Thus, ſuch ſound as would not be heard on a mountain-top, will be diſtinctly heard in a wainſcotted chamber.—We feel much more clearly a tangible object when our finger is drawn alongſt it, than when applied with the ſame force, but by a ſingle preſſure upon it.——We make repeated applications of odorous and ſapid objects, when we wiſh to ſmell or taſte accurately.——The end of a burning ſtick appears much more luminous when quickly whirled in a circle than when at reſt.

k. Whenever the uneaſy ſenſation, *pain*, is raiſed by the too ſtrong application of objects, a ſort of neceſſity is as it were impoſed upon the mind to endeavour to get free of the injuring cauſe, by either withdraw-

ing the grieved part of the body from it, as one retires his hand when his finger is pricked or burnt; or the injuring cauſe is endeavoured to be forced from the body, as a *teneſmus* excites the contraction which puſhes acrid *fæces* out of the *rectum*. In both theſe operations, a convulſive contraction is immediately made in the leſed part, or in the neighbourhood of it; and if the irritation is very ſtrong or permanent, the greater part of the nervous ſyſtem becomes affected in that ſpaſmodic or convulſive way.——Is it this neceſſity which obliges the mind to exert herſelf in reſpiration, or in the action of the heart, when the lungs or heart are gorged with blood? or the *iris* to contract the pupil, when the eye is expoſed to ſtrong light? or ſneezing to be performed when the noſe is tickled? &c.——Will not a *ſtimulus* of any nerve more readily affect thoſe with which it is any where connected than the other nerves of the body? ——May not this ſympathy ſerve as a monitor of the mind, rather to employ the organs furniſhed with nerves thus connected, to aſſiſt in freeing her of any uneaſy ſenſation, than to make uſe of any other organs? ——Will not this in ſome meaſure account for many ſalutary operations performed in the body, before experience has taught us the functions of the organs performing them.

This *niſus* of the mind to free the body from what is in danger of being hurtful, may ſerve to explain the phenomena of a great many diſeaſes, when we are acquainted with the diſtribution of the particular nerves: and from this we can underſtand the operation of medicines that ſtimulate; and may learn how, by exciting a ſharp, but momentary pain, we may free the body from another pain that would be more durable; and that, by having it thus in our power to determine a flow of the liquor of the nerves to any particular part, for the benefit of that part, or the relief of any other diſeaſed part, we can do conſiderable ſervice by a right application of the proper medicines.

l. If a pain-giving cauſe is very violent or long continued, it deſtroys the organs either irrecoverably, or puts them ſo much out of order that they only gradually recover: People have been made blind or deaf for all their lives after a violent effect of light on their eyes, or of ſound on their ears; and we are frequently expoſed to as much light and ſound as to make us unfit to ſee or hear for a conſiderable time. I would explain this

this by a ligature put round the tender branch of an herb. This ligature, drawn to a certain degree, may weaken the canals ſo as to be unfit for the circulation of the juices a good while, till they are gradually explicated and made firm by theſe juices: A ſtricter ligature would diſorder the ſtructure of the fibres ſo much, that the liquors could not recover them. The analogy is ſo plain, that it needs no commentary.——Thus, the influence of a nerve tied with an artery in the operation of an aneuriſm, may ceaſe for ſome time, but be afterwards recovered.

67. 1. In applying the fluid of the nerves to the action of muſcles, it was ſaid, that the natural or involuntary contraction of muſcles was the *niſus* which the nervous fluid flowing conſtantly into the muſcular fibres makes to diſtend theſe fibrils, by enlarging their tranſverſe diameters and ſhortening their axes; and that voluntary action was owing to a greater quantity of that nervous liquor determined towards the muſcle to be put in action, and poured with greater *momentum* into the muſcular fibrils, by the power of the mind willing to make ſuch a muſcle to act, or obliged to do it by an irritating pain-giving cauſe (§ 66. *k*.).

2. Some object to this account of muſcular motion, that, if there is no outlet for the liquor ſuppoſed to be poured into muſcular fibres, muſcles would always be in a ſtate of contraction, which they are not; and if there is a paſſage from the fibrils, the liquor would flow out as faſt as it was thrown in; and therefore no diſtenſion of the fibres or contraction of the muſcles could be made.

3. In anſwer to this objection, it is obſerved, that, notwithſtanding the evident outlet from the arteries into the veins, yet the arteries are diſtended by the *ſyſtole* of the heart, or any other cauſe increaſing the *momentum* of the blood.

4. It has been alſo objected to § 1. that, if it was true, the volume of the muſcle in contraction neceſſarily would be conſiderably increaſed by ſo much liquor poured into its fibrils; whereas it does not appear, by any experiment, that the volume of a muſcle is increaſed by its being put into action.

5. To this it has been anſwered, (1.) That, when the axes of muſcular fibres are ſhortened, and their tranſverſe diameters are enlarged, the capacities of their fibres, and conſequently their volume, may not be changed,

ed, the diminution one way balancing the increaſe in the other. (2.) That the ſpaces between the muſcular fibres are ſufficient to lodge theſe fibres when they ſwell, during the contraction of a muſcle, without any addition to its bulk; and that it plainly appears that theſe ſpaces between the fibrils are thus occupied, by the compreſſion which the larger veſſels of muſcles, which run in thoſe ſpaces, ſuffer during the action of the muſcle; it is ſo great as to drive the blood in the veins with a remarkable accelerated velocity.

6. Another objection to the action of muſcles being owing to the influx of a fluid into their fibrils is, That muſcular fibres are diſtractile, or capable of being ſtretched: and therefore, when a fluid is poured into their hollow fibrils, they would be ſtretched longitudinally, as well as have their tranſverſe diameters increaſed; that is, a muſcle would become longer, as well as thicker, when it is put into action; whereas it is certainly known, that a muſcle is ſhortened while it acts.

7. In anſwer to this, it has been remarked, That, though muſcular fibrils are diſtractile, yet they will not yield to, or be ſtretched by, every force, however ſmall, that might be applied to them. A cord that can be ſtretched in length by the weight of a pound or two, would not yield in the leaſt to an ounce or two; and it muſt likewiſe be oberved, that, gradually as any body is ſtretched, its reſiſtance to the ſtretching force increaſes. A rope may be ſtretched to a certain length by a pound weight appended to it, which would require two pounds to ſtretch it very little further: and therefore the general obſervation of animal-fibres being diſtractile cannot be a reaſonable objection to the account of muſcular motion above mentioned, unleſs a proof is brought that the force which the liquid of the nerves muſt exert upon each fibre of a muſcle, in order to make it act, is capable of diſtracting or ſtretching the fibres; which has not yet been attempted to be proved.—It would appear from the pain cauſed by too great an effort of the muſcles, eſpecially in weak people, that muſcular fibres can bear very little diſtraction without danger of a ſolution of continuity.

8. Muſcles ceaſing to act when their arteries are tied or cut, and being brought into motion by injecting liquors into the arteries even of a dead animal, has been mentioned as objections to the nervous influence cauſing their contractions.

To

To the firſt of theſe experiments, it may be anſwered, That the tying or cutting of the nerves ſooner produces the effect of making the contraction ceaſe, than ſtopping the influx of the arterious blood does; and it will be univerſally allowed, that the influx of blood into muſcles is neceſſary for performing their functions right.

Whoever obſerves the motion which injecting water, or any other liquor, into the arteries of a dead animal, cauſes in its muſcles, will not compare it to what contraction, whether voluntary or excited by irritation, he may ſee in a living one.

9. If muſcular motion depends on the influx of the nervous liquid, the inſtantaneous contraction of a muſcle, when the mind wills to make it act, will be eaſily underſtood from the nerves being always full of their liquor (§ 58. 66. *a*).

10. If either the nerves of any muſcle do not furniſh a ſufficient quantity of their liquor, or if the fibres of a muſcle become too eaſily diſtractile, ſuch a muſcle will be unactive or paralytic.

11. If too great a quantity of the liquor of the nerves is determined to a muſcle or muſcles, by any cauſe which the mind cannot command, ſuch muſcle or muſcles will be convulſed.

12. If the motion of the liquid of the nerves is not uniform, but by diſeaſe becomes irregular, an alternate relaxation and contraction of muſcles may be the conſequence. Hence trembling palſies, *chorea Sancti Viti*, &c. Hence alſo the convulſive tremors which animals have when they loſe much blood.

13. Though the nerves may not furniſh ſo much liquor as may be ſufficient to make muſcles contract with ſtrength enough to overcome the reſiſtances to their actions; yet there may be a ſufficient quantity of liquor in the nerves to allow the impreſſions of objects to be conveyed to the *ſenſorium*. This may be one cauſe of a member's being ſometimes ſenſible after it cannot be moved.

14. Unleſs the liquor of the nerves acquires ſome energy in the brain, which we have no reaſon to think the circulation of the fluids in the veſſels can give it, or unleſs it has other properties than what we can diſcover in it, or unleſs there is an agent regulating its *momentum* and courſe to different parts which we are not conſcious of; if ſome of theſe, I ſay,

do

do not obtain, the action of the heart continuing of equal force to propel our liquors, notwithſtanding all the reſiſtances that are to it, is not to be explained.

15. All muſcles, but eſpecially the heart, continue to contract in an irregular way, after they are cut away from the animal to whom they belonged; which may be owing to the liquors continuing to flow in the ſmall veſſels, and being poured irregularly into the muſcular *fibrillæ*.

16. It is ſaid, that a muſcle cut out of the body continues ſome time to be capable of contraction; whereas, by tying its arteries or nerves, while it is otherwiſe entire in the body, it loſes its contracting power; which therefore does not depend on theſe organs, the arteries or nerves.

The loſs of the power of acting when the arteries or nerves are tied while the muſcle is in the body, is denied by ſome who made the trial; and it might be expected, that the motion of a muſcle would be more conſpicuous where there is no reſiſtance to it, as is the caſe when it is cut away from all the parts it is connected with, than when its connection remains with parts reſiſting its contractile efforts.

17. After the heart, or any other muſcle cut away from an animal, has ceaſed to contract, its contraction may again be reſtored, by breathing upon it, or pricking it with any ſharp inſtrument. That heat or pricking ſhould, by their *ſtimulus* (§ 66. *k*), occaſion contraction in a living creature, may be underſtood; but how they ſhould have the ſame effect in a muſcle ſeparated from an animal, I know not.

68. Some have thought the *ganglions* of nerves (§ 18. 19. 20.) to be glandular, and to perform a ſecretion.——Others, from their firm texture, ſuppoſe them to be muſcular, and to ſerve to accelerate the motion of the liquor in the nerves which proceed from them; but as no proof is offered of either of theſe opinions, they cannot be maintained.——Others would make them ſerve, 1. To divide a ſmall nerve into many nerves; and by theſe means to increaſe the number of nervous branches: 2. To make nerves come conveniently by different directions to the parts to which they belong: 3. To reunite ſeveral ſmall nervous fibres into one large nerve.——Since no proof is brought that theſe three things cannot be done without the interpoſition of a *ganglion*, but, on the contrary, we ſee them performed where there are no *ganglions*, we muſt continue to acknowledge

acknowledge ignorance concerning the uſes of theſe knots, the *ganglions*.

Of the PARTICULAR NERVES.

IT is generally ſaid, that there are forty pair of nerves in all; of which ten come out from the *encephalon*, and the other thirty have their origin from the *ſpinal marrow*.

Of the ten pair of nerves which come from the *encephalon*, the firſt is the OLFACTORY, which long had the name of the *mamillary proceſſes* of the brain; becauſe in the brutes, cows and ſheep, which were moſt commonly diſſected by the ancients, the anterior ventricles of the brain are extended forwards upon theſe nerves, and adhere ſo firmly to them, that they ſeem to make the upper ſide of the nerves. Each of them being large where it begins to be ſtretched out, and gradually becoming ſmaller as it approaches the cribriform bone, was imagined to reſemble a nipple. Thoſe who miſtook the ventricles for part of the nerves, obſerving the cavity in them full of liquor, concluded, that theſe olfactory nerves ſerved to convey the ſuperfluous moiſture of the brain to the holes of the ethmoid bone through which it paſſed into the noſe. But in man, the ventricles of whoſe brain are not thus extended forwards, theſe nerves are ſmall, long, and without any cavity, having their origin from the *corpora ſtriata*, near the part where the internal carotid arteries are about to ſend off their branches to the different parts of the brain; and in their courſe under the anterior lobes of the brain, which have each a depreſſion made for lodging them, the human olfactory nerves become larger till they are extended to the cribriform bone, where they ſplit into a great number of ſmall filaments, to paſs through the little holes in that bone; and being joined by a branch of the fifth pair of nerves, are ſpread on the membrane of the noſe.

The tender ſtructure and ſudden expanſion of theſe nerves on ſuch a large ſurface, render it impoſſible to trace them far; which has made ſome authors deny them to be nerves: but when we break the circumference of the *cribiform lamella*, and then gently raiſe it, we may ſee the diſtribution of the nerves ſome way on the membrane of the noſe.

The contrivance of defending theſe long ſoft nerves from being too much preſſed by the anterior lobes of the brain under which they lie, is ſingular; becauſe they have not only the prominent orbitar proceſſes of the frontal bone to ſupport the brain on each ſide, with the veins going into the longitudinal *ſinus*, and other attachments bearing it up, but there is a groove formed in each lobe of the brain itſelf for them to lodge in.——Their ſplitting into ſo many ſmall branches before they enter the bones of the ſkull, is likewiſe peculiar to them; for generally the nerves come from the brain in diſgregated filaments, and unite into cords, as they are going out at the holes of the bones. This contrivance is the beſt for anſwering the purpoſe they are deſigned for, of being the organ of ſmelling; for had they been expanded upon the membrane of the noſe into a medullary web, ſuch as the optic nerve forms, it would have been too ſenſible to bear the impreſſions of ſuch objects as are applied to the noſe; and a diſtribution in the more common way, of a cord ſending off branches, would not have been equal enough for ſuch an organ of ſenſation.

The ſecond pair of nerves, the OPTIC, riſing from the *thalami nervorum opticorum*, make a large curve outwards, and then run obliquely inwards and forwards, till they unite at the fore-part of the *ſella turcica*; then ſoon divide, and each runs obliquely forwards and outwards to go out at its proper hole in the ſphenoid bone, accompanied with the ocular artery, to be extended to the globe of the eye, within which each is expanded into a very fine cup-like web, that lines all the inſide of the eye as far forwards as the *ciliary circle*, and is univerſally known by the name of *retina*.

Though the ſubſtance of this pair of nerves ſeems to be blended at the place where they are joined; yet obſervations of people whoſe optic nerves were not joined, and of others who were blind of one eye from a fault in the optic nerve, or in thoſe who had one of their eyes taken out, make it appear, that there is no ſuch intimate union of ſubſtance; the optic nerve of the affected ſide only being waſted, while the other was large and plump. And the ſame obſervations are contradictory to the doctrine of a decuſſation of all the nerves (§ 8.); for the diſeaſe could be traced from the affected eye to the origin of the nerve on the ſame ſide.

In

In many fiſhes, indeed, the doctrine of decuſſation is favoured; for their optic nerves plainly croſs each other, without any union at the part where they are joined in men and moſt quadrupeds.

Thoſe people whoſe optic nerves were not joined, having neither ſeen objects double, nor turned their eyes different ways, is alſo a plain proof, that the conjunction of the optic nerves will not ſerve to account for either the uniform motions of our eyes, or our ſeeing objects ſingle with two eyes, though it may be one cauſe of the remarkable ſympathy of the one eye with the other in many diſeaſes.

The *retina* of a recent eye, without any preparation, appears a very fine web, with ſome blood-veſſels coming from its centre to be diſtributed on it; but after a good injection of the arteries that run in the ſubſtance of this nerve, as is common to other nerves, it is with difficulty that we can obſerve its nervous medullary ſubſtance.——The ſituation of theſe veſſels in the central part of the optic nerve, the want of medullary fibres here, and the firmneſs of this nerve before it is expanded at its entry into the ball of the eye, may be the reaſon why we do not ſee ſuch bodies, or parts of bodies, whoſe picture falls on this central part of the *retina*.——An inflammation in thoſe arteries of the *retina*, which ſeveral fevers and an *ophthalmia* are generally attended with, may very well account for the tenderneſs in the eyes, and inability to bear the light, which people have in theſe diſeaſes.——The over-diſtenſion of theſe veſſels may likewiſe ſerve to account for the black ſpots obſerved on bright-coloured bodies eſpecially, and for that ſmoky fog through which all objects are ſeen by people in ſome fevers.——If theſe veſſels loſe their tone, and remain preternaturally diſtended, no objects affect our *retina*, though the eye externally appears ſound; or this may be one cauſe of an *amauroſis* or *gutta ſerena*.——From a partial diſtenſion of theſe veſſels, or *paralyſis* of a part of the *retina*, the central part, or the circumference, or any other part of objects, may be loſt to one or both eyes.

The THIRD PAIR riſe from the anterior part of the *proceſſus annularis*; and, piercing the *dura mater* a little before, and to a ſide of the ends of the poſterior clinoid proceſs of the ſphenoid bone, run along the *receptacula*, or *cavernous ſinuſes*, at the ſide of the *ephippium*, to get out at the *foramina lacera*: after which each of them divides into branches; of which one,

after forming a little *ganglion*, is diſtributed to the globe of the eye; the others are ſent to the *muſculus rectus* of the *palpebra*, and to the *attollens*, *adductor*, *deprimens*, and *obliquus minor* muſcles of the eye-ball. Theſe muſcles being principal inſtruments in the motions of the eye-lid and eye-ball, this nerve has therefore got the name of the *motor oculi*.——I have frequently obſerved in convulſions the eye-lids widely opened, the *cornea* turned upward and outwards, and the eye-balls ſunk in the orbit; which well deſcribed the conjunct action of the muſcles which this pair of nerves ſerves.——The diſtenſion of a conſiderable branch of the carotid, which paſſes over this nerve near its origin on each ſide, may poſſibly be the reaſon of the heavineſs in the eye-lids and eyes, after drinking hard, or eating much.

The FOURTH PAIR, which are the ſmalleſt nerves of any, derive their origin from the back-part of the baſe of the *teſtes*; and then making a long courſe on the ſide of the annular protuberance, enter the *dura mater* a little farther back and more externally than the third pair, to run alſo along the *receptacula*, to paſs out at the *foramina lacera*, and to be entirely ſpent on the *muſculi trochleares*, or ſuperior oblique muſcles of the eyes. Theſe muſcles being employed in performing the rotatory motions, and the advancement of the eye-balls forward, by which ſeveral of our paſſions are expreſſed, the nerves that ſerve them have got the name of PATHETICI.——Why theſe ſmall nerves ſhould be brought ſo far to this muſcle, when it could have been ſupplied eaſily by the *motor oculi*, I know not.

The FIFTH PAIR are large nerves, riſing from the annular proceſſes, where the medullary proceſſes of the *cerebellum* join in the formation of that *tuber*, to enter the *dura mater* near the point of the petrous proceſs of the temporal bones; and then ſinking cloſe by the *receptacula* at the ſides of the *ſella turcica*, each becomes in appearance thicker, and goes out of the ſkull in three great branches.

The firſt branch of the fifth is the OPHTHALMIC, which runs through the *foramen lacerum* to the orbit, having in its paſſage thither a connection with the ſixth pair. It is afterwards diſtributed to the ball of the eye with the third; to the noſe, along with the olfactory, which the branch of the fifth that paſſes through the *foramen orbitarium internum* joins, as was already mentioned in the deſcription of the firſt pair. This ophthalmic

mic branch likewiſe ſupplies the parts at the internal *canthus* of the orbit, the *glandula lacrymalis*, fat, membranes, muſcles, and teguments of the eye-lids; its longeſt fartheſt extended branch paſſing through the *foramen ſuperciliare* of the *os frontis*, to be diſtributed to the fore-head.

The ſmall fibres which this firſt branch of the fifth and the third pair of nerves ſend to the eye-ball, being ſituated on the optic nerve, and, after piercing the ſclerotic coat, running along the choroid coat on the outſide of the *retina* in their courſe to the *uvea* or *iris*, may be a cauſe of the ſympathy between the optic nerve and the *uvea*; by which we more readily acquire the habit of contracting the *iris*, and thereby leſſen the pupil, when too ſtrong light is excluded; and, on the contrary, enlarge the pupil, when the light is too faint.——This, with the ſympathy which muſt ariſe from ſome of the nerves of the membrane of the noſtrils being derived from this firſt branch of the fifth pair of nerves, may alſo be the cauſe why an irritation of the *retina*, by too ſtrong light, may produce ſneezing, as if a *ſtimulus* had been applied to the membrane of the noſe itſelf;—why preſſing the internal *canthus* of the orbit, ſometimes ſtops ſneezing;—why irritation of the noſe or of the eye cauſes the eye-lids to ſhut convulſively, and makes the tears to flow plentifully;—and why medicines put into the noſe do often great ſervice in diſeaſes of the eyes.——In the megrim, all the branches of the nerve diſcover themſelves to be affected: for the forehead is racked with pain; the eye-ball is pained, and feels as if it was ſqueezed; the eye-lids ſhut convulſively, the tears trickle down, and an uneaſy heat is felt in the noſe. Hence we can underſtand where external medicines will have the beſt effect when applied to remove this diſeaſe, to wit, to the membrane of the noſe, and to the forehead;—why alternate preſſure near the ſuperciliary hole of the frontal bone, or ſneezing, ſometimes gives immediate relief in the megrim;—why the ſight may be loſt by an injury done to the *ſupra orbitar* branch;—how it may be reſtored by agitation of that branch of this nerve.

The ſecond branch of the fifth pair of nerves may be called MAXILLARIS SUPERIOR, from its ſerving principally the parts of the upper jaw. It goes out at the round hole of the ſphenoid bone, and ſends immediately one branch into the channel on the top of the *antrum maxillare*; the membrane

brane of which, and the upper teeth, are ſupplied by it in its paſſage. As this branch is about to go out at the *foramen orbitarium externum*, it ſends a nerve through the ſubſtance of the *os maxillare* to come out at *Steno*'s duct, to be diſtributed to the fore-part of the palate; and what remains of it eſcaping at the *external orbitar* hole, divides into a great many branches, that ſupply the cheek, upper lip, and noſtril.--The next conſiderable branch of the *ſuperior maxillary* nerve, after giving branches which are reflected through the ſixth hole of the ſphenoid bone, to join the intercoſtal where it is paſſing through the ſkull with the carotid artery, and the *portia dura* of the ſeventh pair as it paſſes through the *os petroſum*, is ſent into the noſe by the hole common to the palate and ſphenoidal bone; and the remaining part of this nerve runs in the *palato-maxillaris* canal, giving off branches to the temples and pterygoid muſcles, and comes at laſt into the palate to be loſt.——Hence the ach in the teeth of the upper jaw occaſions a gnawing pain deep ſeated in the bones of the face, with ſwelling in the eye-lids, cheek, noſe, and upper lip; and, on the other hand, an inflammation in theſe parts, or a megrim, is often attended with ſharp pain in the teeth.—Hence an obſtruction in the duct of the maxillary ſinus, which obliges the liquor ſecreted there to find out a preternatural route for itſelf, may be occaſioned by the pain of the teeth.—Hence the upper lip often ſuffers when the palate or noſe is ulcerated.

The third or MAXILLARIS INFERIOR branch of the fifth pair going out at the oval hole of the ſphenoid bone, ſerves the muſcles of the lower jaw, and the muſcles ſituated between the *os hyoides* and *jaw*: all the ſalivary glands, the *amygdalæ*, and the external ear, have branches from it: it has a large branch loſt in the tongue; and ſends another through the canal in the ſubſtance of the lower jaw to ſerve all the teeth there, and to come out at the hole in the fore-part of the jaw, to be loſt in the chin and under lip. Hence a convulſive contraction of the muſcles of the lower jaw, or the mouth's being involuntarily ſhut, a great flow of ſpittle or ſalivation, a pain in the ear, eſpecially in deglutition, and a ſwelling all about the throat, are natural conſequences of a violent irritation of the nerves of the lower teeth in the toothach; and pain in the teeth and ear is as natural a conſequence of an *angina*.—Hence alternate preſſure on the chin may ſometimes

ſometimes relieve the violence of a toothach.—Hence deſtroying the nerves of a tooth by actual or potential cauteries, or pulling a carious tooth, ſo often removes immediately all theſe ſymptoms.—Hence no cure is to be found for ſome ulcers in the upper or lower jaw, but by drawing a tooth.—Hence, in cancers of the upper lip, the ſalivary glands are in danger of being affected, or the diſeaſe may be occaſioned to the lip by its beginning in the glands.—Perhaps the ſympathy of the organs of taſting and ſmelling may in ſome meaſure depend on their both receiving nerves from the fifth pair.

The SIXTH PAIR, which is the ſmalleſt except the fourth, riſes from the fore-part of the *corpora pyramidalia*; and each entering the *dura mater* ſome way behind the poſterior clinoid proceſs of the ſphenoid bone, has a long courſe below that membrane, and within the *receptaculum* at the ſide of the *ſella turcica*, where it is immerſed in the blood of the receptacle, but for what purpoſe I am ignorant. It goes afterwards out at the *foramen lacerum* into the orbit, to ſerve the abductor muſcle of the eye.—A defect in this nerve may therefore be one cauſe of a *ſtrabiſmus*. In the paſſage of this nerve below the *dura mater*, it lies very contiguous to the internal carotid artery, and to the ophthalmic branch of the fifth pair of nerves. At the place where the ſixth pair is contiguous to the carotid, a nerve either goes from each of them in an uncommon way, to wit, with the angle beyond where it riſes obtuſe, to deſcend with the artery, and to form the beginning of the intercoſtal nerve, according to the common deſcription; or, according to other authors, this nerve comes up from the great *ganglion* of the *intercoſtal*, to be joined to the ſixth here.

The arguments for this latter opinion are, That, according to the common doctrine, this beginning of the *intercoſtal* nerve, as it is called, would riſe in a manner not ſo ordinary in nerves. In the next place, it is obſerved, that the ſixth pair is larger nearer to the orbit, than it is before it comes to the place where this nerve is ſaid to go off; and therefore it is more probable, that it receives an addition there, rather than gives off a branch. *Laſtly*, it is found, that, upon cutting the *intercoſtal* nerves of living animals, the eyes plainly were affected; they loſt their bright water; the gum, or gore, as we call it, was ſeparated in greater quantity; the pupil was more contracted; the cartilaginous membrane, at the internal

ternal *canthus*, came more over the eye; and the eye-ball itſelf was diminiſhed.

To this it is anſwered, in defence of the more common doctrine, 1*ſt*, That other branches of nerves go off in a reflected way, as well as this does, ſuppoſing it to be the beginning of the intercoſtal; and that the reflection would rather be greater, if it is thought to come up from the intercoſtal to the ſixth. 2*dly*, It is denied that this nerve is for ordinary thicker at its fore than its back part; and, if it was ſuppoſed to be thickeſt nearer to the orbit, the concluſion made above could not be drawn from this appearance, becauſe other nerves enlarge ſometimes where there is no addition made to them, as in the inſtance already mentioned of the trunk of the fifth pair while below the *dura mater*. 3*dly*, The experiments on living animals ſhow, indeed, that the eyes are affected upon cutting the intercoſtal nerve; but not in the way which might have been expected, if the *intercoſtal* had furniſhed ſuch a ſhare of the nerve that goes to the *abductor* muſcle of the eye: for it might have been thought, that this muſcle would have been ſo much weakened immediately upon cutting the *intercoſtal*, that its antagoniſt the *adductor* would have greatly prevailed over it, and have turned the eye ſtrongly in towards the noſe; which is not ſaid to be a conſequence of this experiment. So that the arguments are ſtill equivocal; and more obſervations and experiments muſt be made, before it can be determined, with certainty, whether the ſixth pair gives or receives a branch here. In the mean time, I ſhall continue to ſpeak about the origin of the *intercoſtal*, with the generality of anatomiſts.

At this place where the intercoſtal begins, the fifth pair is contiguous and adherent to the ſixth; and it is generally ſaid, that the ophthalmic branch of the fifth gives a branch or two to the beginning of the intercoſtal, or receives ſuch from it. Others deny any ſuch communication between them; and thoſe who affirm the communication confeſs, that in ſome ſubjects they could not ſee it. After examining the nerves here in a great many ſubjects, I cannot determine whether or not there are nervous filaments going from the one to the other. Sometimes I have thought that I traced them evidently; at other times I obſerved, that what I diſſected for nervous filaments, was collapſed cellular ſubſtance; and, in all the ſubjects where I had puſhed an injection ſucceſsfully into the very

ſmall

ſmall arteries, I could only obſerve a *plexus* of veſſels connecting the one to the other. In any of theſe ways, however, there is as much connection as, we are aſſured from many experiments and obſervations on other nerves, is ſufficient to make a very great ſympathy among the nerves here. Poſſibly the appearances in the eyes of dogs, whoſe intercoſtal nerves were cut, might be owing to this ſympathy.

The SEVENTH PAIR comes out from the lateral part of the *annular proceſs*, behind where the medullary proceſſes of the *cerebellum* are joined to that *tuber*; and each being accompanied with a larger artery than moſt other nerves, enters the *internal meatus auditorius*, where the two large bundles of fibres, of which it appeared to conſiſt within the ſkull, ſoon ſeparate from each other: one of them entering by ſeveral ſmall holes into the *veſtibule*, *cochlea*, and *ſemicircular canals*, is ſtretched on this inner *camera* of the ear in a very ſoft pulpy ſubſtance; and, being never ſeen in the form of a firm cord, ſuch as the other parcel of this and moſt other nerves become, is called PORTIO MOLLIS of the auditory nerve.

The other part of this ſeventh pair paſſes through *Galen's foramen cæcum*, or *Fallopius's aquæduct*, in its crooked paſſage by the ſide of the *tympanum*; in which paſſage, a nerve ſent from the lingual branch of the inferior maxillary nerve, along the outſide of the *tuba Euſtachiana*, and croſs the cavity of the *tympanum*, where it has the name of *chorda tympani*, is commonly ſaid to be joined to it. The very acute angle which this nerve makes with the fifth, or the ſudden violent reflection it would ſuffer on the ſuppoſition of its coming from the fifth to the ſeventh, appears unuſual; whereas, if we ſuppoſe that it comes from the ſeventh to the fifth, its courſe would be more in the ordinary way, and the *chorda tympani* would be eſteemed a branch of the ſeventh pair going to join the fifth, the ſize of which is increaſed by this acquiſition. This ſmaller bundle of the ſeventh gives branches to the muſcles of the *malleus*, and to the *dura mater*, while it paſſes through the bony crooked canal, and at laſt comes out in a firm chord named PORTIO DURA, at the end of this canal, between the *ſtyloid* and *maſtoid* proceſſes of the temporal bone, giving immediately filaments to the little oblique muſcles of the head and to thoſe that riſe from the ſtyloid proceſs. It then pierces through the parotid gland; and divides into a great many branches, which are diſperſed in

the muſcles and teguments that cover all the ſide of the upper part of the neck, the whole face and *cranium*, as far back as the temples, including a conſiderable part of the external ear. Its branches having thus a conſiderable connection with all the three branches of the fifth pair, and with the ſecond cervical, occaſion a conſiderable ſympathy of theſe nerves with it.—Hence, in the toothach, the pain is ſometimes very little in the affected tooth, compared to what it is all along the ſide of the head and in the ear.—Hence probably the relief of the toothach from bliſters applied behind or before the ear, or by a hot iron touching the *antihelix* of the ear.—By this communication or connection poſſibly too it is, that a vibrating ſtring held between one's teeth, gives a ſtrong idea of ſound to the perſon who holds it, which nobody elſe can perceive.——Perhaps too the diſtribution of this nerve occaſions the head to be ſo quickly turned upon the impreſſion of ſound on our ears.

The EIGHTH PAIR of nerves riſe from the lateral baſes of the *corpora olivaria* in diſgregated fibres; and, as they are entering the anterior internal part of the holes common to the *os occipitis* and *temporum*, each is joined by a nerve which aſcends within the *dura mater* from the tenth of the head, the firſt, ſecond, and inferior cervical nerves: This every body knows has the name of the NERVUS ACCESSORIUS. When the two get out of the ſkull, the *acceſſorius* ſeparates from the eighth, and, deſcending obliquely outwards, paſſes through the *ſterno-maſtoideus* muſcle, to which it gives branches, and afterwards terminates in the *trapezius* and *rhomboid* muſcles of the *ſcapula*. In this courſe it is generally more or leſs joined by the ſecond cervical nerve.—Why this nerve, and ſeveral others which are diſtributed to muſcles, are made to pierce through muſcles, which they might have only paſſed near to, I do not know.

The large *eighth pair*, ſoon after its exit, gives nerves to the tongue, *larynx*, *pharynx*, and *ganglion* of the *intercoſtal* nerve, and, being disjoined from the ninth and intercoſtal, to which it adheres cloſely ſome way, runs ſtraight down the neck behind the internal jugular vein, and at the external ſide of the carotid artery. As it is about to enter the *thorax*, a large nerve goes off from the eighth of each ſide: This branch of the right-ſide turns round from the fore to the back part of the ſubclavian artery, while the branch of the left-ſide turns round the great curve of

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the *aorta*, and both of them mounting up again at the ſide of the *æſophagus*, to which they give branches, are loſt at laſt in the *larynx*. Theſe are called the RECURRENT nerves, which we are deſired to ſhun in the operation of *bronchotomy*, though their deep ſituation protects them ſufficiently.—The muſcles of the *larynx* being in a good meaſure ſupplied with nerves from the recurrents, it is to be expected, that the cutting of them will greatly weaken the voice, though it will not be entirely loſt, ſo long as the ſuperior branches of the eighth pair are entire.——Why the recurrent nerves riſe ſo low from the eighth pair to go round a large artery, and to have ſuch a long courſe upwards, I know not.

The eighth pair, above and at or near the place where the recurrent nerves go off from it, or frequently the recurrents themſelves, ſend off ſmall nerves to the *pericardium*, and to join with the branches of the intercoſtal that are diſtributed to the heart; but their ſize and ſituation are uncertain.

After theſe branches are ſent off, the *par vagum* on each ſide deſcends behind the great branch of the *trachea*, and gives numerous filaments to the lungs, and ſome to the heart, in going to the *æſophagus*. The one of the left ſide running on the fore-part of the *æſophagus*, communicates by ſeveral branches with the right one in its deſcent to be diſtributed to the ſtomach: The right one gets behind the *æſophagus*, where it ſplits and rejoins ſeveral times before it arrives at the ſtomach, to which it ſends nerves; and then being joined by one or more branches from the left trunk, they run towards the cæliac artery, there to join into the great *ſemilunar ganglion* formed by the two intercoſtals.

From the diſtribution of this *par vagum*, we may learn how tickling the *fauces* with a feather or any ſuch ſubſtance, excites a *nauſea* and inclination to vomit;—why coughing occaſions vomiting, or vomiting raiſes a cough. —Hence we ſee how the nervous *aſthma*, and the *tuſſis convulſiva*, chincough, are attended with a ſtraitening of the *glottis*;—why food difficult to digeſt occaſions the *aſthma* to weakly people, and why *emetics* have frequently cured the *aſthma* very ſpeedily;——why an attempt to vomit is ſometimes in danger of ſuffocating *aſthmatic* people;—why the ſuperior orifice of the ſtomach is ſo ſenſible, as to be looked on as the ſeat of the ſoul by ſome; ——why people ſubject to diſtenſions of the ſtomach, have ſo often the

ſenſation of balls in their breaſts and throats;—why the *globus hyſtericus* is ſo often attended with a violent ſtrangulation at the *glottis*.

The NINTH PAIR of nerves comes from the inferior part of the *corpora pyramidalia*, to go out of the ſkull at their proper holes of the occipital bone. After their egreſs they adhere for ſome way firmly to the eighth and intercoſtal; and then ſending a branch, that in many ſubjects is joined with branches of the firſt and ſecond cervical nerves, to be diſtributed to the thyroid gland and muſcles on the fore-part of the *trachea arteria*, the ninth is loſt in the muſcles and ſubſtance of the tongue. Some have thought this nerve, and others have eſteemed the third branch of the fifth pair of nerves, to be the proper guſtatory nerve. I know no obſervation or experiments to prove either opinion, or to aſſure us that both nerves do not ſerve for taſting and for the motion of the tongue.—May not the diſtribution of this nerve to the muſcles below as well as above the *os hyoides*, contribute to their acting more uniformly in depreſſing the lower jaw or head?

The TENTH PAIR riſes in ſeparate threads from the ſides of the *ſpinal marrow*, to go out between the *os occipitis* and *firſt vertebra* of the neck. After each of them has given branches to the great ganglion of the intercoſtal, 8th, 9th, and 1ſt cervical nerves, it is diſtributed to the ſtraight, oblique, and ſome of the extenſor muſcles of the head. Whether the name of *tenth of the head*, or of *the firſt vertebral*, ought to be given to this pair of nerves, is of no ſuch conſequence as to deſerve a debate; tho' it has ſome of the marks of the ſpinal nerves, to wit, its being formed of filaments proceeding from both the fore and back part of the *medulla*, and a little *ganglion* being formed where theſe filaments meet.

In the deſcription of the ſixth pair, I followed the uſual way of ſpeaking among anatomiſts, and called *that* the beginning of the intercoſtal nerve which comes out of the ſkull; and therefore ſhall here ſubjoin a curſory deſcription of this nerve, notwithſtanding its much larger part is compoſed of nerves coming out from the *ſpinal marrow*. There is no greater incongruity in point of method to ſay, that the nerve we are deſcribing receives additions from others that have not been deſcribed, than it is to repeat, in the deſcription of a great many nerves, that each of them gives branches to form a nerve which we are ignorant of; which is

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all the difference between deſcribing the intercoſtal before or after the ſpinal nerves.

The branch reflected from the ſixth pair, joined poſſibly by ſome filaments of the *ophthalmic* branch of the fifth, runs along with the internal carotid artery, through the crooked canal formed for it in the *temporal bone*, where the little nerve is very ſoft and pappy, and in ſeveral ſubjects divides and unites again, and is joined by one or more branches from the fifth, particularly of its ſuperior maxillary branch, before it comes out of the ſkull. May not the compreſſion of this nerve by the carotid artery, when ſtretched during the *ſyſtole*, contribute to the *diaſtole* of the heart? As ſoon as the nerve eſcapes out of this bony canal, it is connected a little way with the eighth and ninth; then ſeparating from theſe, after ſeeming to receive additional nerves from them, it forms a large *ganglion*, into which branches from the tenth of the head, and from the firſt and ſecond cervical, enter. From this ganglion the nerves come out again ſmall to run down the neck along with the carotid artery, communicating by branches with the cervical nerves, and giving nerves to the muſcles that bend the head and neck. As the *intercoſtal* is about to enter the *thorax*, it forms another ganglion, from which nerves are ſent to the *trachea* and to the heart; thoſe deſigned for the heart joining with the branches of the eighth, and moſt of them paſſing between the two great arteries and the auricles to the ſubſtance of that muſcle. The intercoſtal after this, conſiſting of two branches, one going behind, and the other running over the fore-part of the ſubclavian artery, forms a new ganglion where the two branches unite below that artery; and then, deſcending along the ſides of the *vertebræ* of the *thorax*, receives branches from each of the dorſal nerves; which branches appearing to come out between the ribs, have given the name of *intercoſtal* to the whole nerve. Where the addition is made to it from the fifth dorſal nerve, a branch goes off obliquely forwards; which being joined by ſuch branches from the ſixth, ſeventh, eighth, and ninth dorſal, an anterior trunk is formed, and paſſes between the *appendix muſculoſa* of the diaphragm, to form, along with the other intercoſtal and the branches of the eighth pair, a large ſemilunar ganglion, ſituated between the cæliac and ſuperior meſenteric arteries; the roots of which are as it were involved in a ſort of nervous net-work of this ganglion, from which

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a great number of very ſmall nervous threads run out to be extended on the ſurface of all the branches of thoſe two arteries, ſo as to be eaſily ſeen when any of the ateries are ſtretched, but not to be raiſed from them by diſſection; and thus the *liver*, *gall-bladder*, *duodenum*, *pancreas*, *ſpleen*, *jejunum*, *ilium*, and a large ſhare of the *colon*, have their nerves ſent from this great *ſolar ganglion* or *plexus*—May not the periſtaltic motion of the inteſtines depend in ſome meaſure on the paſſage of the intercoſtal nerves through the diaphragm?

Several fibres of this ganglion, running down upon the *aorta*, and meeting with other nerves ſent from the poſterior trunk of the intercoſtal, which continues its courſe along the ſides of the *vertebræ*, ſupply the *glandulæ renales*, kidneys, and *teſtes* in men, or *ovaria* in women; and then they form a net-work upon the inferior meſenteric artery where the nerves of the two ſides meet, and accompany the branches of this artery to the part of the *colon* that lies in the left ſide of the belly, and to the *rectum*, as far down as to the lower part of the *pelvis*.

The intercoſtal continuing down by the ſide of the *vertebræ* of the loins, is joined by nerves coming from between theſe *vertebræ*, and ſends nerves to the organs of generation, and others in the *pelvis*, being even joined with thoſe that are ſent to the inferior extremities.

The almoſt univerſal connection and communication which this nerve has with the other nerves of the body, may lead us to underſtand the following and a great many more *phænomena*:—Why tickling the noſe cauſes ſneezing;—why the too great quantity of bile in the *cholera* occaſions vomiting as well as purging;—why people vomit in cholics, in inflammations, or other irritations of the liver, or of the ducts going from it, and the gall-bladder;—why a ſtone in the kidneys, or ureters, or any other cauſe irritating thoſe organs, ſhould ſo much more frequently bring on vomiting and other diſorders of the ſtomach, than the ſtone or any other ſtimulating cauſe in the bladder does;—why vomiting is a ſymptom of danger after child-birth, lithotomy, and other operations on the parts in the *pelvis*;—why the obſtructions of the *menſes* are capable of occaſioning ſtrangulations, belching, cholics, ſtomach-achs, and even convulſions in the extremities;—why veſicatories, applied from the ears to the clavicles of children labouring under the *tuſſis convulſiva*, are frequently of great

ſervice;

ſervice;—why worms in the ſtomach or guts excite an itching in the noſe, or grinding of the teeth;—why irritations in the bowels or the belly occaſion ſometimes univerſal convulſions of the body.

The *ſpinal* nerves riſe generally by a number of diſgregated fibres from both the fore and back part of the *medulla ſpinalis*, and ſoon after form a little knot or ganglion, where they acquire ſtrong coats, and are extended into firm cords. They are diſtinguiſhed by numbers, according to the *vertebræ* from between which they come out; the ſuperior of the two bones forming the hole through which they paſs, being the one from which the number is applied to each nerve. There are generally ſaid to be *thirty pair* of them; ſeven of which come out between the *vertebræ* of the *neck*, twelve between thoſe of the *back*, five between thoſe of the loins, and ſix from the *falſe vertebræ*.

The FIRST CERVICAL pair of nerves comes out between the firſt and ſecond *vertebræ* of the neck; and having given branches to join with the tenth pair of the head, the ſecond cervical and intercoſtal, and to ſerve the muſcles that bend the neck, it ſends its largeſt branches backwards to the extenſor muſcles of the head and neck; ſome of which piercing through theſe muſcles, run up on the *occiput* to be loſt in the teguments here; and many fibres of it advance ſo far forward, as to be connected with the *fibrils* of the firſt branch of the fifth pair of the head, and of the *portio dura* of the *auditory nerve*.——Hence poſſibly it is that a *clavus hyſtericus* changes ſuddenly ſometimes from the forehead to a violent pain and ſpaſm in the back-part of the head and neck.

The SECOND CERVICAL is ſoon joined by ſome branches to the ninth of the head and intercoſtal, and to the firſt and third of the neck; then has a large branch that comes out at the exterior edge of the *ſterno-maſtoideus* muſcle, where it joins with the *acceſſorius* of the eighth pair; and is afterwards diſtributed to the *platiſma myoides*, teguments of the ſide of the neck and head, parotid gland, and external ear, being connected to the *portia dura* of the auditory nerve, and to the firſt cervical. The remainder of this ſecond cervical is ſpent on the *levator ſcapulæ* and the extenſors of the neck and head. Generally a large branch is here ſent off to join the *acceſſorius* of the eighth pair, near the ſuperior angle of the *ſcapula*.

To the irritation of the branches of this nerve it probably is, that, in an

an inflammation of the parotid gland, the neck is pained ſo far down as the clavicle, the head is drawn towards the ſhoulder of the affected ſide, and the chin is turned to the other ſide.——In opening the external jugular vein, no operator can promiſe not to touch ſome of the cutaneous branches of this nerve with the lancet; which occaſions a ſharp pricking pain in the mean time, and a numbneſs of the ſkin near the orifice for ſome time after.

The THIRD PAIR of the neck paſſes out between the third and fourth cervical *vertebræ*, having immediately a communication with the ſecond, and ſending down a branch, which, being joined by a branch from the fourth cervical, forms the PHRENIC nerve. This, deſcending, enters the *thorax* between the ſubclavian vein and artery; and then being received into a groove formed for it in the *pericardium*, it has its courſe along this *capſula* of the heart, till it is loſt in the middle part of the diaphragm. The right phrenic has a ſtraight courſe; but the left one is obliged to make a conſiderable turn outwards to go over the prominent part of the *pericardium* where the point of the heart is lodged. Hence, in violent palpitations of the heart, a pungent acute pain is felt near the left orifice of the ſtomach.——The middle of the diaphragm ſcarce could have been ſupplied by any other nerve which could have had ſuch a ſtraight courſe as the *phrenic* has. If the ſubclavian artery and vein have any effect upon this nerve, I do not know it.

The other branches of the third cervical nerve are diſtributed to the muſcles and teguments at the lower part of the neck and top of the ſhoulder. No wonder then that an inflammation of the liver or ſpleen, an abſceſs in the lungs adhering to the diaphragm, or any other cauſe capable of irritating the diaphragm, ſhould be attended with a ſharp pain on the top of the ſhoulder, as well as wounds, ulcers, &c. of this muſcle itſelf.——If the irritation of this muſcle is very violent, it may occaſion that convulſive contraction of the diaphragm which is called an *hiccough*; and therefore an hiccough in an inflammation of the liver, has been juſtly declared to be an ill ſymptom.

An irritation of the thoracic nerves which produces ſneezing, may ſometimes free the phrenic nerves from any ſpaſm they occaſion; ſo that ſneezing ſometimes takes away the hiccough; and a derivation of the fluid

fluid of the nerves any other way may do the ſame thing: Or the hiccough may alſo be ſometimes cured, by drawing up into the noſe the ſmoke of burning paper or other acrid fumes, ſwallowing pungent or aromatic medicines, and by a ſurpriſe, or any other ſtrong application of the mind in thinking, or in diſtinguiſhing objects: Or when all theſe have failed, it has been put away by the briſk *ſtimulus* of a bliſtering plaſter applied to the back.

The FOURTH CERVICAL nerve, after ſending off that branch which joins with the third to form the phrenic, and beſtowing twigs on the muſcles and glands of the neck, runs to the arm-pit, where it meets with the FIFTH, SIXTH, and SEVENTH cervicals, and FIRST DORSAL, that eſcape in the interſtices of the *muſculi ſcaleni*, to come at the arm-pit, where they join, ſeparate, and rejoin, in a way ſcarce to be rightly expreſſed in words; and after giving ſeveral conſiderable nerves to the muſcles and teguments which cover the *thorax*, they divide into ſeveral branches, to be diſtributed to all the parts of the ſuperior extremity. Seven of theſe branches I ſhall deſcribe under particular names.

1. SCAPULARIS runs ſtraight to the *cavitas ſemilunata* of the upper *coſta* of the *ſcapula*, which is a hole in the recent ſubject, by a ligament being extended from one angle of the bone to the other, giving nerves in its way to the muſcles of the *ſcapula*. When it has paſſed this hole, it ſupplies the *ſupra ſpinatus* muſcle; and then deſcending at the anterior root of the *ſpine* of the *ſcapula*, it is loſt in the other muſcles that lie on the *dorſum* of that bone.

2. ARTICULARIS ſinks downwards at the *axilla*, to get below the neck of the head of the *os humeri*, and to mount again at the back-part of it; ſo that it almoſt ſurrounds the articulation, and is diſtributed to the muſcles that draw the arm back, and to thoſe that raiſe it up.

3. CUTANEUS runs down the fore-part of the arm near the ſkin, to which it gives off branches; and then divides on the inſide of the fore-arm into ſeveral nerves, which ſupply the teguments there, and on the palm of the hand.——In opening the baſilic vein of the arm, at the ordinary place, the ſame ſymptoms are ſometimes produced as in opening the external jugular vein, and from a like cauſe, to wit, from hurting a branch of this cutaneous nerve with the lancet.

4. MUSCULO-CUTANEUS, or *perforans Caſſeri*, paſſes through the *coracobrachialis* muſcle; and after ſupplying the *biceps flexor cubiti* and *brachiæus internus*, paſſes behind the tendon of the *biceps*, and over the cephalic vein, to be beſtowed on the teguments on the outſide of the fore-arm and back of the hand.——This nerve is ſometimes hurt in opening the cephalic vein, and cauſes pain and numbneſs for a ſhort time.

5. MUSCULARIS has a ſpiral courſe from the *axilla*, under the *os humeri*, and backward to the external part of that bone; ſupplying by the way the extenſor muſcles of the fore-arm, to which it runs between the two *brachiæi* muſcles, and within the *ſupinator radii longus*.——At the upper part of the fore-arm, it ſends off a branch, which accompanies the *ſupinator longus* till it comes near the wriſt, where it paſſes obliquely over the *radius*, to be loſt in the back of the hand and fingers.——The principal part of this nerve pierces through the *ſupinator radii brevis*, to ſerve the muſcles that extend the hand and fingers, whoſe actions are not injured when the *ſupinator* acts.

6. ULNARIS is extended along the inſide of the arm, to give nerves to the muſcles that extend the fore-arm and to the teguments of the elbow: towards the lower part of the arm, it ſlants a little backward to come at the groove behind the internal condyle of the *os humeri*, through which it runs to the *ulna*. In its courſe along this bone, it ſerves the neighbouring muſcles and teguments; and as it comes near the wriſt, it detaches a branch obliquely over the *ulna* to the back of the hand, to be loſt in the convex part of ſeveral fingers. The larger part of the nerve goes ſtraight forward to the internal ſide of the *os piſiforme* of the wriſt; where it ſends off a branch which ſinks under the large tendons in the palm, to go croſs to the other ſide of the wriſt, ſerving the *muſculi lumbricales* and *interoſſei*, and at laſt terminating in the ſhort muſcles of the thumb and fore-finger. What remains of the ulnar nerve, after ſupplying the ſhort muſcles of the little-finger, divides into three branches; whereof two are extended along the ſides of the ſheath of the tendons of the flexors of the little-finger, to furniſh the concave ſide of that finger; and the third branch is diſpoſed in the ſame way upon the ſide of the ring-finger next to the little-finger.

When we lean or preſs on the internal condyle of the *os humeri*, the numbneſs

numbneſs and prickling we frequently feel, point out the courſe of this nerve. I have ſeen a weakneſs and atrophy in the parts which I mentioned this nerve to be ſent to, after a wound in the internal lower part of the arm.

7. RADIALIS accompanies the humeral artery to the bending of the elbow, ſerving the flexors of the cubit in its way; then paſſing through the *pronator radii teres* muſcle, it gives nerves to the muſcles on the fore-part of the fore-arm, and continues its courſe near to the *radius*, beſtowing branches on the circumjacent muſcles. Near the wriſt, it ſometimes gives off a nerve which is diſtributed to the back of the hand, and the convex part of the thumb and ſeveral of the fingers, inſtead of the branch of the muſcular. The larger part of this nerve, paſſing behind the annular ligament of the wriſt, gives nerves to the ſhort muſcles of the thumb; and afterwards ſends a branch along each ſide of the ſheath of the tendons of the flexors of the thumb, fore-finger, mid-finger, and one branch to the ſide of the ring-finger, next to the middle one, to be loſt on the concave ſide of thoſe fingers.

Though the *radial* nerve paſſes through the *pronator* muſcle, and the *muſcular* nerve ſeems to be ſtill more unfavourably placed within the *ſupinator brevis*, yet the action of theſe muſcles does not ſeem to have any effect in hindering the influence of theſe nerves; for the fingers or hand can be bended while pronation is performing vigorouſly, and they can be extended while ſupination is exerciſed.

The manner of the going off of theſe nerves of the fingers, both from the *ulnar* and *radial*, is, that a ſingle branch is ſent from the trunk to the ſide of the thumb and little-finger fartheſt from the other fingers; and all the reſt are ſupplied by a trunk of a nerve, which ſplits into two, ſome way before it comes as far as the end of the *metacarpus*, to run along the ſides of different fingers that are neareſt to each other.

It might have been obſerved, that, in deſcribing the poſterior branches of the *ulnar* and *muſcular nerve*, I did not mention the particular fingers, to the convex part of which they are diſtributed. My reaſon for this omiſſion is the uncertainty of their diſtribution: for though ſometimes theſe poſterior branches go to the ſame fingers, to the concave part of

which the anterior branches of the *ulnar* and *radial* are ſent, yet frequently they are diſtributed otherwiſe.

The ſituation of theſe brachial nerves in the *axilla* may let us ſee how a weakneſs and atrophy may be brought on the arms by long-continued preſſure of crutches, or ſuch other hard ſubſtances, on this part; and the courſe of them from the neck to the arm may teach us, how much better effects veſicatories, or ſtimulating nervous medicines, would have, when applied to the ſkin, covering the tranſverſe proceſſes of the *vertebræ* of the neck, or at the *axilla*, than when they are put between the ſhoulders, or upon the ſpinal proceſſes, in convulſions or palſies of the ſuperior extremities, where a *ſtimulus* is required.

The TWELVE DORSAL nerves of each ſide, as ſoon as they eſcape from between the *vertebræ*, ſend a branch forward to join the intercoſtal, by which a communication is made among them all; and they ſoon likewiſe give branches backwards to the muſcles that raiſe the trunk of the body, their principal trunk being extended outwards to come at the furrow in the lower edge of each rib, in which they run toward the anterior part of the *thorax*, between the internal and external intercoſtal muſcles, giving off branches in their courſe to the muſcles and teguments of the *thorax*.

The FIRST dorſal, as was already obſerved, is particular in this, that it contributes to form the brachial nerves; and that the two branches of the intercoſtal, which come down to the *thorax*, form a conſiderable ganglion with it.

The SIX lower dorſal nerves give branches to the diaphragm and abdominal muſcles.

The TWELFTH joins with the firſt lumbar, and beſtows nerves on the *muſculus quadratus lumborum* and *iliacus internus*.

May not the communications of all theſe nerves be one reaſon, why the parts they ſerve act ſo uniformly and conjunctly in reſpiration, and conſpire together in the convulſive motions of coughing, ſneezing, &c. ——The twitching ſpaſms that happen ſometimes in different parts of the muſcles of the *abdomen*, by an irritation on the branches of the lower dorſal nerves, are in danger of occaſioning a miſtake in practice, by their reſemblance to the colic, *nephritis*, &c.——The communications of theſe lower

lower ones with the intercoſtals, may ſerve to explain the violent effort of the abdominal muſcles in a *teneſmus*, and in child-bearing.

As the intercoſtal is larger in the *thorax* than any where elſe, and ſeems to diminiſh gradually as it aſcends and deſcends, there is cauſe to ſuſpect that this is the trunk from which the ſuperior and inferior pairs are ſent as branches.

The FIVE LUMBAR nerves on each ſide communicate with the intercoſtal and with each other, and give branches backwards to the loins.

The FIRST communicates with the laſt dorſal, ſends branches to the abdominal muſcles, to the *pſoas* and *iliacus*, and to the teguments and muſcles on the fore-part of the thigh; while its principal branch joins with the other nerves to form the crural nerve.

The SECOND LUMBAR nerve paſſes through the *pſoas muſcle*, and is diſtributed nearly in the ſame way as the former: as is alſo the THIRD.

Branches of the *ſecond*, *third*, and *fourth*, make up one trunk, which runs along the fore-part of the *pelvis;* and, paſſing in the notch at the fore-part of the great hole common to the *os pubis* and *iſchium*, is ſpent on the *adductor* muſcles, and on the teguments on the inſide of the thigh. This nerve is called the OBTURATOR, or POSTERIOR CRURAL NERVE.

By united branches from the *firſt*, *ſecond*, *third*, and *fourth* lumbar nerves, a nerve is formed that runs along the *pſoas* muſcle, to eſcape with the external iliac veſſels out of the *abdomen*, below the tendinous arcade of the external oblique muſcle. This nerve, which is named the ANTERIOR CRURAL, is diſtributed principally to the muſcles and teguments on the fore-part of the thigh. A branch, however, of this nerve, runs down the inſide of the leg to the upper part of the foot, keeping near to the *vena ſaphæna;* in opening of which with a lancet at the ankle, the nerve is ſometimes hurt, and occaſions ſharp pain at the time of the operation, and numbneſs afterwards.

The remainder of the fourth lumbar and the fifth join in compoſing the largeſt nerve of the body; which is ſoon to be deſcribed.

Whoever attends to the courſe of theſe lumbar nerves, and of the ſpermatic veſſels and nerves upon the *pſoas* muſcle, with the oblique paſſage of the *ureter* over that muſcle, will not be ſurpriſed, that, when a ſtone is paſſing in this canal, or even when it is inflamed, the trunk of the body cannot

cannot be raiſed erect without great pain; or that the ſkin of the thigh becomes leſs ſenſible, and the thigh is drawn forward; and that the teſticle often ſwells, and is drawn convulſively towards the ring of the abdominal muſcles.

The SIXTH PAIR of the falſe VERTEBRÆ conſiſt each of ſmall poſterior branches ſent to the hips, and of large anterior branches.

The *firſt*, *ſecond*, and *third*, after coming through the three upper holes in the fore-part of the *os ſacrum*, join together with the fourth and fifth of the loins, to form the largeſt nerve of the body, which is well known by the name of SCIATIC or ISCHIATIC nerve: This, after ſending large nerves to the different parts of the *pelvis*, and to the external parts of generation and the *podex*, as alſo to the muſcles of the hips, paſſes behind the great *tuber* of the *os iſchium*, and then over the *quadrigemini* muſcles to run down near to the bone of the thigh at its back-part, giving off nerves to the neighbouring muſcles and teguments. Some way above the ham, where it has the name of the *poplitæus* nerve, it ſends off a large branch that paſſes over the *fibula*, and, ſinking in among the muſcles on the anterior external part of the leg, runs down to the foot, to be loſt in the upper part of the larger toes, ſupplying the neighbouring muſcles and teguments every where in its paſſage. The larger branch of the *ſciatic*, after giving branches to the muſcles and teguments about the ham and knee, and ſending a large cutaneous nerve down the calf of the leg, to be loſt at laſt on the outſide of the foot and upper part of the leſſer toes, ſinks below the *gemellus* muſcle, and diſtributes nerves to the muſcles on the back of the leg; among which it continues its courſe, till, paſſing behind the internal *malleolus*, and in the internal hollow of the *os calcis*, it divides into the two plantar nerves: The internal of which is diſtributed to the toes in the ſame manner that the *radial* nerve of the hand ſerves the concave ſide of the thumb and fingers; and the external *plantar* is divided and diſtributed to the ſole of the foot and toes, nearly as the *ulnar* nerve is in the palm of the hand, and in the concave part of the fingers.

Several branches of theſe nerves, that ſerve the *inferior extremities*, pierce through muſcles.

By applying what was ſaid of the nerves in general to the particular diſtribution

diſtribution of the nerves of the *inferior extremities*, we may ſee, How people with fractured legs, eſpecially where there are ſplinters, ſhould be ſubject to convulſive ſtartings of the fractured member:——Why, upon tying the blood-veſſels in an amputation of the leg, the patients ſhould ſometimes complain of violent pain in their toes;—why ſuch patients ſhould alſo be troubled with ſtartings;—why, for a conſiderable time after the amputation of the diſeaſed limb, when the ſuppuration is well advanced, they ſhould complain of pain in the ſore which occaſioned the amputation.

The FOURTH, which, with the two following, is much ſmaller than the three ſuperior, ſoon is loſt in the *veſica urinaria* and *inteſtinum rectum*.

The FIFTH comes forward between the extremity of the *os ſacrum* and *coccygis*, to be diſtributed principally to the *levatores ani*.

The SIXTH, which ſome think to be only a production of the *dura mater*, advances forward below the broad ſhoulders of the firſt bone of the *os coccygis*, and is loſt in the *ſphincter ani* and teguments covering it.

The branches of the four laſt cervical nerves, and of the firſt dorſal, which are beſtowed on the *ſuperior extremities*, and the two crurals, with the ſciatic, which are diſtributed to the *inferior extremities*, are much larger proportionally to the parts they ſerve, than the nerves of the trunk of the body, and eſpecially of the *viſcera*, are; and for a very good reaſon, that, in the moſt common neceſſary actions of life, a ſufficient quantity of fluid, on which the influence of nerves ſeems to depend, may be ſupplied to the muſcles there, which are obliged to perform more frequent and violent contractions than any other parts do.—The ſize of the nerves of the *inferior extremities* ſeems larger proportionally than in the *ſuperior extremities*; the *inferior extremities* having the weight of the whole body to ſuſtain, and that frequently at a great diſadvantage.—What the effect is of the nerves here being injured, we ſee daily, when people happen, by fitting wrong, to compreſs the ſciatic nerve; they are incapable for ſome time after to ſupport themſelves on the affected *extremity:* And this is ſtill more remarkable in the *ſciatic* or *hip-gout*, in which the member is not only weakened, but gradually ſhrivels and waſtes.

N° II.

AN

ESSAY

ON THE

NUTRITION OF FOETUSES.

AN

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WHILE our ſenſes and judgment are in the preſent imperfect ſtate, it is no wonder that men ſhould differ widely in their opinions of things, and ſo in the conſequences they draw from the appearances in nature. Such is the caſe at preſent between my ingenious valuable friend Mr Gibſon and me. He has given a learned critical account of the different opinions concerning the " nouriſhment of fœtuſes" in the Edin. Med. Eſſays, Vol. I. art. xiii. where, after examining the arguments made uſe of for proving their nouriſhment to be conveyed by the navel only, he concludes them to be inſufficient, and ſupports the doctrine of the aliment being received by both the mouth and navel. I formerly wrote Mr Cheſelden, and he publiſhed ſome facts ſerving principally for proving the negative of a fœtus taking its food at the mouth: ſo that Mr Gibſon very juſtly names me as one of thoſe who differ in opinion from him, which I cannot help doing ſtill; and therefore believe myſelf engaged to give my reaſons of diſſent; ſince there is no certainty that Dr Bellenger, whom he more directly attacks, either has ſeen, or will anſwer, my friend's eſſay.

Mr Gibſon having already mentioned the moſt material arguments made uſe of to ſupport the doctrine he favours, I ſhall faithfully repreſent any other reaſons furniſhed by books, or my own reflections, which favour his ſide of the queſtion; and therefore replies will be at leaſt ſhorter, if not unneceſſary.

I ſhall paſs without any examination Alcmœon's opinion of the fœtus receiving its nouriſhment by the pores or veſſels on the ſurface of its body while it is a-forming; both becauſe there are no experiments for proving whether the veins there take in more at this time than the arteries throw out; and that it is not the ſubject of the preſent queſtion, which only concerns the fœtus after it is formed; whoſe nouriſhment is now allowed by all, either to paſs from the amnios by the mouth into its chylopoietic organs, or to be conveyed into its blood-veſſels by means of the umbilical veſſels, or to be furniſhed by both. I maintain the ſecond of theſe opinions, and therefore endeavour to render the other two improbable; though thereby I am under the diſadvantage of ſupporting a negative proof.

The determination of the queſtion, as now ſtated, may be reduced to the ſolution of the few following problems.

I. How far the mouth or umbilical veſſels are neceſſary to the nouriſhment of fœtuſes.

II. Whether the liquor of the amnios is proper food for a fœtus.

III. Whether this liquor paſſes into the ſtomach of a fœtus.

I ſhall firſt conſider theſe problems, ſo far as they relate to viviparous animals; and ſhall, in another ſection, examine, 'How far the analogy 'of oviparous animals, and of plants, ſerves to explain or confirm the 'ſolutions which I give to the foregoing problems.'

SECTION I.

In treating this ſubject, I muſt beg leave to throw away that humble regard to authority, which bore ſovereign ſway in the ſchools of phyſic ſo long, and to paſs all the hypothetical reaſonings to be met with in books,

books, unmentioned. It is only well-vouched facts, and reaſonable conſequences from them, that I will take any notice of; for on theſe, and on theſe only, it is, that a rational foundation of any part of medicine can be laid. The firſt thing therefore which I ſhall do, is to ſet down ſuch facts as I may have occaſion to aſſume in my ſubſequent reaſoning, together with ſome others, ſerving either to confirm and eſtabliſh thoſe, or to render them more clear and intelligible; though few of them are new, yet moſt of them are neglected in the common books of anatomy, and no author of my acquaintance has collected them.

That the truth of theſe facts may be more unqueſtionable, I ſhall either point out the manner in which others may obſerve them; or where I had not the opportunity of an exact enough examination myſelf, I ſhall quote my vouchers, who are authors of the beſt characters for knowledge and candour: And if I affirm at any time the being or ſtructure of things that are not demonſtrable to the ſight, I ſhall ſet down other facts from which they ſeem to be plainly and neceſſarily concluded to be true. But, becauſe my deſign confines me from entering into very particular minute deſcriptions, I generally refer to books where ſuch deſcriptions are to be had, ſo that thoſe who deſire to be more fully inſtructed may know where to be informed; and others who do not incline to give themſelves any further trouble, may believe as well as they pleaſe of my honeſty, and will meet with no great interruption in reading by the ſmall mark of reference to the quotations.

The Preliminary Facts.

1. The human uterus has numerous orifices of veſſels opening into its cavities to pour out liquors there (*a*).

Theſe liquors may at any time be ſeen oozing out, by gently preſſing the ſubſtance of an opened uterus.

2. Towards the fundus of the womb eſpecially, theſe orifices are found to be the extremities of canals that come out from larger cavities lodged within the ſubſtance of the womb; theſe cavities are commonly called *ſinuſes* (*b*).

3. The

(*a*) Tho. Bartholin. Anat. Reform. lib. i. cap. 28. Santorin. Obſerv. Anat. cap. xi. § 11.

(*b*) Bartholin. Anat. Reform. lib. i. cap. 28. Morgagn. Adverſ. Anat. iv. animad. 26, 27.

3. The ſinuſes are much of the ſame texture with the cells of the ſpleen, or rather of the *corpora cavernoſa penis*, being membranous cavities communicating with each other, and having numerous arteries ſpread on them, whoſe lateral branches open into the cells, from which veins go out to be joined to other veins that return the blood from the other parts of the womb (*a*).

4. Theſe ſinuſes are diſtended with blood in the time of the menſes, when their orifices alſo are enlarged (*b*).

I have ſeen this in ſeveral women I diſſected.

5. During the time of pregnancy, the ſinuſes and their canals that open into the womb are gradually diſtended and enlarged.

In a woman who died three or four months gone with child, I ſaw the orifices of theſe canals large enough to receive a gooſe-quill, the ſinuſes being conſiderably larger. At the end of nine months the ſinuſes can contain the point of the largeſt finger (*c*), and the canals from them can receive the little finger (*d*). This I ſaw in two wombs.

6. Beſides the reticular bundles of muſcular fibres, which enter into the ſtructure of the womb (*e*), I have twice ſeen, where the placenta adhered, what agreed exactly with Ruyſch's deſcription and picture of what he calls the orbicular muſcle (*f*): but, having miſſed it in four other fit ſubjects, and conſidering the thickneſs, ſoftneſs, and ſucculency of the villous and internal cellular coats covering the inner ſide of the muſcular fibres of the womb, I ſuſpected that I had too much faith in Ruyſch, and therefore too haſtily, without ſufficient examination, concluded what had an orbicular appearance on the internal ſurface of the womb of the firſt two ſubjects to be muſcular; I now rather believe it to be only a print made by the placenta upon the ſoft ſurface of the womb.

7. The placenta generally adheres to, or near to, the fundus of the womb.

All agree in this. In five women with child, whom I had occaſion to open, the placenta adhered to the interior part of the fundus.

8. The

(*a*) Malpigh. in epiſt. ad Spon.—Littre, in Memoires de l'Acad. des Sciences, 1701.

(*b*) Bartholin. Anat. Ref. lib i. cap. 28. Morgagn. Adverſ. Anat. i. § 33. Adv. iv. § 27.

(*c*) Santorin. Obſer. Anat. cap. 11. § 9. Morgagn. Adv. Anat. iv. § 29.

(*d*) Morgagn. ibid. (*e*) Malpigh. in epiſt. ad Spon.

(*f*) Ruyſch, Epiſt. de muſc. in fundo uteri.

8. The placenta is covered, on the ſide next to the womb, with a fine membranous continuation of the chorion (*a*).

I ſaw this diſtinctly in the five ſubjects I diſſected.

9. The extremities of the umbilical veſſels pierce this membrane, and ſhew their very ſmall orifices on its ſide next to the uterus; and therefore it is compared to the villous coat of the inteſtines (*b*).

The orifices of theſe veſſels of the villous ſurface of the placenta are ſo ſmall, that even lukewarm water, injected by the umbilical arteries, or by the vein of a placenta which had this membrane entire, when puſhed with all the force that I could apply to the ſyringe, only oozed out at a number of ſuch ſmall orifices as I could not perceive, and it came out ſo ſlowly that I was unable to continue puſhing the ſyringe till I could make eight ounces of the water paſs through them. When oil of turpentine with the fineſt powder of vermilion was injected, the oil oozed out, but brought none of the powder with it, though the oil which returned into the umbilical vein, when the injection was thrown in by the arteries, was coloured with the vermilion.

10. The allantois was carefully ſought for in all the five ſubjects I opened; but we could ſee no ſuch cavity, or liquor in it. The membranes had a looſe connection, by a cellular ſubſtance, and a fine tranſparent membrane was obſerved between the chorion and amnios.

11. The uteri of other animals have veſſels opening into their cavities, as well as the human womb, and the ſame trial diſcovers them; and, during gravidation, the internal membrane becomes villous, and has a thick ſucculent cellular ſubſtance interpoſed between it and the muſcular coat.

12. The membranous continuation of the chorion is not ſo evident on the exterior ſurface of the placentæ of brutes, as in the human ſubject; but their ſecundines have numerous orifices of the umbilical veſſels opening on their ſurface next to the uterus, as is evidently demonſtrated by injecting a thin liquor into the umbilical vein or arteries; for it ſoon comes running out every where from the exterior ſurface of the placenta and chorion,

(*a*) Ruyſch Theſ. Anat. xi. Aſſer. iv. n. 18. not. 1. & Theſ. v. n. 41.—Santorin. Obſerv. Anat. cap. 11. § 11.

(*b*) Ruyſch. Theſ. v. n. 41. Rouhault—Memoires de l'Acad. des Sciences, 1714, & 1717.

rion, carrying the powder of vermilion or verdigreaſe along with it; which ſhews the extremities of the veſſels to be larger here than the villous membrane of the human placenta, § 9.

13. The mother ſupplies liquors to the fœtus, which returns others to the mother by means of the uterine and umbilical veſſels.

This ſeems to be plainly proved by obſervations. Fœtuſes, whoſe placentæ were not in the leaſt ſeparated from the uterus, have been quite exhauſted of blood by the mother's dying of an hæmorrhage (*a*); and I have ſeen children pale and weak, by violent flooding in the time of labour.

14. When a fœtus dies, or is ſeparated from its ſecundines by cutting the umbilical rope, the circulation of liquors is wholly ſtopped in the veſſels of the ſecundines, and theſe become a lifeleſs maſs.

The experience of our greateſt practiſers in midwifery ſufficiently proves this. They tell us, that no hæmorrhage or diſcharge of any other liquor happens at the umbilical veſſels, upon the navel-ſtring's being cut or broke, after the veſſels are ſecured on the ſide of the child, as I have alſo ſeen frequently: and another proof is the placentæ commonly ſeparating in a ſhrivelled or ſuppurated ſtate, ſoon after the communication with the child is deſtroyed (*b*).

When one is to obſerve whether the umbilical veſſels have a circulation of blood kept up in them, after their communication with the child is ſtopped or deſtroyed, he needs ſcarce be deſired not to miſtake a few drops of blood, ſuch as would come from an amputated limb of a dead perſon, for an hæmorrhage; but he ought to obſerve one caution, which is, to make ſure, before the trial, that there is no fœtus left with its navel-ſtring untied or uncut: for in the caſe of twins, when often the placentæ are blended, and ſometimes one navel-ſtring ſerves both (*c*), tho' one child is taken away, the other may fill the veſſels of the placentæ, and continue their functions; ſo that an hemorrhage would happen at the cut, but untied, navel-ſtring of the firſt child. We have an inſtance of

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(*a*) Mery, dans l'Hiſt. de l'Acad. des Sciences, 1708. Heiſter, Compend Anat not. 36.

(*b*) Mauriceau, Maladies des Femmes groſſes, liv. 2. chap. 7. Ruyſch, in Theſ. obſerv. et adverſ.

(*c*) Mem. de l'Acad. des Sciences, 1720. Act. Medic. Berol. dec. 6. vol. iv. § 4.

a mother and child being almoſt wholly drained of their blood, by the midwife's neglecting to tie the navel-ſtring of the firſt of the twins, which was brought forth without perceiving that the other ſtill remained in the womb (*a*). This caſe ought to be added to the hiſtories brought in proof of § 13.

15. That power which phyſicians generally now a-days call abſorption, whereby the ſmall open orifices of veſſels imbibe liquors lodged in the cavities of the body, is obſerved to increaſe or diminiſh proportionally to the ſtrength or weakneſs of the creature.

In diſeaſes where the contraction of the veſſels is too great, as in moſt of thoſe that are called acute, there is ſcarce as much moiſture in the cavities or interſtices of the parts, as allows them to ſlide eaſily one upon another. In health, the quantity of ſuch liquors is moderate, and a pretty conſtant equality is kept between the action of the exhalants and of the abſorbents: but when the body turns weak, the exhalants pour out ſo much more than the abſorbents can take in, that all the cavities are found to contain conſiderable quantities of liquors. After death, the action of the abſorbents ſeldom or never can be ſupplied by any mechanical preſſure. For examples of what has been ſaid concerning abſorption, conſider the common phænomena which are to be obſerved in the long alimentary tube, in the large cavities of the abdomen, thorax, pericardium, &c. and in the ſmaller cavities of the tunica cellularis every where, of the cornea, &c. both in a ſound and morbid ſtate.

Hence we may underſtand how purgatives or diuretics may ſerve to drain off extravaſated hydropic waters, by ſtimulating the veſſels to a ſtronger abſorption; and how corroborants may produce the like effect, though more ſlowly.

16. The liquors (§ 13.) are not carried from the mother to the fœtus, or from the fœtus to the mother, by continued canals; that is, the uterine arteries and veins do not anaſtomoſe with the veins and arteries of the ſecundines (*b*): but the extremities of the umbilical vein take up the liquors by abſorption, in the ſame way as the lacteal veſſels do in the guts;

(*a*) Hiſtoire de l'Acad. des Sciences, 1727.

(*b*) Harvey de Generat. Animal. exercit. 70. Ruyſch, Theſ. v. n. 41.

and the umbilical arteries pour their liquors into the large cavities of the ſinuſes, or other cavities analogous to them.

Were I allowed to illuſtrate the communication between a mother and her child in the womb, by a groſs compariſon, I would ſay that the uterine ſinuſes are to a fœtus what the inteſtines are to an adult: The uterine blood poured into the ſinuſes being analogous to the recent ingeſta of food and drink: The liquors ſent from the umbilical arteries to be mixed with the uterine blood, reſemble the bile, pancreatic juice, and the other liquors ſeparated from the maſs of blood: The umbilical veins, and thoſe on the ſurface of the chorion, take up the finer part of this compound maſs, as the lacteal and meſeraic veins do from the contents of the guts: And the groſſer parts of the blood in the ſinuſes are carried back by the veins of the womb, as the excrements of the guts are diſcharged at the anus.

It is plain, from the diſproportionate ſize of the human ſinuſes, and of their excretory canals, to the very ſmall extreme umbilical veſſels, (compare § 5. and 9.), that there can be no anaſtomoſis by continued canals ſuppoſed here; which alſo ſeems to be proved next to a demonſtration by § 14. For if the veſſels of the ſecundines anaſtomoſed, an hæmorrhage or flux of ſome liquors would happen at the umbilical vein whenever the navel-ſtring was broke or cut, and would continue as long as the after-burden adhered to the uterus; and if the umbilical veſſels were tied, the circulation would ſtill continue in the placenta, and it would not become a lifeleſs maſs: But the reverſe of all theſe are obſerved; which makes a moſt ſure proof of the communication of the placenta with the uterus being deſtroyed as ſoon as the navel-ſtring is divided; and as § 14. ſhews the ſecundines to owe their life and action to the fœtus, ſo the reaſon of their taking in no fluids, after it is ſeparated, is evident from § 15.

In brutes, we can obſerve no tearing or breaking of veſſels when we ſeparate the placentæ from their uteri; and when any liquor is injected into their uterine arteries, none of it does paſs into the umbilical veſſels, as I have many times fully tried in the glanduliferous animals, cows, ſheep, &c. and in ſome others. In many animals, the ſecundines and

uterus

uterus do not adhere for a conſiderable time (*a*): and in ſome of theſe, mares for inſtance, in whoſe ſecundines the allantois is every where interpoſed between the chorion and amnios (*b*), there is no way for any nouriſhment to be conveyed to the fœtus, except by the veſſels of the ſecundines; which therefore can only take up their liquors by abſorption: and why may not the ſame obtain in other animals?

It is worth while to remark, by the way, the inconveniencies that are ſhunned by the want of an anaſtomoſis between the veſſels of the womb and ſecundines. The violence of the mother's circulating fluids is not in hazard of deſtroying the embryo while tender: and there are no veſſels to be broken or torn at birth, which would have required too much force in bringing away the placenta, and would have brought on inflammation, ſuppuration, and other bad ſymptoms.

Some gentlemen who contend for an anaſtomoſis, are ſo ſenſible of theſe inconveniencies, that, to ſhun having them objected to them, they will not allow the anaſtomoſing canals to be of one continued ſubſtance, but ſuppoſe the veſſels of the uterus and ſecundines to be joined only *per appoſitionem*; which they explain to be, by the one ſort receiving the other ſome way within them, in the ſame manner as the ſecond ſort of pipes receive the firſt in the injecting inſtruments (*a*): ſo that the coats of the veſſels being thus contiguous, they may ſerve for the tranſmiſſion of liquors, as well as if they were of the ſame continued ſubſtance, and may be ſeparated with a ſmall force, and without any laceration.

This ſuppoſition takes off indeed the objection of ſuch inconveniencies, but is itſelf equally deſtroyed with the former, by the other arguments uſed againſt the anaſtomoſis or propulſion of liquors from the mother into the branches of the umbilical vein, and at the ſame time expoſes the propoſers of it to ſtill greater difficulties. They muſt ſhew, that the ſizes of the oppoſite veſſels are fitted for ſuch an intus-ſuſceptio; whereas the diſproportions of the human are moſt conſpicuous, and in other creatures the chances of unfitneſs are much greater than thoſe of their being rightly adapted to each other. They muſt name ſome other inſtance of

(*a*) Fabric. ab Aquapend. de Form. Fœt. pars 1. cap. 3. Needham. Obſ. Anat. cap. 2.
(*b*) Needham, ibid. et cap. 3.
(*c*) See the firſt article of this Collection.

any thing like this being obſerved any where elſe in a ſound creature. If they take a morbid caſe, ſuch as the cure of wounds by ſymphyſis, to illuſtrate their doctrine by, they would do well to conſider how ſoon the change from contiguous to continued veſſels is made there.

Were it not to prevent any good grounds for a reply, I would leave the doctrine I have advanced to be maintained by the arguments already uſed; but I know there are ſome particular obſervations or experiments which may be inſiſted on as clear evidence againſt me, if I do not take off their force; and therefore I will take the liberty to ſtate ſuch objections, with their anſwers.

Mr Mery (*a*) deſcribes a child that had no heart, lungs, &c. nor nothing analogous to a heart; and therefore cannot conceive any other force that could continue the circulation of the blood in this monſter, than the motion it acquired from the uterine arteries; which, according to him, muſt have inoſculated with the placentary veſſels, that the liquors might be propelled through theſe.

Mr Mery has deſtroyed the neceſſity of his own ſuppoſition in the relation of the fact; for he tells us, That this monſter was twin to a perfect child, whoſe *funis umbilicalis* ſent off the ſmall navel-ſtring of the monſter; and therefore the heart of the complete child would drive forwards the blood of the monſter, at the ſame time that it promoted its own circulation, without any neceſſity of aſſiſtance from the mother's blood.

Mr Cowper is ſometimes quoted alſo for ſupporting the contrary of what I have aſſerted. His words are (*b*): "Theſe blood-veſſels of the "uterus are inoſculated with thoſe of the placenta, as may appear by the "paſſing of mercury from one to the other: ſo that if you pour it into "the hypogaſtric arteries of the mother, it will paſs into the veins of the "placenta, as well as thoſe of the uterus; and, on the contrary, from "the arteries of the placenta to the hypogaſtric veins of the mother, as "alſo into the veins of the placenta. Hence it appears there is a circula-"tion of blood between the mother and fœtus; and it ſeems as if the "blood-veſſels of both did germinate and inoſculate with each other. But

(*a*) Mem. de l'Acad. des Sciences, 1720.

(*b*) Anatomy of Human Bodies, explic. of tab. 54. F. F. F.

" But this requires too much ſpeculation for my occaſions to admit of a " further inquiry at preſent."

I imagine, that every one who reads the preceding paragraph, eſpecially if he is at all acquainted with Mr Cowper's manner of telling what he has ſeen, will readily judge, that this author is there aſſerting rather *à priori* what he thinks would happen, than deſcribing what he really ſaw upon trial. Obſerve only how dubious and timorous his words are: " The inoſculation may appear by pouring in mercury.——It ſeems as if " the blood-veſſels of both did germinate and inoſculate.——This re- " quires too much ſpeculation to admit of a further inquiry at preſent." If he had made the experiment, he would have told us, that he had poured in mercury; and, after ſeeing it paſs in ſuch a manner, was certain ſuch inoſculation did obtain.

Drake, who wrote after the publication of Cowper's Anatomy of human bodies, ſhews plainly, that Cowper never made this experiment in the human ſubject; for after deſcribing a preparation which, he ſays, " Mr Cowper kept by him, of a cotyledon, and part of the uterus of a " cow, in which mercury, poured into a branch of the uterine artery, " went into one of the cotyledons of the uterus, and filled thoſe branches " of the umbilical veins which went from that cotyledon to the navel of " the fœtus," he adds, " It would be a weak objection to allege, that " the obſervation and experiment being made on the uterus of a cow, the " inference would not hold from thence to a woman." And he is obliged to make uſe of the flux of blood which conſtantly follows upon drawing the placenta from women, to prove the continuity of the veſſels of the human womb and ſecundines. Had Cowper ever made mercury paſs from the uterine into the umbilical veſſels in the human ſubject, it would certainly have been told here by Drake, who was greatly aſſiſted by Cowper in at leaſt the anatomical part of his book.

Since the ſecond edition of the Medical Eſſays, Dr Nortwyk has publiſhed an accurate deſcription of an impregnated human womb, and of its contents, to which he has added an account of what authors have wrote on the different parts which he examined (*a*). In this treatiſe, Dr Nortwyk

(*a*) Uteri Humani Gravid. Anatom. et hiſtoria, autore Willielmo Nortwyk, M. D. 4to, Lugd. Batav. 1743.

Nortwyk affirms, That the matter which he injected by the uterine arteries paſſed into the veſſels of the chorion and placenta, which he is ready to demonſtrate at any time in the preparation which he preſerves.

Such a poſitive aſſertion of an anaſtomoſis, or of a continuity of the veſſels of the womb and ſecundines, by a gentleman of ſo much learning and candour as Dr Nortwyk evidently appears to be, has made ſeveral conſiderable men to decide againſt me; and to affirm, upon his authority, that there is an anaſtomoſis. But upon comparing his deſcription with my diſſections of big-bellied women, I think it altogether evident, that a miſtake of the doctor in the diſſection has led him into concluſions directly contrary to what I am perſuaded he will make when the miſtake is pointed out to him. That every one may judge for himſelf, I ſhall here firſt ſet down his deſcriptions of theſe parts; then I ſhall mention what I remarked in my diſſections; and, laſtly, I ſhall point out the circumſtances in both, from which the concluſion muſt be drawn.

" Dr Nortwyk was ſurpriſed that he could not recline over the cut " parts of the womb. Inquiring into the cauſe, he ſaw the chorion " grown to the womb by a true but very ſoft cellular ſubſtance; by " means of which the whole ſurface of the ovum adhered moſt ſtrongly " to the womb, ſo that no mark of diviſion appeared when the ſubſtance " of the womb was raiſed. Having ſoftly depreſſed the ovum with the " back of a knife, and moved the knife backwards and forwards (reci- " procato) betwixt the ovum and uterus, that connecting ſubſtance was " moſt eaſily broken (*a*).

" Numerous injected veſſels with very thin coats were ſeen in this cel- " lular ſubſtance, ſtretched from the chorion into the womb, which he " calls veſſels of the two parts joined by anaſtomoſis, and believes them " to be veins (*b*).

" The larger branches of theſe veſſels were remarkably dilated within " the ſubſtance of the chorion into twice their former capacity, forming " ſinuſes; and in this form were extended an inch, then dividing into " branches ſank deeper into the chorion (*c*).

At

(*a*) Uteri Anat. § 6. N° 1. (*b*) Ibid. N° 2. (*c*) Ibid. N° 3.

" At the placenta the cellular ſubſtance was ſtronger, and the connec-
" tion greater, with veſſels likewiſe extended through it (*a*).

" At the root of the placenta there were numerous very large veſſels
" capable of admitting a child's finger; they were true venous ſinuſes
" made of very thin coats and ſhort, from which branches much ſmaller,
" moſtly very ſmall, ſunk into the placenta, and in ſome places penetra-
" ted to its baſis, where it lies on the chorion (*b*).

" There were no veſſels in the womb of equal ſize, and correſponding
" to theſe ſinuſes; which ſurpriſed him, having ſeen veſſels of a womb
" of a new-laid woman diſſected by profeſſor Albinus, and of one diſ-
" ſected formerly by himſelf, ſo large, that an adult perſon might almoſt
" have put his finger into them (*c*).

" The whole internal ſurface of the womb had many orifices of veſſels
" filled with the injection (*d*).

" The ſurface of the ovum was all ſhaggy, becauſe of the remains of
" the cellular ſubſtance (*e*).

" The chorion was opaque, ſoft, fungous, and ſo very tender as to be
" eaſily torn (*f*).

" Under this fungous there was a reticulated ſubſtance (*g*).

" The fungous and reticulated ſubſtances ſeparated moſt eaſily from
" each other (*h*).

" Placentæ extracted after child-birth, when injected, ended in pulpy
" knots; which, macerated, ſhewed themſelves to conſiſt of very ſmall
" veſſels of the pencil form (*i*).

" The injection into the impregnated womb did not penetrate into the
" fœtus or umbilical rope (*k*).

" On the ſide of the placenta fartheſt from the womb, the red colour
" of the injection ſhined through the chorion; and in one part where the
" chorion was taken away, the ſmall injected veſſels were to be ſeen in
" the preparation (*l*)."

Thus far Dr Nortwyk gives an account of his diſſection, &c.

I have now diſſected five women who died each with a child in the womb,

(*a*) Uteri Anat. § 7. N° 1. (*b*) Ibid. N° 2. (*c*) Ibid. N° 3.
(*d*) Ibid § 9. N° 1. (*e*) Ibid. § 11. (*f*) Ibid. § 12. N° 1. (*g*) Ibid. N° 2.
(*h*) Ibid. N° 3. (*i*) Ibid. § 28. N° 2. (*k*) Hiſtor. Uter. pars 2. § 83. (*l*) Ibid.

womb, before either the membranous part of the ſecundines was torn to let out the water, or that the placenta was the leaſt ſeparated from the womb. One of them was ſaid by the friends to have been between three and four months gone with child; three others were about ſix or ſeven months, and the fifth was paſt eight months, gone with child. I likewiſe examined the body of a ſixth woman, whoſe child in the labour had torn the *os uteri*, and by the aperture had eſcaped into the cavity of the abdomen, dragging its ſecundines along with it. In all of them I found a thick, fungous, ſucculent, cellular ſubſtance between the muſcular part of the womb and its villous coat, through which numerous thin-coated veſſels paſſed; and in this cellular ſubſtance the ſinuſes were. Excepting its ſinuſes, it reſembled the internal cellular coat of the inteſtines.—I was ignorant of this ſtructure when I began the diſſection of the firſt big-bellied woman; and therefore, when I had cut through the firm muſcular part of the womb, and ſaw this fungous ſubſtance, I imagined it to be the placenta. I was ſurpriſed to find the coheſion of this ſuppoſed placenta to the womb ſo firm; but perſiſted to ſeparate the muſcular part of the womb from it, till, having torn a little of the fungous ſubſtance, I obſerved the ſmooth tenſe chorion, from which the fungous ſubſtance ſeparated moſt eaſily, as it did likewiſe from the placenta, by only gently preſſing the ovum with one hand, and raiſing the womb with the other, without the aſſiſtance of any other inſtrument. What of the fungous ſubſtance had been left at firſt with the ovum came off as eaſily.——I avoided this miſtake in diſſecting the other four impregnated uteri which I had occaſion to examine afterwards; and then had the villous coat of the womb entire, and the ſmooth chorion ſpread over all the ſecundines.

Let the following circumſtances be conſidered.

1. The firm adheſion of the uterus to the ovum as deſcribed by Dr Nortwyk; whereas in natural births, and in my five ſubjects, the womb and ſecundines ſeparated moſt eaſily.

2. The want of ſinuſes, or of veſſels a-kin to them in the womb, which gave riſe to his treatiſe; whereas the ſinuſes were demonſtrated by Dr Albinus, and they were ſeen by Dr Nortwyk himſelf in the womb of a woman lately delivered, and they were found in all my ſix ſubjects.

3. The ſhaggy ſurface of the ovum, and the ſoft fungous opaque chorion

deſcribed

deſcribed by the Doctor; whereas the chorion in natural births, and in all my ſubjects, was ſmooth, firm, and tenſe.

4. The ſeparation of the fungous ſubſtance on the ſurface of the ovum mentioned in this ſection was as eaſy, as what I found the ſeparation of the womb from the ovum.

5. Large ſinuſes were found by Dr Nortwyk in the placenta and chorion, which never were ſeen in theſe parts of any other ſubject.

From theſe circumſtances I muſt think, that the Doctor perſiſted in the error which I committed in diſſecting the firſt impregnated uterus which I had occaſion to examine, and brought off the internal cellular ſubſtance and ſinuſes of the womb with the ovum, in which caſe all the appearances would be preciſely as he has deſcribed them; and he will be under no neceſſity of imagining ſome particular form of veſſels here, or any extraordinary change of ſtructure made in placentæ by extracting them at birth; on the contrary, the reaſons of all the phænomena are obvious, and he has afforded me a very pretty proof of their being no anaſtomoſis between the veſſels of the uterus and ſecundines.

Leſt the laſt paragraph which I quoted from Dr Nortwyk ſhould make any incline to think, that, in his preparations, ſome of the placentary veſſels were injected, I muſt explain the appearances there mentioned, which I ſhall do by the aſſiſtance of the Doctor himſelf. "The placenta, "ſays he juſtly, (§ 15. 28.) conſiſts of a great many knobs, between which "the membrane (the exterior lamella of the chorion) is inſerted, as the "pia mater is between the convolutions of the brain; and the ſoft ſpongy "internal ſubſtance of the womb is inſinuated into the furrows between "theſe knobs."—No wonder, then, that the uterine veſſels filled with a coloured ſubſtance ſhine through the chorion on the other ſide of the placenta, or are ſeen when the chorion is taken away. Let us remember this when we read any where, that injections into the uterine veſſels *placentam ſubibant*.

To Dr Nortwyk's experiment in proof of liquors not going from the uterine veſſels into thoſe of the ſecundines, I ſhall add a trial which I made of injecting theſe parts of a woman three or four months gone with child. Having fixed a pipe into one of the iliac arteries, and having tied the other iliac artery and the veins, I puſhed through the pipe fine oil

of turpentine, which is a liquor that eaſily goes from the extreme arteries of any part of the body into the correſponding veins. I continued this injection till all the veſſels of the womb, both arteries and veins, were in hazard of burſting, and till all the gentlemen preſent agreed, that a ſufficient quantity and force were employed. Not one drop of this oil was found in any branch of the umbilical veſſels or in the fœtus, though it was ſearched for moſt carefully.

Dr Nortwyk is of opinion, that nothing can be concluded againſt the anaſtomoſis of the veſſels of the womb and ſecundines, from the experiment juſt now related: For, (ſays he), (*a*), "Injections do not always "paſs where there is a continuation of veſſels: thus, for example, "Ruyſch (*b*) informs us, that though he filled numerous branches of the "ſpermatic artery running in the interſtices of the ſeminal tubes, and "alſo the ſmaller lateral branches of arteries beſtowed on the tubes; yet "he never could make his injection enter the tubes, notwithſtanding that "De Graaf (*c*) deſcribes theſe tubes as ten times larger than the injected "arteries."

If the ſeminal tubes were of the ſize deſcribed by De Graaf, where they begin at the extremities of the ſecerning arteries, and theſe extremities were no ſmaller than the arteries which Ruyſch injected ſome application might be made of this example to the preſent caſe: but ſeeing the ſpermatic arteries may divide, for ought we know, into branches not one millionth part the ſize of thoſe which Ruyſch injected, before they became ſeminal tubes; there is no other inference to be drawn from this quotation from Ruyſch and De Graaf, than that the ſpermatic arteries divide into branches, before they become ſeminal tubes, too ſmall for Ruyſch's injection to enter.—If the ſpermatic arteries had been as large at their extremities as what were ſeen in the internal ſurface of the womb in Dr Nortwyk's preparation, and if the ſeminal tubes had been as large at their beginning as what he calls *placentary veſſels*, I make no doubt that Ruyſch's injection would have filled the larger ſeminal tubes, *epidydimis vas deferens*, &c. as Dr Nortwyk's injection ought to have filled the umbilical

(*a*) Hiſt. Uteri Gravid. pars 2. § 83. (*b*) Theſ. Anat. iv. N° 8.
(*c*) De Viror. Organ. p. 43.

umbilical vein, and ſeveral of the veſſels of the fœtus, had it once entered into ſuch large branches of that vein as he imagined.

Let us next examine the trials made on brutes for proving the anaſtomoſis or continuity of the veſſels of the womb and ſecundines.

I have already tranſcribed Dr Drake's account of Mr Cowper's "having poured mercury into the uterine artery of a cow, that went into "one of the cotyledons of the uterus, and filled thoſe branches of the "umbilical veins which went from that cotyledon to the navel of the "fœtus."

Mr Cowper (*a*) mentions ſome other preparations of the ſame parts in cows, but takes no notice of this one; and Drake expreſſes himſelf ſo little like an anatomiſt in comprehending both the glandula of the womb and the placenta of the ſecundines under the name of *cotyledon*, that I ſuſpected his having committed a miſtake here: and therefore I repeated the experiment many times, by pouring mercury ſometimes into a branch of the uterine arteries diſtributed to one of the glandulæ, and at other times I poured the mercury into a branch of one of the umbilical arteries ſent to a placenta, but never could make one drop of it go from the veſſels of the one into the veſſels of the other. The weight of the mercury frequently makes the glandula and placenta ſeparate from each other, and then the foveæ of the glandula and the interſtices of the papilla of the placenta have quickſilver lying in them; but none of it is to be ſeen in any thing like a veſſel of the placenta when it is poured into the artery of the womb, or of the glandula when it is poured into the umbilical artery.

Slade is quoted (*b*) for ſaying, "The placentulæ of cows have more "and larger veſſels than the cotyledons; and if a black liquor is injected "into the artery which is ſent to a placentula, the contyledon remains "white. The liquor injected into the arterious veſſels of the uterus was "carried to the cotyledons, and by the cavities of the cotyledons into "the ſubſtance of the placentæ."

Theſe words being *carried into the ſubſtance of the placentæ*, may ſignify no more than effuſed on their unequal pappy ſubſtance. I have tried injections of very different kinds ſo often into the veſſels of the womb and

(*a*) Anatomy of Human Bodies, explic. of tab.

(*b*) Vid. Blaſ. Anat. Animal. p. m. 122.

ſecundines of cows, prepared in all the different ways I could contrive for making liquors paſs from the one to the other, without having once made a drop to paſs, that I cannot be more certain of any thing than that there is no anaſtomoſis or continuity of theſe veſſels in cows.

Vieuſſens is ſaid to have made the following experiment (*a*): "He tied "the left carotid artery of a living bitch with young; and then, having "put a ſmall ivory funnel into the right carotid, he poured quickſilver at "different times towards the head, till it amounted to about four pounds. "By the time this quickſilver was poured in, the creature appeared to be "quite dead, and he diſſected her before a great many witneſſes." After deſcribing the progreſs which the quickſilver had made in the veſſels of the bitch, he has theſe words: "Mirum dictu! Fluidum hocce corpus, "nullo rupto vaſe, et ne una quidem gutta ſanguinis effuſa, placentam "unumquemque catulum obvolventem permeavit, et in ipſas umbilicales "venas protruſus fuit: Ipſummet fluidum cavitates cordis, ſtomachi, "veſicæ felleæ, inteſtinorum, et veſicæ urinariæ, ingreſſus eſt. Protruſus "à me in arteriam carotidem dextram mercurius, in arterias, et ſubinde "in ductus lactiferos mammarios, ſeſe immiſit, ut ſupra indicavi."—No more of this deſcription relates to the fœtus than "That fluid, (the mer-"cury), without breaking any veſſel, or the effuſion of one drop of blood, "paſſed through the placentæ ſurrounding each whelp, and was puſhed "into the umbilical veſſels themſelves;" all that follows about the heart, ſtomach, &c. being only applicable to the mother's organs, as appears by the reference to what he had ſaid above, where the parts of the mother only were mentioned, and by the account which he gives of this experiment in another treatiſe (*b*) in theſe words: "Mercury being poured in-"to the right carotid artery of a bitch about two months gone with whelp, "the left carotid being tied, paſſed into the umbilical vein of the whelps "without any breaking of the veſſels."

This experiment of Vieuſſen's is ſtrangely contrived; for, by tying one carotid artery, and putting a funnel into the other, he left the vertebral arteries

(*a*) Manget. Theat. Anat. lib. 2. cap. 3. Excerpta è Raymundi Vieuſſenii epiſtol. ad excell. Prof. celeb. Medic. Facult. Patav. et Bonon. in Genevenſi Verheyenii editione.

(*b*) Diſſertat. de ſtructura et uſu uteri et placentæ muliebris, in Genevenſi Verheyenii editione.

arteries alone to propel the blood and quickſilver through the veſſels of the head, from which they were to return to be diſtributed through the whole body.—Some of the blood of the vertebrals muſt have had a retrograde motion into the carotids by their anaſtomoſes, to hinder the entry of the quickſilver.—If the head of the bitch was placed ſo depending, as the weight of the mercury could overcome the reſiſtance of that blood, which probably has been done; then this ponderous liquor muſt have paſſed through the tender very ſmall arterious veſſels of the brain, and have aſcended in the veins, contrary to its own gravity, to come to the heart; after which it muſt have performed the circulation through the heart and lungs to be ſent into the aorta, from which it behoved to be puſhed through the veſſels of the womb into the ſecundines.

I endeavoured to imitate Vieuſſens's experiment on a living bitch, but the creature died before any ſucceſs could be expected; and therefore, with the aſſiſtance of my colleague Dr Andrew Sinclair, P. M. and of Mr Gibſon, I took another way to try if the mercury would paſs from the womb into the umbilical veſſels. I cut as much of the teguments of the neck of a pregnant bitch immediately dead, as to have a view of as much of the carotid artery as I could open and put a pipe into; then hanged the bitch by the neck higher than where the pipe was; and, in this poſture, poured in the quickſilver, by which we prevented the mercury's running out at cut veſſels, and gave it the preſſure of a very high column to make it run further into the veſſels than it would have done otherwiſe. The quickſilver ſoon ran plentifully out at the vagina, the orifice of which was then tied, and more mercury was poured into the carotid, till all of us agreed, that, if there was any anaſtomoſis or continuity between the veſſels of the womb and ſecundines, the mercury muſt have paſſed from the one to the other. When we opened the bitch, we ſaw the veſſels of the uterus and of its cornua very turgid with quickſilver. The body of the uterus and the right cornu contained no fœtus, but were diſtended with extravaſated quickſilver. There was one whelp in the left cornu, which we tied above and below where the fœtus was lodged, then cut it out and laid it on a plate.—When this cornu was cut longitudinally, the annular placenta ſeparated moſt eaſily from it; and, as we were ſeparating them, the mercury ran plentifully out of the veſ-

ſels

ſels of the cornu, but not a drop of it appeared in, or dropped out of, any veſſel on the exterior ſurface of the placenta or of the chorion.—After the amnios was opened, there was no mercury to be ſeen in the fœtus or in the umbilical veſſels, though we could trace theſe to their very minute branches in the placenta and membranes. When the ſecundines had been handled ſome time, and the amnios was turned outermoſt, ſome exceeding ſmall and ſhort ſtreaks of quickſilver appeared under that membrane; but, not being contained within any thing like the coat of a veſſel, Dr Sinclair and I judged them to be no other than ſome drops of the mercury, which we had ſeen ſtick to the outer ſurface of the placenta, when they fell from the cornu, that had been preſſed by handling into the ſmall interſtices of the placentary ſubſtance; and therefore concluded that no mercury had paſſed from the uterus into the umbilical veſſels.—I repeated this experiment in a bitch that had five whelps in her cornua, without one drop of quickſilver being ſeen in any veſſel of any of their ſecundines, though both arteries and veins of the uterus and cornua were full of it. I deſignedly dropt ſome quickſilver on one of the placentæ; and then worked it in with my fingers, till I formed ſuch ſtreaks as we had ſeen in the former trial, which I verily believe was all that Vieuſſens ſaw. Though, if we would grant, that ſome of the quickſilver in his experiment had entered the branches of the umbilical veſſels, or even though the mercury had been found in the whelps, it would be no proof of the anaſtomoſis or continuity of the uterine and umbilical veſſels: For ſince, according to him, the bitch was alive, till, at different times, near four pounds of mercury were poured in, (*credat Judæus*), the placentary veſſels might have abſorbed the quickſilver.

Would a man, who believed that the above experiment ſhowed an anaſtomoſis, write in the following manner as Vieuſſens has done (*a*)? "It "is obſerved, that quickſilver injected into the arteries of the womb, "does not run into its cavity, unleſs when its ſubſtance is ſtrongly preſs-"ed with the fingers; for then ſome parts of the mercury fall into the "womb by the pores of the lymphatico-arterious canals that form its ſub-"ſtance." And again (*b*), "The effuſion of blood at birth, without "doubt, was alſo the cauſe why ſeveral old anatomiſts, who were little "acquainted

(*a*) Differt. de Structura et Uſu Uteri, &c. § 51. (*b*) Ibid. § 56.

" acquainted with the natural œconomy of the human body, yea and Mr " Mery, believed that the arteries of the womb directly opened into the " veins of the placenta, and that the arteries of the placenta opened into " the veins of the womb; from which they concluded, that the mother's " blood circulated into the body of the fœtus, and that the blood of the " fœtus paſſed into the mother's body. But the falſity of this opinion, " which was refuted by many anatomiſts of the laſt century, who were " not only ſkilful diſſectors, but very learned natural philoſophers, ſhall " be moſt evidently demonſtrated from what I am to ſay, when I explain " the internal ſtructure and the uſe of the placenta; ſo that the abettors " of it will readily reject it."

I have ſometimes ſeen quotations from Preſton (*a*) and Heiſter (*b*), for experiments proving this diſputed anaſtomoſis; but there are no ſuch experiments mentioned in either of them. Preſton tells only that he ſaw, 1. Air paſs from the umbilical vein into the umbilical arteries. 2. Air, and an injected liquor, forced into the hypogaſtric arteries of a woman newly brought to bed, made their way into the cavity of her womb. 3. An injection into the umbilical vein of a fœtus, which filled both its veins and arteries.——Heiſter has nothing but what I have already taken notice of.

Though I think this § 16. ſufficiently proved; yet, to ſhorten hereafter the diſpute concerning the nouriſhment of a fœtus, I may remark, that it will be ſufficient for my purpoſe in the preſent queſtion, to have part of the veſſels of the ſecundines granted to be abſorbents, (the negative of which, I dare affirm, nobody will undertake to prove), though others were found to be continued or to inoſculate with thoſe of the uterus.

17. The red particles of the blood are not probably abſorbed by the ſmall extremities of the umbilical vein.

My reaſons for thinking ſo are: The ſmallneſs of the orifices of theſe veſſels (§ 9.); the chylous appearance of what is ſeparated by the glandulæ of cows and ſheep, though the extremities of the veſſels of their placentæ are larger than in the human ſubject (§ 12.); and the want of an example of red globules being abſorbed any where elſe.

If

(*a*) Philoſ. Tranſact. Lowthorp's Abridg. vol. iii. p. 210.

(*b*) Compend. Anat. not. 36.

If it ſhould be aſked, Whence then has the fœtus red blood? I anſwer, without entering upon any philoſophical compariſon of the placenta in a fœtus, and of the lungs in reſpiring animals, That fœtuſes of viviparous animals have their red blood from the ſame ſource that chickens in ova have theirs; which can be no other than the action of their heart, and of the veſſels in their body and ſecundines.

If it ſhould be further objected, That the inſtances mentioned (§ 13.) of children being exhauſted of blood by hæmorrhages from the mother's veſſels, ſhow the red globules to be ſent out from the ſecundines into the uterus, and therefore probably ſuch are taken in; the anſwer is ready, viz. That theſe inſtances prove the loſs of ſuch red particles no more than the wan colour, faintneſs, and the emptineſs of the veſſels, in a violent diarrhœa, are certain ſigns of bloody ſtools; which none will affirm they are.

18. The placenta does not increaſe in the ſame proportion which the fœtus does; for the ſmaller the fœtus is, the placenta is proportionally larger (*a*).

19. The ſmaller ſhare by far of the blood ſent out by the umbilical arteries, is returned to the uterus, moſt of it being poured into the umbilical vein by anaſtomoſing canals.

This may be ſeen by injecting liquors into the umbilical arteries of any creature. Rouhault (*b*) calculates, that only one ſeventh part of the capillary branches of the human umbilical veſſels reach the exterior ſurface of the placenta.

20. The progreſſive motion communicated to liquors by the power of abſorption being ſlow, and no external alternate preſſure having a conſiderable effect in increaſing the momentum of the liquors moving in the veſſels contained within the uterus, it would appear that the blood returning to the fœtus is puſhed forward principally by the force of the heart and arteries of the fœtus itſelf.

That the force of the heart may be ſtrong enough to drive forward the blood in ſuch a long courſe as it muſt make in the ſecundines, the *canalis arterioſus* is ſent from the pulmonary artery into the deſcending aorta, whereby

(*a*) See the figures in Ruyſch, theſaur vi. Heiſter, fig. 27.

(*b*) Mem. de l'Acad. des Sciences, 1715.

whereby the blood thrown out by the umbilical arteries is propelled by the united force of both right and left ventricles of the heart; and theſe arteries anaſtomoſe with the branches of the umbilical vein by larger communicating canals than the arteries and veins commonly have in other parts of the body, as appears by injections: for liquors thrown into the umbilical arteries towards the placenta, require leſs force to make them return by the umbilical vein; and when injected with the ſame force, they return more quickly than they do into the vein correſponding to any other artery of a child when the artery is injected.

21. In the greater number of animals that have hitherto been carefully examined, the allantoid membrane, with its contained urine, has been found (*a*).

22. The allantois of ſome animals (mares, bitches, cats,) ſurrounds the amnios, being every where interpoſed between it and the chorion. In others, (cows, ſheep, goats), the allantois incloſes a conſiderable ſhare of the amnios. And in others, (ſwine, rabbits), it is confined to a ſmall ſpace (*b*).

23. At thoſe places where the allantois is not interpoſed between the other two membranes of the fœtus, the chorion adheres to the amnios by a very fine cellular ſubſtance, which eaſily yields to any ſtretching force, as every one muſt ſee in examining the ſecundines.

24. The amnios has numerous ramifications of the umbilical veſſels ſpread upon it (*c*); the orifices of the lateral branches of the arteries pouring out liquors into its cavity.

Injections plainly diſcover this. For after injecting a thin liquor, water for example, into the umbilical arteries, dry the interior ſurface of the amnios well with a cloth: then preſs the membrane gently, or continue the injection; and the water is ſeen coming out on that ſurface, in the form that we ſee ſmall drops of perſpirable matter come out on the ſurface of the ſkin at the finger-points when we preſs the finger hard or have tied a ſtring round it. I have many times repeated this experiment, and always with ſucceſs.

25. Seeing we can demonſtrate veins alſo on the amnios, and ſeeing

(*a*) Needham, Obſerv. Anat. de Form. Fœt. cap. 3. (*b*) Id. ibid.
(*c*) Id. ibid. Cowper's Anat. of Human Bodies, expl. of tab. 59. A. A.

the veins of all other membranous bags that have arterious canals throwing liquors into their cavity are endued with an abſorbing power, and take up fluids from the cavity, we may conclude, that the veins here are the ſame way employed.

26. The liquor contained in the amnios is either wholly ſeparated from the veſſels of that membrane; or it is furniſhed partly from them, and in part from the fœtus.

In the creatures whoſe amnios is every where incloſed by the allantois (§ 22.), it is impoſſible this liquor can be tranſcolated from the uterus or its cavity through all the membranes into the cavity of the amnios; becauſe, if the allantois could allow a paſſage to ſuch a fluid, its own contents would neceſſarily go along with it, which every one would confeſs would be of bad conſequence: but the truth is, that the allantois does not allow liquors to paſs through it. In thoſe creatures where the allantois only ſurrounds part of the amnios, if we did ſuppoſe the chorion and amnios capable every where elſe of ſerving as ſtrainers, the liquor would always be found in conſiderable quantity in the cellular ſubſtance between them (§ 23.); which it is not: and what ſhould hinder it to run out as faſt as it could be conveyed in?

Let none here aſſume canals having orifices opening on the ſurface of the chorion, and ſent directly into the cavity of the amnios, unleſs he undertakes to demonſtrate them. There can be no ſuch canals in the creatures whoſe allantois ſurrounds their amnios; for there are no threads extended croſs the allantois.

Harvey's obſervation (*a*) of this *liquor amnii* being ſeen in a large quantity before the fœtus is formed, may probably be objected to me as a ſure argument of its being derived from ſomewhere elſe than the umbilical veſſels, or ſurface of the fœtus; and that can only be from the cavity of the uterus by tranſcolation.

Harvey's aſſertion is only this negative, That he did not ſee a fœtus in the very ſmall conceptions he examined; but it is very evident from later obſervations (*b*), That the rudiments of the fœtus, and its *funis umbilicalis*

(*a*) De Generat. Animal. exercit. 56.

(*b*) Compare Harvey's exercit. 15. 16. 17. with Malpighius *de ovo incubato*, in the firſt three or four days of incubation; and his exercit. 56. with Kerkring. Anthropogr. Ichnogr. and Ruyſch, Theſ. 6. and many other later obſervations.

lis, may be ſeen much ſooner, and while the conception is leſs than what he determines it to have been in the caſes where he ſays he could not ſee it: and, in my opinion, extra-uterine fœtuſes prove clearly, that the embryo is always lodged much ſooner in its ſecundines than we can diſcern the different parts of theſe; far leſs need we expect to be able to diſtinguiſh the different parts they contain. I ſhall readily allow that the *liquor amnii* is in larger proportional quantity the younger a conception is: And the reaſon of this appearance may very eaſily be underſtood, from what was ſaid concerning abſorption (§ 15). From the obſervation itſelf, compared with what is above in this ſection, I would infer, that the veſſels of the amnios furniſh by much the larger ſhare of the liquor contained in it.

Whoever conſiders the large placenta (§ 18.), the quick growth (§ 32.), and the weakneſs, of a young fœtus, will not affirm its being incapable of furniſhing this liquor of the amnios.——The veſicles full of water, in which there is no fœtus, and conſequently no placenta, when found in the womb, cannot be eſteemed to be ova, but are hydatides, of which great numbers are often found here (*a*); and therefore ſerve nothing for determining the preſent queſtion.

N. Authors having differed widely concerning the quantity and quality of the *liquor amnii*, and my obſervations not having been univerſal enough to fix a general rule, I ſhall delay any inquiry into the ſtate of this liquor, till I come to examine it as it is employed in accounting for the nutrition of a fœtus; where I ſhall conſider it, according to all the different opinions of authors.

27. As ſoon almoſt as we can obſerve any embryo, its umbilical veſſels diſcover themſelves (*b*).

28. The mouth, lips, and cheeks of fœtuſes, are at firſt wanting, and leave a large chaſm inſtead of a mouth; which is gradually contracted by the formation and conjunction of theſe parts, till it is brought to a due ſize (*c*).

29. While fœtuſes continue in the womb, their muſcles are ordinarily

(*a*) Vid. Hiſtor. in Haller. not. m. in § 679. Inſtitut. Boerhaavii.

(*b*) Harvey, exercit. 56. Ruyſch, Theſ. 6. Riolan. Anthropograph. lib. 6. cap. ult.

(*c*) Harvey, ibid.

left to act only by their natural contraction, or the fœtus is said to be in a ſleeping ſtate; but ſometimes, when its eaſe or preſervation requires a change of ſituation, it ſeems to perform ſome voluntary motions, which are called its *ſtirrings*.

The poſture of a child is owing to the muſcles being left to their natural contractions, the ſtronger ones always prevailing, till their antagoniſts exert ſuch a reſiſtance by being ſtretched as brings them to an æquilibrium. No wonder, therefore, that the ſpine is ſo much bowed forward, and the head is bended towards the knees; the thighs are brought forward; the legs are bended back; the arms hang down, but are drawn a little forward; the fore-arms, hands, and fingers, are all bended, and thereby the hands are placed round the knees: For it will appear to any who ſhall take the trouble to conſider the ſtructure of theſe parts, that the members are all brought to that ſide where the muſcles have an advantage over their antagoniſts in number and ſtrength, or in the angles of inſertion, or in the length of the lever they act with.

That the poſture above-deſcribed ariſes from the natural contraction of the muſcles, while the fœtus is in a ſleeping ſtate, is farther evinced, by obſerving how much children ſleep after they are born, and how the members naturally go into near the ſame poſture when people fall aſleep.

30. The ſtomachs of the youngeſt fœtuſes we can diſſect are full of a mucous liquor, which remains of near the ſame conſiſtence all the time of geſtation, except that it becomes gradually ſomewhat more viſcous as the fœtus increaſes.

This has obtained in all the different animals I have had occaſion to diſſect.

31. The ſmall guts of fœtuſes are full of a glairy mucaginous liquor, which becomes thicker and darker coloured as it deſcends to the great guts, where it is collected under the name of *meconium*.

32. Fœtuſes increaſe proportionally leſs the longer they continue in the womb.

Mauriceau (*a*) pretends to determine the proportional increaſe of a child

(*a*) De maladies de femmes groſſes, liv. i. chap. 5.

child to be ſixty-four times its own weight in triple the time. The numbers he condeſcends on are the following: At birth, a child weighs 12 pounds, of 16 ounces each; at three months, it weighs 3 ounces; at one month, three fourth parts of half a drachm; and at ten days, leſs than half a grain.

Having now eſtabliſhed the neceſſary facts, I deſign to uſe them hereafter as ſo many axioms or data; and, to ſave repetitions, I ſhall only refer to them by the numbers prefixed to each, in the ſolution of the ſeveral problems, to which I now return.

PROBLEM I. *How far the* Mouth *or the* Umbilical Veſſels *are neceſſary to the Nouriſhment of the* Fœtus.

AUTHORS have all known that fœtuſes have been brought forth without mouths: but ſeveral of theſe monſters being found, upon a ſtrict examination, to have ſome other paſſage leading from the ſurface of their bodies into their ſtomachs, ſeveral writers of good account have affirmed, or at leaſt in an indirect way have inſinuated, that ſuch vicarious paſſages are never wanting when the mouth is ſhut or deficient; which they think rather a ſtronger proof of the ordinary canal by the mouth in complete fœtuſes being altogether neceſſary for the nouriſhment of the fœtus, than if no ſuch monſters had been ſeen; ſince, ſay they, we hereby ſee how careful nature is to preſerve a paſſage from without into the chylopoietic organs.

To remove all pretences for concluding hereafter ſo generally that a vicarious paſſage is never wanting, allow me to point out ſome authors, who give accurate and well-vouched hiſtories of monſters who had no ſuch canals, and in ſome of which it was impoſſible they could have them, or they muſt have been altogether uſeleſs.

Children (*a*), a whelp (*b*), and a lamb (*c*), were brought forth without heads, or any paſſage into the chylopoietic bowels. In other fœtuſes that had heads, all paſſage to the ſtomach was ſhut up: See ſuch obſervations of

(*a*) Two by Littre, Mem. de l'Acad. des Sciences, 1701; one by Mery, ibid 1720.
(*b*) De Graaf, de Mulier. Organ. cap. 15. (*c*) Antoine, Hiſt. de l'Acad. des Sciences, 1703.

of children (*a*), of whelps (*b*), of a lamb (*c*), of a pig (*d*). Where the paſſage into the ſtomach has been open, there have been no inteſtines (*e*); and, where the guts were, nothing could get down into them (*f*).

Theſe examples are ſo exact in ſhowing the little neceſſity there is for either mouth or chylopoietic organs in the nouriſhment of fœtuſes, that I need ſcarce mention how much they ſerve to determine the firſt part of this problem; and they make remarks on the hiſtories of fœtuſes, who had the vicarious paſſages, unneceſſary: only allow me to caution the young phyſiologiſts, not to take ſome authors aſſertion, of the food being conveyed by thoſe extraordinary canals, for an eſtabliſhed truth, till they have examined what is to be ſaid for and againſt it.

Though the former part of the problem ſhould be determined in the manner I have argued for, which takes away all probability of nouriſhment being furniſhed to fœtuſes by the mouth alone; yet the gentlemen who are of opinion that it is conveyed by both the umbilical vein and the mouth, endeavour to reſolve the latter part of it ſo as ſtill to favour their ſentiments: for they undertake to prove, that the ſupply by the navel may be wanting, as well as that by the mouth; and therefore, that both contributing towards the nouriſhment in the natural ſtate of the fœtus, whenever one of them is wanting, the other performs the function of both, as is ſometimes done in other parts of the body. I acknowledge great probability in this reaſoning, if they can bring a clear convincing proof of fœtuſes ſubſiſting and increaſing without receiving liquors by their navel-ſtring. Seeing, then, this part of the problem is of ſuch importance in the preſent queſtion, I muſt be excuſed for inſiſting particularly on the ſeveral facts which I have obſerved to be advanced by authors in proof of the navel not being indiſpenſably neceſſary toward the nouriſhment of a fœtus.

The firſt argument uſed by the gentlemen of the other ſide of the queſtion,

(*a*) Littre, Mem. de l'Acad. des Sciences, 1701. Buchnerus, Act. Med. Phyſic. Acad. n. c. vol. ii. obſ. 96.

(*b*) Littre, Hiſt. de l'Acad. des Sciences, 1703. Brady, Philoſ. Tranſ. n. 304.

(*c*) Ruyſch, Theſ. 4. n. 55. (*d*) Bellinger. de Fœt. Nûtr. cap. 9.

(*e*) Lemery, Hiſt. de l'Acad. des Sciences, 1704.

(*f*) Calder, Medical Eſſays, vol. i. art. 14.

ſtion, is, That authors of the beſt character (*a*), who have diſſected viviparous animals with young, aſſure us there is no adheſion or connection between the ſecundines and uteri of moſt animals, for a conſiderable time after the conception is lodged there; and, in ſome animals, many months paſs before there is any adheſion (*b*): therefore, ſay they, the fœtus can receive nothing all this time from the mother by the umbilical veſſels; and conſequently is then wholly nouriſhed by the mouth.

On the ſuppoſition that the uterine veſſels muſt always inoſculate with thoſe of the ſecundines, before the umbilical veſſels can receive any liquors from the mother, this argument is indeed of great force. But according to the ſcheme which I have explained, and, I hope, have proved in § 16. & 17. of preliminary facts, it is a matter of indifference, whether the liquors furniſhed by the mother are applied to the bibulous orifices of the abſorbent veſſels of the ſecundines, while the liquors are contained within cells formed in the ſubſtance of the uterus (§ 2.—5.), or when they are poured into the cavity of the uterus itſelf: for thoſe veſſels will equally well perform their office in both caſes, and thereby ſerve to nouriſh the fœtus ſufficiently; which muſt take off the neceſſity we were here imagined under, of ſuppoſing the food to be wholly received at the mouth. Nay, in ſome animals, for example mares, whoſe allantois ſurrounds the amnios (§ 22.), and whoſe ſecundines have no connection for a conſiderable time with the uterus, what has been juſt now ſaid is finely illuſtrated; and there is downright demonſtration of all the fœtus's nouriſhment being conveyed by the umbilical veſſels, as was remarked § 16.

Next, ſeveral obſervations are brought to ſhow, that the paſſage of liquors by the navel has often been ſtopped long before birth. The firſt I ſhall mention is one of Mr Petit (*c*): "Mr Petit (ſays the ſecretary of "the Academy of Sciences) cauſed the navel-ſtring of a human fœtus to "be ſhown, which had a knot in its middle, where one could obſerve the "marks of the contiguity (*d'attouchement*) of the parts that formed the "knot; which proves that the knot had been made long before the wo-"man's delivery."

It may be ſaid, that this is in ſome meaſure anſwered by what Mauri-

ceau

(*a*) Harvey, Needham, de Graaf. (*b*) Needham, Obſ. Anat. de Form. Fœt. cap. 2.
(*c*) Hiſt. de l'Acad. des Sciences, 1718.

ceau (*a*), Deventer (*b*), and other practical writers in midwifery, affirm of the danger children are in of loſing their lives when the umbilical rope is preſſed or expoſed to the cold air before birth, and by obſervations of fœtuſes being killed by knots on the navel-ſtring (*c*). But the fact, as it is told, is open to ſtrong objections; for there is not one circumſtance mentioned by which we can know whether this knot ſtopped the courſe of the blood, or if it was any more than one of the common ones, about which ſome midwives make ſo much to do. I have given a figure of one, ſerving to ſhow, by my injection paſſing, that liquors will not ſtop in ſuch. See Plate I. fig. 5. "repreſenting a piece of the funis umbilicalis, whoſe veſſels are diſtended with wax." AA is the large vein; BB, the the two arteries twiſting ſpirally round the vein; C, a very remarkable convolution of the arteries, which reſembled a knot, before the injection was thrown in.——Further, I ſee no reaſon to conclude from Mr Petit's obſervations, as the ſecretary has done, that becauſe there were marks of the parts which compoſed the knot, touching, or being contiguous to each other, therefore the knot muſt have been of an old ſtanding. Add to all this, that there is no mention made of the child's condition, whether it was born dead or alive. So that, from the whole, I muſt think there can be no uſe made of this obſervation in this argument. And I muſt alſo acknowledge, that the obſervations of children ſaid to be killed by knots on the navel-ſtring, are as little to my purpoſe: for though the authors who relate them, do aver the knots to have been the cauſe of death, yet they do not mention circumſtances in the fact ſufficient to ſupport their opinion; for which I muſt decline the greateſt authority, though it were ever ſo favourable to my ſide of the queſtion.

The ſecond obſervation brought to prove the courſe of the blood interrupted in the umbilical veſſels before birth, is what Mr Heiſter (*d*) quotes from Fred. Hoffman's Diſſertation *de pinguedine*. Unluckily that treatiſe is not among the collection of Hoffman's Diſſertations I am poſſeſſed of; and therefore I muſt take the relation of the fact at ſecond-hand. It is this: "A perfect child was born, whoſe umbilical rope was all corrupt "and

(*a*) Maladies des femmes groſſes, liv. ii. chap. 26. (*b*) Ars Obſtetric. cap. 38.
(*c*) Ruyſch. obſerv. xi. Gutterman. in commerc. Norimberg. 1731. ſemeſt. 1. ſpec. 20.
(*d*) Compend. Anat.not. 37.

" and putrid, *(putredine totus corruptus erat.")* Mr Heiſter adds, " It " would have been impoſſible that it ſhould have lived, unleſs it had taken " its nouriſhment ſome other how than by the navel."

Though, for ought that is expreſſed here by either Hoffmân or Heiſter, it ſeems to be ambiguous, whether this complete child was born dead or alive, yet I ſhall ſuppoſe the latter caſe: and, when this is granted, the account is ſuch as one cannot pretend to gueſs from it how long this navel-ſtring had been corrupted; what parts had been deſtroyed by the putrefaction; whether the cellular membrane and mucus of the rope only were affected, or if the veſſels involved in them were alſo deſtroyed. In ſhort, this ſtory does not ſeem diſtinct enough to allow any conſequence to be drawn from it. Leſt, however, any ſhould build on a ſtrict ſenſe of the word TOTUS, which ALL the world knows is generally uſed in a very vague way, let ſuch reconcile any appearance of a *funis umbilicalis* with the total and complete corruption of the membranes, mucus, and veſſels compoſing it.

The two following hiſtories are much more exact and to the purpoſe. One is from Chatton (*a*); the other is told by Petrus Rommelius (*b*). Both agree almoſt exactly in the principal circumſtances. Healthy children are born with the navel ſkinned over. The ſecundines, when afterwards brought away, are of a natural ſize, and the extremities of the umbilical rope are coaleſced. The mother of the one told Mr Chatton, that ſhe had gone with child three weeks longer than her ordinary time; and he thinks the navel was as ſound as a child three weeks old uſed to have it. Rommelius judges the other child's navel to have been as ſound as in children ſeveral months old. A little impervious proceſs about the ſize of a worm ſtood out from the navel, and the umbilical rope was as ſmall as a gooſe-quill.

Theſe authors have been very fond of ſetting the world a-ſtaring, otherwiſe they would never have made the compariſons of the ſoundneſs of the navels of the children in their hiſtories with thoſe of children ſo many weeks or months old. I wiſh they would explain to me what is the difference as to ſoundneſs in a ſound navel of children three days, weeks,

(*a*) Vander Wiel, Obſerv. Cent. Poſt. pars 1. not. in obſ. 32.

(*b*) Ephemerid. German. dec. 2. ann 7. obſ. 209.

months, or years old. Since there is none, we are to inquire how long time theſe navels had probably been in ſkinning over after the navel-ſtring was broke or eroded. The circumſtance of the ſecundines being of a natural ſize, ſhews that this accident did not happen long before birth; for from what was ſaid in § 14. of the placenta being a lifeleſs maſs after the communication betwixt it and the child is deſtroyed, and from what the beſt and moſt experienced practiſers in midwifery (*a*) agree in, the ſize and ſtate of the after-burden muſt be greatly changed in very little time after it is in that lifeleſs ſtate which muſt be here ſuppoſed. The only way of judging in what time a ſkin might be brought on the navel of the children mentioned in the foregoing hiſtories, is to determine, How ſoon after birth childrens navels are ſkinned over; and then to inquire, Whether a cicatrice would be ſooner or later brought on by the child's continuing immerſed in its waters after the navel-ſtring was broke. I have frequently ſeen, and among the reſt in my own children, the tied piece of the navel-ſtring fall off, in four, three, or two days after birth, and the ſkin was found where the ſhrivelled ſtring ſeparated: And it is generally known how very ſoon the remains of the navel-ſtring drop off from brutes. If then ſuch a ſeparation can be made ſo ſoon, when dry rags are applied, or by being expoſed to the air, we have reaſon to think that the ſkin would be much ſooner brought on the navel while the parts were ſoaking in the *liquor amnii:* for we have very convincing proof what the effects of ſuch a ſalt liquor is in the ſaliva, which not only ſerves to keep the mouth ſoft and flexible, but very ſoon heals wounds or mild abſceſſes there; the urine will ſcarce allow ſurgeons to keep the wound in lithotomy long enough freſh, but, notwithſtanding their utmoſt efforts, it often renders the paſſage callous. The ſynovia of the joints, the glary liquor of tendinous or ligamentous ſheaths, and, in ſhort, all ſuch liquors of our body, do the ſame. From all which I would conclude, that the navel-ſtrings which are the ſubject of our preſent inquiry, were broke very ſoon before birth; and if I ſhould allow the time to have been a day or two, the fœtus might continue ſo long in life, without any new ſupplies of nouriſhment, as well as it does ſeveral days after

(*a*) Mauriceau Maladies des Femmes Groſſes, liv. ii. chap. 9. Ruyſch. in Theſ. Obſerv. adverſ.

after birth, when it ordinarily takes only ſome purgative ſyrups; and there is recorded (*a*) an inſtance of a child that lived ſeven days after birth, though nothing could paſs out of its ſtomach into its guts to nouriſh it. The probability of a child's living without nouriſhment in the womb ſo long as I have allowed, is certainly much greater than that it ſhould continue in life days, weeks, or months, after the waters have been evacuated, and continued to be conſtantly diſcharged (*b*), on the ſuppoſition which the gentlemen of the other ſide make of its receiving its food moſtly by the mouth for ſome time before birth. I would therefore conclude from the whole, that theſe children whoſe hiſtories Chatton and Rommelius relate, were under no neceſſity of being ſupplied with nouriſhment any other way than by the navel, and conſequently do not prove what was deſigned by appealing to them.

A more direct proof the umbilical veſſels not being ſo neceſſary as I argue for, is offered by examples of fœtuſes who had no navel-ſtring. I know only two caſes where this is alleged: one is told by Vander Wiel; the author of the other is anonymous.

Vander Wiel ſays (*c*), "In the time of the fair at the Hague, in the "year 1683, a male child, a year and three months old, born of poor "parents in February 1682, was expoſed for a ſhow. When it was born, "there was not the leaſt veſtige of the umbilical rope; and therefore the "midwife had no occaſion to ſeparate it from the child's belly. The "navel alſo was wanting: but inſtead of it a broad round red ſpot, as "large as a ſtiver piece of money, covered with a very thin ſkin, ap-"peared in the hypogaſtrium, near to the ſhare-bones; within the cir-"cumference of which ſpot two papillulæ or aqueducts were ſeen, at an "inch diſtance from each other, by which the urine was evacuated. The "child died at three years of age." In the notes upon this obſervation he tells us, its body was not opened after its death.

This ſeems to me ſuch an hiſtory as one can rely very little on: for it would appear to be on the parents information that Vander Wiel aſſerts there was no navel-ſtring; their buſineſs, to be ſure, was to make the caſe as wonderful as they could, to draw in cuſtomers. There is not any

(*a*) Medical Eſſays, Vol. I. Art. xiv. (*b*) Mauriceau dans pluſieurs obſervat.
(*c*) Obſerv. Cent. Poſt. pars 1. obſerv. 32.

where mention of ſecundines, to know whether the umbilical rope was hanging at them; and the breadth of the ſpot anſwers very well to the navel; which probably would have been made as certain by a diſſection, as it was conſpicuous in another caſe related towards the end of the notes upon this obſervation, and very like to it in all the principal circumſtances, excepting that here the umbilical rope was evident. (See ſuch an hiſtory in the Medical Eſſays, Vol. III. Art. 14.) Since then this hiſtory is ſo imperfect, and on an hearſay, while the very caſe which the author tells as analogous to it brings it to make for my ſide of the queſtion, I am hopeful it will not be advanced any more againſt me.

The ſecond caſe of a navel being wanting, is told in a letter of an anonymous author in words to this purpoſe (*a*): "An hare big with young "being caught, its belly was carefully opened, and immediately three "conſiderable balls tumbled out: they were of a whitiſh colour exter- "nally; with this difference, that the coat of the firſt which fell out was "not pellucid, whereas the other two were ſurrounded with a pellucid "coat. I conſidered theſe globes accurately, and could not obſerve on "their ſurface the leaſt mark of their adhering any where. I alſo with "great care examined the uterus that was cut out, which I found per- "fectly entire, and of a natural ſize, without any marks of a conception, "or of any breach in it. When I had cautiouſly cut theſe globes or balls, "I found in each a little hare covered all over with fur, and of the big- "neſs new-kittled hares commonly are. The membranes ſurrounding "them were eaſily taken off whole and entire; but I could find no veſtige "of the umbilical rope either in the ſeparated membranes or bodies of "the hares. After this, I viewed the membranes more exactly, diſcover- "ing them to be double and eaſily ſeparable. In the ball whoſe mem- "branes I ſaid were opaque, the external one was thicker; the one with- "in this was thin and pellucid, its internal ſurface being covered with a "yellowiſh mucus. Internally, there was a ſpace about the bigneſs of a "guilder piece of money, that reſembled a ſmall uterine placenta, equally "covered with a thin ſkin, but without any veſtige of the umbilical rope. "I cut the placentulæ, and found them internally liver-like (*hepatiſor- "mes*), whitiſh, of a ſoft vaſcular texture, full of canals and papillulæ.

"Theſe

(*a*) Commerc. Literat. Norimberg. 1731. ſpec. 27. art. 4.

" Theſe are what were partly faithfully related to me, and partly were " obſerved and remarked by myſelf. Indeed, having never had an op- " portunity, I did not ſearch into the fœtuſes of hares before. This whole " matter ſeems a paradox to me."

Many inconſiſtencies diſcover themſelves in this obſervation at firſt reading, even in the part of it where one would think the author is telling what he ſaw. Two of the balls are pellucid; and the third has only a round ſpot on the interior ſurface of its membranes, which he ſeems to expect ſhould have had umbilical veſſels coming out from it, and is much diſappointed at miſſing of them. After, I ſay, he has thus made it evident that there were no placentæ, yet afterwards hepatiform vaſcular placentæ are very accurately deſcribed.——The membranes are taken off whole and entire from the fœtuſes incloſed in them, after the globes containing the fœtuſes had been cautiouſly cut.——The placentæ are hepatiformes, either from their ſhape, form, and bulk, being before inviſible; or they are like livers, becauſe they are white.——Though it is now agreed that a placenta is no more than numerous ramifications of the umbilical veſſels, yet here are placentæ without their veſſels being derived from any part; which to me appears to be an expreſs contradiction and impoſſibility.—— Though the whole affair is a paradox to him, he has not the curioſity to open one of the young hares, that he might ſee whether the umbilical veſſels were wanting within their bodies as well as without.

Though this gentleman has concealed himſelf in a country where people are far from ſhunning to be the firſt public tellers of ſuch prodigies of nature as come to their knowledge, yet I ſhall not doubt of his ſincerity; but cannot help ſaying, that his ignorance, at leaſt in the ſtructure of the fœtuſes of hares, which he ſays he never had an opportunity of diſſecting before, has led him into miſtakes numerous enough to give me ſufficient cauſe to decline his teſtimony. And as to the principal thing which relates to the preſent queſtion, the want of a *funis umbilicalis*, I think I can, with the help of Needham's third table of his obſervations *de form. fœt.* make an apology for his not diſcovering it, by ſhewing that others, more accuſtomed to the diſſection of hares, might have miſſed of it as well as he. Needham repreſents the fœtus of a rabbit with its ſecundines, (which differ ſcarce any thing from thoſe of a hare), where

that

that part of the umbilical rope, in which all the veſſels are incloſed, is very ſhort, and ſeven or eight conſiderable branches go from it ſeparately to the placenta. If theſe veſſels were all broke at the place where they ſeparate, by the running of the dam, or falling out of the balls, or in opening the membranes, the ſhort navel-ſtring would contract, and be hid by the fur, ſo as to be diſcovered with difficulty; and the extremities of the broken veſſels would appear on the placenta like papillulæ, and the placenta would be vaſcular and whitiſh-coloured, as the anonymous obſervator has deſcribed it. This account is natural and eaſy enough to bear a ſtrong air of truth with it.

If then accurate inſtances are recorded of fœtuſes being nouriſhed without any poſſibility of their receiving aliment by the mouth or into their chylopoietic organs, and if there can be no diſtinct unexceptionable proof made out of their being ever ſupplied with nouriſhment without the navel-ſtring, I muſt determine the firſt problem, by affirming, That the umbilical veſſels are abſolutely neceſſary toward the nouriſhment of a fœtus, and that the mouth is not ſo.

PROBLEM II. *Whether the Liquor contained in the* Amnios *is proper* Food *for a* Fœtus.

WHEN we conſider this liquor as it is ſometimes repreſented, to wit, that it is at firſt mild and mucaginous, and afterwards becomes thinner, more acrid, and urinous, it would appear ill calculated for the food of the fœtus in its different ſtates: for while the parts of a fœtus are weak, and have little action, they are not ſo well fitted for digeſting and breaking the coheſion of a fluid whoſe particles ſeparate with ſuch difficulty; whereas it would have been much more capable of digeſting ſtronger food after its ſtomach, guts, and other chylopoietic organs, were become ſtronger: conſequently this liquor ought to have been of the reverſe conſiſtence to what is above deſcribed, as we ſee happens in a caſe which muſt be allowed to be very analogous to the preſent ſubject, that is, in the conſiſtence of milk, which is at firſt thin and purgative, but afterwards becomes thicker and ſtronger food.

Needham may perhaps be ſaid to have deſcribed this liquor really to

" be

be as I have argued it ſhould have been formed; for he tells us (*a*), "That "the liquor of the amnios becomes conſiderably thicker than it was at "firſt in the larger animals." And in another place (*b*), he affirms, "That "it gradually becomes thicker, and ſoon acquires the conſiſtence of the "white of an egg; nay, in the laſt months of a cow's going with young, "it is thicker and more viſcid than any gelly." This agrees exactly with what I alſo remarked in cows, whoſe fœtuſes, with their ſecundines, I have examined in a great many different ages. But neither in this view of the conſiſtence of this liquor does it appear proper nouriſhment; for, according to the old adage, *Eſt modus in rebus:* Though the food of a fœtus might be expected to be groſſer in the laſt months, when its organs are ſtronger, than ſoon after conception; yet a liquor ſo very thick and viſcid as Needham deſcribes, would be altogether indiſſoluble, and very improper for nouriſhing a creature whoſe organs of digeſtion are ſtill in a tender ſtate, and for whom nature has provided ſuch a dilute fine liquor as milk is, to ſerve for food a conſiderable time after the birth, when all its parts are become much more robuſt and ſtrong. If we can make any judgment in this affair, from a view of the ordinary courſe and tenor of nature, we muſt think, that if the *liquor amnii* had been deſigned to be ſwallowed for food, it would have been at firſt a thin ſerum that gradually came afterwards near to the conſiſtence and nature of milk: but this I never ſaw, nor do I know that any has affirmed this liquor to have been ever obſerved of ſuch a proper conſiſtence in the different times of gravidation; and therefore muſt conclude, that it is not deſigned to ſerve for food.

The *liquor amnii* ſeems not only thus improper food, while it is in a natural ſtate; but there are examples of its being ſo much depraved, that it muſt have been of the worſt conſequences to the fœtus to have fed upon it. Such is the hiſtory related by Dr Bellinger (*c*), of a woman who had laboured under a virulent gonorrhœa during her pregnancy, of which ſhe was cured a very little time before her delivery. The waters were very putrid and fœtid, and the membranes tender and almoſt rotten; yet the

(*a*) Obſerv. Anat. de Form. Fœt. cap. 3. (*b*) Ibid. cap. 5.

(*c*) Tract. de Fœt. Nutr. cap. 9.

the child was born well and healthy; which the Doctor thinks could not have happened, if this child had received ſuch putrid waters into its bowels.

The force of this obſervation is attempted to be taken off, by remarking, That poiſons, and other noxious ſubſtances, do leſs harm when taken into the ſtomach, than when immediately mixed with the blood.—Every body, I believe, will grant this to be true, if the quantities received both ways are equal: but it is of no uſe in the preſent queſtion, unleſs this other propoſition is alſo proved, viz. That ſuch a quantity of this putrid liquor, as is ſufficient to nouriſh the fœtus, muſt be taken in either by the mouth or umbilical veſſels; then, indeed, by a plain ſyllogiſtical conſequence, it follows, that ſuch a quantity of the putrid *liquor amnii* will do leſs harm by being received at the mouth, than if it had been conveyed by the navel. I can, however, ſee no reaſon to allow the minor propoſition to be true; nor am I ſenſible of being brought, by a denial of this propoſition, under a neceſſity of giving the placenta a faculty of ſeparating the pure from the impure, or of having the goodneſs to ſend the impure to the amnios, where it does no harm, and the pure to the fœtus, where it does much good. I preſume every one's practice has taught him, that there is no neceſſity to ſuppoſe the whole maſs of the mother's blood to have been tainted by the virulent matter of this gonorrhœa. I can imagine this diſeaſe to have had its ſeat at firſt in the vagina, and then to have attacked the internal *os uteri* and the mucus with which it is commonly filled in the time of pregnancy, (ſee an inſtance of an ulcerated *os uteri* from ſuch a cauſe (*a*) by Des Noves;) and this corrupted mucus might communicate its fœtor to the liquor of the amnios, without the veſſels of the placenta having received one drop of this putrid liquor: And therefore, according to the doctrine which I endeavour to ſupport, the child might remain healthy and ſound, unleſs the waters had been long enough acrid to affect the ſurface of its body; whereas, had ſuch putrid liquor ſerved it for food a very ſhort time, it ſcarce could have eſcaped without ſome diſeaſe. Nay, from what was ſaid concerning the ſource of the *liquor amnii* being either the fœtus, or its umbilical arteries, (*vid.* § 24. and 26.), it neceſſarily follows, that the *liquor amnii* in this caſe could not have been corrupted in any other way than what I have

(*a*) Morgagn. Adverſ. Anat. 4. animad. 40.

have juſt now aſſigned; for we can never imagine that a child could have ſuch corrupted liquors circulating in its veſſels without being tainted.

It may be objected, from what I have ſaid (§ 25.) of the branches of the umbilical vein abſorbing the *liquor amnii*, that ſuppoſing this liquor to have been corrupted in the manner I have explained it, the fœtus could not have remained ſound; becauſe the abſorbent veins muſt have taken up this corrupted ſtuff, to mix it with the blood of the fœtus. To this I anſwer, That the quantity taken up by abſorption is but ſmall, and the time would appear to have been but ſhort in which it could here have been abſorbed. Next, I would obſerve, That though a gentle contraction is neceſſary for increaſing abſorption, yet very acrid ſubſtances irritate abſorbent veſſels to ſuch a ſtrong contraction, as makes them incapable of performing their functions, which I take to be one principal reaſon why poiſons, when ſwallowed, do ſo much leſs harm than when they are immediately mixed with the blood: And hence the very acrid kinds of them are obſerved to produce all their bad effects on the *primæ viæ*, without any appearance of their having entered the blood-veſſels (*a*). So that we have reaſon to think the child to have been in much leſs danger of ſuffering, by what the abſorbents of the amnios could take up in ſuch a caſe, than if the putrid liquor had been ſwallowed for food, when it would ſurely have hurt the alimentary tube; and if it had gone further, it muſt have tainted the whole maſs of blood; or if the lacteals had refuſed it entrance, the child would have been famiſhed; and, at any rate, it would have laboured under ſome diſeaſe; whereas, in the hiſtory, it is affirmed to be have been ſound and healthy.

Whether, then, we conſider the liquor of the amnios in a ſound or morbid ſtate, it appears to be very ill calculated for ſerving as food to be taken into the ſtomach of a fœtus.

PROBLEM III. *Whether the* Liquor Amnii *paſſes into the Stomach of a* Fœtus.

THE impoſſibility of having ocular demonſtration of the fact inquired after in this third problem, has occaſioned a great many circumſtances to be uſed by way of arguments, each of which we muſt examine; and if

(*a*) Wepfer de Cicut. Aquat. Mead on Poiſons.

they all point one way, and the concluſions ariſing from them are favoured by the ſolutions of the two preceding problems, the general concluſion concerning the nutrition of the fœtus will be ſufficiently warranted.

The firſt thing I offer againſt the *liquor amnii* paſſing into the ſtomach of a fœtus, is the improbability of a liquor that is to ſerve for food, being previouſly ſent into the fœtus's own veſſels, there to circulate and to be ſecerned, in order to prepare it for being ſwallowed, which § 24. and 26. ſhow would be the caſe on this ſuppoſition.

No matter where this liquor is ſeparated, or from what ſource it comes, will the advocates of the other ſide ſay, if its paſſage into the ſtomach can be proved; which they infer does happen, from,

1. The reſemblance which they allege is to be ſeen between the liquor of the amnios and that of the ſtomach.

I have already deſcribed the liquor of the ſtomach, as I have ſeen it in fœtuſes of different animals, (ſee § 30.); but have not had opportunities to obſerve the liquor of the amnios in the different ſtates of a ſufficient variety of fœtuſes, and therefore ſhall firſt conſider it as it is repreſented by the gentlemen who differ in opinion from me, and afterwards ſhall ſuppoſe what I ſaw in cows to be general.

If the liquor of the amnios is at firſt mild and mucaginous, and afterwards becomes thinner and more acrid, it differs greatly from the liquor of the ſtomach, which, on the contrary, turns gradually more viſcous as the fœtus increaſes, (§ 30.) Nor will it ſuffice to ſay, that the finer parts are abſorbed by the veſſels of the ſtomach: for, by ſuch an abſorption, it could never happen, that a thin watery liquor would leave a greater quantity of groſs mucus than a thick gelly would do; eſpecially when there is leſs time allowed for the abſorption of the watery liquor, by the quicker digeſtion which the fœtus muſt be ſuppoſed to have when it becomes larger and ſtronger. Upon which account, too, the contents of the ſtomach would be more and much oftener diluted by the thin food ſwallowed in greater quantities, and more frequently. And then we might expect ſometimes to ſee the thin liquor lately taken down, and the thick remains of the former food, diſtinct, without being blended; as we obſerve the mucus of the ſtomach of adults to keep in a ſeparate body from any thin liquors drunk ſome little time before they are vomited. This, however, is never

never obſerved in the fœtus, though it has neither reſpiration, vomiting, nor other conquaſſatory preſſure on its ſtomach, to incorporate the different liquors contained there; and therefore there is no probability that they ſhould be ſo intimately blended. So that, on the whole, the liquors of the amnios and ſtomach are ſo far from reſembling each other in this caſe, that their appearances diſcover them to be very different, and deſtroy the ſuppoſition of that of the amnios ever being ſent down into the ſtomach.

Let us next ſee how well the *liquor amnii* of cows, taken for a general rule, will ſerve to ſupport this alleged reſemblance. It muſt indeed be owned, that, till the liquor of the amnios comes to a certain degree of viſcidity, which, as near as I could gueſs, happens when the cow has gone three-fourths of her time, the appearances of reſemblance are pretty favourable: only, while the fœtus is very young, the objections to the former ſuppoſition take place; becauſe, for ſome time, this liquor is glairy, then becomes more watery, and afterwards thickens, till it comes to much the ſame conſiſtence with that in the ſtomach, at the period juſt now mentioned; after which the appearances are quite deſtructive of any reſemblance, for the *liquor amnii* becomes conſiderably thicker. And even during that favourable period, when their conſiſtence is ſo like, I have often ſeen the *liquor amnii* of a dark brown-colour, and turbid; while the liquor in the ſtomach was of a very pale watery colour, and pellucid: And at other times I have obſerved the contrary of this, and other remarkable varieties of appearance; which perſuades me, that there is no communication between the cavity of the amnios and the ſtomach.

It will be remarked, that I have made no compariſon of the taſte, ſmell, or coagulation of theſe two liquors; which is omitted deſignedly, becauſe neither ſmell nor taſte are very greatly different in any of the ſaltiſh watery liquors of the body: for that in the pericardium, thorax, abdomen, joints, the ſaliva, &c. of a fœtus, ſmell and taſte as like to either of the liquors that are the immediate ſubject of our inquiry, as theſe two do to each other; and different ſalts, heats, &c. produce much the ſame effect upon all of them.

2. The liquor of the amnios is ſaid to be generally conſumed, or in very little quantity, at or near the birth; from which it is inferred, that it has been ſwallowed down by the fœtus. De Graaf, in confirmation of

this fact, tells us (*a*), that he diſſected a rabbit when ſhe was about to kittle: In the time of his diſſecting the mother, ſome of the fœtuſes came out with their membranes entire, and without any liquor contained in the amnios or chorion. He obſerved alſo the ſame thing in the others that were taken out of the uterus; and, to be aſſured that the coats were not broken, he diſtended the membranes with air, and found they were entire.

Whatever truth is in the general propoſition, I think De Graaf's obſervation, which he fancies equal to a proof of it, is good for little; becauſe it ſhows only what happened in that particular animal, without determining what the quantity of the liquor is for ordinary in rabbits; far leſs does it teach us what we ought to ſay of animals in general.

I am certain that a great many creatures have not all this liquor conſumed at birth, having had my arm wet up to the ſhoulder when the waters broke, while my hand was in the vagina, in ſome caſes where neceſſity has obliged me to act the accoucheur to women; and we ſee every day how the cloaths are wet when the waters come away. I have alſo ſeen a remarkable quantity of liquor ſtill remaining in the amnios after the delivery of ſeveral animals; but my obſervations have not been ſufficient to determine (except in one ſpecies of animals, cows,) what proportion the liquor of the amnios bears at birth to what it was formely; and I know no author, except Harvey, who ſeems to write on this ſubject accurately and from obſervation. When he is endeavouring to prove the *liquor amnii* to ſerve for food to the fœtus, he raiſes this objection to himſelf (*b*): "One might believe, that the liquors which we appointed for "food to the fœtus are excrementitious; and chiefly on this account, be- "cauſe they increaſe as the fœtus turns bigger; and in the birth of ſeveral "creatures, when it is probable all the aliment is conſumed, they are ſeen "in great plenty." And where he is treating of the human waters, and is proving the *liquor amnii* to be no excrement, he ſays (*c*), "It is ſeen in "leſs quantity proportionally *(pro proportione)* near the time of birth." Allow me to add, what obſervations frequently repeated have taught me, that in cows this liquor is evidently decreaſing in its quantity ſome months before the delivery.

It is evident what a loſs I muſt be at to lay down any general rule concerning

(*a*) De Mulier. Organ. cap. 15. (*b*) De Humor. Uteri. (*c*) Exercit 56.

cerning the proportional quantity of the *liquor amnii* in the different times of gravidation in different animals. What the gentlemen who differ in opinion from me will undoubtedly be beſt pleaſed with, is to take my own obſervations on cows as the general rule; which I am ſatisfied rather to do, than to be expoſed to perpetual wrangling about this fact. Let us ſuppoſe then, that the liquor of the amnios increaſes in its quantity for ſome more than the firſt half of the time of geſtation, and after that decreaſes, till at the birth it is in very ſmall quantity. The conſequence they draw is, that the conſumption of the liquor is made by its paſſing into the ſtomach of the fœtus. But, with ſubmiſſion, they cannot come ſo ſoon at their concluſion: They muſt previouſly prove one or other of theſe two propoſitions, either that the liquor does go down into the ſtomach, or that it cannot poſſibly be carried off any other way. The truth or falſehood of the firſt of theſe depends on the arguments examined in the ſubſequent part of this eſſay, and muſt ſhare the ſame fate with them; and, as to the latter propoſition, I flatter myſelf that I have demonſtrated another paſſage by which it may go (§ 25.), and really by which only we can ſuppoſe it to go, in order to account for all the phenomena, which I would do thus. While the fœtus is weak, the arteries of the amnios pour out more than the veins take up, (§ 15. and 26.); and the heat, aſſiſted by the conquaſſatory motion to which the liquor is expoſed, melts down its particles, and makes it appear more watery: But, when the veſſels of the fœtus become ſtronger, and conſequently the veins abſorb more, (§ 15.); the quantity collected does not increaſe ſo faſt, and in ſome time liquors thrown out and thoſe abſorbed are pretty near equal, when the quantity of the *liquor amnii* remains much the ſame; till at laſt, the veins prevailing, the quantity diminiſhes, and continues to do ſo till birth. But, ſeeing the veins take up chiefly the finer particles, what they leave muſt become more thick and viſcous. All this will, *cæteris paribus*, be obſerved in different animals proportionally to the ſizes and numbers of the veſſels. If what Rohault (*a*) affirms be true, of the human *liquor amnii* being always in a watery ſtate, (which, ſo far as I could obſerve, it is rather more than in other creatures,) the arteries or exhalant veſſels are ſmaller, and the veins perform leſs abſorption than thoſe of brutes do.

This

(*a*) Mem. de l'Acad. des Sciences, 1714.

This *liquor amnii* ſerves to keep the fœtus and its membranes ſoft and extenſible; hinders them from cohering; and defends the fœtus from preſſure or other violence, which it needs moſt to be protected from while its parts are very tender, for which this liquor is then, at leaſt, in greater proportion than afterwards when the fœtus is firm and ſtronger; and, by the liquor's real or proportional quantity being leſs towards the time of birth, the mother is not in ſo much danger of ſuffering by the overſtretching of her uterus, as ſhe certainly would be if the waters increaſed proportionally with the fœtus.

What I have ſaid of the changes produced on the *liquor amnii*, will perhaps be better underſtood, by naming ſome analogous caſes: ſuch are, the viſcid nature which the water in a dropſy of old ſtanding acquires; the progreſs of encyſted tumors from a hydatis to a ſteatom; the courſe of a large œdema at the end of an acute diſeaſe, to its changing into what the ſurgeons call a *white ſwelling*; and at laſt to its cure. None that I know ever affirmed the liquors reaſſumed into the maſs of blood in any of theſe caſes; nor what is conſtantly abſorbed in a natural ſtate, from the pericardium, thorax, abdomen, &c. to ſerve as nouriſhment; and therefore I cannot expect, that what is juſt now ſaid of the *liquor amnii* will weaken what I ſaid formerly of the improbability of a creature's furniſhing its own food.

3. Beſides theſe arguments deduced from the quality and quantity of the *liquor amnii*, it is further pleaded by thoſe who favour the opinion of the nutrition of a fœtus by the mouth, that the fœtus ſhews it was in uſe to take down aliment while it was in the womb, by its knowing how to ſuck as ſoon as it is born.

This is building on that *divinæ particula auræ*, that principle which is commonly called *inſtinct*, and of which we obſerve daily examples in propagating the ſpecies, and preſerving the individuals among animals, but of which we have no comprehenſion. Can any one aſſign a phyſical cauſe, why of ducklings and chickens hatched under the ſame hen, the former ſhould, contrary to the example and anxious warnings of the parent, run into each pool they can come at, while the others ſhun going into water? Who taught a young ſtallion that has been always kept out of ſight of mares, either the inſtruments or manner of generation. And,

in

in the preſent caſe, what is there in the leaſt analogous to a nipple within the amnios, on which the fœtus could have practiſed ſucking while in the womb? Theſe are ſubjects we may admire, but loſe ourſelves whenever we pretend to account for them.

4. Here is, ſay they again, a liquor in the amnios conſtantly applied to the orifice of a canal that leads to a cavity, and therefore it probably will paſs down there.

To this it is anſwered, That there are impediments both to the entry and paſſage of the liquor.—The firſt is, the lips being generally found ſhut in a fœtus. This, however, is denied by the other ſide to be true in fact. In my opinion, it is of no great conſequence in the argument, whether the lips of a fœtus are found to be contiguous or not, unleſs ſome other circumſtances can be determined at the ſame time. If the lips, for example, are found ſhut, it is neceſſary to know whether the fœtus, while in life, had not, or did not exerciſe, the power of opening them: And if, on the other hand, the mouth is ſeen open, we ought to inquire whether that is not owing to the ſhrivelling contraction or handling of the parts after death. In moſt of the fœtuſes of cows which I looked at, the lips were contiguous; in ſome few, I have ſeen the point of the tongue lying between them; and, in all the human fœtuſes which I have had the opportunity of ſeeing, the lips were contiguous. One might indeed judge that the mouth generally would be ſhut in a living fœtus, from what was ſaid (§ 29.) of the muſcles of a fœtus being left to their natural action, and from what we ſee in moſt animals when they are aſleep. The force by which the lips are kept contiguous, will, however, not probably be ſo great as that by which the eye-lids are ſhut, becauſe the *ſphincter oris* does not ſeem to be ſo much ſuperior to its antagoniſts, as the *orbicularis palpebrarum* is to the *rectus aperiens palpebram*.

This obſtacle of the lips is not the only one: for the under-jaw, being ſupported by its levators, will keep the tongue applied to the roof of the mouth; and the pharynx always is ſhut in animals, unleſs when the voluntary convulſive action of deglutition is performed. That I might know how theſe parts appeared in a fœtus, I opened the mouths of ſeveral; then cautiouſly depreſſing the point of the tongue, I ſaw the root of it raiſed up againſt the palate. When the root was alſo depreſſed, I obſerved the

the *velum pendulum* was hollow below, where the tongue had been lodged; and was ſo convex above, as to ſhut up the paſſages to the noſtrils. As to the pharynx being always ſhut, it is univerſally known: but, to make ſure of it, I put a funnel into the mouths of ſeveral fœtuſes, after their tongues were depreſſed; and, holding them erect, I poured water into the funnel, but none paſſed farther than the root of the tongue.

I cannot omit the mention of the remarkable mechaniſm employed here, for keeping the tongue cloſely applied to the palate; chooſing the human fœtus, as beſt known, to illuſtrate it by. It is known, that the force exerted by muſcles in their natural contraction is increaſed and diminiſhed proportionally to their being more or leſs ſtretched. It is alſo known, that the muſcles coming from the jaw to the tongue and *os hyoides* are thicker, conſequently ſtronger, than thoſe that come to theſe parts from the ſternum and ſcapulæ. Now, when a fœtus lies with its neck bended, ſuch of thoſe muſcles as are ſituated below the *os hyoides* are conſiderably relaxed, which thoſe above it are not. Since therefore theſe latter are naturally ſtronger, and gain ſo much over the others by the difference of their ſtretching, it is no wonder that they pull the *os hyoides*, tongue, &c. ſtrongly upwards, and preſs them ſo ſtrongly againſt the upper part of the fauces and mouth, as to leave their print in the flexible parts, and, by bringing all the ſides of the paſſage into the œſophagus cloſe together, prevent any thing from getting down into it.

Since then there are ſuch obſtacles to be overcome, the *liquor amnii* cannot paſs, unleſs either the force with which it is ſqueezed is ſuperior to the reſiſtance, or the fœtus muſt perform the action of deglutition.

I ſhall not ſtop here to conſider the bad conſequences which ſuch preſſure on the very tender parts would have, while the chaſm of the mouth is not ſhut (§ 28.) to make reſiſtance; but ſhall proceed directly to examine what is called by ſeveral writers an experiment which demonſtrates the paſſage of the liquor of the amnios into the ſtomach. It is related thus by Mr Heiſter (*a*): "I received a full-formed perfect fœtus of a cow, "incloſed in the uterus and membranes, in cold winter weather, where "not only the liquor of the amnios which ſurrounds the fœtus was "frozen, but the ſame liquor was found frozen in the mouth, œſopha-

"gus,

(*a*) Compend. Anat. not. 37.

" gus, and ſtomach, like one continued ſubſtance: The column of ice " in the œſophagus was about an inch thick. I happened to ſee the ſame " another winter."

If any uſe is to be made of this experiment, in proving the *liquor amnii* to be ſent into the ſtomach, it muſt be ſaid, that the freezing of the liquors did no more than ſhow more diſtinctly how the waters were lodged before they were turned into ice: and if this is true, then we would ſee all the contents of the ſtomach run out, whenever a fœtus is ſuſpended with its head loweſt; or, if the mouth and œſophagus are ſlit open, while the fœtus is hanging by its mouth after being taken out of the *liquor amnii*, we would obſerve part of the column of water to run out at every cut, and all the canal would be ſeen full below where it is opened. Theſe things would certainly, I ſay, be ſeen, if the experiment did no more than conſolidate the water naturally lodged in the œſophagus. But, after many repeated trials, I can declare, that none of theſe things do happen; and therefore it is more reaſonable to believe, that the icy column which Mr Heiſter ſaw in the œſophagus, was introduced there from the amnios or ſtomach by the immenſe expanding force of freezing liquors confined within the frozen rigid uterus and ſecundines, which every body knows is far ſuperior to any reſiſtance can be ſuppoſed here.

To make myſelf ſtill more certain about the nature of this experiment, I repeated the trial already mentioned, of pouring water into the mouth through a funnel; and, that it might not be thought to be hindered by the liquors already contained there, I emptied the ſtomach before I began to pour the water; but ſtill the ſame ſucceſs of nothing paſſing down attended it. To confirm all more, I puſhed a trocar into the amnios of ſeveral calves involved each in its uterus and ſecundines, and forcibly injected milk through the canula of the trocar; then I cauſed the uterus to be preſſed ſtrongly by ſeveral people, ſometimes equally, other whiles alternately: but though the milk was thus intimately blended with the *liquor amnii*, none of it would paſs into the ſtomach; which to me is a demonſtration, that Mr Heiſter's experiment ought not to be mentioned as a proof of what naturally happens to a fœtus, but only as a trial of the force of expanſion in freezing liquors.

It is hardly worth while to take notice of thoſe who ſay, that the preſ-

ſure which the *liquor amnii* ſuffers muſt make it go down through the open mouth into the vacuum formed in the ſtomach: For the mouths of fœtuſes are oftener found ſhut than open; there never can be a vacuum in the ſtomach; and the external preſſure muſt be equal on the ſtomach as on the mouth.

5. The only other ſuppoſition to be made of the fœtus taking the *liquor amnii* into its ſtomach, is, that it ſwallows down theſe waters, by performing the voluntary convulſive action of deglutition.

The gentlemen who aſſert that the fœtus does perform deglutition, ſay, that becauſe it has the organs of deglutition, and a capacity of exerciſing them, therefore it performs this action as well as it employs ſome other muſcles in its ſtirrings. But this way of reaſoning can never ſerve their purpoſe; becauſe there are many other actions which a fœtus has the organs and capacity to perform, and yet evidently does them not. They muſt therefore previouſly ſhew ſome neceſſity the fœtus is under to perform this particular action, or ſome manifeſt advantage it is to gain by it. There can be no ſuch neceſſity; and I hope it appears, by what was ſaid in the ſolution of the ſecond problem, and elſewhere in this paper, that the taking the *liquor amnii* as food, the only advantage to be imagined here, would be hurtful to them: And therefore, if the will did contribute to the actions of theſe organs of deglutition in a fœtus, it would be directed by inſtinct to keep the paſſage into the ſtomach cloſe ſhut, inſtead of forcing down the *liquor amnii* into it.

That ſometimes fœtuſes ſwallow the contents of the amnios, is evident, ſay ſome, from the *fæces alvinæ* having been ſeen both in the amnios and ſtomach of fœtuſes (*a*). And, add they, if a fœtus does ſometimes ſwallow, it probably does ſo always.——To which it may be anſwered, 1ſt, That in a few extraordinary caſes here referred to, it is not certain that the fæces were ſwallowed; for ſince genuine meconium is to be ſeen in the jejunum and ilium of fœtuſes (*b*), and new-born children have vomited meconium (*c*), why might not the fæces found in the amnios in the morbid examples cited have been brought up from the ſtomach? Needham, one of the authors quoted, gives a very reaſonable objection to the fæces

(*a*) Needham de Form. Fœt. cap. 5. Steno in act. Haſn. tom. ii. obſ. 89.

(*b*) Haller, not. f. in Boerhaave Inſtit. § 583. (*c*) Mauriceau, Obſ. 300.

fæces being ſwallowed, if even they were evacuated at the anus of a fœtus: For, ſays he, "The thickneſs or viſcidity of the *liquor amnii* is ſo "great, that it does not eaſily mix with them; neither can what is voided "by the anus be allowed to come to the mouth of the fœtus."——2dly, Though it were granted, that in the above caſes the fæces had been ſwallowed, the concluſion that the contents of the amnios are ordinarily ſwallowed, has been too haſtily made. They might as well infer from theſe caſes, that the *fæces alvinæ* are for ordinary to be found in the cavity of the amnios, which every body knows to be falſe. We may endeavour to account as well as we can for theſe morbid phænomena; but we muſt not draw ſuch haſty general concluſions from them.

Slade (*a*) obſerved, among the glutinous fæces contained in the rectum of a fœtus calf, hairs of the ſame colour with thoſe which covered the calf; from which it is inferred, that the calf muſt have ſwallowed theſe hairs.——Whoever makes this inference, muſt likewiſe ſay, that the calf had licked itſelf with its tongue a conſiderable time before, and with it brought off theſe hairs which were found in the rectum: for hairs do not fall off from fœtuſes for ordinary; and Slade takes no notice of hairs in the liquor of the amnios or the ſtomach, though he deſcribes both, and in ſuch a manner as to ſhow, that the calf did not ſwallow the liquor of the amnios, for that of the ſtomach was more viſcid and whiter-coloured than it. Why might not theſe hairs have been formed in the guts of this calf, as they are formed frequently in the omentum, urinary organs, heart, arteries, inteſtines, &c.?

6. Leſt the direct proof of the *liquor amnii* being preſſed or ſwallowed down ſhould fail, there are ſome other arguments advanced that are thought to imply a neceſſity of ſuch a liquor having been taken down: among the reſt, it is argued, That it is neceſſary to keep the chylopoietic organs of ſufficient dimenſions, for receiving the due ſupplies of food after birth.

If it had been conſidered how very languid and ſlow the motion of the contents of theſe organs muſt be in a fœtus, where the contractile tone of its own fibres is ſo very weak, and where there is no exterior alternate preſſure by reſpiration or any other power, it might have been thought,

(*a*) Apud. Blaſ. Anat. Animal. p. m. 122.

that the liquors ſupplied by the veſſels of theſe hollow viſcera would be ſufficient for this purpoſe, without the addition of any thing from without; and what we obſerve of the youngeſt fœtuſes we can diſſect, having their ſtomachs full (§ 30), ſeems plainly to point out the ſource of the liquors there to be no other than the bowel itſelf. It would appear to me, that the contrivance of puſhing the blood in the deſcending aorta, with the united force of both ventricles of the heart (§ 10.), is in part deſigned to promote a greater ſecretion in theſe hollow viſcera, where the reſiſtance to the effuſion of the liquors will be leſs than in ordinary glands.

7. The quantity of mucus in the ſtomach and ſmall guts, and of the meconium in the great guts (§ 30. 31.), is looked upon by ſeveral writers as a very convincing argument for the fœtus's feeding on the liquor of the amnios; and, as a proof *à poſteriori*, they mention De Graaf's (*a*) example of a whelp brought forth without a head, whoſe ſtomach was empty, and in whoſe inteſtines there was found but a ſmall (*modica*) quantity of excrements. It is alſo probable, that a circumſtance in the ſecond child which Mr Calder deſcribes (*b*) may be made uſe of here, viz. That having the paſſage from the ſtomach into its guts ſhut up, there was but a ſmall quantity of meconium in its great guts. For it may be ſaid, that De Graaf's whelp ſhews the ſtomach not to furniſh its own liquor, but to receive it from the mouth, and, as well as Mr Calder's child, had little meconium, becauſe the *liquor amnii* was not ſent down into the guts.

I am ſo far from thinking that the quantity of matter ordinarily contained in the ſtomach and guts of a fœtus, is any argument for food being furniſhed from the amnios, that, on the contrary, it appears to me very ſtrong againſt that opinion: for it is not to be imagined that the meconium ſhould be the recrement of any proportion worth notice of the food it had during the whole nine months of gravidation, ſeeing there is ſcarce more meconium than what an infant, when it is nouriſhed by the mouth after birth, paſſes of fæces in one day; and that the colour of the meconium evidently diſcovers the liquors ſecerned within the the fœtus's body to compoſe the greateſt ſhare of it.

If

(*a*) De Mulier. Organ. cap. 15. (*b*) Medical Eſſays, vol. i. art. 14.

If De Graaf's whelp is applied to the uſe I have made of it, namely, to prove the ſtomach incapable of furniſhing any liquor, becauſe this one was found empty, it will certainly be allowed by every one to prove too much; ſince none can, with any ſort of reaſon, ſay, that the ſtomach ſecerns no liquor. But leſt I ſhould be ſaid to extend this example deſignedly to too general a concluſion, in order to elude the natural conſequence, I ſhall give my opinion of the fact as it is related. It is this, That I would blame a faulty diſpoſition in the veſſels of that whelp's ſtomach for its emptineſs; becauſe I ſhall ſoon give poſitive proof of the ſtomach's being capable of furniſhing the quantity of liquor commonly found there in fœtuſes, without receiving any thing from the amnios.

It needs be no ſurpriſe that there were few excrements in Mr Calder's child, ſince the two great ſources of them were wholly or in part ſtopped. The ſtomach ſent nothing down; and the divided duodenum hindered the biliary and pancreatic liquors to paſs freely.

But, to overbalance theſe two examples, and indeed the general argument alſo, by poſitive proof of the ſtomach and guts being able to furniſh their contents, which muſt be of more weight than any negatives can, I ſhall likewiſe mention two hiſtories. The firſt is of the pig, which Dr Bellenger (*a*) deſcribes, brought forth with its mouth quite ſhut up, but having its ſtomach and guts full of the uſual contents. The other inſtance is rather ſtronger: for Mr Antoine (*b*) found a glairy yellow liquor, like to excrements, in the ſtomach and guts of a lamb, that had neither head, heart, lungs, liver, nor pancreas; which I hope will be convincing, that the meconium is no other than the groſſer parts of the liquor ſecreted in the alimentary tube, and of the bile and pancreatic juice.

Theſe are all the arguments of any weight that I know to be advanced for proving the paſſage of the *liquor amnii* into the ſtomach. In anſwer to which, I have offered reaſons, which ſeem to me to turn them all in favour of the ſide of the queſtion oppoſite to that for which they were advanced; and therefore I muſt conclude this third problem, by aſſerting, "That the *liquor amnii* does not paſs into the ſtomach of a fœtus."

THE

(*a*) De Fœt. Nutr. cap. 9. (*b*) Hiſt. de l'Acad. des Sciences, 1703.

The Conclusion.

Seeing, then, all the three problems are reſolved, with reſpect to viviparous animals, ſo as to favour the nutrition by the navel alone, allow me to ſum up all by a ſhort recapitulation of the arguments which I have inſiſted on at ſo much length.

The fœtus being capable of receiving its whole nouriſhment by the umbilical vein alone, whereas none can ſubſiſt without the umbilical veſſels.——The liquor of the amnios being ill calculated in its natural ſtate for the food of a fœtus; and becoming ſometimes altogether unfit food in morbid caſes without the fœtus being any way injured.——It being highly improbable that a creature ſhould furniſh its food out of its own body, which muſt be the caſe if the fœtus feeds on the *liquor amnii*.——Seeing it cannot be inferred from any reſemblance of the liquors of the ſtomach and amnios, nor from any other appearances, that that of the amnios ever is ſent down into the ſtomach.——Seeing no direct proof can be had of the *liquor amnii* being preſſed or ſwallowed down; but, on the contrary, all circumſtances make it probable that it does not go down.—And ſince all the phenomena of a fœtus can moſt reaſonably be accounted for, without ſuppoſing the liquor of the amnios to be any part of its food; is it not reaſonable, after all this, to exclude the mouth from the office of conveying the aliment of the fœtuſes of viviparous animals, and to believe that all their nouriſhment is conveyed by the umbilical veſſels?

SECTION II.

I come now to conſider, "How far the nutrition of the fœtuſes of oviparous animals, and of plants, ſerves to illuſtrate or confirm what has been argued for in the preceding ſection;" the plan of which I ſhall here follow: but beg to be excuſed, if, inſtead of mentioning only the facts immediately neceſſary, I take the liberty to give a ſhort hiſtory of an egg, and of the changes brought on it by incubation, with an abſtract of the formation and vegetation of the ſeeds of plants. My reaſons for taking in more facts than are juſt neceſſary, are, That ſeveral of theſe cannot be rightly

rightly underſtood, without a previous knowledge of others: and, in the next place, I have obſerved, that ſuch an hiſtory of eggs and plants as I propoſe to give here, is very little known, notwithſtanding accurate treatiſes have been wrote on theſe ſubjects; which I think may be attributed to their being treated of in a manner that requires more ſtudy than moſt people are willing to employ, in picking out, from among the numerous particular examples theſe authors deſcribe, the facts neceſſary for compoſing an ordinary general ſyſtem; which is what I aim at here.

Of the Nutrition of the Fœtuſes *of Oviparous Animals.*

To ſave the perpetual repetition of my being aſſured of the truth of each fact by repeated obſervations, I have to obſerve once for all, that unleſs where I expreſsly confeſs I had no opportunity, or neglected to examine them, I conſider myſelf obliged to give ocular demonſtration of what I aſſert.

1. The ſhell of an egg becomes more brittle by being expoſed to a dry heat.

2. The ſhell is lined every where with a very thin, but pretty tough membrane; which, dividing at or very near to the obtuſe end of the egg, forms a ſmall bag, where only air is contained.

3. In a new-laid egg, this folliculus appears very little, but becomes larger when the egg is kept.

4. The albumen, or white of an egg, is contained in concentrical membranes, but is not all of the ſame conſiſtence: for the exterior part of it is thin, and diffuſes itſelf almoſt like water when the membranes are broke; whereas its interior part is more viſcous.

5. The white of an egg can make its way through the ſhell, as appears from its waſting by keeping, eſpecially if it is expoſed to gentle heat.

6. The globular vitellus or yolk would ſeem to be no other than a liquor incloſed in a membrane; becauſe, whenever the membrane is broke, it runs all out; and it is ſpecifically heavier than the white.

7. The chalazæ are two white ſpongy bodies, riſing very ſmall from oppoſite ſides of the membrane of the yolk, but gradually become larger

as

as they are ſtretched out from it in an oblique direction with regard to the two ends of the egg.

8. If we compare the chalazæ to the extremities of an axis paſſing thr ugh the ſpherical vitellus, this ſphere will be compoſed of two unequal portions, its axis not paſſing through its centre; conſequently, ſince it is heavier than the white (§ 6.), its ſmaller portion muſt always be uppermoſt in all poſitions of the egg.

9. The yellowiſh-white round ſpot, called *cicatricula*, is placed on the middle of the ſmaller portion of the yolk; and therefore, by § 8. muſt always appear on the ſuperior part of the vitellus.

10. The cicatricula ſeems to be compoſed of ſeveral circles of different colours; and, in a fecundated egg, contains the embryo or chick. See Malpighi ( ).

11. Eggs, whoſe obtuſe ends are all rubbed over with lintſeed oil, or ſuch other ſubſtances as block up ſmall pores, are as fit for bringing forth chickens, when incubated by a hen, as other eggs are.

I did not make the experiment; but can give a voucher, whoſe ſcrupulous candor, with ſincere good wiſhes and endeavours for the improvement of phyſic in this place numbers muſt be acquainted with: I mean my father; who beſmeared eighteen eggs in the manner mentioned; then having put a mark on them, he ſet them, with the like number of other eggs, under three hens, who brought out thirty-ſix chickens, not one egg of the whole number failing.

12. After INCUBATION, the *folliculus aëris* is gradually extended; till, near the time of the excluſion of the chick, it occupies, as near as I could judge, ſome more than a third of the cavity of the ſhell.

13. The extended folliculus does not collapſe, upon being expoſed to the preſſure of the atmoſphere, after incubated eggs are opened (*b*).

By

(*a*) De Ovo Incubat.

(*b*) It is ſomewhat out of my ſphere to inquire how this additional air gets into the folliculus: but if any are curious enough to make this inquiry, I would recommend to them to obſerve how this folliculus diſtends and keeps ſtretched in an exhauſted receiver of an air-pump; to exhauſt the air gradually out of the ſhell, while it ſtands expoſed to the atmoſphere, both while the folliculus is entire, and after it is broke, obſerving always the riſing or falling of the mercurial gage; to conſider § 11. and 13.; and to conſult Bellini *de mot. cord.* prop. ix. and Hale's Staticks.

14. By incubation, the albumen becomes thinner and more turbid, eſpecially on its upper part near to the air-bag, where it is alſo firſt conſumed: and it is afterwards diminiſhed towards the ſharp end of the egg, till at laſt nothing of it is left except a white cretaceous ſubſtance at the lower part of the ſhell.

15. As the part of the white neareſt to the cicatricula is waſted, its membrane and the cicatricula ſtill approach nearer till they become contiguous. This membrane of the albumen is what is commonly called the *chorion*.

16. Some time before the albumen is quite conſumed, what remains of it is placed at the lower part of the egg; and therefore the yolk is interpoſed betwixt it and the membrane which immediately contains the fœtus. See § 9. and 10.

17. The white of a fecundated egg is as ſweet and free from corruption, during all the time of incubation, as it is in a new-laid egg.

I taſted, ſmelled, and ſwallowed the whites of eggs during all the ſtates of incubation, both when they were raw and boiled, and conſtantly found it as juſt now deſcribed; and therefore cannot imagine how Bellini (*a*) could affirm it to have a heavy, abominably-ungrateful taſte, a ſtinking ſmell, and not only to occaſion, when ſwallowed, a troubleſome ſenſation in the ſtomach and guts, but to prove purgative. He muſt unluckily have examined none but ſubventaneous eggs: which is further confirmed by his deſcription of the ſmall particles in the colliquated albumen, that reflect light ſo ſtrongly as the eye cannot bear it; which I ſaw in ſome ſubventaneous eggs, but could not obſerve in any that were impregnated.

18. According to Bellini (*b*), the colliquated white always becomes incapable of coagulation by heat; but in the trials I made, it frequently did coagulate, though I found the ſucceſs of this experiment very uncertain: the only general rule I could fix was, that, before the 9th or 10th day of incubation, the thinner white did not generally coagulate; but after that it frequently did.

13. Very ſoon after incubation, the volume of the yolk appears increaſed;

(*a*) De Motu Cord. prop. vi. (*b*) Ibid.

ſed; and, by its riſing then nearer to the upper part of the egg, one may conclude, that its ſpecific weight decreaſes.

20. The yolk becomes pale and more fluid for ſome time, eſpecially on the ſide next to the chick, where its bulk alſo ſooneſt increaſes; but afterwards the membranes of the yolk turn firmer and ſtronger, and the liquor in them is leſs in quantity, and becomes more viſcous.

21. As the chick increaſes, the yolk is depreſſed in the middle; and is ſoon brought into a form ſomething like to a horſe-ſhoe, in the middle of which the chick is lodged.

22. The yolk remains freſh and uncorrupted all the time of incubation, and is always coagulable.

23. Not long before the excluſion of the chick, the whole yolk is taken into its abdomen.

24. The whole albumen and vitellus are not conſumed by the chick: for ſome part of the humours of the egg eſcapes through the ſhell, and is not ſupplied by any thing from without; as evidently appears by an egg's becoming ſo much ſpecifically lighter, as to ſwim in water after incubation, though it ſunk in it when recent.

25. The chalazæ remain long without being conſiderably changed, unleſs that they are brought nearer to each other by the creſcent form of the yolk; at laſt they degenerate into a dry chalky ſubſtance.

26. The cicatricula very ſoon is enlarged by incubation; and, being buoyed up on the top of the yolk to the ſuperior part of the egg, it is placed very near to the air-bag; and when both increaſe, they become contiguous.

27. The cicatricula is called *amnios*, when it becomes large, and contains the colliquamentum or liquor in which the chick is immerſed.

28. The quantity of the colliquamentum gradually increaſes till the 15th or 16th day of incubation; on the 18th, it is all conſumed; and, in the three following days, ſcarce any moiſture can be obſerved on the internal ſurface of the amnios.

29. The liquor of the amnios is more clear and tranſparent than the colliquated white; its taſte is more ſalt, and it has no obſervable ſmell. Its conſiſtence is at firſt a little viſcous, then it becomes more fluid, and afterwards turns a little ropy again.

N. I can ſay nothing of the particular times when it does or does not coagulate by heat: for it is in ſo ſmall quantity, during the greater part of the time of incubation, that one can ſcarce gather as much in a ſpoon as is fit to make any experiment with; and when all the egg is boiled hard, it adheres ſo cloſely to the white, that it is ſcarce poſſible to diſtinguiſh one from the other. Malpighius (*a*), ſpeaking of the egg between the 14th and 19th day, ſays, "That this thin diaphanous liquor of the "amnios was ſometimes forced by boiling into a white taſty ſubſtance;" which my trials alſo confirmed.

30. The allantois and its contained urine are to be ſeen in an egg, as well as in the ſecundines of viviparous animals (*b*).

31. Though the heart is among the firſt parts of the chick that can be diſtinguiſhed, yet the umbilical veſſels are ſeen much about the ſame time that the heart is obſerved.

I did not inquire into this fact; but have two very good vouchers for its truth, Harvey (*c*) and Malpighius (*d*).

32. The umbilical veſſels gradually diſperſe their branches upon the amnios, upon the vitellus, and upon the membranes of the albumen: The extremities of their much greater number, being immerſed into the white, are extended proportionally as it is colliquated.

33. Near to the end of incubation, the umbilical veſſels begin to ſhrivel and decreaſe, till at the excluſion they are very ſmall.

34. The embryo is ſeen in an egg at firſt in form of a ſmall worm: then its carina or ſpine, with the large prominencies that afterwards ſhew themſelves to be the brains and eyes, appear; the other bowels ſeem hanging from the ſpine; the chaſm of the mouth diſcovers itſelf; the extremities ſprout out; the viſcera are gradually covered with the teguments; and at leaſt the beak, nails, and feathers are ſeen: after which, all the parts become ſtronger and firmer, the proportional bulk of the head decreaſing.

For the particular times when all theſe changes are thus orderly brought about, conſult Fabric. ad Aquapendente, Harvey, and Malpighius.

35. After all the parts of the chick are formed, it is always found lying

(*a*) De Ovo Incubato. (*b*) Malpig. Append. de Ovo Incub. tab. vii.
(*c*) De Generat. Animal. exercit. 16. & 17. (*d*) De Ovo Incubato.

on its ſide, with its neck greatly bended forward, the head being covered with the upper wing, and the beak placed between the thighs.

36. When the ſhell is opened after the chick is large and ſtrong, it may be ſeen to bounce and ſpurn, ſometimes opening its mouth wide, eſpecially if it is ſtirred or pricked.

37. The mouth, œſophagus, and ingluvies, are always found moiſt; but never contain any quantity of liquor that can be collected or will run out in drops.

38. The bulbous glandular part of the œſophagus immediately above the ſtomach, or what Peyer (*a*) calls the *infundibulum*, and the ſtomach, are full of a liquor, in the youngeſt chick we can diſſect, and continue full the whole time of incubation; neither infundibulum nor ſtomach having yet got the tendinous firmneſs they have in adults; nor can we obſerve the dry pellicle which is ſo eaſily ſeparated from theſe parts in hens.

39. This liquor of the ſtomach is at firſt thin and more watery; afterwards it becomes curdy; and at laſt is all in form of a greyiſh white mucus, unleſs that ſome part of it frequently is coloured yellow or green by a mixture of bile. It always coagulates, by boiling, into a firm yellowiſh white ſubſtance.

40. The quantity of fæces was not large in the great guts, of any chickens I opened before excluſion.

41. A little time before the excluſion, the chick may frequently be heard making the ſame pieping ſound that hatched chickens make. In three eggs, which were all I opened in this ſtate, the beak of the chick had perforated the membrane of the *folliculis aëris*.

42. The ſhell at the obtuſe end of the egg frequently appears cracked ſome time before the excluſion of the chick.

43. The chick is ſometimes obſerved to perforate the ſhell with its beak; but, in thoſe I ſaw tumbling out of the ſhell, it was broke off irregularly, at the place where the membrane of the *folliculis aëris* was joined to it.

44. After the excluſion of the yolk is gradually waſted, being conveyed into the ſmall guts by a ſmall duct, its membranes gradually contract them-

(*a*) Comment. in Anat. Ventricul. Gallin.

themſelves, and the duct becomes ſhorter. On the tenth day after excluſion, the vitellus was no larger than a ſmall pin-head, and the duct was ſcarce one twentieth part of an inch long.

From this hiſtory of the egg and of incubation, I ſhall endeavour to deduce the manner in which the colliquated white is taken in by the chick.

Authors generally ſeem to agree, that the oviparous fœtus, while very young, receives its nouriſhment by the navel; but ſeveral of the beſt reputation have been of opinion, that afterwards it is conveyed by the mouth. I ſhall examine the arguments they uſed in proof of this, and then ſhall ſubjoin ſome negative reaſons which they have not taken notice of.

Bellini (*a*) has deſcribed the cicatricula, or *facculus amnii*, with the chalazæ firſt formed in the back of the hen; to which, according to him, the vitellus is afterwards joined, and the white is acquired as they tumble down the oviduct. He ſays the chalazæ are compoſed of numerous canals, which open into the amnios, and ſend out their roots into the cavity of the yolk, and into the white. It is eaſy to conceive what conſequences may be drawn from this deſcription, by thoſe who aſſert the nouriſhment to be carried by the mouth, viz. That here are direct paſſages into the cavity where the chick is, which can take up the liquors no other way than by the mouth.

The anſwer to this obſervation is the ſame as has been made to the other facts already quoted from this author. I deny that the *facculus amnii* is formed before the vitellus; on the contrary, the vitellus is evidently to be ſeen before the cicatricula or chalazæ can be diſcerned. Next, I deny the chalazæ (if they are canals) to have the leaſt communication with the amnios, at any time, or in any ſtate of the egg, otherwiſe than as they are both adhering to the membrane of the vitellus, upon which, or within which, no particular fibres, no canals, are ſtretched to the cicatricula. Every one has it in his power to examine theſe facts. If then the facts are denied, the conſequences cannot be admitted.

Since there are no canals paſſing through the yolk, that open into the *ſaccus colliquamenti*, and the cicatricula comes to be placed on the upper part

(*a*) De Mot. Cord. Prop. ix.

part of the yolk, and contiguous to the air-bag (§ 26.), it is evident, that the *liquor amnii* muſt be furniſhed by the chicken, which being covered with feathers, having no mammæ, bladder of urine, or large ſalivary glands, can only ſupply it by the branches of the umbilical veſſels ſpread on the amnios.

Harvey (*a*) affirms, that a liquor is found in the mouth and ingluvies of the chick, which he concludes to be the colliquamentum or *liquor amnii*, from their reſemblance; from the quantity of the contents of the ſtomach; from the chick's being ſeen to open its mouth; and from the neceſſity creatures are in of ſwallowing, or of forcing back by vomiting, whatever is introduced to the root of their tongue.

As to the reſemblance, I do not ſee how the compariſon can be made, ſeeing the liquor in the mouth and crop is in ſuch ſmall quantity, (§ 37.) But ſuppoſe that a ſufficient quantity was collected, the two liquors agreeing in ſeveral properties would not of itſelf be a ſufficient proof of their being the ſame; and if, for argument's ſake, the liquor in the crop was granted to be in very large quantity, and to agree in every property with that in the amnios, it would certainly appear in the ſame form for ſome time in the ſtomach, whereas it is always found very different there in the larger fœtus (§ 39.), and Harvey confeſſes as much in this place: therefore it may be concluded, that it does not go down into the ſtomach.

If ever any thing like fæces has been ſeen in the crop of chickens, as has been alleged by ſome, it might be no more than the yellow or green-coloured ſubſtance brought up from the ſtomach, (§ 39.)

The quantity of the contents of the ſtomach and inteſtines may be accounted for from § 38. applied to what was ſaid on viviparous animals.

Though creatures that reſpire are under a neceſſity of either ſwallowing, or forcing back by vomiting, whatever is introduced beyond their fauces, I cannot think it ſhould be thence concluded, that a fœtus is under the ſame neceſſity; for, as it does not exerciſe reſpiration, it will ſuffer no inconvenience by a liquor lodging near to the glottis: whereas creatures that breathe cannot allow any ſubſtance to remain there without danger of the glottis being ſtopped, or of ſuch ſubſtances falling down the trachæa, either of which would be of bad conſequence; which the creature

(*a*) De Generat. Animal. exercit. 58.

creature prevents, by forcing ſuch ſubſtances out of ſuch a dangerous ſituation.

But, to enforce the negative of the colliquamentum paſſing by the mouth, obſerve, that there are only three days in which this paſſage can moſt probably be ſuppoſed to happen, which are from the 15th to the 18th day of incubation: for before the 15th, the quantity of the *liquor amnii* is increaſing, which is no great ſign of its being ſwallowed; and after the 18th this liquor is not to be ſeen, *vid.* § 28. If, then, the *liquor amnii* were all ſwallowed between the 15th and 18th days, the ſtomach ought to be fuller at this time, and its contents ſhould be thinner, more pellucid, &c. like to the colliquamentum; which I am certain does not happen. Beſides, if we ſuppoſe the power of digeſtion ſo ſtrong as to expel this liquor as faſt as it is taken down in theſe three days, it would certainly follow, that this powerful digeſtion, continuing in the three ſucceeding days, while there is no liquor to be ſwallowed, the ſtomach ought to be quite emptied; which every one who opens the ſtomachs of chickens at this time will ſee it is not. And, laſtly, as a more direct proof ſtill againſt Harvey, I broke the ſhells of ſeveral incubated eggs, while the colliquamentum was in large quantity; and before the amnios was opened, I ſaw the chickens open their mouths very wide ſeveral times, but could not obſerve the quantity of the liquor in which they lay any way leſſened. I afterwards carefully diſſected the chickens, and found no other than the common ſmall quantity in the crops, and the ordinary curdy mucus in the ſtomach; which ſeems to me a demonſtration that they do not ſwallow.

After ſuch convincing profs, it will be needleſs to make any application of the arguments in the former part of this eſſay to this ſubject; and therefore I ſhall only deſire the reader to compare the poſture of a chick, and of a hen while ſhe ſwallows liquors, that they may ſee the poſture of the chick's neck to be moſt unfavourable to the ſuppoſition of deglutition being performed; and then ſhall conclude with a very ſhort hiſtory of incubation, aſſigning what I imagine to be the moſt probable reaſons of the ſeveral appearances.

By the heat of the hen, or of ſtoves equal to it, aſſiſted poſſibly by the action of the air contained in the *folliculus aëris* (§ 2. 3. 12.), the albumen becomes

becomes thinner, eſpecially where it is moſt expoſed to theſe forces (§ 14.); and the vitellus in the ſame manner becomes eſpecifically lighter (§ 19.), and therefore readily riſes in the white. And as, by being divided into two unequal portions by its axis the chalazæ, it preſents the ſmaller portion to the incubating heat at firſt, (§ 8. 9.); ſo the change in conſequence of incubation being ſooneſt and moſt produced here (§ 20.), and the cicatricula being enlarged at the ſame time, the ſmaller portion of the yolk becomes of the leaſt ſpecifical weight; and therefore is buoyed up to the ſuperior part of the egg, whereby the *folliculus aëris* and membranes of the cicatricula become contiguous when they enlarge (§ 26.), and the vitellus can never be in hazard of compreſſing the tender embryo; and the umbilical veſſels are ſituated ſo as to have their extremities immerſed in the liquors, that firſt undergo the proper change, for being imbibed by their orifices, (§ 32.)—The incubation continuing, the white is ſtill more and more colliquated, and the umbilical veſſels are proportionally extended, the veins to abſorb it, and the arteries to throw out any particles that are unfit for the chick till they are farther prepared, but eſpecially to drive forward the liquors in the veins, as was explained in the account of the viviparous animals, (§ 20.)—When the white in the upper part of the egg is exhauſted, its membranes become contiguous to the amnios, (§ 15.); and thereby the membranes involving the fœtus become ſufficiently ſtrong to reſiſt the motions of the chick, when its eaſe or ſafety prompt it at any time to ſpurn.—The powers of incubation above-mentioned, aſſiſted by the pulſation and conquaſſatory motions of the numerous umbilical veſſels ſpread on the yolk (§ 32.), diſſolve that humour more, and render ſome part of it fine enough to be taken up by the ſmall extremities of the umbilical vein, ſome of which penetrate its membrane: By which the liquor at laſt becomes thicker (§ 20.); and the membrane, being in part emptied, will more eaſily yield to the weight of the chick; and is preſſed into the form of a horſe-ſhoe (§ 21.), while the net-work of veſſels extended on this membrane render it ſtronger and firmer.—The *folliculus aëris* not only aſſiſts in colliquating the albumen; but, when the humours of the egg come to occupy a leſs ſpace, by eſcaping through the ſhell (§ 24.) and by being changed into the ſolid ſubſtance of the chick, the folliculus enlarging (§ 12.) keeps the chick and humours ſteady, without

without danger of being diſordered and broke by the motions of the egg. ——Branches of the umbilical veſſels being diſtributed to the amnios, (§ 32.), the arteries will pour out their liquors into its cavity in greater quantity than the veins can take them up, as long as the fœtus is weak; but, whenever the fœtus becomes ſtronger, and conſequently the abſorbent power of the veins increaſes, (vid. § 15. of Sect. I.), they will take up the fluid of the amnios faſter than the arteries pour it in, and its quantity will be diminiſhed till it is quite exhauſted (§ 28. and 29.) —This abſorption will go on more ſpeedily in proportion alſo to the umbilical veſſels being leſs diſtended with albumen, whereby there is leſs reſiſtance to the progreſſive motion of the abſorbed liquors; which probably is the reaſon of the colliquamentum being all taken up between the fifteenth and eighteenth days.—By the conſtant circulation and renewal of all theſe humours of the egg, they keep freſh and uncorrupted in a fecundated egg, (§ 17. and 22.); but corrupt ſoon in a ſubventaneous one, or in ſuch whoſe fœtus dies in the time of incubation.—Wherever veſſels are not ſufficiently filled, they contract themſelves; and therefore, the albumen being exhauſted in the laſt days of incubation, the umbilical veſſels gradually ſhrivel (§ 33.), which prevents the danger of an hæmorrhage when the chick is ſeparated from its membranes. But, as the white is not ſufficient at this time fully to ſupply the chick, the yolk is taken into its body (§ 23.); and being there preſſed, it is thrown gradually by the proper duct (§ 23. and 44.) into the guts, to ſupply that defect.——The veſſels and glands which open into the alimentary tube ſeparate at leaſt as much liquor as will moiſten it; and, the ſtomach having no callous ſtrong cruſt on its internal ſurface, (§ 38.), will ſeparate more than it can do in the adult; and in the mean time the glands of the infundibulum pour out a liquor that is always thicker as the chick increaſes, till it becomes a very thick white mucus: And therefore the contents of the ſtomach of the fœtus in the egg muſt have the appearance deſcribed (§ 39.), and will be ſlowly paſſing off into the inteſtines.——The ſhell at the obtuſe end of the egg becoming more brittle, by being ſo long expoſed to a dry heat (§ 1.), and the membranes loſing their toughneſs when their moiſture is exhauſted, the chick very eaſily tears them, and breaks off that end of the ſhell, to make its way into the common atmoſphere.——The mother

having no juices prepared within her body to give to the chick for food after it is hatched, and its organs for taking in and digeſting aliment being for ſome time too weak to ſupply it ſufficiently with nouriſhment, the vitellus is made to ſupply theſe deficiencies, till the chick is ſufficiently confirmed and ſtrong (§ 44.); after which, it is no longer the ſubject of my preſent inquiry.

Of the Nouriſhment of Plants while in a Fœtus State.

THE firſt eight numbers of the following facts are taken from Mr Geoffroy (*a*); and all the others, except one or two obſervations of my own, are collected from Malpighius (*b*).

1. Flowers contain the male and female organs of generation of plants.

2. The male organs are ſmall bladders (the apices), full of a very fine duſt; each particle of which is of a particular diſtinguiſhed form in each ſpecies of plants.

3. When this duſt or farina is ſufficiently ripe, the bladders break with an elaſtic force, and throw the duſt from them.

4. The female organ is the ſtylus, piſtillum, or tuba, conſiſting of ſeveral canals, which are open and wide at one extremity; but in the other, neareſt to the ſtalk of the plant, terminate in one or more cavities, where ſmall roundiſh ovula are contained.

5. Both organs of generation are contained within, and protected by, leaves of different make and colour in different plants; which leaves are generally called the *petala* of flowers.

6. Some flowers contain both the male and female organs, and therefore are called hermaphrodites; others only contain one or the other kind, and thence are named male or female.

7. Thoſe flowers which are only male or only female, either grow both from the ſame root, or the male only grow on one plant and the female upon another of the ſame ſpecies; from which ſuch plants are ſaid to be male or female.

8. When the male farina, or duſt, is prevented from having acceſs to the

(*a*) Mem. de l'Acad. des Sciences, 1711.

(*b*) Anat. Plant. cap. *de ſeminum generat.* et in tractat. *de ſem. veget.*

the female organs, either the ovula do not increaſe into ſeeds, or, if they do grow, they are deformed, do not contain any germ or rudiment of the young plant, and are not prolific.

9. When the fecundated ovula increaſe, the germ or young plant of each is ſeen lodged in a pulpy ſubſtance named the *ſeminal leaves*; which again adhere to, and frequently are ſunk ſome way into a depreſſion of a membrane, which forms a little bag for containing a liquor; and therefore this bag is called the *amnios*.

10. From this ſide of the amnios, oppoſite to that where the germ, with its *ſeminal leaves*, is fixed, a tube (the *umbilicus*) goes out to be continued to the uterus.

11. Before the umbilicus reaches the uterus, it paſſes through a cavity formed by another membrane that is full of liquor, or contains a great number of ſmall veſicles diſtended with liquor; and therefore is compared to the chorion.

12. The chorion and amnios become more and more turgid with liquors for ſome time; but then the liquors begin to diminiſh, the chorion being ſooneſt emptied, and the navel-ſtring ſhrivels away till it can no longer be obſerved.

13. In the mean time the germ and ſeminal leaves increaſe apace.

14. At laſt all the liquors in the chorion and amnios are conſumed; their membranes contract and ſhrivel; the ſeed is ſufficiently large and confirmed; the ſmall peduncle, by which it adheres to the uterus, ſhrivels, turns hard and brittle, and the ſeed falls off with the leaſt force.

15. The ſeed is compoſed of its membranes or teguments, of a large farinaceous part, and of the ſmall germ joined to the farinaceous ſubſtance by a ſmall peduncle, which is inſerted into the germ between the caulis, ſtalk, or plume, and the radicle or ſmall root, of this young plant.

16. The germ is evidently the young plant, where the plume and root may plainly be ſeen.

17. When the fecundated ſeed is ſowed at the proper ſeaſon, the farinaceous ſubſtance ſoon becomes ſofter, and the germ ſtretches its ſtalk upwards and its root downwards.

18. The farinaceous ſubſtance either remains under ground, turning larger for ſome time, but having its ſubſtance changed more and more

into a milky liquor, or it is extended upwards in form of one or two pulpy juicy leaves: From theſe different forms which this farinaceous ſubſtance takes, it is called the *cotyledons*, *ſeminal leaves*, or *lobes*.

19. After ſome time the lobes begin to ſhrivel, and to have their liquors conſumed; and at laſt, when their juices are all waſted, they fade away and fall off.

20. The plant grows very faſt all this time.

21. When the cotyledons are taken off before the plants are put into the earth, ſcarce any of them will vegetate, and all periſh very ſoon.

22. Thoſe that advance any, after being thus deprived of their cotyledons, increaſe rather in their plume than root.

23. When the ſeminal leaves are taken away, after allowing the plant to vegetate ſo far as to come above ground, it periſhes in a little time, the roots generally fading firſt.

24. If the cotyledons are taken away later, moſt of the plants die, and thoſe that continue to grow are always very ſmall.

25. When only one cotyledon is taken away, the plants do grow, but are not near ſo large or ſtrong as the others that are left entire.

26. By taking away the plume, when it firſt ſprouts above ground, the roots grow very large and quickly.

To fix an analogy here between animals and plants, it will be neceſſary to determine how long either of them ſhould be ſaid to remain in the ſtate of a fœtus: which, in my opinion, ought to be underſtood ſo long as the young creature is nouriſhed ſolely by liquors furniſhed by the uterus of the parent; but as ſoon as it is ſupplied any other way with all or any part of its nouriſhment, it can no longer be looked on as a fœtus.

If this is agreed on to be the diſtinguiſhing character of a fœtus, it will be evident, that we are only to regard plants as fœtuſes while the ſeed is ripening, and before the earth, water, moiſture of the air, &c. have communicated immediately any matter for its increaſe: and in this caſe it will appear moſt probable, that the umbilicus pours in liquors from the uterus and chorion into the amnios, from which it is taken up by the veſſels of the ſeminal leaves, to be conveyed partly into the fœtus, and partly into the leaves themſelves; by which the plant is increaſed, and

its

its parts are explicated, and a ſubſtance is provided for nouriſhing it afterwards, when its tender roots either can receive from the earth very little, or any thing leſs than is neceſſary for the ſufficient growth of the plant.

In running this analogy between animals and plants, you will obſerve a mixture of the mechaniſm of the viviparous and oviparous animals in the nouriſhment of the fœtuſes of plants. For the little plant having, as in the viviparous animals, a communication with the uterus of the parent till it is fully formed, the whole quantity of the liquor it is to be nouriſhed with is not at firſt to be ſeen, as the albumen is in the egg; but the uterus furniſhes the liquor to be gradually abſorbed by the cotyledons or placenta: And then, on the other hand, plants reſemble the oviparous animals, in ſo far as the parent being uncapable of ſupplying any juices prepared in its own body, after the fœtus is ſeparated from the womb, for the nouriſhment of the plant; and the young plant not being in condition, for ſome time, to ſubſiſt entirely on the new nouriſhment it muſt receive; the farinaceous cotyledons, or pulpy ſeminal leaves, do the ſame good office to the plant as the vitellus does to the chick after it is hatched.

Since the reſemblance is ſo great between animals and plants, it would be ſuperfluous, after what has been ſaid of the former, to enter into a particular detail of the reaſons of the foregoing phænomena of plants; and it is almoſt needleſs to ſay, that I would conclude both the oviparous animals and plants to favour my opinion, of the whole nouriſhment of all fœtuſes being conveyed by particular abſorbent veſſels, and not by the ordinary canals through which the aliment muſt paſs after the creature is out of its fœtus ſtate; for theſe are obvious to any who reads theſe eſſays with the leaſt attention.

N° 12.

Practical COROLLARIES from the preceding Eſſay.

BEING conſcious to what length the eſſay on viviparous animals had run out, I did not intermix any account of morbid phænomena with the deſcription of the parts, or with the arguments concerning the nouriſhment of the fœtus, which alſo would have had the bad effect of diverting the reader's attention from the principal deſign: but conſidering how much ſuch phænomena may ſerve to explain, and poſſibly confirm, ſome part at leaſt of my reaſoning, and knowing how ill any thing that is not practical goes down with ſome people, I beg to be ſtill further indulged, while I bring a few examples to ſhow, that the knowledge of the ſtructure of the parts is abſolutely neceſſary for underſtanding the nature of diſeaſes; and that all theory is not mere idle ſpeculation, but that reaſon and experience united lay the ſureſt foundation of the practice of phyſic.

I. Seeing the veſſels of the womb and of the placenta do not anaſtomoſe (§ 16.), and women have an erect poſture, and are ſubjected to periodical evacuations from their uterus, which has larger canals opening into it than are to be obſerved in other animals (§ 2. 3. 4. 5.), we may underſtand how much more liable women are to ſuffer abortions, than the females of other creatures are. For, the contents of the impregnated human uterus preſs more on the orifice of the womb to force it open; the ſuperfluous quantity evacuated periodically at other times, is apt to thruſt off the placenta; and, being poured into the cavity of the womb, either corrupts there, or forces open the *os uteri*; both which will probably occaſion the loſs of the fœtus: whence women much more ſeldom conceive immediately before the menſes are to flow, than ſoon after that evacuation is paſt. Thence alſo we underſtand why looſening, as the women call an appearance of blood from the uterus, is a ſymptom that diſcovers great hazard of abortion.

II. Nature

II. Nature endeavours to provide againſt the inconveniencies mentioned in the preceding paragraph, by making the placenta adhere ſooner to the human womb than is ordinary in other creatures; and by furniſhing the human fœtus with a larger proportional placenta, whereby the adheſion is ſtronger, and on both accounts the evacuation is prevented.

III. When there is the largeſt quantity of the ſuperfluous liquors collected, the ſtrongeſt puſh muſt be given to ſeparate the placenta from the womb; but the menſes are generally ſtopped after pregnancy, and the child is too ſmall for ſome months to conſume them; wherefore women are moſt expoſed to abortions in the third or fourth month of their going with child.

IV. We ſee what diſorders are brought frequently on women at each period when their menſes are about to flow, and what miſchiefs almoſt conſtantly attend their obſtructions; and therefore need not be ſurpriſed at the fainting, nauſea, reachings to vomit, &c. that ſo often attack women in their firſt months of pregnancy: ſome of which help to remove and prevent other diſorders; for by the vomiting, for example, not only an evacuation is made, but leſs chyle muſt be ſent into the blood-veſſels, which therefore will have leſs of the ſuperfluous liquors. This again teaches us to remove or mitigate ſuch ſymptoms, when they become very violent and dangerous, by proper evacuations.

V. Since the ſeparation of the placenta from the womb muſt ſo evidently produce abortion, we may ſee that this may be occaſioned by very different cauſes, operating in various manners, and requiring very different treatment in preventing the loſs of the fœtus, when our advice is aſked timely.

1. Whatever occaſions too great a quantity of blood to be ſent to the uterus, or aſſiſts or increaſes its momentum to thruſt off the placenta, ſuch as plentiful living, compreſſion of other large veſſels, frights, violent exerciſe, ſhocks of the body, fevers, &c. will bring a woman into danger of abortion. The cure, however, is plainly pointed out; to wit, blood-letting, mild food in ſmall quantities, and reſt.

2. When the adheſion of the placenta to the womb is too weak, and the *os uteri* does not make a ſufficient reſiſtance to its own dilatation, whether theſe depend on the ordinary general conſtitution of the body, or on a particular

particular diſpoſition of the womb, or on a ſudden relaxation, as in fainting, the ſame bad effect, abortion, may ſtill follow; but the cure muſt be very different from what is to be uſed in Numb. 1. For here we muſt rely on corroborants; and though much exerciſe is at firſt to be ſhunned, yet if the patient can by degrees be brought to bear moderate exerciſe, it will aſſiſt the other medicines conſiderably.

3. If the ſinuſes of the womb are allowed ſuddenly to collapſe, by the want of a large enough quantity of liquors to diſtend them, as by the neceſſary ſupplies to the blood being with-held, or by violent evacuations, eſpecially loſs of blood, not only the weakneſs mentioned in Numb. 2. may follow; but the veſſels of the placenta, which have not been proportionally emptied, will be diſengaged from the excretories of the ſinuſes, by their being deprived of ſufficient ſpace to lodge in, and there is great danger of abortion. In ſuch a caſe we are to be on our guard not to apply ſmart ſtimulants to rouſe the languid mother too haſtily; for ſuch medicines increaſe the contraction of the veſſels of the uterus, and will drive off the placenta ſoon: but we ought to repair the quantity of her blood by mild balmy food, with a mixture ſometimes of the leaſt irritating cordials.

4. All cauſes that can produce a ſtrong contraction of the fibres of the uterus, or of the parts that can preſs upon it, as, for inſtance, of the diaphragm and abdominal muſcles, will be in danger of forcing away the placenta, and of opening the *os uteri*, whereby abortion is occaſioned. Therefore ſharp pains in any part of the body, and eſpecially in or near to the uterus, rough emetics, ſharp acrid purges, teneſmus, ſtrangury, piles, or ſuch like, are every day bringing on abortion. The radical cure is certainly to remove the cauſe of the pain or irritation, which muſt be done by medicines adapted to its particular nature and ſeat, which are too numerous to be mentioned here. If this cannot be executed ſo ſoon as we would deſire, we are to leſſen its bad conſequences as much as poſſible, by blunting its violence, and counteracting its effects. The firſt of theſe indications will principally and moſt ſpeedily be purſued in moſt caſes, (except perhaps in the inflammatory ones), by giving opiates. The ſecond intention is anſwered by diminiſhing the momentum of the blood, which venæſection effectually does, and is always uſeful in the inflamma-

tory

tory caſes; but is not ſo proper in ſome other circumſtances, where however the opiates generally anſwer our intentions.

VI. The liquors ſent into the fœtus by the umbilical vein not having their propelling force communicated from the mother (§ 16.) the ſtate of the mother's pulſe cannot affect the child otherwiſe than by the occaſioning abortion, or vitiating the fluids that are to be abſorbed; and therefore we may be convinced, how vain it is to pretend to account, in a phyſical way, for the impreſſions ſaid to be made on children by the imaginations of the mothers. We may hence alſo ſee, that children may be infected with the diſeaſed juices of the mother; but that it is poſſible for them to eſcape catching the diſeaſes of their mothers, if either they are only topical, without affecting the whole maſs of fluids; or, even when the mother's blood is ſpoiled, the child may be free of her diſeaſe, if the morbid particles are ſuch as the placentary veſſels cannot abſorb. This you ſee is in ſome ſenſe giving the veſſels a power of chooſing good or bad.

VII. The placenta is largeſt proportionally in the youngeſt fœtuſes (§ 18.), by its being leſs capable of yielding to the ſtretching power of the contents of the uterus, than the membranous parts of the ſecundines are; and thereby it is better calculated for the greater proportional growth of the fœtus when young.

VIII. Though the ſurface of the placenta is not extended proportionally to the increaſe of the fœtus, yet the orifices of the ſinuſes ſeem to keep up to that proportion (§ 5.): therefore the ſurface of contact between the uterus and placenta rather decreaſes than turns greater; and a greater quantity of fluids is applied to that ſurface. Which may be one reaſon why the after-burdens of ripe children are brought away more eaſily than thoſe of abortions.

IX. By being acquainted with the muſcular ſtructure of the uterus (§ 6.), we come to know how the placenta ſeparates more eaſily after the child is born, than while it is yet contained in the uterus. For, as long as the child remains there, the womb is hindered from contracting, upon which, and the want of a muſcular contraction in the placenta, the ſeparation of the after-burden depends. And ſince the degree of contraction of the uterus will be proportional to the diſtraction of its muſcular fibres, as

happens in all muſcles, we may ſee another reaſon why the after-burdens of abortions are more difficultly brought away than thoſe of ripe children; and we may obſerve, how reaſonable the uſe of *pulv. ad partum*, or other cordial ſtimulating medicines, is, in ſuch caſes, to haſten this contraction, when there is not ſome ſtronger contra-indication, ſuch as fever or inflammation, to forbid their uſe.

X. The ſinuſes of the human womb (§ 3.) are much more ſafe and uſeful than any continued arterious canals could have been: For theſe would have occaſioned too great an hæmorrhage when the placenta was ſeparated; whereas, in the way the ſmall branches of the arteries are diſpoſed upon the membranous ſides of the ſinuſes, they muſt be compreſſed as ſoon as the uterus contracts; and at the ſame time, the reſiſtance which the womb occaſioned to its own returning blood by its preſſure on the large veins, being taken off when the womb collapſes, the lateral branches of the minute arteries can be very little diſtended with blood, and the ſinuſes will be very little filled. To illuſtrate this, remark a very analogous caſe, the œdematous ſwellings of the legs in women with child, which go off as ſoon as they are delivered. Hence we may be convinced, that the only means whereby we can ſave a woman's life, whoſe placenta ſeparates before birth, is to deliver her immediately. And hence it is plain, why the lochia or cleanſings gradually diminiſh in quantity, and loſe their red colour.

XI. Seeing the reſiſtance to the blood in the deſcending aorta is taken off upon delivery; and that not only the placenta ſeparates with more difficulty when the womb has not contracted itſelf, but alſo a greater hæmorrhage muſt happen; it will appear no wonder that weak women ſhould be ſo liable to faint at this time, eſpecially if they have been kept in an erect poſture, and the midwife is too anxious to bring away the placenta ſoon. Hence we ought to learn to deliver ſuch lying in a bed, or on a couch; and the uterus ought to be allowed ſome time to contract, and the mother ought to have time given her to recover the fatigue of her throes, before the after-burden is brought away. Hence alſo we may be convinced, how neceſſary ſoft compreſſion by bandage is on the belly after delivery.

XII. When the quantity of the mother's blood is ſmall, or when the con-

contraction of the uterus is very quick, or when an obſtruction happens in the arteries of the ſinuſes, the cleanſings will be in very ſmall quantity. The conſtitution of the patient, and the ſtate of the pulſe, readily diſcover what the want or too ſmall quantity of the lochia depend on; and, in the firſt ſuppoſition, there is no harm from this ſtoppage, but we do miſchief if we attempt to force them; but, in the other caſes, we ought to encourage this evacuation by ſoft relaxing internal medicines, and by injections, fotuſes, &c. applied to the womb, or near it, while other evacuations are promoted or made if the ſymptoms become urgent.

XIII. The liquor of the ſtomach being ſo thick (§ 30.) while all the digeſtive powers of a child are very weak at birth, we may eaſily underſtand what bad conſequences, ſuch as its ſticking to the guts, obſtructing the orifices of the lacteals, &c. may be produced by this mucus remaining there; and therefore ought to admire the wiſdom of our Creator, who has provided ſuch a thin diluent purgative milk at this time, for preventing theſe diſorders; and may hence learn how neceſſary it is to cleanſe the *primæ viæ* of new-born children by proper medicines, eſpecially when they are not ſuckled by their mothers, and have not a nurſe whoſe child is as young as themſelves.

XIV. The want of reſpiration to ſqueeze forward the bile, and the reſiſtance made to its entry into the guts of fœtuſes, by the tough ſlime which lines the inteſtinal tube, make the effuſion of their bile very ſlow; and therefore their gall-bladder is generally full of a green ſharp bile. Hence at birth, or ſoon after it, children are often obſerved to have the jaundice, the thick ſlime producing the ſame effects in them as is diſputed for from ſtones *. This jaundice generally yields to any gentle purgative, and very often is carried away by any medicine that increaſes the contraction of the guts; which is no more than might be expected from underſtanding the cauſe of the diſeaſe. It is alſo from this collection of bile during geſtation, that children are ſo frequently ſubject to gripes and green purging ſoon after birth, which cleanſes their guts of the unneceſſary ſlime and meconium, and diſcharges that ſharp bile, which might bring on diſorders of worſe conſequence if it continued to lodge

* See No 38. of this COLLECTION.

there: So that, however troubleſome it may be to the innocent babes, they are generally the better for it afterwards.

XV. From the care bountiful Providence is at, not only to ſupply a ſufficient quantity of nouriſhing juices to the fœtuſes of animals and plants, but alſo to furniſh ſubſtances prepared by the mother's organs, for ſerving them after they are ſeparated from her, viz. milk in the viviparous, the yolk in the oviparous animals, and the farinaceous ſubſtance of the ſeeds in plants; and from what we obſerve of brutes, who follow the dictates of nature more cloſely than man does, how they only gradually come to uſe the common food of their parents; we may be convinced, that the food provided by nature, milk, is the moſt proper for infants; that a ſudden change of food is dangerous to ſuch tender creatures; and that therefore the food given children when they are to be weaned from the breaſt ſhould be ſuch as is neareſt to milk, and the breaſt ought to be taken only by degrees from them. By which method I have often prevented all the troubleſome diſorders which generally attend weaning.

XVI. From what was remarked above (§ IV.) of the diſorders women are frequently ſubject to when their menſtrua are about to flow, we may rationally conclude, that a nurſe, who has ſuch a redundancy of ſuperfluous liquors, will have her milk changed to the worſe. And, from what all practiſers in phyſic have obſerved of the effects of deriving a more than ordinary quantity of our juices to one part, in order to make a revulſion from another, we have reaſon to think, that a nurſe, whoſe menſes are brought on by any other cauſe than a ſuperfluity of liquors, will come not only to have leſs, but alſo worſe milk, after ſuch an evacuation; and therefore a nurſe who menſtruates ought not to be choſen. But if particular circumſtances oblige us to continue a child with ſuch a nurſe, we ought to conſider the cauſes that occaſion her menſes to flow; and according to theſe, we are to order the child to be kept up from the breaſt, either before the evacuation in the firſt ſuppoſition, or for ſome time after it when it has been brought on by any other cauſe.

N° 13.

REMARKS

ON THE

COATS of ARTERIES, their DISEASES, and particularly on the Formation of an ANEURISM *.

THE curious and accurate account of the aneuriſm, which was ſhown to me, before it was ſent you, by a gentleman to whom I ſtand indebted for many obliging acts of friendſhip, and Mr Macgill's deſire that I would endeavour to explain the nature of this diſeaſe, which appears neither to have been exactly examined, nor rightly underſtood, by chirurgical writers, have given riſe to the following remarks on the coats of arteries, their diſeaſes, and particularly on the formation of the aneuriſm; and, as a ſequel to this, I ſhall afterwards lay before you ſome figures of the arteries of the arm, accompanied with a few reflections on the aneuriſm occaſioned by venæſection, which is by much the moſt frequent that admits of any cure.

In ſeveral parts of the body, arteries receive a ſtrong firm covering from the contiguous parts, which has been deſcribed as their exterior coat; ſuch as, the membrane that ſurrounds the aorta while it is within the pericardium, the pleura and peritonæum ſpread over the deſcending aorta in the thorax and abdomen, &c. But ſeeing this coat is only to be obſerved in ſome parts, where particular purpoſes are to be ſerved, ſuch as ſtrengthening an artery where it is more than ordinary expoſed to the ſtretching force of the circulating fluids, counteracting the reſiſtance made by ſome ſolid body on its oppoſite ſide, ſaving it from compreſſion, &c.

* Originally printed in the Edin. Med. Eſſays, being Art. xvi. of Vol. II.

I think it ought not to be conſidered when we ſpeak of the coats of arteries in general.

All arteries are covered externally with a cellular ſubſtance, compoſed of very fine pellucid membranes, which are capable of being ſtretched, even ſuddenly, to a great extent without breaking; and they collapſe as quickly when the ſtretching force is removed. There is always more or leſs of an oily liquor contained in the communicating cells of this ſubſtance; and the proper veſſels of the arteries run in it, ſpreading branches every where on the cells for the ſecretion of that oil. When either the membranes are diſtended by a liquor thin enough to enter the cells, or when the exterior part of the membrane is gently drawn, the cellular texture is evident: but when a groſs ſubſtance is forced into the more internal part of this cellular membrane, it conceals the fine threads of the membranes mixed with it; and whenever the cells are empty, they collapſe ſo cloſe together, that the whole appears to be one membranous coat, conſiſting of ſeveral layers.

All arteries are ſurrounded with ſuch a ſubſtance as I have juſt now deſcribed; and therefore it may be reckoned one of their coats: Though I muſt obſerve, that the ſame kind of cellular ſubſtance is common to at leaſt all the flexible parts of the body, where every little fibre is connected to another by the ſame contrivance. See Boerhaave's preface to his edition of the *Autores varii de morbo Gallico*.

This cellular ſubſtance of the arteries ſerves to connect them to the ſurrounding parts, without hindering or diſturbing their actions or motions; it prevents their being ſo readily compreſſed; it gives a ſafe paſſage to the veſſels of their other coats; it contains oil for lubricating and keeping the interior coats flexible.

What really deſerves to be called the firſt proper coats of the arteries, is the muſcular or tendinous; which, in the human body at leaſt, conſiſts of annular fibres connected ſtrongly together. It is to theſe principally that the recoiling of an artery is owing, after it has been diſtended by the ſuperior force of the ſyſtole of the heart; and the elaſticity of the ſubſtance connecting the annular fibres, which is of the cellular kind, is very remarkable in the quick contraction of an artery after it has been ſtretched longitudinally.

The

The moſt internal coat of arteries cannot be rightly obſerved while they are ſound and recent; becauſe it is ſo thin, and adheres ſo firmly to the muſcular coat, that it appears in form of a very thin layer of longitudinal fibres: but after the arteries are kept ſome time, and their texture becomes more eaſily unravelled by the beginning putrefaction, it ſeparates very eaſily, and ſhows numerous inequalities on its interior ſurface, with veſſels diſperſed on it; and a cellular ſubſtance is ſeen connecting it to the muſcular coat. But there is no appearance of any muſcular ſtructure in it, and it tears very ſoon upon attempting to diſtract or ſtretch its fibres; ſo that it would ſeem to bear a very ſtrong reſemblance and analogy to the villous coat of the inteſtines, whoſe proportional greater diſtenſions and contractions above what arteries ever ſuffer, and thicker *tunica cellularis interna*, will account for the papillæ and rugæ ſo much more obſervable in the guts than the arteries. I ſuſpect it muſt be this coat which Mr Winſlow (*a*) calls the *duvet*, which he affirms he ſaw filling up the cavity of the ſmall ſecerning arteries of the glands, and on which he builds his account of ſecretion. I imagine it a membrane analogous to this, which, diveſted much of its cellular ſubſtance, forms the valves in the veins.

This interior coat will prevent any particles of our fluids from inſinuating themſelves into the cellular ſubſtance of the other coats; it renders the ſurface of the arteries more ſmooth and poliſhed than otherwiſe it would be; and we may conclude, from the analogy of other parts, that its veſſels ſeparate a liquor to protect and lubricate its own interior ſurface.

From the texture of the external cellular coat of arteries, as above explained, it is evident, that obſtructions are very apt to be formed here; which, according to the different ſeries of veſſels in which the obſtruction is, and the different natures of the obſtructed liquors, will produce various diſeaſes, as well as in the *tunica cellularis* elſewhere in the body, which is the ſeat of numerous diſeaſes that are ſaid by authors to affect other parts. To take but one example of the many which Boerhaave (*b*) names: Here it is that inflammations are placed; this it is that melts down

(*a*) Mem. de l'Acad. des Sciences, 1711. (*b*) Præfat. in Autores de Morbo Gallico.

down into pus in all ſuppurations. Let ſurgeons reflect, whether ever they ſaw the proper muſcular fibres diſſolved into pus; or if firm membranes, ligaments, the ſkin, &c. do not caſt off in ſloughs, when they are eroded. Let thoſe who examine the bodies of people dead of pleuriſies, inflamed guts, &c. remark, whether the membranes ſaid to be affected are not entire, and the pus is not collected in the cellular ſubſtance under the membrane. But, to return to the preſent ſubject, the diſeaſes of the external cellular coat of arteries may ſerve to diminiſh the diameter of the artery, if they compreſs it. If the oil in the cells becomes too thin, or only lymph is contained in them, the muſcular coat may be too much relaxed. If there is too ſmall a quantity of the moiſtening liquors, the artery loſes that flexibility that is neceſſary for it: And if the morbid matter becomes acrid, it may erode or deſtroy the muſcular coat; though this will be done with difficulty, becauſe of its firm texture. Hence we daily ſee large arteries long ſoaked in the pus of abſceſſes without any hæmorrhage.

The muſcular coat will be ſubject, as well as other muſcles, to too great rigidity or laxity, to convulſive contractions, or paralytic affections; though theſe will not ſhow themſelves evidently, becauſe of the action of the heart upon the artery, and of the elaſticity which this coat has, independent of the circulation.

What was ſaid of the texture of the moſt internal coat, will naturally lead one to think that it muſt be ſubject to diſeaſes, and that theſe will be much a-kin to the maladies of the external cellular coat; allowance only being made for the violent compreſſion which the internal one muſt always ſuffer, from the impetuous ſtream of blood on one ſide, and the briſk reaction of the muſcular coat on the other; the effects of which may be readily enough underſtood from what I have had occaſion to ſay elſewhere (*a*) on ſuch compreſſion. It is only in the cellular membranes of this interior coat that ever I ſaw any of the bony or calculous concretions of arteries. I have more than once obſerved the cavity of a large artery almoſt blocked up by a ſteatomatous thickening of this coat; and frequently I have obſerved purulent matter collected in it.

Notwithſtanding

(*a*) Accounting for oſſification in the Anatomy of the Human Bones. *Vide* N° 3. of this Collection.

Notwithſtanding the morbid ſtate of this coat, and of its cellular membranes by which its connected to the muſcular coat, offers itſelf ſo frequently to the view of thoſe who diſſect the human body, practical authors and obſervators have not been at pains to remark how far the animal œconomy was thereby diſturbed, I offer the few following conjectural queries to their conſideration. May not diſeaſes here often occaſion great inequalities and irregularities of the pulſe? May not a *tabes purulenta* have its ſeat here, without any bowel being affected? Will not a ſmall eroſion of this coat, and a conſequent oozing of the blood through the cellular texture of the other coats, more naturally account for the ecchymoſes that happen ſo frequently in diſeaſes, where the blood is acrid, than breaking of the veſſels can do? Are not the ſmall veſſels, where the motion of the fluids is ſloweſt, more liable to ſuffer this eroſion than the larger ones are?

The preceding account of the coats of arteries may let us ſee, that no aneuriſm can happen, unleſs through ſome fault of the interior coats; therefore it will be neceſſary to take a view of the ſeveral ways theſe coats may be ſo vitiated, as to give any chance for the formation of an aneuriſm.

1. A large opening made into an artery, with a proportional aperture in the teguments, produces only an hæmorrhage: but, if the external orifice in the ſkin is ſo ſmall, as not to allow the blood to eſcape as faſt out at it as it flows from the artery, the neighbouring cellular membranes will ſoon be filled with blood; the member becomes every where ſwelled and diſcoloured; and, in ſhort, what is generally called a baſtard aneuriſm is formed.

2. If the aperture into the artery is very ſmall, and the blood cannot eſcape through the teguments, it will coagulate before it can be puſhed to any conſiderable diſtance from the orifice by which it eſcaped; and thereby an obſtacle will be made to the ſucceeding blood's ſpreading in the *tunica cellularis*, which ſoon will be formed into a lamellated membrane, by the oil being ſqueezed out, while the extravaſated blood becomes firmer and harder, ſo as to appear of the polypous conſiſtence, by the preſſure it ſuffers. I had ſometimes occaſion to be much ſurpriſed at ſeeing how ſoon ſuch a change can be brought on the arterious blood; the inſtances I mean are, where, after a limb was amputated, the patient's

faintneſs hindered the arteries to ſpring as uſual, by which one lay undiſcovered, and was not ſtitched; but, in a few hours after the dreſſings were put on, occaſioned an hæmorrhage, notwithſtanding the bandages had been tightly applied, and a prentice preſſed ſtrongly with his hand on the end of the ſtump. When the wet dreſſings were removed, I ſaw the clotted blood on them become firm, of a pale colour, and having the appearance of a fibrous texture. Since then ſuch coagulated blood is contained in a membranous ſubſtance, the diſeaſe, in the caſe we have ſuppoſed, will have the appearance of a circumſcribed encyſted tumour, which the pulſation of the neighbouring artery and the jett made at its open orifice will communicate a pulſation to, till either the bulk of the ſwelling, the quantity of liquor below the coagulum, or the great reſiſtance of the parts ſtretched on the tumour, render the vibration imperceptible; and, till once the polypous concretion turns very large, the tumour will become much leſs on compreſſing it ſtrongly, by the fluid blood being forced back into the artery through the perforation in its coats; that is, a tumour, attended with all the ſymptoms of what is called a *true aneuriſm*, is formed, though the principal part of the ordinary definition, viz. the diſtenſion of the proper coats of the artery, is wanting.

3. If the muſcular coat is only perforated, the interior coat will be puſhed out at the interſtice of the divided fibres; and not being capable of being ſtretched far without breaking, the caſe is ſoon reduced to one or other of the two former ſuppoſitions.

4. If part of the muſcular coat only has ſuffered a ſolution of continuity, the remaining fibres are either able to reſiſt the force of the blood without being diſtracted beyond their natural tone, in which caſe they will reunite, eſpecially if they have been divided by a ſharp inſtrument cutting tranſverſely; but, when there is loſs of ſubſtance, or a longitudinal inciſion, the breach can only be made up by ſyſſarcoſis; but in neither caſe will either ſort of aneuriſm happen, unleſs more fibres afterwards yield to bring it to be no longer able to reſiſt the impetuous blood, as I think would for moſt part follow, from what I have ſeen in trying ſome experiments for obſerving what happens in an artery taken out of the body when it is filled with quickſilver and preſſed, after ſome of the muſcular fibres have been cut or broke. If either, then, the fibres continue

to

to break gradually, or the diſtenſion of them is ſudden, when all are torn, the diſeaſe is reduced to the ſuppoſition made in § 1. and 2.

5. When part of the fibres are broke, cut, or eroded, (any of which ways you may conceive the ſolution of continuity to be made on all the ſuppoſitions yet mentioned), we can imagine ſuch a proportion to remain entire, as being very near, but not altogether, able to reſiſt the fluids, will yield very gradually, and form a true aneuriſm, in the ſenſe the common chirurgical books explain it: But, beſides the many chances againſt ſuch a preciſe approach to an equilibrium happening between a leſed artery and its contained liquor, I muſt obſerve, that, though membranes become ſtronger and thicker as they are gradually ſtretched, yet muſcular fibres ſeparate more and more, leaving larger interſtices: And therefore, if the annular fibres of an artery were thus ſeparated, the interior coat would ſoon yield in their intervals, and the blood would burſt out to form one or other of the tumours deſcribed in § 1. and 2.; and when it is confined, as in § 2. the circular fibres would appear like ſo many columns or croſs bars in the tumour; which agrees very well with ſeveral deſcriptions of aneuriſms handed down to us.

6. If a ſmall part of the muſcular coat of an artery loſes its natural tone, or contracting force, by any paralytic diſorder, it will yield to the ſtretching force of the blood; and thus an aneuriſm may be formed, which will have all the characters of what is commonly named a *true aneuriſm*. You ſee, that a partial palſy, and that very gradually coming on, muſt be here ſuppoſed; otherwiſe the fibres being ſeparated, and the internal coat breaking, will reduce it ſoon to the ſtate mentioned in § 5.: And indeed it would appear from what is there ſaid, that, before it becomes of any very conſiderable bulk, we have reaſon to judge the ſame would happen here. Beſides, ſuch a palſy as has been here ſuppoſed will very rarely be formed, becauſe of the great ſympathy and connection which the whole arterious ſyſtem has, the pulmonary artery and aorta making each one hollow muſcle continued from the heart to their ſmall ramifications: And I believe a palſy is ſeldom or never obſerved to affect only one extremity, or the middle of a muſcle, while the other parts of it continue to be vigorous and active.

7. The only ſuppoſition we need make concerning the interior coat of

arteries alone being affected, is a ſolution of its continuity; which will readily happen by all ſudden overſtretching of an artery, or it may be made by any eroding cauſes, ſuch as ſuppuration, &c. I cannot ſay poſitively, that the want of this coat is capable of producing an aneuriſm; but ſhall offer a conjecture, which may poſſibly be improved afterwards by obſervation. It is this: When this coat is removed, ſome particles of our liquids may inſinuate themſelves into the cellular membrane connecting the muſcular fibres; and, gradually enlarging theſe paſſages, may at laſt penetrate through it, to be diffuſed in the external cellular coat: And thus at length this caſe is reduced to what is mentioned towards the cloſe of § 5. I was brought into this way of thinking, partly by obſerving how readily cellular membranes tranſmit liquors, and by ſeeing air eſcape through all the other coats of the guts when the villous one is removed.

From the whole we may ſee, that what authors call now a-days a true aneuriſm will very ſeldom be formed: which may be ſtill further confirmed by mentioning the remoter cauſes which are agreed on by all to occaſion it for ordinary; theſe are, wounds, bruiſes, ſtraining, loud laughing, crying, &c. All ſuch, you ſee, make a ſudden violent effort on the arteries, and therefore do not rightly anſwer to any of the ſuppoſitions we made of the manner this diſeaſe could poſſibly be brought on. And, to eſtabliſh what you ſee I argue for, of the true aneuriſm being a very rare diſeaſe, I peruſed a great number of hiſtories of aneuriſms, beſides thoſe mentioned by Dr Freind (*a*), and could not find above two or three that were diſſected, ſo much as alleged to have been true aneuriſms; and there was not one, where it is ſaid that the aneuriſmal ſac conſiſted of ſtrong annular muſcular fibres; which muſt, however, be the true criterion whereby the true aneuriſm can be known, ſeeing from what was ſaid in § 2. confirmed by ſeveral accurate hiſtories, blood, extravaſated in the *tunica cellularis*, will have all the other ſymptoms that are deſcribed as proper to the true aneuriſm.

(*a*) Hiſtory of Phyſic, Vol. I.

N° 14.

REFLECTIONS

ON THE

ANEURISM occaſioned by BLOOD-LETTING.

THE engraved figures will give a better idea of the ſituation and courſe of the arteries of the arm that are the ſubject of the following reflexions, than any words can; and therefore, without adding any verbal deſcription, I ſhall proceed to the explication of the plate.

PLATE II.

Fig. 3. repreſents the moſt ordinary diſtribution of the humeral artery.

1. A part of the pectoral muſcle.
2. The *biceps flexor cubiti.*
3. The *coraco-brachialis* muſcle,
iv. The *brachiæus internus.*
4. The *brachiæus externus.*
5. The *brevis* and *longus extenſor.*
6. The *pronator radii teres.*
7. The *ſupinator radii longus*, and *extenſor carpi radialis* drawn outwards by a thread.
8. The *ſupinator radii brevis.*
9. The *flexor carpi radialis.*
10. The common origin of the *palmaris longus* and *flexor carpi ulnaris.*

A The trunk of the humeral artery giving off branches in its courſe to the neighbouring muſcles.

B The place below the joint of the elbow, where it is about to ſplit into its two large branches.

C The

C The radial branch.

D The common trunk of the ulnar and median arteries.

E A branch going off from the humeral artery above the elbow toward the internal condyle, behind which it anaſtomoſes ſometimes by a large canal with a branch ſent up from the ulnar, oftner they communicate by a great many ſmall branches, and frequently I could not diſcover any conjunction of theſe two arteries.

F The part of the humeral artery, where it commonly begins to be covered by the aponeuroſis of the biceps muſcle.

G A branch ſent up from the radial artery behind the external condyle of the *os humeri*, to anaſtomoſe with ſuch a branch of the humeral artery as E is.

The ſame parts are pointed out in the three following figures, by the letters and ciphers employed in the firſt figure, which makes a repetition of their explication needleſs.

Fig. 4. Is borrowed from Mr Cowper's Scheme of Arteries *.

a Is a branch ſent off from the humeral artery, to anaſtomoſe, behind the internal condyle of the humerus, with the artery *b* which comes from the trunk of the ulnar and median arteries.

H The ulnar artery.

I The median artery.

k Branches given to the muſcles of the hand from the humeral artery, juſt as it is about to ſplit into its branches.

Fig. 5. Shows the humeral artery dividing into two great branches as it is coming out from the arm-pit. Theſe branches are repreſented as if they lay at each others ſides, which the oblique view I gave of them to the painter obliged him to; but the one *c* which afterwards becomes the radial, is placed directly anterior to the other in the ſubject, the ulnar *d* lying pretty cloſe to the bone.

Fig. 6. Repreſents the humeral artery ſplitting near the middle of the arm, *e* being the larger anterior more ſuperficial branch, which goes on to divide as the humeral artery in fig. 3. does, while the leſſer branch *f* runs

* Appendix to the Anat. of Human Bodies, tab. iii.

runs close on the bone to open into the common trunk of the ulnar and median arteries.

H The ulnar artery.

I The median artery.

L The branch marked *b* in the fourth figure.

Not. The muscles 6, 9, 10, are here cut through, and hang over the cubit, while those marked 7 are drawn outwards, that the arteries might be distinctly seen.

I still preserve the arms represented by fig. 3, 5, 6.

By the distribution of the humeral artery in fig. 3. it would appear, that the artery, which is in hazard of being hurt by the lancet in blood-letting of the arm, is for ordinary the trunk of the humeral artery; and that the lancet must pierce the tendinous aponeurosis of the biceps muscle before it touches the artery. To be still more assured of this, I pushed pins into the arms of several bodies at the ordinary place where the basilic vein is opened, and where the cicatrices of former venæsections were seen; and, allowing the pins to remain there, I dissected the parts, till I saw what has been above asserted to be true.

Sometimes, when the median vein is opened lower than ordinary, the radial artery may be hurt; but then its wound must be so near its rise from the trunk, that it is impossible to make any ligature on the radial artery above the aperture; and therefore, seeing the humeral artery must be tied, if the operation of the aneurism is performed, the consequences will be the same as if the humeral artery had been wounded.

In all patients, then, whose vessels are distributed in the common way, without any considerable anastomosis between the humeral artery and its large branches in the fore-arm, it is in vain to expect that any pulse should be felt at the wrist immediately after the operation of the aneurism is performed; and, at the same time, the want of a pulse there needs not make the surgeon go on precipitately to the amputation of the member, because the numerous small anastomoses may be sufficient to keep life in it, and may possibly be gradually enlarged so much, as to restore vigour

vigour and ſtrength to it, and even to make a perceptible pulſe at the wriſt.

When the operation of the aneuriſm is performed at the bending of the elbow to one who has the anaſtomoſis repreſented in fig. 4. the humeral artery muſt be tied, but the pulſe at the interior ſide of the wriſt will continue; and probably that on the exterior ſide will ſoon be reſtored, becauſe the blood may have the ſhort retrograde motion from the inſertion of the anaſtomoſing tube into the ulnar artery, to the place where the radial artery begins, without any great diminution of its momentum.

Thoſe who happen to have ſuch a diviſion of the humeral artery as is repreſented in fig. 5. can only have the radial artery hurt in venæſection; and, after the operation of the aneuriſm, will have a ſtronger pulſe than formerly in the interior ſide of the wriſt, but will probably want it in the exterior ſide.

If the veſſels anaſtomoſe as in fig. 6. you will readily ſee, that, the anterior branch only being hurt, the operation of the aneuriſm may be performed without interrupting entirely the courſe of the blood either in the radial or ulnar artery; and therefore the pulſe may ſtill be felt in the common place on both ſides of the wriſt.

I have very little to add, by way of remarks on the hiſtory related by Mr Macgill, having, in the account already given of the formation of aneuriſms, prevented any explication of the principal phænomena. I may, however, obſerve, that in that hiſtory we can trace the gradual formation of the polypus; and, from the mixture of the deep-coloured parts of the blood then ſqueezed out, with ſome of the diſſolved cellular membrane, may underſtand how a liquor, like to coffee made of half-burnt beans, could be collected within this aneuriſm.

If the common notion of the true aneuriſm being a ſac formed by the dilated muſcular coat of arteries, has not had its riſe from theory only, I would ſuſpect, that the firſt aſſertors of it, ſeeing the pleura covering an aneuriſm in the thorax, or the tendinous aponeuroſis of the biceps here in the arm adhering firmly to ſuch a tumour, miſtook them for the muſcular coat of the artery. I have an argument for this ſuſpicion, which ſeems very ſtrong to me, whatever it may do to others who are leſs liable to miſtake one thing for another: it is this, That notwithſtanding my theory

theory and diſſections had brought me to think true aneuriſms to be at leaſt a very uncommon diſeaſe; yet when I ſaw Mr Macgill lay the tendinous aponeuroſis bare, I was ready to have renounced my opinion, being perſuaded it was the muſcular coat of the artery, till he moſt dexterouſly proſecuted the aponeuroſis to its riſe from the biceps, and ſo fully convinced me of the miſtake into which I ſhould moſt readily have been led, without diſcovering it, if the operation had been performed in the more ſpeedy way of laying the whole tumour open by one inciſion.

N° 15.

CASE of an ANEURISM.

ANDREW RADY, living in Galloway, had the misfortune, in being bled in the baſilic vein of the right arm by ſome gardener there, to have his artery hurt, which was followed by an aneuriſm. Some more than a year after, he came to town here, and was received into the Infirmary in May 1735. On the 22d day of that month, Mr George Cuningham, the ſurgeon then in attendance, performed the operation. After the tourniquet was applied, Mr Cuningham laid open the tumour from one end to the other, with one longitudinal inciſion; then taking out the polypous ſubſtance, and a ſmall quantity of liquid blood, the ſmall aperture of the artery was ſo plainly ſeen, that I put a probe into it, and raiſed the trunk of the artery, while he paſſed the needle behind it, the ſides of the wound being held aſunder in the mean time by two blunt hooks. The proper membrane of the tumour was very thick and ſtrong, and required force to puſh the blunt aneuriſm-needle through it; but the nerve was preſſed by the tumour a good way from the trunk of the artery, ſo that there was no danger of taking the nerve within the ligature. After making the ſuperior ligature, the tourniquet was untwiſted, but no blood came by the orifice; which ſhewed the anaſtomoſing canals to be very ſmall: the ſecond ligature was, however, made below the orifice, for ſecurity. The cavity was filled with ſoft lint, and the other ordinary dreſſings were applied. That afternoon his hand ſwelled and became warm; which removed all our fears of the circulation being entirely ſtopped. No pulſe was to be felt on either ſide of the wriſt for ſeveral days; but before the 5th of June, when both the ligatures ſuppurated off, the pulſe was plainly to be felt on both ſides of the wriſt; and he cured ſoon, having as much ſtrength and motion in that whole member as ever.

To

To make this operation more ſpeedy and ſafe, I would propoſe, that as ſoon as the longitudinal inciſion is made, and the polypus with the blood is removed, the patient's elbow being bended ſome way, the operator ſhould take hold of the humeral artery with the thumb and forefinger of the left hand; and, griping it towards the back-part, ſhould puſh the needle cloſe upon his own nails, by which he has a ſure direction whereby he may ſhun the nerve, which he can readily diſtinguiſh from the artery by feeling, and can, in that poſture of the arm, eaſily draw the artery ſo far outwards as to keep free of the nerve.

The operation then of the aneuriſm, which appeared, by the deſcription ſurgeons gave of it, to be very nice, difficult, tedious, and precarious, may be done eaſily, quickly, and ſafely, by opening the whole tumour at once, and then putting the ligature about the artery as juſt now deſcribed.

No 16.

A White Swelling of the KNEE.

MANY inſtances are daily ſeen of that tormenting, dangerous diſeaſe, the *white ſwelling* of the joints: but before one has an opportunity of examining them by diſſection, to underſtand the nature of the diſeaſe right, the matter has become ſo ſharp, that it erodes the bones themſelves; and then one ſees the ſame thing as he would do in a *ſpina ventoſa*. I met with one patient in our Infirmary, whoſe joint of the knee was juſt as far advanced as I wiſhed to examine, when it was amputated. It gave me a better idea of that diſeaſe than I had before, and poſſibly may do ſo to ſome others.

Iſabel Blackadder, a young woman of a delicate tender conſtitution, having hurt her left leg by a fall ſome years ago, an ulcer broke out near her heel, and ſeveral pieces of bone caſt out at it; but it recovered ſo well, that ſhe went to ſervice again.

In the end of 1734, having hurt the ſame leg by another fall, the knee ſwelled, and became very painful and ſtiff; for which ſhe was taken into the Infirmary: where, after blooding, a few doſes of *aquila alba*, and embrocation with *aq. Mindereri*, the ſwelling and pain both ſeemed to abate; but ſoon became as bad as formerly, and never afterwards yielded to any medicines.

The ſkin of the ſwelled parts was not diſcoloured, and on the inſide of the joint a fluctuation was felt in one or two points; but the quantity of liquor appeared very ſmall, and the fluctuation had a different feeling to what commonly pus collected in a cavity has. Her pains were very ſharp, eſpecially upon the leaſt motion of the affected leg; her fleſh and ſtrength decayed daily, and the hectic ſymptoms increaſed: which at laſt brought her ſo low, that ſhe could not be raiſed to a ſitting poſture without

out fainting; which laid her under the neceſſity of ſuffering the member to be amputated.

In this condition ſhe was when the member was cut off above the knee by Mr Douglas; after which ſhe recovered daily, and walks on a wooden leg of the ſame form which Alexander Sheppard uſed (*a*).

When the diſeaſed joint was diſſected, all the cellular membranes, in which fat is naturally contained under the ſkin, between the muſcles and tendons, and upon the ligaments, were found full of a glairy matter, which had inſinuated itſelf ſo much every where, and had made the other parts ſo ſoft, that we could ſcarce diſtinguiſh one from another. In ſeveral places of this glairy ſubſtance, there were ſmall cavities full of pus. When the articulation of the knee was opened, all the mucous glands and fatty membranes were ſeen in the ſame condition with the exterior parts; the ſemilunar cartilages themſelves between the tibia and femur being quite ſoft, and with the ſame cellular mucous appearance that the glands had. We alſo obſerved ſome pus within the cavity of the joint, but the extremities of the bones were ſcarce begun to be eroded.

(*a*) See N° XIX. *infra*.

No 17.

Part of the CARTILAGE of the JOINT of the KNEE ſeparated and oſſified.

IN the letter incloſed in this paper *, you have an account of a white ſwelling from a very uncommon cauſe, treated by my good friend Dr Simpſon, profeſſor of medicine in the univerſity of St Andrew's. In it the Doctor does not, and indeed could not, determine how the looſe bone he deſcribes came into the cavity of the articulation. I believe it may not be diſagreeable to you to relate what I ſaw once in the joint of the knee, very like to the bone he took out, and which may ſerve to explain that phænomenon.

In the body of a woman, aged 40, which I diſſected in February 1726, I found, within the ligament of the articulation of the right knee, a bone of the ſhape and ſize of a ſmall turky-bean, depending by a ligament half an inch long from the external ſide of the tibia. The bone, when cut, had only a thin external firm plate, being compoſed within of cells which were full of oil. On ſeparating the femur and tibia, I ſaw the ligament came out from the exterior edge of the cartilage covering the exterior cavity of the tibia; and more internally a part of the cartilage of the tibia, of the ſame ſhape with the bone, was wanting. In Plate II. fig. 7. A is the bone hanging by its ligament, and B is the bone cut open. The circumſtances of this malefactor made it impoſſible for me to know exactly her ſymptoms or complaints before her execution.

* This, and the letter alluded to, make Art. xix. and xx. of Vol. IV. Edin. Med. Eſſays.

N° 18.

An anomalous TUMOUR of the LEG, unſucceſsfully treated.

A WOMAN, about forty-ſix years of age, after having been troubled ſeveral months with a tumour on the outſide of her leg, aſked my advice. The external part of her leg was equally ſwelled: only about the middle it pointed, as we commonly call it, or was more prominent, red-coloured, and felt ſofter; and, on preſſing it with the fingers alternately, a liquor fluctuated below them. The pains of this tumour were ſo violent, that the patient aſſured me they had not allowed her, for ſome time paſt, to ſleep a quarter of an hour at once. Her body was very lean. She had no appetite, but a conſtant thirſt. The hectic paroxyſms and night-ſweats came regularly every day. Every third day ſhe was ſeized with a diarhœa. Her menſtrua had left her a conſiderable time before.

Imagining moſt of theſe ſymptoms to proceed from pus pent up and abſorbed by the eroded veſſels, I was of opinion they would probably abate, if that matter was freely evacuated by an external orifice. Having therefore applied ſuppurating cataplaſms two days, and the teguments of that prominent part becoming thinner, with the fluctuation ſtill more evident, I made an inciſion of an inch and half long with a lancet. In the cutting, I was ſenſible, by the reſiſtance and grating ſound at the edge of my lancet, that the tendinous aponeuroſis was cut: though the inciſion was large and deep enough, not one drop of pus was diſcharged; only two or three ounces of mucus dropped out.

Next day I brought two ſurgeons in my neighbourhood to viſit my patient; and, having taken off all the dreſſings except the pledgets which covered the orifice, I deſired them to feel the ſwelling, and give me their opinion of it. They both affirmed their having felt the fluctuation of matter under their fingers. When the laſt pledgets were taken away, a fungus appeared at the orifice, which reſembled the flabby *tunica celluloſa*, ſo often to be ſeen in the back and other depending parts of thoſe that die

die of tedious lingering diſeaſes. I cut off ſome of this fungus, put gentle eſcharotics on the remains of it, and dreſſed the reſt of the wound with ſuppurants. On the ſecond day, the fungus came out much larger, and violently ſtretched the aperture of the teguments and tendinous aponeuroſis, by which a gangrene was begun all round the edges. I cut off the fungus, enlarged the oriſice conſiderably, and dreſſed it up with antiſeptics and ſuppurants in the common way. In two days, the gangrened parts fell off; and, the aperture being now very large, I diſſected, from between the two bones of the leg, near a pound of that flabby ſubſtance. After having cut as deep as I durſt, without riſking the opening of the large arteries, I thruſt a probe through that ſoft fatty ſubſtance, till I felt it and ſaw it ſtriking againſt the ſkin of the oppoſite part of the leg.

Expecting therefore no ſucceſs from this method, I reſolved to perform the amputation as ſoon as the fever and diarrhœa, which were now come on, were abated; but neither were ſtopped by any medicines given, and in a few days the patient died.

The ſkin of all the leg appeared after death ſound: but the *tunica cellulosa* and muſcles were all degenerated into that pappy ſubſtance which had appeared as a fungus; and I could not diſtinguiſh one muſcle from another, though I was at pains to diſſect them.

The perioſteum was every where ſeparated from both tibia and fibula; between it and the bones, an acrid dark-brown liquor was contained; and the ſurfaces of the bones were rough and yellow.

I had occaſion ſoon after to ſee a leg affected with juſt ſuch another ſort of tumour; but it was opened ſooner, before any other bad ſymptoms had come on. It would not cure with either external or internal medicines, and the patient would not allow amputation; ſo that it was palliated, till both ſurgeon and patient wearied of each other.

Pray, Gentlemen, under what claſs of tumours is this to be reckoned? Is it a-kin to the windy ſwellings of the joints? or to what the French call the *fatty tumours?*

If you know the ſpecies of tumour, what is the pathognomic ſign by which it is to be diſtinguiſhed from *eryſipelas-ædematodes*, or the ſlow phlegmons; for I am much afraid of falling into ſome ſuch miſtake as the former, unleſs you will explain the difference to me.

No 19.

History of an ULCER of the Leg.

Alexander Sheppard, a ſmith, aged 36 years, having accidentally wounded the fore-part of his leg with the point of a hook about the beginning of harveſt 1732, an inflammation and ſuppuration were brought on this member, and were neglected till October, when he was received into the Infirmary here.

In examining the ſtate of this diſeaſed leg, a ſinuous ulcer was diſcovered to extend itſelf the whole length of the leg. This, being laid open, ſent out only a very ſmall quantity of ſanious ichor; and, in a few days after, the knee was attacked with a painful ſwelling, which ſoon yielded to a fomentation of urine, in which wormwood, chamomile, and mallows had been boiled. The ulcer ſeemed to be in a good way for ſome days after this: but then proud ſpongy fleſh roſe from it, which was kept down by ſprinkling *red precipitate* upon it; and, in order to correct his bad habit of body, he was ordered to drink plentifully the decoction of guajac, and had repeated doſes of mercurial purges given him. Theſe medicines had a good effect for ſome time; but, upon interrupting the uſe of them a little, the matter of the ulcer turned more ſanious, he felt a pain and ſtiffneſs in his knee, pimples broke out all round the ulcer of his leg, and the itch appeared every where elſe on his ſkin. The mercurial purgatives were therefore repeated, and again brought the leg to a better condition, but left a diarrhœa that continued ſeveral days.

In the beginning of January 1733, he was ſeized with a feveriſh paroxyſm like that of an ague, and next day a red ſwelling of the eryſipelatous kind was obſerved on the back-part of the diſeaſed leg near the ankle.

The day following, the tumour of the leg was leſs; but his knee was conſiderably ſwelled, though without any heat or redneſs; his pulſe was frequent, with thirſt, heat, and other feveriſh ſymptoms. A low vegetable diet was preſcribed, with emulſion, or milk and water, for his drink, and emollient fotuſes and cataplaſms were applied to his knee. Not-

withſtanding which, the feveriſh ſymptoms continued, the knee ſwelled more and became more painful, and a large ſuppuration began in the back-part of his leg. Theſe were ſoon followed by an obſtinate diarrhœa; ſo that, before the end of this month (January), he was emaciated to ſkin and bone, was ſo weak as ſcarce to be able to turn himſelf in his bed, his appetite was quite loſt, and he had conſtantly a quick pulſe and thirſt, with night-ſweats, and a colliquative diarrhœa. His knee was greatly ſwelled, with its ligaments ſo weak that the bones could be made to have the appearance of a partial luxation, and a certain grating was felt on moving the patella from one ſide to the other; at the ſame time, a large collection of pus was made in the back-part of the leg.

He had refuſed to allow the amputation of his leg to be made when it was firſt propoſed to him; but, finding himſelf worſe every day, and being convinced that the only chance he had for life was to have that operation performed, he allowed it to be done, on the firſt day of February, by Mr Hope, who was the ſurgeon then attending.

The member was taken off four inches above the knee. When this joint was diſſected, the cartilages were found eroded, and the bones were become carious.

From the day of the operation, he had no more diarrhœa; and, in twelve days after, all the other hectic ſymptoms were gone, his fleſh and ſtrength being evidently recovered conſiderably.

The cure went on ſucceſsfully all the months of February and March; except that, on March 16th, a livid-coloured ſpot, about the ſize of a ſixpence, was obſerved towards the poſterior part of the wound, which, having a pledgit dipped in brandy applied to it, could not be ſeen next dreſſing.

April 6th, ſeveral granula of fleſh that came out, with very ſmall peduncles, from the ſolid ſubſtance of the bone, threw out a conſiderable quantity of blood; and four or five more ſuch hæmorrhagies, from theſe fleſhy papillæ, happened in this month, and were always ſtopped by applying oil of turpentine.

April 12th, a large livid fungus ſprouted out from the cavity of the bone, and ſeveral other ſuch fungi were ſeen upon the fleſhy parts alſo

of

of the wound. Theſe were removed by repeated ſearing with a red-hot iron, and the application of oil of turpentine.

In the beginning of May, he was altogether free from the fungi and hæmorrhagies; and, May 15th, a piece of the thigh-bone, about the thickneſs of a crown, exfoliated.

He was then cured of his itch; and appeared to be every way in good health and vigour, with the bone covered, and all the wound cicatrized, except about the breadth of half-a-crown in the middlemoſt prominent part where the bone was, on which a ſkin could not be brought; and therefore it was neceſſary to contrive ſuch an inſtrument for him to walk with, as would not allow the weight of his body to bear on this raw part, and that could make the ſoft parts to ſupport the body, without reſting on the bone.

The inſtrument he made uſe of with ſucceſs, was of the form which you ſee repreſented Plate II. fig. 8. 9.

A (fig. 8.) is a box of wood made firm on the outſide by two rings of iron *a*, *a*, and covered within with a thick quilting of wool under chamois leather.

B is the ſtick or leg, of ſuch a length as anſwers to the ſound extremity.

A piece of ſtrong bend-leather, ſhaped as in fig. 9. is fixed to the brim of the box A, the two ends CC being at a diſtance from each other, and having py-holes for paſſing the lace D (fig. 8.) through; the middle long part E has a large piece of thick chamois, or thin well-dreſſed buff-leather, F, fixed to it.

G, G, is a belt of buff, at one end of which is the buckle H, and the other end I is pierced with holes for eaſily paſſing the tongues of the buckle.

K, L, are two ſmall ſtraps coming from the lower edge of the belt G.

m, *n*, Are two ſmall buckles faſtened to the bend leather.

The patient having the thigh of his breeches fitted to his ſtump, ſo that the prominent raw part, with the dreſſings upon it, paſſes through a hole left in the end of the breeches, the ſtump is put through the bend-leather into the pyrmidal box, which does not allow the raw part to ſink to its bottom, and the laced part D is brought to anſwer to the courſe of the large crural veſſels on the inſide of the thigh. Then the lace is drawn ſo tight, that the bend-leather may gripe the thigh all round, by which the

whole weight will not reſt upon the cicatrix of the ſtump on the ſides of the box, but the teguments of the thigh all bear a ſhare, while the tight lacing will have no bad effect in ſtopping the circulation, the larger veſſels being free from any compreſſion. E comes upon the outſide of the thigh, as high as the great trochanter; and F covers the glutæi muſcles, and, being pliable, allows them and the joint to move eaſily. The belt GG is then, faſtened round the loins; and the ſtraps K, L, are ſecured by the buckles *m*, *n*, to ſupport the inſtrument in the inſide of the thigh.

If the belt GG does not ſupport all well enough, a ſuſpenſory muſt be put over the ſhoulders, to be faſtened to it at two different parts both before and behind.

Any who read the preceding hiſtory, and conſider the nature of the matter evacuated at the ſinus, its ſmall quantity, the feveriſh ſymptoms coming upon this, nature's effort to throw it off by a new ſuppuration, and by the ſkin where it erodes the conduits, it could not paſs, and hæmorrhages, fungi, &c. that came on afterwards, will obſerve very ſtrong marks of a ſharp purulent matter reaſſumed into the blood; and, from the ſucceſs of this caſe, ſurgeons may be encouraged to undertake operations to patients with very unfavourable ſymptoms, when they can thereby take away a *fomes purulentus*, or any other cauſe upon which the ſymptoms depend. That it may not be thought I recommend bold operations from the ſucceſs of this ſingle inſtance, I muſt tell you, that, among the ſmall number which our Infirmary, ſo lately erected, can maintain, there are ſeveral ſuch other caſes recorded. 1. Patrick Higgins, fourteen years of age, with the bones of his leg carious, hectic fever, colliquative ſweats, and diarrhœa, was received into the Infirmary, September 17. 1730, where his leg was amputated, and went out of it plump and ſtrong, with a firm cicatrice, 21ſt December thereafter. 2. Margaret Cleghorn, hectic, weak, and emaciated, with the bones of the foot and leg carious, was admitted 2d March 1732, underwent the ſame operation, and was perfectly cured. 3. Iſabel Blackadder, whoſe hiſtory I have already related. And, analogous to theſe caſes, I have ſeen people in much the ſame circumſtances from very large ulcerated bleeding cancers, large internal abſceſſes of the liver, kidney, &c. who recovered daily after the amputation of the cancer, or opening the abſceſſes.

Plate II.

Fig. 1.

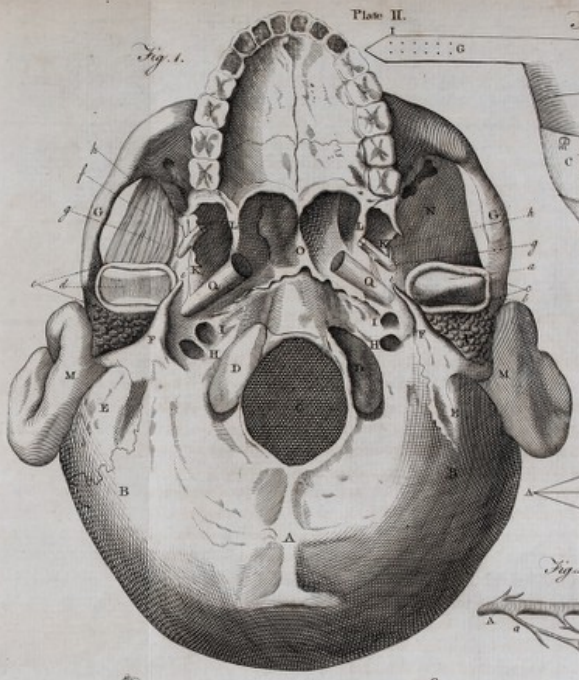


Fig. 8.

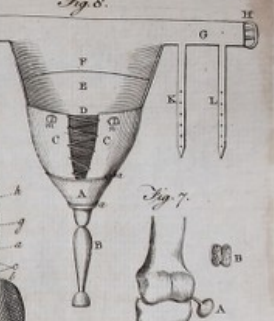


Fig. 7.

Fig. 2.

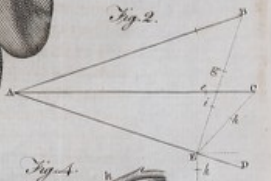


Fig. 4.

Fig. 3.

Fig. 5.

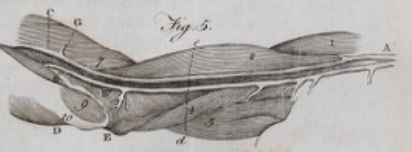


Fig. 6.

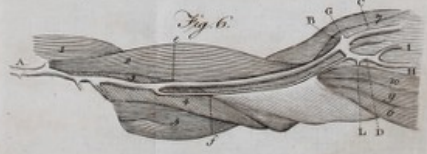
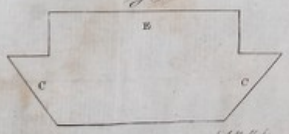


Fig. 9.



N° 20.

REMARKS

ON THE

AMPUTATIONS of the larger EXTREMITIES.

IN the operations of ſurgery, there are a number of little circumſtances, ſeveral of which ſeem at firſt view to be of no great conſequence; but, when their obſervation or neglect comes to be attended to in practice, they are found to contribute conſiderably to a ſpeedy or tedious cure, to bring on or prevent bad ſymptoms, to keep the patient eaſy, and preſerve him, or to put him to pain, and bring him into danger: and therefore their good or bad effects ought to be duly conſidered, and the proper caution concerning them ought to be given, by thoſe who write for the public upon ſuch ſubjects; in which particular our chirurgical authors are for moſt part very negligent. As an example of this, I ſhall make ſome remarks on the amputations of the larger extremities; an operation, than which there is none of thoſe that are called the greater or more dangerous, more frequently performed, and about which the directions ſeem to be very particular, and confirmed by the frequently repeated experience of authors.

This operation of amputation conſiſts in a proper precaution to prevent any hæmorrhage during the operation; cutting all the ſoft parts, which cover the bone or bones; ſawing it or them through; ſecuring the cut veſſels from bleeding afterwards; and dreſſing, ſo as to promote a ſafe and eaſy cure. In this order, then, I ſhall make my remarks.

The precaution taken to prevent a hæmorrhage during the operation, is by applying Petit's, or the common tourniquet. I ſhall refer to what the contriver Mr Petit ſays (*a*) of the advantages and conveniences of his inſtrument;

(*a*) Memoires de l'Acad. des Sciences, 1718.

ſtrument; and ſhall only conſider the common one, which ſurgeons, who generally have not, or do not know the other, do commonly make uſe of. It conſiſts of a thick ſubſtance, to be placed on the large common artery of the member, for compreſſing it; a circular compreſs to be put round the limb, to defend the teguments; a ſtrong ſtrap that is to be twiſted; a ſmall ſtick with which the twiſting of the ſtrap is to be made; and a ſmall piece of paſteboard or horn, to allow the twiſting to be made more eaſily, and to defend the teguments below the twiſted part from being hurt by it.

Several French authors order a thick compreſs to be placed over the artery for its compreſſion: but a roller, which our ſurgeons generally uſe, is much preferable; becauſe, as the arteries lie deep in the interſtices of muſcles, between which the compreſſing ſubſtance muſt ſink before it can affect the arteries, this cannot be done near ſo well by the plain ſurface of a compreſs, as by a convex roller.

The ſize of this roller muſt be proportioned to the diſtance between the muſcles, and to the depth of the ſituation of the artery. If the roller is too thick, it will be borne off from the artery by the muſcles; and if it is too ſmall, the muſcles will hinder the twiſted ligature from preſſing it ſufficiently on the artery.

Not only muſt the ſize of the roller be regarded, but care muſt be taken to roll it up of a due firmneſs: If it is too ſoft, it will have the fault mentioned of the compreſs; if it is too hard, it preſſes with too narrow a ſurface, from below which the artery may ſlide, and the circulation may therefore be continued in it after the ligature or ſtrap is fully twiſted. One muſt eaſily judge that ſuch a firmneſs is required in the roller as allows it to retain its cylindrical form, till a conſiderable force is applied to make it a little flat.

Authors in their writings, and ſurgeons in performing this operation, are uncertain in the application of the circular compreſs of the tourniquet. Some put this compreſs round the member, before they place the roller on the artery; which may be attended with very bad conſequences: for, if it be wrapped looſely round, it comes to be wrinkled and doubled by the twiſted ſtrap, which both hurts the ſkin, and hinders the twiſting; if it be put tight round, it keeps off the roller from ſinking between

between the muſcles, and the hæmorrhage is not prevented, as I have ſeen happen both from this cauſe and too hard a roller. The roller ought therefore always to be applied firſt upon the artery, and then the circular compreſs is to be drawn tight over both roller and member.

If the roller and compreſs are not ſewed to each other, the roller may ſometimes be in hazard of ſhuffling out from below the compreſs in the time of the operation, and for moſt part will do it when the twiſting ſtrap is left looſe after the operation, and all the dreſſings are applied, which may be attended with danger of hæmorrhage during the operation, and the ſurgeon is diſappointed of uſing the tourniquet ſo quickly as he would wiſh, if any bleeding happens after the operation. Not only therefore ought the roller and compreſs to be ſewed together, but the ends of the compreſs ought to be ſo ſecured that it may not fall off.

I have nothing to remark on the common directions for the ſtrap, paſteboard, twiſting-ſtick, and the twiſting, unleſs to take care that the ſtrap is ſtrong enough, and no way worn, leſt it break, and the veſſels be let looſe upon the operator in the middle of the operation. If ſuch an accident ſhould happen, the ſurgeon had need to keep his preſence of mind; which if he does, there will be no great danger: for an aſſiſtant may ſupply the want of the tourniquet, by griping the roller firmly, till either a new ſtrap is provided, or rather till the ſurgeon has finiſhed the operation; which it is his buſineſs to do, in ſuch circumſtances, as quickly as he can. Nay, though there is no ſuch aſſiſtant, the ſurgeon, by ſawing the bones through very quickly, and then putting his fingers on the large arteries, till he has brought the ſtitches round them with the other hand, may prevent too great a loſs of blood.

In cutting the ſoft parts which cover the bones, all care ſhould be taken to have the ſkin and bone as equal with the ſurface of the wound in the muſcles as poſſible; for, if the ſkin is retracted much in the circumference of the wound, and the bone jets out far in the middle, a tedious cure is to be expected. For this purpoſe, the ſkin is not only to be drawn firmly up, while the fillet, which is put immediately above where the circular inciſion is to be made, is applied tightly, but the aſſiſtant who holds the upper extremity of the member, is to draw the ſkin, and, if he can, the muſcles too, as tightly as poſſible, both to ſave them, and

to

to keep them tenſe, by which they cut much more eaſily. And the operator is not only previouſly to cut the ſkin round, and then to make the circular inciſion of the muſcles cloſe by its upper cut edge in the thigh, and other places where a ſtrong retraction of the ſoft part is expected, as is recommended by ſome late French writers; but, after cutting the perioſteum round as near to the fleſh as poſſible, he is to ſcrape it upwards with the edge of his knife, by which the ſide of the blade muſt puſh upwards the muſcles which are next to the bone, and which retract leaſt becauſe of their connection to the bone; ſo that, the bone being ſawed near to the fleſh, the whole ſurface of the ſtump may be plain, without any pyramidal prominence in the middle, which not only protracts the cure by its larger ſurface and diſtance of the ſkin from the bone, but is a great inconvenience to the patient ever after by the prominence being perpetually galled with every thing that preſſes on it.

Before the ſaw is to be applied, a piece of ſlit linen is always ordered to be put round the bone, wherewith the ſoft parts may be drawn up and defended from the teeth of the ſaw. I have almoſt always ſeen one of two inconveniences happen from this piece of linen: Either the ſurgeon applied his ſaw ſo cloſe to it, that the linen was engaged in the teeth of the ſaw, which made it impracticable for the ſurgeon to go on in ſawing, till it was diſengaged; or elſe, to ſhun this, he left too much of the bone without the fleſh, with a greater chance of a tedious exfoliation, and a certainty of a pyramidal ſtump. This linen ought either not to be applied, from the want of which I never ſaw any inconvenience; or it ought not to be allowed to touch the bone, that the ſurgeon may be at liberty to apply his ſaw upon the bone cloſe enough to the fleſh.

The common directions are ſufficient for the ſawing.

To ſecure the cut veſſels from bleeding, aſtringents and other ſtyptics are found altogether inſufficient in ſuch amputations as I now treat of. Cauſtics are both uncertain, and deſtroy more than is neceſſary. Compreſſion by common bandages cannot reſtrain the hæmorrhage; and Mr Petit's new compreſſing machine (*a*), if it is to be depended on to ſtop the bleeding of arteries in the muſcular part of the thigh at a diſtance from any bone, or if it can be applied to that artery of the leg which lies

(*a*) Memoires de l'Acad. des Sciences, 1731.

lies cloſe to the ſide of the fibula where it pierces through the ligament between the bones, will be long before it is in the poſſeſſion of moſt ſurgeons. The artery-forceps is generally neglected now as an inconvenient inſtrument, with which a ſurgeon may tear the artery, or may make a ligature which is too eaſily puſhed off the ends of the veſſels. Stitching with a needle and thread has been found by numberleſs trials to be ſuch a ſafe and ſure method of ſtopping the bleeding of large arteries, that it is now univerſally practiſed among us, and therefore is what I ſhall only here conſider.

The form of the needles employed here, amd the way of making a thin flat ribband, by waxing a number of ſmall threads together for tying the veſſels, inſtead of the common round threads formerly uſed, are now too well known to be inſiſted on.

In puſhing the needle round the artery, the ſurgeon ſhould be careful to carry it within the ſubſtance he pierces, two thirds or three fourths of the circumference of the artery: for, if the thread is only lodged within the fleſh of one half or leſs of that circumference, the artery may be miſſed altogether in drawing the ligature, or ſuch a ſmall part of one ſide of the extremity of the artery may be taken into the nooſe of the knot, that it will eaſily ſlide off; and though the bleeding appears ſufficiently guarded againſt at firſt, yet a freſh hæmorrhage begins ſoon after. I remember once to have ſeen this accident occaſioned in the manner now deſcribed.

In paſſing the needle thus, as few muſcular fibres, tendons, or ligaments, ought to be taken within the nooſe as poſſible, but the ſurgeon ſhould attempt to thruſt his needle only through the cellular ſubſtance in which the arteries of the extremities lie: for the threads, when drawn, have greater effect in bringing the ſides of the artery together, when the ſubſtance comprehended in the nooſe is ſoft and thin, than when it is firm and thick; leſs pain is given by ſhunning the nervous parts; leſs ſubſtance is loſt when the tied parts fall off; and there is no ſuch danger of the ſtitches being ſo long in caſting off, and conſequently of the new fleſh growing over the knots ſo far, that they are ſcarce to be come at to cut them away, without danger of opening the artery again; or by leaving the ſtitches, ſinuous ulcers are formed in the ſtump, and no cure can be made. I have

more than once ſeen all thoſe inconveniencies, from more than was neceſſary being taken into the nooſe of the thread in ſtitching arteries. This, which I look on as a hurtful practice, has ſome reaſons to ſupport it, which has brought people into the exerciſe of it; ſuch is the fear they have of the thread's cutting the coats of the artery in tying, unleſs ſome other firm ſubſtance is taken in. But this none who makes uſe of ſuch flat thread as I mentioned, and has been the leaſt accuſtomed to make ſuch ligatures, is in any danger of; nay, it is not in any one's power to cut the coats of an artery with ſuch thread, by the ſole force of tying: indeed, by pulling outwards at the ſame time he makes the ligature, the ſurgeon may tear the artery; but this every ſurgeon guards againſt. Next it may be ſaid, in defence of comprehending the firmer ſurrounding parts within the nooſe, that otherwiſe the ligature may be puſhed by the force of the blood over the extremity of the artery: But this will be found to be without foundation too; for, as ſoon as the ligature is made, the cellular ſubſtance beyond the ſtitch, having ſtill a communication with the ſurrounding cells, ſwells, and turns firmer and harder, ſo as to prevent the thread from ſliding.

That fear of cutting the coats of arteries in tying the threads makes ſurgeons frequently tie them too looſe; if the blood is ſtopped, they require no more. But they ought to conſider, that threads tying arteries only come away afterwards by the tied parts mortifying or ſuppurating away, and that the ſooner ſuch corruption is brought on (which will be exactly in proportion to the tightneſs of the ligatures) the ſeparation of the threads will be the more ſpeedy. The rule therefore will be, that, where the artery is very large, and conſequently where the plug of coagulated blood obſtructing its orifice, the firm concretion of its ſides, the new ſprouting fleſh, or whatever elſe it is that blocks up its orifice, muſt be longer in forming, the ligature is not to be ſo very tight, that its ſeparation may be longer in making, and all hazard of hæmorrhage may be ſhunned. But, where the artery is not large, the tighter the threads are drawn, ſo much the better, that they may ſooner fall off, and the cure may be more ſpeedy.

It may be eaſily judged, from what has been ſaid that the compreſs of linen recommended by ſome authors to be put between one ſide of the

artery

artery and the nooſe of the thread, cannot be approved; the effects of it being to prevent the tight enough ligature of the veſſel; and if it ſhould ſhuffle out ſoon, an hæmorrhage muſt be expected; or, if it remains, the pus which it imbibes will become too acrid.

After the two knots are made on the ligatures of the veſſels, ſeveral writers recommend the thread's being left of ſuch a length, as to turn over on the ſide of the ſtump; but, when this is done, the blood or matter which comes from the wound never fails to glue thoſe threads ſo firmly to the other dreſſings, that theſe can ſcarce be brought off without the threads being pulled more or leſs, which endangers the tearing the extremities of the arteries, or making the threads ſlide over them, to occaſion an hæmorrhage; whereas, by leaving the threads ſo ſhort that they can ſcarce reach to the edge of the wound, they are always kept moiſt, and ſo cannot adhere to the dreſſings, to run that riſk.

In amputations, the ſurgeon ought not to content himſelf with tying only ſuch veſſels as he obſerves throwing out blood, while the patient is faint with the pain, but he ſhould endeavour to rouſe him from that faintiſh ſtate by a cordial; and then, wiping off the coagulated blood with a ſponge wet in warm water, he ſhould examine narrowly all the ſurface of the ſtump, to diſcover the bubbling ſtreams, to ſecure them before the dreſſings are put on, otherwiſe he may expect to be obliged, by a freſh hæmorrhage, to undo all.

At firſt dreſſing, ſurgeons uſe to be very anxious about the bleeding; and, for that reaſon, applied great quantities of aſtringent powders: but theſe were obſerved to purſe up the ſmall veſſels too much, and thereby to retard the ſuppuration; while, by the hard cake which they form, they gall the wound, and cannot be taken off without much difficulty and pain; and therefore they have been long diſuſed in this country. In place of which, pledgits wet with hot oil of turpentine were applied: This gave very ſharp pain; and by it ſometimes there is hazard of bringing on an hæmorrhage at its firſt application; afterwards it hardens the veſſels and reſiſts the ſuppuration, and never miſſes to ſcald and bliſter the ſkin round the ſtump; and thus creates ſuch pain as the patient complains more of than he does of the wound. If the larger veſſels be well tied, and no fault committed in applying the other dreſſings, there is

occaſion for no other application to the wound than the threads of ſoft half-worn linen, which the French call *charpie*, the Engliſh *lint*, and we *caddis*; which is a gentle abſorbent, is ſoft and eaſy to the wound, and, by the corrupting liquors it imbibes, proves one of the ſtrongeſt, moſt mild and ſafe ſuppuratives.

Great pains were commonly taken to form the lint into neat pledgits before it was applied; but it is impoſſible to make pledgits without folding the extremities of the threads, where it becomes thicker and harder, and ſo makes an unequal preſſure, which produces ſeveral ill effects. I have often ſeen wounds changed to the worſe, by the unequal compreſſion of pledgits, compreſſes, and bandages, of one dreſſing. In order to ſhun theſe inconveniencies, the lint needs only to be laid into thin parcels, as is done when pledgits are to be made; or rather the ſtump is to be covered with pieces of the new-invented ſcraped cottony lint in ſheets, cut of a proper ſhape and ſize; for with theſe the inequalities between bones or elſewhere can be perfectly well filled up, and an equal ſoft compreſſion can be made on the whole ſurface of any broad wound or ulcer; in all which the lint ought always to be applied in the form juſt now mentioned.

This way of dreſſing makes the compreſſes that are commonly deſired to be put on the extremities of the arteries, and the particular pledgits for the bones, altogether unneceſſary.

The bladder, which ſome yet recommend to be put upon the lint, is of no uſe, and only hinders the ſurgeon from diſcovering ſoon enough any oozing of blood from the ſtump, and therefore ought not to be applied.

The Malta compreſs is pretty well contrived, though it would be better to have a cap of woollen, or ſome ſuch ſubſtance, that would contain the ſtump, without any part being doubled or folding over another, as muſt be done with the angles of the Malta compreſs, which therefore make an unequal preſſure on the parts of the ſkin they are applied to. The two long compreſſes that are ordered to be applied croſs the ſtump upon the Malta, ſeem unneceſſary, if not hurtful; for being made to croſs on the middlemoſt prominent part of the dreſſing, they preſs only the bone, which anſwers no purpoſe, and they hinder the equal compreſſion which ought to be made by the bandage on the other parts of the wound. At

the

the ſame time, the ends of theſe compreſſes which are laid upwards on the member, bruiſe and gall the ſkin when the bandage is applied tight upon them. I have ſeen them ſunk their whole thickneſs into the ſkin.

The circular compreſs commonly placed round the edge of the ſtump, with its ends folded over each other, is alſo of no ſervice, and contributes to the unequal compreſſion of the parts on which it is applied. The thick narrow compreſs ordered to be put on the courſe of the large artery of the member, and the turns of the bandage directed to be made round the limb, both which are ſaid to be intended to moderate the courſe of the blood in the artery, and thereby to prevent an hæmorrhage, are effectual means of bringing the hæmorrhage, becauſe they have much greater effect in ſtopping the blood returning in the veins, than they can have in preventing the flow of it through the arteries: on which account, all the arterious canals correſponding to theſe compreſſed veins, muſt be diſtended; and, among the reſt, the cut veſſels of the ſtump muſt be greatly enlarged.

Notwithſtanding all the effectual methods we now have for preventing an hæmorrhage in amputations, ſurgeons ſtill continue to act as if they were as much afraid of it as they had reaſon before either tourniquet or ſtitching were known, and by this do ſeveral hurtful things; among the reſt, the too tight application of the bandage upon the other dreſſings is one. If the circulation is not entirely ſtopped, and a mortification brought on by it, they think it cannot be too tight. But beſides this hazard of mortification, there are ſeveral diſadvantages which they are expoſed to by this practice; whereof the very thing they are afraid of, the hæmorrhage, is one, as I ſhall endeavour to demonſtrate, in conſidering the effects of the different turns of the amputation-bandage applied tightly.

The longitudinal turns of the bandage, which are made to paſs over the middle of the ſtump in different directions, to cover it all over, exert their greateſt power againſt that middle part where the bone is, which bears over their preſſure from the other parts, and the large arteries which ſhrink up farther than the extremity of the bone cannot be affected by their preſſure. If this middle part is ſhunned in making the longitudinal turns, the fleſh only is preſſed; and therefore will be thruſt upwards

wards from the bone, which is left prominent and bare, to occaſion a tedious cure, and at laſt a pyramidal ſtump, which is always after uneaſy to the patient. The immediate effect of too great preſſure on the ſoft parts, is to hinder the ſmall veſſels from diſcharging themſelves; which creates pain and inflammation, and does not allow the ſuppuration to come on. I had occaſion to ſee this prettily confirmed in the caſe of one James Spence, who had the amputation performed in the middle of the fore-arm in the Infirmary here. By changing the poſture of the fore-arm ſoon after the operation, he had made the longitudinal turns, which went alſo round the elbow, tighter than they were at firſt applied. Three days after, there was not the leaſt appearance of ichor coming through the dreſſings, nor any ſuppurating ſmell; his pulſe became quick; and he complained of pain, throbbing, and girding in the ſtump. I judged what was the cauſe, and cut all the longitudinal turns at the elbow: in a few hours after, his complaints were all gone, and the exterior dreſſings were ſtained with the liquor oozing through them; next day all the ſymptoms of a mild plentiful ſuppuration were ſeen, and the cure was ſoon completed.

The circular turns of the bandage, when tight, muſt ſtop the return of the blood in the cutaneous veins; and, by making thus a greater reſiſtance to the blood in the arteries which anaſtomoſe with them, will occaſion the contracting power of the heart and arteries to dilate, and force more blood into their other branches; but theſe being cut in the amputation, will pour out their blood, and ſo an hæmorrhage is brought on. Analogous to this it is, that when a ligature is put round the arm or leg, it becomes all red below, the lateral branches having much more blood thrown then into them than they had when the circulation was free. It can be to this cauſe only, that a phænomenon, which ſurpriſes many ſurgeons, is owing: to wit, after dreſſing a wound according to art, it bleeds; upon taking off all the dreſſings, not a drop comes out. If the ſurgeon wiſely thinks to prevent any further blooding, by ſtill a tighter bandage, the hæmorrhage is greater, unleſs he will chooſe to riſk a mortification. To ſatisfy ſome gentlemen fully of the truth I argue for, I took the management of a tourniquet while the amputation of a thigh was performing: after the large arteries were all ſtitched, I let looſe the tourniquet,

quet, and ſcarce any drops of blood fell from the ſtump. I then gradually twiſted the tourniquet; whenever it became a little tight, the whole ſurface of the wound ſeemed oozing orifices of veſſels. I twiſted it again fully, and ſtopped them all; then untwiſting gradually, ſhowed them the ſame bubbling ſcene, till the tourniquet was quite looſe, when no more blood came.

From the whole, I would conclude, that no more is required of the bandage than to preſs the other dreſſings very gently to the wound. If a ſurgeon is to fall into any of the extremes, of too looſe or too tight bandage, the former will, in my opinion, do much leſs harm than the latter.

Our Britiſh ſurgeons would do well not to be ſo free in blood-letting as the French operators direct. I ſhall not now examine whether the French conſtitutions require this evacuation more than we do; or whether ſo frequent and plentiful evacuations of blood is a faulty practice among them, introduced at firſt by a miſtaken theory, and prevailing afterwards by cuſtom: but this is certain, that though blooding is exceedingly neceſſary in plethoric habits that undergo the amputation, and is the grand remedy when fever and inflammation ſeize a patient after this operation, it is by no means a general rule, that all who ſuffer amputation ſhould be let blood of either before or after the operation; for I have in many inſtances ſeen the cure performed without one bad accident, when the patient has ſcarce loſt two ounces of blood in the operation, and was neither blooded before nor after it; and, on the contrary, I have obſerved, in the hoſpitals at Paris and elſewhere, people ſink under the loſs of blood, dying with œdematous ſwellings in ſeveral parts.

What I find had induced practiſers to imagine, that in amputations there was a greater neceſſity of letting blood than in other wounds of equal extent with the ſtump, is their ſuppoſing, that, immediately upon a limb's being taken off, the remaining arteries of the body are obliged to circulate the quantity of blood they contained before, with the addition of what was ſent to the amputated member; which additional quantity they pretend to relieve them of by venæſection: but when it is conſidered that the amputated member takes away its proportion of the liquors of the body with it, and therefore leaves no more in the other veſ-

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ſels than they contained before, the reaſon for this practice muſt ceaſe. For ſome days after the operation, the patient is always kept on a ſpare low diet, to prevent any fulneſs; and conſequently there is no occaſion for blooding in the firſt days after an amputation, on account only of any plethora the loſs of a limb can be ſuppoſed to bring on. Afterwards, indeed, when the patient comes to recover his appetite, and a fuller diet is allowed, it is reaſonable to think a plethora may be brought on by the chylopoietic viſcera preparing a great quantity of chyle to be mixed with the blood, whoſe veſſels will be too much crowded, becauſe of the want of thoſe that have been cut off. For which reaſon, it is neceſſary for all who have loſt a large member, after their recovery, to uſe a ſpare diet, or to make frequent evacuations, otherwiſe they will probably be ſubject to the plethoric diſeaſes.

The caſes, then, in which blood-letting is required after amputation, are, when the patient is of a full habit of body, and has loſt little blood before or in the time of the operation; or when there is violent pain or ſwelling in the member, without being occaſioned by any application made to the ſtump; or when the pulſe becomes very quick and ſtrong, with heat, thirſt, and other feveriſh ſymptoms; then indeed blood-letting, ſuited in quantity and repetition to the ſymptoms and ſtrength of the patient, is abſolutely neceſſary. But if, in the firſt three or four days after the operation, the pulſe is only a little more frequent than ordinary, without violent pain or other bad ſymptom, a low diet, with cooling drinks and laxative clyſters, if the patient is coſtive, will be ſufficient.

It may perhaps ſeem ſurpriſing, that I have not mentioned hæmorrhage as one of the ſymptoms which require venæſection, the remedy univerſally employed for checking or ſtopping hæmorrhagies. My reaſon for this omiſſion, is the opinion I have, that hæmorrhage, after amputation, ſeldom requires blood-letting; nay, that the common practice is pernicious in moſt ſuch caſes.—Vigorous plethoric patients have hæmorrhage, either from neglecting to tie ſome of the large veſſels, for which ligature is proper; or from too tight bandage, which muſt be taken away or cut; or from fever, for which I have directed blood-letting: but by far the greater number of thoſe who undergo amputation of the larger extremities are weak, emaciated, and more or leſs hectic from tumours or ulcers

of

of long continuance. Theſe perſons veſſels are ſo lax, and their blood is ſo thin, that their ſtumps often bleed, during the time of the cure, from a number of imperceptible orifices. Venæſection exhauſts the ſmall remains of blood and ſtrength of ſuch patients, and increaſes both cauſes of the hæmorrhage. To ſuch, therefore, I order *pulv. cort. Peruvian.* with *pulv. ſtyptic.* ſeveral times a-day, claret warmed with cinnamon, mace, or nutmeg, as a cordial to be taken frequently; and I cauſe theſe ſpiceries and wine to be mixed with their food. The records of the Infirmary contain ſeveral hiſtories of poor patients who were brought from the brink of the grave by this method.

The phyſicians and ſurgeons of the Royal Infirmary here have always followed the method above-mentioned, and have not loſt one patient of fourteen who have had amputations of the larger extremities performed.

Since theſe fourteen, there have been eighty-five more patients in the Infirmary, who had the like operations performed on them, of whom eight died. Two of theſe eight had violent contuſions on their bodies, and the limbs had a mortification in them. The other ſix were all emaciated with hectic ſymptoms before the operation, and ſurvived it ſeveral weeks or months; ſo that the death of none of them can reaſonably be imputed to the operation.

It is generally too ſoon to take off the firſt dreſſings on the ſecond, third, or even fourth day after an imputation; for they ſtill adhere to the wound, and cannot be brought away without pain and bleeding: And there being no ſuch effectual ſuppurative as the liquor ſent out from the wound, the fifth, ſixth, or ſeventh day, is generally ſoon enough for removing the dreſſings. If the ſmell of the ichor of the wound becomes in the mean time very ſtrong and offenſive to the patient, it may be neceſſary to cut the band, and, with the aſſiſtance of ſciſſars, to take off the compreſſes and exterior part of the lint, on the third or fourth day, and to apply clean things in their place; but the lint next to the wound ought not to be removed till the ſuppuration moiſtens and ſeparates it.

At the ſecond dreſſing, there is no occaſion for any other ſuppurant, than not to be too anxious in cleaning off the pus that adheres to the ſtump, all moiſture upon the ſkin being carefully dried, to prevent excoriation.

Nothing contributes afterwards more to a ſpeedy cure than dreſſing ſeldom: The rule that might be taken from nature is, to wait till the patient is ſenſible of an uneaſy itching in the wound; which ſhews the pus is beginning to turn acrid, which commonly happens every ſecond or third day. And as I hinted formerly, an equal gentle compreſſion is of great uſe in keeping up a right ſuppuration, and preventing the growth of ſpungy fleſh.

If the threads with which the arteries were tied ſhould remain too long, (that is, three weeks or a month, according to the largeneſs of the artery), and the new ſprouting fleſh covers the ligatures, they had beſt be cut out, leſt, by the growing of the fleſh, they ſhould become ſo much covered that they can ſcarce be come at, and ſinuous ulcers ſhould be formed to prevent a cure. The beſt method of making this exciſion is, to take hold of the depending threads, and to introduce a probe or ſmall directory along them, till it enters the nooſe; which is eaſily known by drawing the nooſe very cautiouſly outwards with them, for the reſiſtance which the thread makes will very plainly be felt. Upon the probe or directory, ſlide in one blade of a pair of ſciſſars a little opened, till the point of it is where the other inſtrument was, and the point of the other blade is conſequently on the outſide of the nooſe when it is ſniped in two, and is eaſily drawn out. In bringing the threads away in this cautious manner, there is no danger of bringing on an hæmorrhage from the artery round which the thread had been tied; for long before this time, ſo much of what was taken at firſt into the nooſe muſt have fallen off, to make it quite looſe, and without any effect upon the artery.

If the patient is of a tolerable habit of body, and is managed in the manner above deſcribed, dry lint, and ſometimes touching the ſprouting fleſh with lunar cauſtic, are all the medicines neceſſary towards a complete cure, without any exfoliation of the bone; which the ſurgeon ought to be ſo far from endeavouring to promote, unleſs he ſees the bone corrupted by ſome accident or miſmanagement, that, on the contrary, it ſhould be his ſtudy how to prevent it. The common methods for which, as alſo for procuring an exfoliation, are, in my opinion, very faulty. Of the fourteen who ſufferd amputation in the Infirmary, there was no exfoliation from any of their bones, except from the thigh-bone of Alexander

Sheppard

Sheppard (*a*). In two others, Iſabel Blackader and John M'Millan, who had the amputation alſo performed above the knee, towards the end of their cure there was a very ſmall piece or two of bone obſerved among the pus: but in no other was there any thing like bone ſeen to come off, though in ſome of them it was thought altogether improbable to prevent ſome corruption and conſequent ſeparation of a part of the bone; particularly in Margaret Cleghorn, whoſe tibia and fibula were ſo ſpongy at the place of amputation below the knee, that, had their condition been known before, the knife might have been made to cut them through as well as the teguments and muſcles. Notwithſtanding which, and a bad hectic habit of body, both bones were quite covered with fleſh at the third or fourth dreſſing, the wound healed ſoon, and the cicatrice has remained now firm ſeveral years.

In theſe remarks on amputations, I have blended the rules of management ſo with reaſoning, that ſeveral readers will not at firſt have a full orderly view of all the ſteps to be taken in performing this operation after the manner I have propoſed; nor do I deſign to ſum up the agenda, on purpoſe that thoſe who have moſt need of rules, I mean the young ſurgeons, may have them more firmly fixed in their memories, by taking the trouble to compare what they read in the books of chirurgical operations with what has been ſaid here, and then to form for themſelves a complete deſcription of the whole operation and method of cure, by following the order I have done, but ſupplying from their books what is here ſuperficially paſſed over as being common, and changing the ordinary directions for ſuch of mine as they ſhall think reaſonable and confirmed by practice.

(*a*) See No 19. *ſupra*.

N° 21.

HISTORIES

OF

COLLECTIONS of Bloody LYMPH in Cancerous BREASTS.

NO mention being generally made by chirurgical writers of a collection of bloody lymph in the breaſts of women, as a conſequence or attendant of the ſcirrhous or cancerous tumours of thoſe glandular parts, the following hiſtories of ſuch caſes may at leaſt teach practiſers to know when they meet with ſuch a diſeaſe, and may ſave them from being accuſed of deſtroying their patients by their ignorance.

I. A woman about fifty years of age ſhowed me her right breaſt, in the exterior ſide of which there was a large very hard unequal tumour, in which ſhe frequently felt a ſharp pain. In the hollow of the arm-pit was ſuch another hard tumour. Both of them had increaſed very ſlowly.

I ordered her to be let blood of, to take a cooling purgative ptiſan once a-week, and to live on a ſpare cooling diet, which ſoon made the pains eaſier. Some people, however, having promiſed to make a complete cure of her breaſt, prevailed on her to apply warm ſuppurative cataplaſms to the part; which brought a fluctuation of liquor that was believed to be a complete ſuppuration, till it broke, when, as the woman and her relations informed me, about four pounds of bloody water ran out: After which the woman was in conſtant violent racking pain, which made her again deſire me to viſit her. Near the arm-pit, there was then an orifice which could admit three fingers at once, that was the entry to a very large hollow ulcer, from which there was a conſtant diſcharge of abominably ſtinking watery ſanies. Upon preſſing the ſac, I made ſeveral

ſpoonfuls

ſpoonfuls of this liquor to run out. The woman was ſo weak that ſhe could not turn herſelf in her bed, to which ſhe was confined; her pulſe was very quick and low; ſhe had a diarrhœa, night-ſweats, and cough; and was kept conſtantly awake by the ſharp pains of the ſore.

To make her ſomewhat eaſier the ſhort time ſhe had to live, I made tepid roſe-water, with a little vinegar, brandy, and liquid laudanum, to be injected into the ſac frequently; and gave her a cordial julep, with ſome laudanum to be taken ſometimes: By which the pain was blunted during the two days more ſhe lived.

II. My advice was aſked for a middle-aged woman living in the country, who had been two years ſenſible of a hard tumour in the upper part of her left breaſt, which was very ſmall in the beginning, but was increaſed gradually to a great bulk, notwithſtanding different medicines ſhe had taken, and the application of mercurial and gummous plaſters, &c. The cutaneous veins of this breaſt were turgid; the ſkin was become red; lancinating pains often pierced through the tumour, which was very hard. At the time of the menſtrual evacuation, the tumour became ſo large as to appear to be fixed to the ribs, upon plentiful blood-letting ſubſided, and was again moveable.

My opinion was, that either the breaſt ſhould be extirpated: or, if that was not conſented to, by general evacuations and a low diet, the increaſe of the tumour ſhould be retarded; and by a cooling lotion, ſuch as *acet. lethargyr.* diluted with water, the inflammation of the ſkin ſhould be prevented.

Some time after, my correſpondent wrote to me, that the tumour had ſuddenly increaſed to a very great bulk, with an increaſe of the pain: that it then became ſoft in ſome parts, with a fluctuation of liquor, while the hard tubercles were felt at other parts: that at length the whole tumour became red, ſoft, and full of liquor; and had been opened at the lower part, when two pounds of a bloody water, which had no ſmell, were evacuated.

Next day the pain was much more violent than formerly; the wound had a cadaverous ſmell; and the ſuperior part of the breaſt was ſtill turgid with liquor: To evacuate which, another inciſion was made; and, four pounds of the bloody water being let out, the breaſt became very flaccid,

flaccid, the pain increaſed violently, a gangrene appeared on all the ſkin of the breaſt, and next morning their patient died.

When the breaſt was diſſected afterwards, it was found to be an empty bag without any tumefied gland in it.

III. A middle-aged woman, mother of ſeveral children, who had always been of a weak habit, and ſubject to nervous diſorders, having accidentally bruiſed her right breaſt ſlightly, felt ſoon after a hard tubercle toward the exterior ſide of that breaſt, which, notwithſtanding ſome purgatives and aperient decoctions that were given to her, increaſed conſiderably. She was with child when I firſt ſaw her along with ſeveral other gentlemen, who thought the extirpation proper: But her condition prevented its then being performed; and gentle deobſtruents, with mild food, were recommended.

The tumour grew bigger, a ſmall hard knot formed below the edge of the pectoral muſcle, and the axillary glands tumefied and became hard.

She aborted in the ſixth month of her pregnancy; and had a very plentiful diſcharge of lochia, but without any change being made on the tumours. As ſoon as ſhe had recovered from the abortion, ſhe took rhubarb and other mild purgatives frequently; her menſes returned in ſufficient quantity at the regular periods; ſhe was more free of the nervous diſorders than ſhe had been for a conſiderable time; the tumours however in her breaſt and arm-pit increaſed faſt.

After the whole breaſt ſeemed to be ſcirrhous, a fluctuation of liquor was perceived in ſeveral places toward the exterior and ſuperior part of the tumour, and ſhe complained of pricking pains in it. Soon after, the breaſt ſwelled faſt, the fluctuation was felt every where in it, and the veins of the ſkin became very large and varicous, the uneaſineſs from the weight and pain keeping the patient almoſt entirely from ſleep.

The teguments at laſt turning red, pointing, and ſo thin that they would ſoon have been opened by the liquor, a very ſmall lancet was puſhed into a depending part of it free from large veins, and three pounds of a blackiſh red lymph were allowed to run out; and the further evacuation at that time was prevented by a tent adapted to the ſmall orifice, ſecured by a piece of adheſive plaſter.

The

The liquor which was drawn off had no ſmell; and, when expoſed to heat, coagulated as the ſerum of the blood does.

The patient bore the evacuation well, and was eaſier than ordinary all day.

Next morning, when the dreſſings were removed, the ſkin appeared of a natural colour, and the veins were all contracted. A pound of the ſame ſort of bloody lymph flowed out of the wound. After which the glandular part in the middle of that breaſt could be diſtinctly felt, and did not ſeem larger than the glandular part of the other breaſt; but the tubercle at the edge of the pectoral muſcle, and the hardened axillary glands, were as large as ever.

After the ſecond dreſſing, the patient complained of a ſharp pain near to the wound; which being ſuſpected to be occaſioned by the point of the tent touching ſome of the glandular parts, now when the breaſt was collapſed, it was changed for one no longer than would go no deeper than the thickneſs of the lips of the wound.

Betwixt this third and the fourth dreſſing, the lymph oozed at the ſides of the tent, and had ſomewhat of a putrid ſmell.

On the fourth day after the opening, the teguments were ſo thin as to allow the original tumour in the exterior part of the breaſt to be diſtinctly felt; and it ſeemed rather larger than when it began to be concealed by the collection of lymph.

On the fifth and ſixth day, there was little change; only the lymph became more fœtid, and more of an aſhy colour.

Seventh, the large tumour of the breaſt felt ſofter.

Eighth, the quantity of lymph was leſs, and ſome tolerably good pus came out upon the tent. The ſmell and conſtant oozing of the lymph being uneaſy to the patient, a ſponge dipt in *aq. calc.* and *aq. Regin. Hungar.* and afterwards preſſed near dry, was laid over the breaſt.

During the eleven following days the appearances mended; for the quantity of liquor flowing by the orifice decreaſed, its ſmell became leſs fœtid, and its conſiſtence was nearer to that of pus; at the ſame time the large tumour became leſs and ſofter.

Afterwards frequent ſuppurations came on in different parts of the teguments: The glandular tumour increaſing, the pain deprived the patient

tient of ſleep, and, with the evacuation, waſted her, took away her appetite, and made her gradually weaker; ſo that, after ſuffering, for two months more, all the uneaſineſs which commonly attends ulcerated cancers, ſhe died.

IV. A woman who had born ſeveral children, being again with child in 1733, the 37th of her age, obſerved the nipple of her right breaſt drawn inwards, ſo that, when ſhe was brought to bed, the child could not catch hold of it to ſuck it.

When this child was a year old, the mother was ſuddenly frightened when her menſes were on her; which put them away, and ſhe never after had any return of them.

In March 1739, ſhe recovered from a dangerous fever; ſoon after which, ſhe was expoſed to cold, and was violently in wrath, fear, and grief, receiving at the ſame time a bruiſe on her right breaſt. This ſhock confined her to her bed three months; and ſoon after it, ſhe perceived a ſmall painful red tumour in the inferior exterior part of the right breaſt, which ſhe neglected.

In the end of July 1740, when I ſaw her firſt, the right breaſt was very large and hard, with ſuch ſharp pain that ſhe ſlept none; the veins of the ſkin were varicous, and the nipple was ſhrunk out of ſight: I however felt a fluctuation in it, and judged it to be ſuch a caſe as the preceding.

Next day, July 31ſt, I made a young gentleman, my pupil, put a ſmall lancet in the inferior anterior part, where it was thinneſt and moſt prominent. He let out eight ounces of a bloody lymph, without ſmell, but ſalt when taſted; which, held in a ſpoon over a candle, coagulated. A very ſhort tent was put into the orifice, ſecured from going into the cavity by a thread, and hindered from coming out by an adheſive plaſter. She ſlept better that night, having leſs pain.

Auguſt 1ſt, Four ounces of the ſame ſort of lymph ran out, the tumour was leſs, the ſkin was of a natural colour, and the veins were contracted. A little lime-water and melroſe were injected tepid into the cavity of the ulcer.

Auguſt 3. Two ounces and an half of liquor ran out of the ſore: This liquor

liquor was more of a purple colour, and leſs ſalt to the taſte. It was dreſſed as formerly.

4th, The tumour felt as if divided in the middle, and as if it were falling to pieces; her appetite was better, the pain leſs; an ounce of liquor ran out; the dreſſings the ſame.

5th, She underwent what the women call a *weed*, which reſembles the paroxyſm of an ague. This day the liquor evacuated at the ſore was in greater quantity, thinner, darker coloured, more fœtid, and, when held in a ſpoon over a candle, did not coagulate. By drinking plentifully of thin warm liquor, ſhe had a profuſe ſweat, which carried off the weed.

6th, The tumour was harder, the pain greater, the liquor fœtid; a little digeſtive was added to the injection.

Two months attempts were made to melt down the hardneſs; but ſo unſucceſsfully, that it increaſed, became more painful, and waſted her: yet ſhe abſolutely all the while refuſed to let it be cut off. Her left breaſt then inflamed, was ſoon brought to ſuppuration by proper applications, and cured in few days.

Soon after, five ſmall tubercles were obſerved in the right arm-pit: which diſappeared in a few days, upon a fungous excreſcence thruſting out at the orifice in the breaſt of the ſame ſide, and ſome long tough ſubſtances coming out with the matter.

Some days after, a ſoft equal tumour, about the ſize of a large nutmeg, without pain or diſcolouring, ſtarted up at the interior ſide of the affected breaſt, the fungus in the orifice having retired at the ſame time, and the lips retorting, with all the very bad ſymptoms of an ulcerated cancer: which in a ſhort time made her ſo miſerable, that ſhe was content to ſubmit to the amputation of the breaſt; which was done ſucceſsfully by the ſame young gentleman who, under my directions, had taken care of her from the beginning.

Some months after the wound was firmly cicatrized, and ſhe ſtrong and well, ſome knots began to appear in the arm-pit, and at the edge of the pectoral muſcle. She was frighted for more cutting; and let them increaſe and ſpread, till now ſhe ſeems to be in the way of ſuffering all the miſeries of a cancer that cannot be taken away. My prognoſtic was too much verified in this patient.

The quick return of the cancerous knots, after the extirpation of the breaſt in this caſe, calls to my remembrance a problem which I have often wiſhed to have a ſolution of, Whether ought cancerous tumours to be extirpated, or ought the palliative method only to be followed when they cannot be reſolved?

The reſolution of a cancer I acknowledge to be very rare; but having ſeen two ſuch tumours, or at leaſt what I judged to be ſuch, cured, I would not exclude the ſuppoſition altogether.

To encourage others to tell their experience and opinion, I ſhall give mine.

Of near ſixty cancers, which I have been preſent at the extirpation of, only four patients remained free of the diſeaſe for two years. Three of theſe lucky people had occult cancers in the breaſts, and the fourth had an ulcerated cancer of the lip.

The diſeaſe does not return always to the part where the former tumour was taken away; but more frequently in the neighbourhood, and ſometimes at a conſiderable diſtance.

Upon a relapſe, the diſeaſe in thoſe I ſaw was more violent, and made a much quicker progreſs than it did in others on whom no operation had been performed.

When an ulcerated cancer, that can be extirpated, is waſting the patient ſo faſt, that it muſt bring death in a ſhort time, there ſeems little doubt that it ought to be taken away, as the only means of prolonging life.

If an occult cancer is occaſioned to a young healthy perſon by a bruiſe, or ſuch other external cauſe, the hope of eſcaping a relapſe would perſuade us to extirpate it.

In all other cancerous caſes, the earneſt intreaty of the patients who have had the danger of a relapſe fairly explained to them, and not the ſurgeon's perſuaſions, ſhould make the extirpation be undertaken.

My practice continues to confirm what I have here ſaid (which was written ſeveral years ago) concerning the frequent return of cancers, notwithſtanding many attempts of different kinds to prevent it. Courſes of mercury, drinking the decoction of guajac, aperient roots, millepedes, and ſuch other attenuants and deobſtruents, did no good. What did moſt

ſervice,

ſervice, was the keeping a part of the wound, made in the extirpation, open in the form of a perpetual iſſue; which retarded the return ſo long in ſome patients, that I flattered myſelf I had at laſt hit on the preſervative againſt a relapſe. But even in this I have been diſappointed.

Since the above was firſt written *, I have ſeen many cancers return after extirpation; and very few that did not return, notwithſtanding the uſe of *mercury*, *guajac*, *millepedes*, *verrucæ equinæ*, and a variety of other medicines, which were given with a deſign of freeing the blood of the cancerous matter. One woman, who had a large cancerous mamma extirpated, had part of the wound kept open in form of a perpetual iſſue, and remained long without a relapſe; which made me hope ſuch drains would be preſervatives againſt a return of ſcirrhous tumours: but they have failed in ſeveral other caſes.——Sea-water, taken frequently in ſuch quantity as to purge gently, is ſaid to have diſcuſſed ſcirrhous tumours; but I do not know that ſufficient trials of it have yet been made.

* Originally inſerted in the Edin. Med. Eſſays.

N° 22.

Cure of an Ulcer of the Lungs by Blood-letting.

THE ulcer of the lungs is a diſeaſe ſo frequently fatal, that ſome of the ableſt phyſicians make it a queſtion, whether ever a conſumption from that cauſe has been cured. And indeed whoever conſiders the important office of this viſcus, its ſpungy texture, its perpetual motion, and the particular rapidity with which the copious blood pours through its veſſels, will not be greatly ſurpriſed that a ſuppuration here ſhould ſo little yield to the efforts of phyſic.

A good many different methods of cure have been tried; but none of them is much celebrated for its ſucceſs. A new one has been lately recommended; which, in my humble opinion, is by no means abſurd, I mean that of frequent bleeding in ſmall quantities.

Young people of plethoric habits, and ſuch as have been accuſtomed to frequent blood-lettings, are very often ſubject to this diſeaſe; and in theſe it is to be generally obſerved moſt acute, and to ſlide on the faſteſt to its cataſtrophe. In ſuch patients, I ſhould take Dr Dover's method of cure to be extremely reaſonable, eſpecially if it is uſed with proper cautions, and before the conſtitution is much drained of its natural fluids.

I ſhall offer the reaſons that occur to me in behalf of this doctrine. Any body, I believe, will allow, that to heal the ulcer is to cure the diſeaſe; and this method, I think, bids as fair to do that as any. It is granted on all ſides, that ſome degree at leaſt of a fever is neceſſary to the making of pus; and that the quantity of pus will always be, *cæteris paribus*, in proportion to the force of the heart. It is likewiſe undeniable, that the more the circulation is hurried, the conſtitution is the more heated, the purulent matter acquires the greater virulency, becomes the ſooner thin, and is the faſter reſorbed; while in the mean time the circulating fluids are attenuated, exalted, and expelled the faſter. Thus the

whole

whole train of hectic ſymptoms is very remarkably influenced, or rather their degree of virulence is entirely determined, by the velocity of the blood. The reſorbed pus occaſions the hectic fever, and that again prepares new pus; that is to ſay, ſupplies freſh fuel to the diſeaſe. And thus the ſtruggle is maintained till the heart ceaſes to beat.

Now, as blood-letting is the moſt effectual way to abate the force of the heart, it muſt of courſe diminiſh the quantity of pus, and alleviate all the bad ſymptoms that owe their origin to this fomes. The mere ſubtracting of acrimonious blood, too, ſeems to be no deſpicable advantage, ſince this diminution may eaſily be repaired by the addition of more laudable juices from the aliments; which, in this caſe, ought always to be of a mild kindly nature, eaſily elaborated, and for the moſt part aceſcent, to be adminiſtered frequently, and in ſmall quantities at a time. And, beſides, if bleeding takes off, or conſiderably abates, the hectic fever, it may come to be of no real expence at all, ſince by this means the great waſte of fluids, by colliquative ſweats, or diarrhœa, will be ſaved. For which reaſons it might perhaps be, with proper cautions, ventured upon, even in patients that are already pretty much exhauſted: ſeeing it is certain, that their veſſels are ſtill exquiſitely full, and may, in proportion to their contracted ſtate, even ſuffer a plethora; which appears often in the weaker ſex, who are frequently viſited with regular returns of their menſes to the very laſt ſtage of the diſeaſe, notwithſtanding all the loſs they undergo by plentiful colliquative diſcharges.

But the good ſucceſs of riding, and other exerciſes, in the cure of conſumptions, may be objected to this reaſoning, ſince theſe concuſſions and agitations of the body ſhould, according to this ſcheme, by accelerating the motion of the blood, rather aggravate the malady, and ſpur it on to its laſt fatal ſtage, than contribute to its cure. This fact, at firſt ſight, ſeems to ſhake the doctrine here advanced; but, when more narrowly conſidered, I am apt to think it rather ſtrengthens it: For beſides the advantages of corroborating the flaccid fibres, and compacting the melted fluids into a juſt denſity, there is perhaps a very conſiderable one procured from theſe exerciſes, by their enabling the veſſels to throw out the purulent miaſmata as faſt as they are taken in; and as by this means an accumulation of reſorbed pus is prevented, the hectic paroxyſm, during which

which the ulcer is moſt ſupplied with new pus, is either quite cut off, or much mitigated.

In a word, the particular violence with which this diſeaſe is obſerved to act, and the uncommon diſpatch with which it proceeds, in plethoric habits and warm conſtitutions, plainly ſeems to indicate this practice at leaſt in ſuch patients.

Blood-letting will, for the ſame reaſons, be equally juſtifiable in all internal ulcers, though there ſeems to be the greateſt neceſſity for it when the lungs are the ſeat of the diſeaſe, upon account of the abundant torrent of blood that rolls with ſo much fury through their numberleſs veſſels.

Before I put an end to this paper, I muſt take the liberty to propoſe a few queries, concerning the management of conſumptions by this method, which I ſhall ſubmit to the conſideration of proper judges.

1. Whether is it not a reaſonable piece of caution to abſtain from blooding, as long as there are any well-grounded ſuſpicions of abſceſſes yet unbroken in the lungs, ſince bleeding in that caſe would only weaken the patient to no purpoſe? And whether all the proper methods of deterging and expectorating ought not to be diligently uſed before bleeding is called in?

2. Whether it is not the moſt proper time to let blood when the patient is pretty much recovered from the fatigue of his laſt paroxyſm, after his having cleared his lungs as much as poſſible by coughing?

3. Whether, in the very time that the blood ſprings, it may not be adviſeable to make him draw in gently aſtringent, drying, and balſamic ſteams, ſuch as of myrrh, maſtic, &c.?

4. Whether the more volatile, detergent, and antiſeptic medicines, ſuch as aloes, myrrh, vinegar, kindled pitch, ſulphur, &c. might not be happily conveyed to the lungs in this ſhape?

5. Whether there may not frequently be harm in inſiſting much upon expectoration? ſince by this means the ulcer is ſtill kept crude; the plexus of new tender veſſels is broken in forming; the lungs are robbed of that lymphatic and mucous moiſture, which would much contribute to heal the ulcer (*a*); and their nerves are laid bare to every ſtimulating cauſe; whence

(*a*) This is in conſequence of an obſervation made in an Eſſay on the nutrition of Fœtuſes, Vol. II. Med. Eſſays, or No XI. of this Collection.

whence an inceſſant cough, and all its bad effects. May not antiſeptic ſteams, and a mild aceſcent diet, iſſues, &c. much take off the neceſſity of expectorating medicines? Are mild pacifics, (the preparations of our own poppies, eſpecially their ſeeds, in form of emulſion), mixed in ſmall quantities with balſamic, refrigerating, and gently detergent materials, to be allowed only at night? And even during the operation of the paregorics, will not the lungs, (if their tone is not much enervated, and the opiates are not too ſtrong), when their veſſels begin to be overburdened, be ſufficient, of their own accord, in moſt caſes, to expel the offending load, without the aſſiſtance of any more artificial ſtimulus? Does not the ſucceſs of opium in the catarrh, even when the mucus is very thick and hard to be diſcharged, warrant this practice, and even invite us to it?

Laſtly, would not the bark, and other medicines that corroborate without ſtimulating much, frictions, and gentle exerciſe, be neceſſarily uſed at the ſame time with blooding, to aſſiſt in curing the hectic fever, and to prevent crudities, hydropic collections, tumours, and other bad ſymptoms, that might probably be introduced by loſs of blood?

N° 23.

No 23.

An uncommon DROPSY from a ſteatomatous OMENTUM.

CHRISTIAN SETON was ſubject to the eryſipelas in her legs from her youth. At 31 years of age ſhe married, but never conceived. Her menſes left her when ſhe was 39 years old. Three years after, viz. in July 1727, ſhe perceived her belly turning bigger than naturally it uſed to be, which ſhe imagined was occaſioned by a draught of ſour wine which ſhe had taken two years before. In Auguſt following, her legs alſo began to ſwell, when ſhe aſked the advice of ſome phyſician. He ordered her ſeveral purgatives and other medicines; notwithſtanding which, her diſeaſe increaſed very faſt.

When I firſt ſaw her in the beginning of October, her belly was ſwelled ſo big, as to reach down beyond the middle of her thighs when ſhe was ſitting. The baſtard ribs, and *regio epigaſtrica*, were violently protruded outwards, and the point of the xiphoid cartilage was turned directly forwards. Her thighs and legs were œdematous, and double their natural thickneſs. The upper part of the trunk of her body, her face, and ſuperior extremities, were greatly emaciated. She had no appetite for food; but had a thirſt, though not violent. Her tongue was moiſt, but ſlimy. She was coſtive, and paſſed very little urine. The pulſe was weak and frequent. The breathing was ſo difficult, that ſhe durſt not lie down, but was obliged to ſit always in an erect poſture. A perpetual cough, night and day, kept her from ſleep; and with the cough ſhe ſpit up a thick mucus. She was ſo weak as not to be able to ſtand. On ſtriking the belly, a fluctuation of water was plainly felt. To all theſe ſymptoms was added one of the worſt circumſtances that can happen in ſuch a diſeaſe, want of attendance, and of the common neceſſaries of life.

Several

Several of the moſt preſſing and uneaſy ſymptoms in her caſe depending on the violent diſtenſion of her belly, I reſolved to attempt giving her ſome relief by tapping her; which I performed in preſence of my colleague Dr John Innes profeſſor of medicine, Mr Charles Allan ſurgeon, and ſeveral ſtudents of phyſic; and let out ſix Scots pints or twenty-four pounds of water: which at firſt came off briſkly in a ſtream, but in a little only dropped from the canula of the trocar, and at laſt ſtopped entirely before the ſwelling of the belly was near gone; though I took care, during the operation, to keep the abdomen tightly compreſſed with a belt and aſſiſtant's hands, and to clean the pipe frequently by introducing a probe through it. The patient bore the evacuation without the leaſt fainting; and I left her eaſier, with the belt I commonly uſe on theſe occaſions, well charged with the fumes of benzoin, maſtich, and ſuccinum, applied to her belly, and drawn pretty tight. In the evening, ſhe took a cardiac mixture, with ſome drops of liquid laudanum; ſhe ſlept well all night, and was conſiderably refreſhed in the morning.

The regimen now ordered her was to drink none, or very little; but, when ſhe was thirſty, to put a little bit of tamarinds mixed with cryſtals of tartar into her mouth; to eat fleſhes, or with any other food to mix wine and ſpiceries. Theſe might appear ridiculous directions for one in ſo much poverty: But the honourable Mrs Margaret Balfour of Burleigh, moved with her wonted extenſive charity, had promiſed to ſupply every thing neceſſary for diet or attendance; and as long as my poor patient lived, the promiſe was moſt punctually and bountifully performed; for that honourable lady not only gave orders to her ſervants to execute whatever directions I gave, but carefully inſpected the due execution of them. Every day, the patient's belly was well rubbed with flannels ſtrongly charged with the aromatic fumes. Every fourth day, ſhe had a purgative given her of *Decoct. amar. cum dupl. ſenn. unc.* ii. *Oxymel ſcillit. unc. ſem. Syrup. de rhamn. unc.* i. *Pulv. jalap. ſcrup.* i. *Miſc.* And four times every intermediate day ſhe took the bulk of a nutmeg of an electuary compoſed of *Rad. helen. irid. florent. gum. ammon.* and honey; waſhing each doſe down with one fourth of the following liquor, *Decoct. amar. unc.* iv. *Sp. ſuccin. drach.* ii. *Miſc.*

By the uſe of this ſort of diet, and of theſe medicines, ſhe paſſed very

large quantities of water both by ſtool and urine; and in a few weeks all her ſymptoms went off, except the ſwelling of her belly, which was however greatly diminiſhed, and gave her no uneaſineſs.

In the month of February 1728, having ſat long in church, expoſed to the air, which was then very cold, and having neglected to take her medicines ſome time, the quantity of her urine leſſened much, ſhe became coſtive, and the former bad ſymptoms returned. Nor could I after this procure the evacuation of water, which had been ſo beneficial to her, by any medicines; ſo that ſhe in a ſhort time relapſed into as bad circumſtances as when I ſaw her firſt, with the addition of a very ſharp pain under her ſhort ribs, eſpecially of the left ſide.

On the 2d of July, I again tapped her with a larger trocar than what I had formerly made uſe of; and drew off firſt mucus, then pus, which ſunk immediately to the bottom of the veſſel where the mucus had been put, and had white membranes mixed with it. Theſe two liquors, mucus and pus, ran alternately, till I had evacuated in all ſixteen pounds, when no more would run; and in the time of the evacuation, I had frequently been obliged to draw out the tough ſlimy ſtuff, which ſtopped the pipe with a probe. When I thruſt the probe ſoftly into the cavity of the abdomen, it was ſoon reſiſted by a firm ſolid ſubſtance, which on the leaſt touch bled.

The lower part of the belly ſubſided remarkably on this tapping; but the *regio epigaſtrica* yielded nothing.

The patient being no way relieved by this evacuation, I again tapped her on the 14th of July, but was reſolved to prevent the matter contained from being ſtopped by a narrow canula; and therefore performed the operation with a trocar as large as my little finger, but could bring away only eight pounds of purulent matter. The poor patient, daily turning worſe, died ten days after; and I was allowed to examine the body.

The body being laid on a table, had the appearance repreſented in Plate III. fig. 1.: The belly, A, hanging down over the thighs, and monſtrouſly ſwelled every where; but with a depreſſion D croſs the belly about midway between the navel B and the ſternum, the under part of which was advanced, and the point of the xiphoid cartilage E was directed ſtraight forwards. The hypochondria were alſo conſiderably raiſed. The thighs

F and

F and legs were greatly œdematous, and the reſt of her body was much emaciated.

The *tunica celluloſa* of the abdomen was very thin, without any water contained in it. In cutting through the muſcles and peritoneum, on the left ſide of the navel, two pounds of yellow water ran out; and from the cavity G (fig. 2.) where this was lodged, ten ounces of pus were taken, with white tender membranes ſwimming in it. Having cut the containing parts from the navel to the left loin, no more water appeared, but eight ounces of pus were collected. All round the cavity, in which the water and pus were lodged, I obſerved a white hard ſubſtance, ſeeming to be compoſed of conjoined veſicles, and adhering ſtrongly to the peritoneum. This I diſſected away from the peritoneum, till, in cutting upwards, I had reached half-way between the navel and ſternum; when it adhered ſo very cloſe, and became gradually ſo thin, that I was of opinion I would ſooner and better diſcover what it was, and how far it reached, by cutting it through at H, and opening into the cavity: which therefore being done, I raiſed the containing parts ſtrongly, and looking behind them ſaw this knotty ſubſtance BB adhering to the peritoneum three inches further up; and then, ſeparating from the peritoneum, it was extended backwards, and ſupported a conſiderable quantity of water D lodged above it. I next with my ſciſſars cut cloſe off from the peritoneum that ſubſtance, which, being extended from one ſide of the abdomen to the other, ſerved as a ſort of tranſverſe mediaſtinum or diaphragm to divide that cavity into two. After this, ſeeing nothing more above the navel in danger of being deſtroyed, I divided the containing parts in the common way of diſſection, and turned up the two quarters of the tegumeńts now raiſed on the ribs, to have a better view of the veſicular ſubſtance BB adhering to their internal ſurface. It conſiſted of a fatty membrane beſet with veſicular bodies, full either of mucus, or of a white hard ſteatomatous ſubſtance. The *regio epigaſtrica* C (fig. 1.) was exceedingly enlarged; and out of the cavity D (fig. 2. and 3.) formed in it, I took with a ſponge thirty pounds of water, which had preſſed out the ſurrounding bones, and had thruſt the diaphragm conſiderably upwards. I next diſſected the teguments from the veſicular body F (fig. 2.) as far

as it reached, which was to the *ossa pubis;* and then divided them in the ordinary way.

All the teguments being thus removed, I viewed carefully the contents of the abdomen yet in sight. At the upper part, I saw the great cavity of the epigastrium D. Below this appeared a very large membranous sac C, of a browniſh black colour, distended with air, and reaching from the extremity of the cartilages of one side to those of the other, when it sunk down under both hypochondria; the middle part of it was much the largest, and no division into cells, or longitudinal ligaments, were to be seen on it; though I found evidently afterwards it was the great arch of the colon. The part of the fatty membranous body left, when I cut this, in raising the two superior quarters of the teguments, mounted over this sac; and then sinking backwards adhered to another viscus, which I could not yet discover, without putting some parts out of their situation; and from the under part of this same sac depended a white vesicular fatty substance, with large blood-vessels, I, spread on it: This at first was thin; but gradually as it descended became thicker, till it was hid by the anterior lamella, which had been dissected off from the peritoneum. When this last was raised, I softly thrust my hand into a large bag formed between the two, as far down as the *ossa pubis*, where they made one continued substance. Besides these, I could observe no other viscus, except the cæcum or great sac of the colon K, lodged in the cavity of the right ilia. Wherefore I dissected that vesicular body away from all the parts to which it was contiguous or adhered; and, in cutting, remarked, that all the little cells opened in this dissection poured out water. When this body was wholly removed, (see fig. 3.), I could not at first discover any thing in the cavity below, except a flat circular protuberance L, lying on the vertebræ, covered with a dirty black-coloured membrane; and this, in a great many places, had a white tender membrane, resembling the pellicle formed on boiled milk when it cools, lying upon it. The cavities of the loins were very large, and filled with water as well as the pelvis, and under the water pus was every where found. When these liquors were taken out with a sponge, the surface of the cavities had much the same appearance with that of the large middle protuberance. The cellular sub-

stance

ſtance ſurrounding the pelvis was two inches thick, and diſtended with water and mucus.

Looking at laſt narrowly to the great protuberant body, I perceived ſome faint reſemblance of the convolutions of the ſmall guts appearing through the black membrane, and diſcovered the colon MN in the ſame way in the loins. When the membrane was diſſected off, all the inteſtines came in view, of the colour and ſize of which they are commonly found in hydropic emaciated bodies; but the ſmall guts and folds of the meſentery, where they were contiguous, ſlightly adhered to each other by a weak ſort of membrane, which, when tore by gently drawing the viſcera, yielded water out of its cells.

The great guts were diſtended with air, and in a natural enough condition.

The meſentery was ſhorter than ordinary, but otherwiſe ſound.

The ſtomach, hid in the great epigaſtric cavity, was very little larger in its tranſverſe diameter than the ſmall guts, but of a natural colour, without any black membrane over it. From its fundus, the remains of the cut omentum depended, which was the veſicular ſubſtance I at firſt divided in opening the abdomen.

The liver was quite hid under the baſtard ribs; and adhered ſo firmly to the livid peritoneum by its membrane, which was about a quarter of an inch thick, that I could not obſerve its colour or ſubſtance, till I had taken off the membrane, when this great bowel looked pale, and had very little blood in its veſſels.

I found no concretion in the gall-bladder.

The ſpleen was much in the ſame condition with the liver.

The pancreas was pale and hard.

The kidneys were in a natural condition, but with little blood in them.

The ureters were of the ordinary ſize.

The bladder, ovaria, *tubæ Fallopianæ*, and uterus, were all ſound, only covered with a thick livid membrane.

The water and pus taken out with ſponges amounted in all to forty pounds.

I directed a ſervant to carry home the large veſicular body which occupied all the anterior part of the abdomen, and there examined it. It

conſiſted

conſiſted of two lamellæ, which were thin above, but gradually turned thicker as they deſcended, till at the loweſt part, where they united, they were ſix inches thick. Each was covered all over with a ſmooth membrane, only the anterior was ulcerated at its ſuperior external part. Several ounces of purulent matter, with pellicles ſwimming in it, were taken out from the cavity formed between the laminæ. When the external membrane was ſeparated, each ſeemed to conſiſt of veſicles of different ſizes, ſome of which were diſtended with water, others with mucus, and a third ſort with a ſteatomatous ſtuff. So far as could be diſcovered, there were no communicating paſſages immediately from one veſicle to another.

From the whole, there is reaſon to conclude this body to have been the omentum diſeaſed, which very probably might be the cauſe of the dropſy, as well as tumours of other parts frequently are, of which I have ſeen ſeveral examples.

Whether is it peculiar to the membranous parts, when ſuppurated, to have pellicles, like to that which gathers on boiled milk, mixed with the pus? I have ſeen them after inflammations of the guts, pleura, and in the foregoing hiſtory of the omentum.

Whether are thoſe pellicles the membranes ſeparated and turned tender by ſoaking, or the particles of the pus adhering and preſſed firm?

N° 24.

Improvements in performing the Operation of the PARACENTESIS or Tapping of the BELLY.

THE place where chirurgical writers determine the perforation to be made with the trocar in tapping the belly, is four or five inches below, and as much to a ſide of the navel, or the point where a line at that diſtance from and parallel to the *linea alba* would be interſected by another line drawn perpendicular to the *linea alba*, at four or five inches below the navel. If this point is ſuppoſed to be determined on a healthy man of middle growth and ſtature, it certainly is a very ſafe and convenient place for making the puncture: for it is ſufficiently dependent, eſpecially when the perſon lies on the ſame ſide; there are no thick fleſhy bellies of muſcles to pierce; nor are the muſcles entirely tendinous, but are become tendineo-carnous; and at this place there are no large blood-veſſels or nerves in hazard of being wounded: All which advantages no other part of the abdomen has. But then this rule of meaſuring four or five inches is certainly not to be applied to hydropic people; it being very precarious, and conſequently very often dangerous: for though the diſtance is taken in full meaſure when the abdomen is diſtended, yet, when the belly ſubſides, the perforation will be found nearer to the navel in proportion to the degree of diſtenſion. For inſtance, ſuppoſe that the anterior part of the abdomen is diſtended by water to double its natural length and wideneſs; that when the water is drawn off, this cavity is contracted to its natural ſize; and that all the parts have been equally ſtretched, and are again equally contracted: then, though four inches were taken both ways from the navel, it is plain, that, after the contraction, the diſtance each way will be but two inches; ſo that the perfora-

tion

tion is not depending enough, the rectus muſcle is pierced and probably ſome of the larger branches of the epigaſtric veſſels are wounded.

What undoubtedly is meant, is to make a proportional allowance for the quantity of diſtenſion: and ſome authors have ſaid ſo much; but none of them, except Garangeot, have laid down any other general rule for chooſing the place of tapping. He indeed ſays (*a*), that the puncture ought to be made in the middle between the navel and ſpine of the *os ilium*: But as this ſpine is of a conſiderable extent, his rule is much too uncertain; eſpecially conſidering, that the preciſe point to be pierced can be determined in all ſubjects, and in every degree of diſtenſion which the belly ſuffers in dropſies, by only remarking, that in a ſound ſtate a point four inches below and to a ſide of the navel, is the middle betwixt the navel and anterior ſpinal proceſs of the *os ilium*, and that the muſcular parts of the abdomen are near equally ſtretched in the *hydrops aſcites apertus*: whence it follows, that this middle point between the navel and this ſpinal proceſs, is invariable, or nearly ſo; and therefore is the part where the perforation ought always to be made in tapping.

Till of late that Dr Mead, by preſſing on the abdomen with an aſſiſtant's hands, while the water of the *hydrops aſcites* was evacuated, diſcovered the ſudden taking off the preſſure from the deſcending aorta in ſuch ſubjects as ſcarce have blood enough to fill the veſſels of the body, to be the true reaſon of the ſyncope, inflammation, and great diſtenſion of the veſſels of the abdominal bowels, and particularly of the inteſtines; ſurgeons were very careful to draw off a ſmall quantity of water at once, and rather choſe to repeat the operation more frequently, though they were ſenſible at the ſame time of ſeveral diſadvantages attending their method: for beſides the pain and uneaſineſs to the patient, and the danger orifices made any where in the teguments of hydropic people are in of mortifying, the guts ſtill loſe more of their tone by ſoaking long in water, and the air being neceſſarily admitted by the canula into the cavity the abdomen, is liable ſometimes to rarify, diſtend the belly, and form a tympanites, and never miſſes to haſten the putrefaction of the water; from which a train of various bad ſymptoms muſt follow.

All theſe evil conſequences might then be prevented, by drawing off all

(*a*) Traité des Operations du Chirurgie, tom. i. chap. 6. art. 1.

all the water at once, and preſerving the preſſure ſtill on the belly, which can be ſupplied by art, but ought, for greater ſafety, to be done gradually and equally as the water runs out; which neither the preſſure with hands in time of the operation, and applying a bandage afterwards, which is the practice in England, nor the ſwathing with a towel immediately afterwards, as I have ſeen done in the hoſpitals at Paris, are rightly calculated for; and therefore theſe ſeveral years I have always uſed a belt, of the form in Plate III. fig. 4. made of fine flannel, covered with ſtrong linen. The body of the belt, A, is only ſo wide as to reach from the ſpine of the one *os ilium* to that of the other; to one end of this body ſtrong tapes or ribbons B are ſewed at a little diſtance from each other, and to the other end as many well-poliſhed buckles C are put. Near the inferior ſide of the belt, and at a ſmall diſtance from each end, a little window DE is cut, which can be ſhut with two buckles G, and ſtraps F.

When the operation of the paracenteſis is to be performed, I mark with ink the middle point between the navel and anterior extremity of the ſpine of the *os ilium* of the ſide which I deſign to pierce: then I apply the belt, with the flannel ſide next the ſkin, well charged with fumes of *benzoin*, *maſtich*, and ſuch other drying and corroborating medicines; taking care that the point of the ſkin formerly marked with ink, ſhall be in the middle of one of the windows or openings of the belt: after which, a linen compreſs, or piece of flannel, is put on the back, to defend it from being hurt by the buckles, and a long piece of flannel three or four fold is put under the buckles, that they may not fret the ſkin. And, laſtly, the ſtraps or tapes are put through the buckles, and drawn a little tight; by which the water is preſſed in greater quantity to the part of the abdomen where there is the leaſt reſiſtance, which will be the part uncovered by the belt, or the open window; and therefore that part becomes more prominent and tenſe, which facilitates the perforation, and makes a greater diſtance there between the containing parts and viſcera, and conſequently makes leſs danger of the guts, &c. being wounded by the point of the trocar.

Gradually as the water is drawn off, the ſtraps are pulled ſtraighter; and if the patient will be ingenuous, the ſame preſſure can be kept on

the abdomen all the time of the operation, and after the entire evacuation, as was on it before one drop of the water was taken away; becauſe the operator has a very certain gage, the breathing, to judge by: for the difficulty of breathing, which hydropic people labour under, being wholly the effect of the water preſſing the diaphragm upwards, and thereby ſtraitening the lungs, any force equal to that of the water preſſing all the parts of the abdomen equally, will have the ſame effect. For this reaſon, the patient muſt, from time to time, acquaint the ſurgeon if he is ſenſible of his breathing more freely, when the ſtraps are to be drawn tighter, till the patient judges the difficulty of breathing to be the ſame as it was formerly. In this way I have drawn off, more than once, from very feeble emaciated patients, ſixteen Scotch pints or ſixty-four pounds of water at once, without the leaſt faintneſs or uneaſineſs.

After all the water is evacuated, which is greatly aſſiſted by the preſſure, a pledget and plaſter are to be put on the orifice, from which the canula was taken, in the common way; and a compreſs being applied over theſe, the window is to be ſhut on this, and brought to the ſame tightneſs with the reſt of the band. At pleaſure this window can be opened and ſhut, and the wound can be dreſſed; and the whole belt may, as occaſion requires, be ſlackened or ſtraitened.

In Plate III. fig. 4. this Belt is repreſented.

A Its body.
B The ſtraps.
C The buckles.
D The window.
E The part of the belt that cloſes up the window.
F The ſmall ſtraps.
G The little buckles.
H The window ſhut up.
I The ſtraps and buckles.

The belt juſt now deſcribed is what I have only made uſe of hitherto; but have ſometimes been ſenſible of inconveniencies in applying it when the belly is very greatly diſtended: for, in ſuch a caſe, the *oſſa innominata* kept

kept the belt from being rightly applied to the lower part of the belly, which is ſtretched down over the patient's thighs; the ſuperior part of the abdomen, being conſiderably ſmaller than the lower, is not ſufficiently ſtraitened; and after the operation is finiſhed, the belt is liable to be gathered all in wrinkles round the loins, eſpecially if the patient is reſtleſs and careleſs.

To prevent theſe inconveniencies, I think a further improvement may be made to the belt. See Plate III. fig. 5. Let a ſlanting flap K be added to its inferior edge; from which let two ſtraps LL, with buckles at their extremities, go out to paſs between the patient's thighs, and to be faſtened to other ſtraps MM, which come out from the upper edge of the circular band, or to a ſcapular bandage brought over the patient's ſhoulders. It is evident that the flap K will compreſs the hypogaſtric region, which the circular belt could not reach; and that the additional ſtraps, being tightly drawn, will keep the circular band ſtretched at its full breadth.

No 25.

The Diſſection of a Cataractous Eye.

December 15. 1736, In preſence of Dr John Taylor phyſician, and of Mr John Douglas ſurgeon in this place, I diſſected the eye of a man which had been examined while he was alive by ſeveral phyſicians and ſurgeons, who all unanimouſly declared the man to labour under a cataract of that eye.

The cornea of this eye was perfectly pellucid, without any opacity in it:—The aqueous humour ſeemed to be in due quantity and quality:—We could diſcover no fault in the iris:—The opaque cryſtalline lens incloſed in its capſula was not ſo large as it is commonly in a ſound human eye: inſtead of being circular, it was of a triangular form; and its interior convexity was ſcabrous and unequal, of a yellowiſh white colour, the yellow caſt appearing much ſtronger after the eye was opened than it did while the eye was entire:—The connection of the cryſtalline incloſed in its capſula, to the ciliary circle, and to the vitreous humour, was much weaker than it is for ordinary; ſo that by reclining the eye to one ſide, after the iris was taken away, the weight of the cryſtalline made it ſeparate on any ſide from which I reclined it:—The poſterior convexity of the cryſtalline was ſmooth, but of a more yellow colour than the anterior part of the lens.

When an inciſion was made into the capſula, the included lens ſeparated from it, without our being able to perceive any connection between them:—The capſula was opaque, but of a much whiter colour than the cryſtalline itſelf:—The cryſtalline was nearly of the ſame conſiſtence all through, without either watery or gelatinous exterior ſubſtance, or being harder and firmer towards the centre.—It was all compoſed of a great many ſtrata of a greeniſh yellow ſubſtance, which became more on the green caſt as we ſeparated the lamina nearer to the centre, where we could obſerve no firm nucleus:—The vitreous humour was all clear and tranſparent:—We ſaw no fault in the retina:—The colour of the internal ſurface of the choroid coat did not ſeem ſo deep as it commonly is.

N° 26.

Four Caſes of the Tumefied OVARIUM.

SOME years ago, I opened the dead body of a married woman, aged thirty-ſix years; who, I was informed, had always been healthy till two years before her death; when, her menſes ſtopping, ſhe imagined herſelf with child; and her belly having gradually turned bigger, every thing was prepared for the birth. But after the tenth month of her ſuppoſed pregnancy was completed, her belly entirely ſubſided, upon a conſiderable diſcharge of water *per vaginam*. In ſome little time after which, her menſtrua returned; and having undergone two or three periods of them, ſhe was for a ſecond time obſtructed, with the other common ſymptoms of pregnancy. At the end of the ninth month, when ſhe had the ſame appearance with other women in ſuch condition, ſhe was ſeized with bearing-pains, and continued ſeveral days in labour: the fatigue of which at laſt waſted her ſtrength ſo much, that ſhe died.

The abdomen appeared all over greatly diſtended; and at the under part, I felt through the teguments a hard ſolid ſubſtance, diſtinct from all the other parts.

The teguments of the abdomen being cut, I abſorbed with a ſpunge, out of the cavity, ſixteen pounds of a dark-brown coloured water; which was ſo acrid, as to give a pricking pain to my fingers when ſoaked in it. From the hollow of the ilia, I took out ſome ſpoonfuls of a white-coloured mucus.

The internal ſurface of the peritonæum, and the external of all the bowels, were black.

A ſpongy body of a lead colour grew out, and received veſſels from the *inteſtinum ilium* and part of the meſentery.

The ſpleen was ſofter than ordinary.

The

The liver was grown to the peritonæum in all its convex ſurface; it appeared of a lead colour externally, but was red when cut.

I found in the gall-bladder ſix concretions, reſembling ſmall bramble-berries in their black colour and unequal ſurface.

The inferior part of the abdomen, from a little below the navel to the *oſſa pubis*, was filled with a large body, which was adhering to the peritonæum and guts contiguous to it. The greateſt length of this ſubſtance was ſtretched tranſverſely from one *os ilium* to the other, and was twelve and two fifth inches; the breadth of it from the *oſſa pubis* upwards was ſeven inches, its thickneſs five and a half.

This ſubſtance being removed, I ſaw the *veſica urinaria*, uterus, and right ovarium, with its *tuba Fallopiana*, in a natural ſtate, but could not diſcover the left ovarium; and the left tuba was cut away with the preternatural body above deſcribed, to which I afterwards found it firmly adhering.

The blood-veſſels were very large, and obſervable on the ſurface of that large body, which had two ſtrong membranous coats covering it all round; the exterior of which was eaſily diſſected off, by a cellular ſubſtance being interpoſed betwixt it and the internal membrane, which contained a great many veſicles of different bulk, diſtended with mucus, or with a firm ſteatomatous ſubſtance; and in ſome of the bags both mucus and ſteatoma were found.

From which ſtructure, and the preceding account of the diſeaſe and diſſection, it is pretty evident, that this preternatural body was the left ovarium monſtrouſly overgrown and diſtended.

Hist. II. A woman of 21 years of age, while under the violent pains of labour of her firſt child, was very impatient, and toſſed from one place to another. Soon after, ſhe was ſenſible of a weight in her right groin, which, in the different poſtures of her body, removed always to the moſt depending part. However, as it was not attended with pain, ſhe did not complain of it for ſome months, till, the weight increaſing, and a ſwelling and hardneſs being plainly felt in that groin, ſhe aſked advice of ſome phyſicians and ſurgeons; who applied external medicines, and gave internal ones, without her being at all relieved.

A year and a half after her child-bed, Dr Alexander Dundas, Mr James Robertſon ſurgeon, and I, were conſulted about her. Her body was at this time waſted to ſkin and bone, as the common phraſe is; and ſo weak, that ſhe could not turn herſelf from one ſide to the other. Her pulſe was very weak, but quick. She had no appetite for food; and ſhe no ſooner took any, than a feveriſh paroxyſm was brought on, which terminated in a ſweat. The thirſt was perpetual, and ſcarce to be quenched. She had conſtantly looſe ſtools; and paſſed green, violently fetid fæces. She ſlept none in the night; and towards the morning had generally a large ſweat. Her menſtrua had not appeared of a very long time. The right ſide of her belly was conſiderably ſwelled: and we could feel with our fingers a hard tumour below the teguments, extended over that whole ſide; ſo that we could not be ſenſible of its terminating either at the baſtard ribs or *os innominatum*. This tumour pointed conſiderably outwards about four inches below the navel, and as much to a ſide of the *linea alba;* at which place ſhe had for ſome time before complained of the greateſt pain. Here the teguments felt thin, and a liquor fluctuated evidently below our fingers.

The prognoſis we made will eaſily be preſumed not to have been very favourable. And, after acquainting the relations of our patient's danger, we propoſed opening that prominent part of the tumour, as the only remedy that had the leaſt chance of relieving her, though the conſequences even of that operation were very uncertain. Having obtained the conſent of all concerned, Mr Robertſon made an inciſion of an inch long into the part where the greateſt appearance of pus was; but we were all not a little ſurpriſed to obſerve nothing but a great blaſt of wind to follow the lancet, and the belly to ſubſide conſiderably in an inſtant. The patient complained leſs of pain that night. Next day, a large quantity of green fetid fæces, ſuch as ſhe had purged of a long time, was evacuated at dreſſing the wound; and the two following days the ſame kind of matter was diſcharged, but the quantity of it diminiſhed daily; and in the mean time her diarrhœa decreaſed in proportion, and ſhe ſlept tolerably well all night.

The fifth day after the inciſion, neither wind nor fæces came by the wound; but it diſcharged about four ounces of good pus.

From

From this time, we entertained hopes of her recovery: For the diarrhœa was quite ſtopped, her appetite became better, her ſtrength increaſed, the hectic fever and ſweatings gradually diminiſhed, and ſhe ſlept well. An analeptic diet of jellies, broths, aſſes-milk, &c. was preſcribed her; and cooling emulſions, with gentle opiates at bed-time, were given. The ulcer yielded a moderate quantity of well-digeſted pus, and the hard tumour of the abdomen diminiſhed conſiderably; ſo that in two weeks we could preſs the points of our fingers betwixt the ribs and its ſuperior extremity, and betwixt the *os innominatum* and the lower circumference of this hard ſwelling.

After a month's dreſſing, we diſcovered a ſinus going out from the old orifice, and extended under the teguments about four inches down, and outwards, which Mr Robertſon cut open; by which the ſurface of the tumour being laid bare, we endeavoured to encourage the ſuppuration as much as poſſible, by gentle eſcharotics, mixed with digeſting balſams, applied to the ulcer, and emollient ſuppurating poultices laid over the whole hardneſs. The diſcharge, obtained by theſe, daily waſted the tumour; and, in three months, ſhe ſeemed to be in perfect good health, and refuſed the ulcer to be kept any longer open, though there was ſtill a hardneſs and ſwelling to be felt ſome inches round the orifice; ſo that we were obliged to cicatrize the ulcer.

She continued about two years free of all complaints, when a new ſuppuration came on. But ſhe was ſo afraid of being put to pain by making new openings, that ſhe would allow none of us to be informed of her indiſpoſition; but managed it herſelf, with the advice and aſſiſtance of ſome good women whom ſhe confided in. One of whom told me, after her death, that, frequent ſuppurations coming on, and the ſmall orifice made by the pus ſoon cloſing, her former bad ſymptoms gradually appeared; and, having ſtruggled in a miſerable way about three years from the firſt beginning of her relapſe, ſhe at laſt ſunk under the diſeaſe, and died.

The account the patient gave of the firſt riſe and ſymptoms of her diſeaſe, ſeems to lead one to judge the ovarium to have been affected; and the ovarium being ſuppoſed monſtrouſly ſwelled, adhering to the colon, at laſt inflamed and ſuppurated, with the pus eroding a hole through the coats of the ovarium and the contiguous adhering colon, will readily account

count for all the phænomena in this caſe, which, at firſt view, ſeem attended with ſo many difficulties.

Hist. III.————aged twenty-ſix years, of a delicate weak conſtitution, in bearing her fifth child, was put to moſt violent pain by her midwife pulling away the placenta indiſcreetly; which pain, however, after ſome hours, abated conſiderably, and continued moderate till the ſecond day after, when ſhe complained of a moſt racking deep-ſeated pain of her left groin. There was no hardneſs, ſwelling, or diſcolouring, to be obſerved. When ſhe attempted to lie on the left ſide, the pain was greatly increaſed. Her pulſe was quick, but weak. He thirſt was exceſſive, her belly coſtive, and the quantity of urine ſmall. The lochia were in ſufficient quantity. She was leaner and weaker than ordinary, and often complained of being faint.

Emollient eccoprotic clyſters were injected; ſhe had almond-milk given for drink, and farinaceous ſlabs for food. When faint, ſhe took a ſpoonful of a cordial mixture. The pained part was frequently fomented with emollients. The ſymptoms ſtill increaſing, I obſerved, on the eighth day, a large tumour below the muſcles, extended from the *os pubis* to the ſuperior part of the left *os ilium*, and the ſkin above it of a red colour. Her ſtrength by this time was ſo much ſpent, that ſhe could ſcarce turn herſelf in her bed. Lying on either ſide tortured her ſo much, that ſhe was obliged to lie conſtantly on her back. She breathed with great difficulty, and frequently fainted. Since therefore no hopes of reſolving the tumour appeared, I applied a ſuppurative cataplaſm all over it, continued her cordial, and every evening gave a ſmall doſe of opium.

She continued in this miſerable and extremely weak condition for ſome more than two weeks; and at laſt was attacked with a vomiting and diarrhœa, which continued two days, till the purulent matter of the tumour, eroding the teguments about two inches above the ring of the external oblique abdominal muſcle, was diſcharged in a conſiderable quantity: After which the vomiting and diarrhœa ſtopped, the fever diminiſhed, the pain abated, and ſhe began to ſleep calmly.

The orifice of the ulcer being ſmall, I propoſed to enlarge it by cutting; which ſhe abſolutely refuſed to ſuffer, as ſhe had done alſo my opening

the tumour when I firſt was ſenſible of matter fluctuating in it. A tent charged with baſilicon and red precipitate was introduced, and the former cataplaſm continued. Some days thereafter, two other ſmall holes were made by the acrid pus, at a little diſtance from the former, which gradually were enlarged by the conſtant uſe of the eſcharotic powder. The liquor diſcharged by theſe orifices was ſometimes purulent; but much oftener was glairy mucus, reſembling the white of an egg.

The orifices being kept open, and the ſuppuration encouraged, by continuing the method of dreſſing mentioned, the hardneſs gradually melted down, the bad ſymptoms went off, and ſhe recovered ſtrength; but for ſeveral months was often attacked by violent aſthmatic fits, from which the *oxymel pectorale* of the Edinburgh diſpenſatory never miſſed to relieve her. Since this time ſhe has enjoyed as good health as ever, and has born ſeveral children.

The manner of this tumour's increaſe, its being confined to one ſide, without any ſtopping of the lochia when the inflammation was violent, and without any diſcharge of pus *per vaginam* when the tumour ſuppurated, and the liquor evacuated by the orifices of the teguments being moſtly mucus, all conſpire to point out the ovarium, and not the uterus, to have been affected.

Hist. IV. In a letter from Mr Hugh Sutherland ſurgeon, now phyſician, at Kirkwall in Orkney, I was deſired to give advice in the caſe of a gentlewoman, who, ſix weeks after being delivered of a child, complained of a pain and hardneſs at the lower part of the right ſide of the belly; which, afterwards ſpreading upwards, and to the left ſide above the *os pubis*, gave her great trouble. Her menſtrua had not appeared for ſome months after childbed; her urine was in ſmall quantity; ſhe was conſtantly hectic, had no appetite for food, and was reduced to great weakneſs and to ſkin and bone.

Mr Sutherland informed me, that an hyſteric plaſter, beſmeared with *ol. ſuccin.* had been applied to the tumour; and that it was afterwards embrocated with a liniment compoſed of *Ung. alth. Sp. ſal. ammon. Ol. ſuccin. et anif.* She had taken the ſtomachic bitters ſome time, and uſed *ſal prunel.* diſſolved in her ordinary drink. By theſe medicines her menſtrua were

were brought to be regular, the urine came to be in good enough quantity, and the hectic fever ſeemed to be gone: but her appetite ſtill continued bad; and, after eating, ſhe was ſick and uneaſy. Her belly was ſo coſtive, ſhe ſcarce had a ſtool once a-week. She ſtill was weak and lean. The pain, hardneſs, and tenſion of her belly, increaſed evidently. Though ſhe ſlept much, both in the night and day; yet ſhe neither was ſtrengthened nor refreſhed, but always awaked weary and fatigued.

In anſwer to this account, I wrote Mr Sutherland, that I ſuſpected the right ovarium to be tumefied; and in caſe my ſuſpicion was juſt, probably he would, upon inquiry, find, that the progreſs of the tumour had been much in this manner. Before any ſwelling and hardneſs diſcovered themſelves, our patient was ſenſible of a weight, which changed its ſeat to different depending parts of the pelvis, according to the different poſtures of her body. The increaſe of the tumour was from below upwards; and when once it became ſo large as evidently to make the teguments of the belly prominent, the tumour was fixed, and would ſhift place no more. If there was no ſuppuration yet begun, the pain would be but obtuſe, without any external redneſs or hardneſs in the teguments, and without fever, thirſt, &c. If a ſuppuration was begun, all theſe ſymptoms, which I juſt now ſuppoſed her free of, would be appearing.

On the ſuppoſition of no ſuppuration, I was of opinion the tumour ſhould, if poſſible, be reſolved; and therefore propoſed to foment the ſwelled part frequently with an aperient reſolvent fotus, and to keep a cataplaſm made with the emollient *farinæ*, a conſiderable proportion of *galbanum* diſſolved in the yolk of an egg, ſome *ung. alth.* and the liquor for fomentation conſtantly applied to the part. In the mean time, ſhe ſhould continue the uſe of the ſtomachic bitters, with pills compounded of the ſtinking gums, and a ſmall proportion of aloes; ſhould be ordered the lighteſt, eaſieſt digeſted, and leaſt heating food; and ſhould drink whey, barley ptiſan, or wine and water.

If the ſymptoms of ſuppuration were come on, it ought to be forwarded as much as art could.

Some months after I had ſent this letter, an anſwer was delivered to me from Mr Sutherland, by my patient's huſband, acquainting me, that the progreſs of the tumour had been preciſely in the manner I had de-

ſcribed, but without any of the ſymptoms of ſuppuration: That this lucky gueſſing at ſymptoms I had not been informed of, and of which they had not taken the leaſt notice before my letter, had given our patient great courage, and had made her punctually obſerve the directions I had mentioned: by means of which the tumour and pain were altogether removed, without any obſervable evacuation of matter any way; and my patient was healthy and ſtrong.

Since her recovery ſhe has born children, and continues in a good ſtate of health: only that ſhe is ſenſible of what ſhe calls a weakneſs in that ſide; and after travelling and riding, ſhe feels pain where the tumour was formerly.

N° 27.

No 27.

Artificial Passages for Natural Liquors.

A Gentleman had been plagued with a tedious tooth-ach, which occaſioned a very hard tumour above the joining of the cheek and gums of the ſecond *dens molaris* in the upper jaw on the left ſide. The tumour having ſuppurated, broke outwardly on his cheek; the matter flowing out of the ulcer was for ſome time very fetid, and ſeveral carious pieces of bone came out of it. This ulcer continuing long, the patient came to this place with Dr Hugh Sutherland, now phyſician in Orkney.

There was then in the ulcer a tent about the ſize of a gooſe-quill, an inch and an half long: when the tent was taken out, it was covered with purulent-like matter; but upon leaning his head forward, and to the left ſide, a clear liquor, reſembling glairy ſpittle, dropped out. No ſuch liquor or pus had ever run out of his noſe upon reclining his head to the right ſide and downwards. The ſore had no fetid offenſive ſmell. A probe gently bended, being put into the ſore, was turned in different directions in a large cavity formed of bone, lined with a ſmooth tenſe membrane, which covered the bone every where that we applied the point of the probe. The roots of the rotten tooth, which began this trouble, and had often been attempted to be drawn by different tooth-drawers, were ſtill faſt in their ſockets. Dr Sutherland and the patient both informed me, that they had ſeveral times obſerved a thickneſs, and felt what they thought to be a fluctuation of liquor in the palate or root of the mouth, which there was not then any appearance of. The patient was otherwiſe in good health.

By cutting the gum between the roots of the rotten tooth, I made way for a thin piece of iron, which I puſhed forcibly in between theſe roots; and then thruſting it to a ſide, I priſed the one root inwards out of its ſocket, and made the other ſo looſe, that it came afterwards eaſily out.

A ſmall gimblet being immediately put into the fartheſt back ſocket, I endeavoured to make it pierce into the *antrum maxillare*, but could not direct it ſo far back. To give a diſcharge of the mucus into the mouth, and to prevent its running out at the orifice in his cheek, till the ſwelling of the palate ſhould give an opportunity of making a more effectual drain, I laid aſide the tent; and, puſhing a ſhoemaker's awl from the joining of the gums and cheek into the ſinuous ulcer near the aperture made into the antrum by the former caries, by the means of a very flexible probe, I introduced a ſmall cord into the wound made with the awl, and brought an end of it out at the external orifice of the ulcer, deſiring the mouth to be frequently rinſed with brandy, to render the new wound callous ſoon.

The patient's buſineſs obliging him to return home, he went away with this ſeton; which being taken out ſome time after, this new paſſage ſhut up as well as the external orifice: ſoon after which the palate ſwelled; and, being opened by Dr Sutherland, ſome ſmall pieces of bone came out, and our patient has been well ever ſince.

Hist II. In conſequence of a toothach and rotten root, a tumour roſe in a young gentleman's cheek, which had been opened in the inſide of his mouth, and a glairy clear matter was evacuated: but the inciſion cloſing ſoon, the tumour again appeared; and, when I firſt ſaw him, was as large as a ſmall golf-ball, filling all the hollow of the cheek, and being conſiderably prominent. I judged it to be of the encyſted kind, forced out of the remains of the rotten tooth: but the tumour not evacuating at the ſockets, Mr John Douglas, at my deſire, opened it with a lancet within his cheek. Clear mucus being preſſed out at the orifice, the tumour ſubſided; when we plainly felt three exoſtoſes pointing towards each other, between which the ſac had been nitched. One of the exoſtoſes roſe from the root of the naſal proceſs of the maxillary bone: the ſecond grew out from that ſame proceſs, or from the anterior orbitar proceſs of the *os malarum* near to the orbit: and the third, which was the largeſt, reſembling, when felt through the teguments, an old cock's ſpur, roſe out of the cheek-bone. We could be ſenſible of no bone being bare or ſpoilt by a probe introduced at the wound; nor had we reaſon, from the nature of the matter evacuated,

cuated, to judge that there was any carious bone. A tent, with a thread hanging to it, was put into the wound; which was continued ſome weeks, brandy and melroſe being frequently injected into the empty cyſt, and the patient rinſing that ſide of the mouth often with brandy. After we thought the paſſage callous, the tent was no more uſed, and the patient has had no more return of the tumour.

Hist. III. Upon drawing the roots of a rotten tooth of a young lady, who had a tumour reſembling the one deſcribed in the former hiſtory, a yellowiſh-coloured thin liquor flowed out of one of the ſockets; this liquor had a great many particles reſembling oil ſwimming on its top, but had no fetid ſmell. The ſwelling immediately ſubſided; no exoſtoſis was felt; a ſmall probe introduced into the hole of the ſocket could not be made to touch any bare bone in the circumference of a large cavity it was put into; nor could we diſcover the paſſage by which the liquor came from the external cyſtis into the ſocket of the tooth. The management of this caſe was the ſame as of the preceding; the oily particles appeared ſeveral days in the liquor that flowed when the tent was taken out; at length they could not be obſerved. The lady has continued well, and free of ſwelling.

N° 28.

The CURE of an ULCER of the CHEEK, with the ſuperior ſalivary Duct opened.

MR KER of Frogton, a young gentleman of a delicate conſtitution, and threatened with a conſumption from an ulcer in his lungs, was ſeized, after riding in a cold night, with a very hard tumour about the middle of his left cheek. The gentlemen who attended him endeavoured at firſt to reſolve it: but, obſerving a ſuppuration to come on, it was opened with a lancet on the inſide; and afterwards an external orifice was alſo made, and eſcharotics were applied to waſte down the hard ſtool of the tumour that ſtill remained. When no more hardneſs was felt, his ſurgeon endeavoured to incarn and cicatrize, but was diſappointed by a conſtant plentiful diſcharge of a thin clear lymph. The orifice was again enlarged; and it was dreſſed a conſiderable time with aſtringents and driers in different forms, but without any ſucceſs.

In September 1727, being accidentally in the neighbourhood of Kelſo, where Mr Ker lived, I was ſent for thither, to adviſe with Drs Abernethy and Scott, phyſicians there, and with Mr Jamieſon ſurgeon, concerning his cure. The external orifice in his cheek was as large as would have received the point of my thumb; and, at the bottom of it, we could diſtinctly ſee ſome part of the ſuperior ſalivary duct laid bare, with a hole in the outer ſide of it, large enough to allow the button of a middle-ſized probe to enter it; and, when he moved his lower jaw at our deſire, the ſaliva ran out plentifully at that orifice. When the jaw was not moved, a very ſmall quantity of the ſpittle oozed out; but, in time of dinner, it made a napkin, laid eightfold over the plaſter that covered the ulcer, wet all through.

We agreed to make an artificial opening for the ſaliva into his mouth, which I did in the following manner: Having with two fingers of one hand

hand ſtretched his cheek outwards, I directed the point of a large ſhoemaker's awl, which I held in the other hand, into the open breach of the duct, and thruſt the awl obliquely forwards through the cheek into the mouth, betwixt my two fingers; then drawing back the awl, I paſſed an eyed flexible probe, mounted with a ſmall cord of ſilk, through the paſſage made by the awl, and brought it out between his lips with my fingers, leaving one half of the cord hanging from the external ulcer: then the ends of the ſeton, being diſengaged from the probe, were tied looſely near the angle of the mouth; and his external ulcer was dreſſed up with dry lint kept on with a plaſter. He was deſired to rinſe that ſide of his mouth frequently with brandy; and the ſides of the external ulcer were kept from growing out too faſt, or turning callous, with the lunar cauſtic. In leſs than three weeks, this management had the deſired effect of rendering the paſſage, in which the cord was engaged, callous, (which the looſeneſs of the cord, and the want of pain when it was drawn, plainly ſhowed;) when Mr Jamieſon took out the cord, and cured up the external ulcer very ſoon. In a little time after, I ſaw our patient here in Edinburgh, with a firm cicatrice on the part where the ſore had been.

This operation is plainly directed by my friend Mr Cheſelden in theſe words (*a*): "When this duct is divided by an external wound, the ſa-"liva will flow out on the cheek, unleſs a convenient perforation be "made into the mouth, and then the external wound may be healed."

(*a*) Anatomy, book iii. chap. 3.

N° 29.

AN

ESSAY

ON THE

DISEASES of the LACRYMAL CANALS.

THE many improvements that have been made of late in moſt chirurgical operations, as they ſhow how imperfect ſurgery was formerly, ſo they ſhould be an incitement for endeavouring to improve it ſtill further: which will be found no difficult taſk to any who carefully conſiders the natural ſtructure and ſituation of the parts that are affected in the ſeveral external diſeaſes; who examines the changes which theſe diſeaſes do, or may, make on the body; who from thence lays down reaſonable intentions of cure, whereby the parts may be brought as near to a natural ſtate as poſſible, or the functions of ſuch as are diſordered or deſtroyed may be ſupplied by art; and laſtly, who diligently weighs the manner, immediate effects, and conſequences of every ſtep to be taken in executing theſe intentions. I ſhall endeavour to ſhow, in the following remarks on the *fiſtula lacrymalis*, how far the want of due attention to theſe neceſſary circumſtances is capable of keeping us in ignorance, and leading us into error. I made choice of the *fiſtula lacrymalis* for an example, becauſe it is a common enough diſeaſe, that has been often ſeen and treated by ſurgeons, is wrote of in all the ſyſtems of ſurgery and in moſt collections of obſervations, and is more particularly examined by the profeſſed oculiſts; yet, in my opinion, is very little underſtood, and has very defective or faulty rules laid down for its cure.

Without troubling the reader with critical obſervations on the old diſtinction

ſtinction of anchylops and ægylops, or on the impropriety of reckoning all ægylopes or ulcers of the internal canthus of the eye to be *fiſtulæ lacrymales*, or on the characters of any ulcer neceſſary to conſtitute a fiſtula; I ſhall only inform him, that the diſeaſe I now treat of, is ſuch an indiſpoſition of the canals that convey the tears from the eye to the noſe, as does not allow the tears to paſs as they ought.

The lacrymal canals, whoſe diſeaſes are the ſubject of this eſſay, have been deſcribed by ſeveral anatomiſts; but, none of them having theſe diſeaſes in view, their words or pictures will not probably give the reader an idea of theſe parts ſuited to my purpoſe: wherefore I ſhall give a ſhort deſcription of them, illuſtrated by figures, before I enter upon any account of their diſeaſes.

The two lacrymal points, A, B, (Plate III. fig. 6.) ſituated each on a little prominence near the internal extremity of the edge of each palpebra, take in the tears to be conveyed by two little ducts of about four tenths of an inch long, which are continued from the points inwards and ſomewhat downwards, (the ſuperior being the longeſt and moſt oblique), till they open into the lacrymal ſac, D. Between the points and the angle where the palpebræ join, the *caruncula lacrymalis*, C, is placed. The lacrymal ſac, D, lies upon the groove formed partly in the naſal proceſs of the maxillary bone, and partly in the anterior half of the *os unguis*, to which its back-part adheres ſlightly; but this membranous bag is connected firmly to the ridge which is raiſed on the *os unguis*, at the poſterior part of the groove, ſerving at this place as a proper diſtinguiſhing boundary between the orbit and exterior parts; ſo that the lacrymal half of the *os unguis* is without the orbit, while its poſterior half conſtitutes a ſhare of the bony ſides of that cavity. Such another firm connection of the lacrymal ſac to the bones is alſo to be obſerved at the fore-part of the groove, where a ſmall future joins the *os unguis* to the naſal proceſs of the maxillary bone.

The lacrymal groove of the *os unguis*, D, is about two tenths of an inch broad in its middle wideſt part, and is about half an inch long from the top, till it is covered by the maxillary bone, and a complete bony canal is formed for incloſing the whole lacrymal duct; which, after a ſhort progreſs, opens into the noſe immediately below the middle of the ſupe-

rior edge of the lower *os ſpongioſum*, where its extremity becomes ſmaller than any other part of it.

When we view the ſide of the noſe after the bones have been divided by a perpendicular ſection, we ſee the *oſſa ſpongioſa*, K, L, (fig. 7.) ſituated near horizontally, depending by their ſuperior edge from the other bones, and removing farther from them as they deſcend. The anterior extremity of the ſuperior *os ſpongioſum* K, is fixed to the other bones very near where the upper part of the *os unguis* is joined to the frontal bone; and the ſuperior edge of the inferior, L, is very little below where the great lacrymal duct begins.

This ſhort deſcription will, I hope, aſſiſt the reader to underſtand the ſeveral morbid caſes I am now to conſider.

If, after any eroſion of the eye-lids, the lacrymal points, or the ſmall pipes going from them to the lacrymal ſac, are entirely blocked up by their ſides growing together, which may be known by the conſtant weeping of the affected eye, after a diſeaſe capable of producing ſuch an eroſion, without any tumour, but on the contrary with a depreſſion of the teguments covering the lacrymal ſac, and by the points being ſo obliterated, that one of Anel's ſmall probes cannot be puſhed by them into the ſac; in ſuch a caſe, I ſay, the patient muſt all his life bear the deformity and uneaſineſs of a weeping eye, or ſome ſuch operation as the following muſt be attempted: Let the lacrymal ſac be opened in a ſlow cautious diſſecting manner; after which puſh a ſmall round curve needle with a waxed thread from one of the prominencies of the palpebræ, where the lacrymal point naturally is, into the ſuperior part of the ſac; draw out the needle at the aperture lately made, and leave the thread by way of a ſeton; do the ſame at the part where the other *punctum lacrymale* was. Soon after the ſmall inflammation theſe threads may raiſe is over, the briny tears trickling along them will make the paſſages callous, and fit for ſupplying the office of the natural ducts when the threads are to be taken out; and the aperture in the ſac, which has been kept open by doſſils, and refreſhing ſometimes with the lunar cauſtic, will very readily ſhut up as ſoon as this manner of dreſſing is forbore, and that it is only covered with a pledgit. The ſucceſs with which an artificial paſſage, formed

this

this way into the mouth has ſupplied the ſalivary duct *, may make us judge, that the method juſt now propoſed might alſo be ſucceſsful.

When the fibres of the lacrymal ſac are too weak, or the large duct is obſtructed by ſome concreted liquors, the ſac is gradually ſtretched by the tears which regurgitate frequently at the *puncta lacrymalia*. Some call this diſeaſe a *dropſy*, others would have named it a *hernia*, of the lacrymal ſac. We know it by the tumour of the ſac, without hardneſs, diſcolouring, or pain, which diſappears as ſoon as we preſs out the tears at the *puncta lacrymalia*. While this diſeaſe is recent, theſe tears are pure; afterwards ſome pus appears with them, becauſe of the excoriation which the ſac ſuffers. Leſt there ſhould be any hazard of miſtaking a tumour or ſmall abſceſs in the teguments, which cover the lacrymal ſac, for the diſeaſe of the ſac juſt now deſcribed, as I have ſeen done, allow me to mention, that ſuch tumour is eaſily diſtinguiſhed from the hernia or dropſy, by its not diminiſhing or not diſcharging a large quantity of tears or pus at the *puncta lacrymalia* upon preſſure.

The method of cure in the dropſy, is to paſs one of Anel's probes from the *puncta lacrymalia* into the noſe, to remove any grumous matter that may be lodged in the lacrymal canals; and then to inject, by the lacrymal points, mild, detergent, and gently aſtringent liquors, ſuch as melroſe diluted in lime-water, to which a little brandy may afterwards be added, or any chalybeate water, or a little weak wine, &c.: which injection is to be repeated twice or thrice a-day; and in the intervals the cure is aſſiſted by external compreſſion, made with compreſs and bandage, or the proper compreſſing machine, and by corroborants. We read of ſeveral cures performed in this manner by Mr Anel and Mr Heiſter; I have alſo had ſucceſs with it.

It will be neceſſary here to obſerve, that the ſmall duct, going from the ſuperior lacrymal point A, (fig. 6.), being more oblique than the inferior, it will be more proper for paſſing the probe by; and, becauſe the paſſage from that point into the noſe is not ſtraight, the probe muſt be bended into a ſmall arch of a large circle. The ſuperior eye-lid being then raiſed, and its edge turned a little outwards with the fingers of one hand, the ſurgeon, reſting the other hand on the patient's cheek near the exterior

* See the preceding article.

exterior canthus of the eye, introduces the probe, with its convexity upwards, into the punctum; and raiſing his hand gradually as he puſhes the probe forward, he brings it almoſt perpendicular to the lacrymal ſac, by the time that the probe reaches the lower part of that ſac; then he turns the probe ſoftly, till he brings its concavity towards the noſe; and puſhes it downwards through the great duct into the noſe. After which he moves it up and down, and to different ſides, to break any concreted matter lodged in it.

The inferior *punctum lacrymale*, B, will be fitter for introducing the pipe of the ſmall ſyringe into, and for making the injections by; becauſe the inferior eye-lid has not near ſo much motion as the ſuperior, and is more eaſily held with its edge turned a little outwards, at the ſame time that the ſurgeon has a better reſt on the patient's cheek for the hand that holds the ſyringe, than he can have in making the injection by the ſuperior point.

A propoſal has been lately made to introduce a ſmall pipe at the lower part of the lacrymal duct, into the ſac, by which medicines may be conveyed for curing ſeveral diſeaſes of the lacrymal canals; but I don't know whether cures have been made with this pipe.

If theſe methods of injecting and compreſſion are not ſucceſsful, and the internal part of the lacrymal ſac is become ſpongy and ulcerated, which we judge to be the caſe by the quantity of pus expreſſed with the tears, the ſac muſt be opened by an inciſion. When the ſac is much diſtended, and the matter in it is thick, it is as eaſily opened as any common abſceſs: but, when the ſwelling is little, and the matter is thin, I have obſerved, that, notwithſtanding the ſkin was kept as tenſe as I could betwixt my thumb and two fingers, and an aſſiſtant endeavoured all he could by preſſure on the *puncta lacrymalia* to prevent the tears and pus eſcaping by theſe orifices; I ſay, notwithſtanding theſe precautions, I obſerved that the preſſure of my knife ſqueezed out the liquors contained in the ſac, and made it collapſe ſo much that it could not be opened without a manifeſt riſk of cutting the poſterior ſide of the ſac, and ſo laying the bone bare, which evidently appears neceſſary to be ſhunned in the caſe I now ſpeak of. When the ſac is full of ſpongy fleſh, or has contracted after an unſucceſsful attempt of the operation, it is ſcarce poſſible to know

know when the ſac is opened, or how much of it is opened, by an inciſion, without having ſome directory for the knife. To avoid theſe inconveniences, in ſuch caſes, I introduced a ſmall probe at one of the *puncta lacrymalia*, and cauſed an aſſiſtant to raiſe up the ſac with it, while with a gently-crooked ſharp-pointed biſtory, I cut the ſtretched teguments in the common way, till I felt or perceived the naked probe; when, laying aſide the biſtory, and taking a pair of crooked ſciſſars, I introduced the probe-pointed blade into the ſac, and cut it firſt upwards, and then downwards, till its whole length was opened.

In making this opening, the tendon of the orbicular muſcle of the eyelid muſt be cut through; but it is of no conſequence, for the firm cicatrice afterwards ties that muſcle to the bones here ſufficiently to prevent any inconvenience. We are however to take particular care not to cut ſo near to the joining of the palpebræ, as to be in any hazard of dividing them, which might occaſion a conſiderable deformity: and it will be more convenient to ſave the angular artery and vein, than to wound them; becauſe, if they are wounded, the blood which they pour out hinders the operator to ſee ſo diſtinctly what he is doing.

After the ſac is fully opened, we can obſerve in what condition it is, and are at liberty to free the naſal duct of any thickened matter that happens to be in it. Small doſſils, armed with ſome proper medicines, either of the detergent, drying, or ſtrengthening kind (according to the morbid ſtate of the ſac), are laid into the ſac, but without being very hard, or being ſtuffed ſtrongly in, leſt unneceſſary pain and inflammation ſhould be occaſioned. The lips are then covered with a ſmall pledgit, and this is kept on by a ſemilunar ſnip of adheſive plaſter; and, if the dreſſings do not keep well enough in the ſac, compreſſes, and the compreſſing inſtrument, ſhould be put upon them. While the diſeaſe is curing by proper medicines, the lips are kept freſh with the lunar cauſtic. When once the ſac is made ſound, the orifice in the teguments cloſes very ſoon after the uſe of the doſſils is forbore, if the patient is in any thing of a tolerable habit of body. I have practiſed this method with ſucceſs.

When the large *lacrymal duct* is excoriated, or has fungous fleſh riſing from it, which will be known by the acute pain, or great inſenſibility, and by the difficulty of paſſing a probe through it after the ſac is opened,

and

and by a view of its ſuperior part, there is a neceſſity of dropping or injecting proper medicines into it, and of keeping its ſides from becoming contiguous by introducing ſome convenient ſubſtance into it. When medicines are made to paſs through it, the patient muſt be deſired to hold his head forwards, that the liquors may run out at his noſe, inſtead of falling back into his fauces. In my opinion, a ſmall tent of lint, ſecured with a thread, and armed with medicines, is preferable to a ſmall wax bougie, or any thing that is oily, becauſe theſe keep the parts raw much longer, and do not imbibe ſuitable medicines. As ſoon as the duct is brought to a right condition, the diſeaſe is the ſame as in the preceding ſuppoſition.

Let us now ſuppoſe, that the fungous fleſh riſing from the ſides of the duct has united and blocked up the paſſage entirely, which can only be diſcovered after the ſac is open, by the impoſſibility of introducing a probe, or making liquors paſs through it, into the noſe, while it feels ſoft and yielding, without that ſort of firm reſiſtance which a bone covered with a membrane makes, and which cannot be deſcribed well in words, but what all ſurgeons of any practice know. In the caſe as I have now put it, I think there is ſtill no neceſſity of hurting the bones in order to make a paſſage for the tears. What I would propoſe is, to puſh a ſmall ſhoemaker's awl, or ſome ſuch inſtrument, through the middle of the fungus into the noſe; and then to keep this artificial paſſage open, and to render it callous by a tent or ſeton. In making the perforation, the inſtrument muſt be held with its concavity towards the noſe; and it muſt be thruſt through ſlowly, and with no great force, the ſurgeon changing its direction a little whenever he touches the bone with its point: when the drops of blood coming out of the noſe, ſhew the inſtrument to have perforated far enough, it is drawn back, and the tent or ſeton muſt be immediately paſſed in the ſame way. The ſeton is preferable, in my opinion, but requires the probe by which it is introduced to be of very flexible ſilver, and previouſly brought to a particular form. Fig. 8. is a probe about three inches long, bended into a ſemicircle, only with near half an inch toward the point pretty ſtraight: this I have made to paſs from the lacrymal ſac into the noſe, and brought it out at the noſtrils, of ſeveral dead bodies, without uſing force, or changing its form. The

ſmall

ſmall cord that is brought through in the eye of this probe, is to remain for ſome days, without ſhifting the part engaged in the duct, till it becomes looſe by the ſuppuration which happens round it; then it may be drawn a little, having beſmeared the part that is to be next introduced with ſome gentle ſuppurative balſam. In a very little time, the ſuppuration will waſte as much as is ſufficient; and then the detergents and deſiccatives will ſuceed in bringing the canal near to the natural ſtate. I need ſcarce mention the tying of the two ends of the cord after each dreſſing, to keep them from hanging over the face, whereby they would be in hazard of being unwarily pulled; or the neceſſity of dreſſing the ſac all the while, as in the former ſuppoſition; or taking out the cord and curing all up, after the duct and ſac are ſound, they are ſo obvious.

If the duct has been blocked up in a child, and no cure is attempted till the perſon comes of age, the duct may be ſo obliterated or ſmall, that the method now propoſed cannot be executed, and an artificial paſſage muſt neceſſarily be made through the bone. But as this caſe can never be certainly diſcovered till the ſac is opened, we ought ſtill to proceed in the cautious way I formerly mentioned for this part of the operation. The place of the *os unguis* where this perforation ought to be made, will eaſily be determined from the deſcription I gave of the parts, and from the advantage of the canal for the tears being at the moſt depending part of the ſac. It muſt not, however, be attempted to be made where the natural duct was; for, in piercing the bones in that place, and with that direction, the inſtrument will more readily pierce into the large *ſinus maxillaris* than into the noſe. If the perforation is attempted to be made too far outwards, the inſtrument muſt be forced through the maxillary bone, which cannot be pierced but with great difficulty. I imagine any one may eaſily underſtand the place and direction for making the perforation right, by obſerving how the two pins are placed in fig. 6. and how they come through the *oſſa ſpongioſa* in fig. 7. at M and N; for the pin E in fig. 6. being thruſt perpendicularly through the *os unguis*, about the middle of the lacrymal ſac, pierces the anterior extremity of the upper *os ſpongioſum* at M, in fig. 7.; and the pin F in fig. 6. thruſt very obliquely through the *os unguis*, at the loweſt part of the ſac, pierces the *os ſpongioſum inferius* at N, in fig. 7. The pin F, placed ſo far back as to be con-

tiguous to the ridge dividing the *os unguis* with the perpendicular direction of the other pin E, would anſwer all intentions without any riſk.

The inſtruments with which this perforation has hitherto been ordered to be made, appear to me very faulty. One general fault to all of them is, their deſtroying more of the *os unguis* than is neceſſary or ſafe: for wherever the orbitar part of it is diſeaſed, there is great danger of an inflammation and ſuppuration being brought on the muſcles and fat within the orbit; which may be attended with a train of troubleſome dangerous ſymptoms, that art can do little to relieve, becauſe of the quantity of fat, in which pus diffuſes itſelf eaſily, and cannot be reſtrained by medicines or compreſſion in ſuch a cavity as the orbit, and in the neighbourhood of ſuch a ſenſible moveable neceſſary organ as the eye. The actual cautery gives great pain, burns the neighbouring parts, raiſes inflammation, and leaves a carious piece of bone to exfoliate; which retards the cure much. The directory, or blunt ſtilet, when puſhed through the bone, fractures it far and near, and often ruſhes into the noſe ſo far as to break the *ſeptum narium*. The olive-ſhaped blunt perforative, or the tapering ſtrong forceps, make large fractures in the bone, beſides opening a paſſage large enough to let the point of one's finger paſs, where one no larger than a crow-quill is required. In place of all theſe, then, I would propoſe always to make uſe of a drill, ſmall perforative of a trepan, gimblet, trocar, or any ſuch ſmall inſtrument that can perforate with little force and no fracture. The trocar is the inſtrument I have made this perforation with ſeveral years paſt, in the following manner. Chooſing a trocar, the ſtilet of which is of the ſize I wiſh to have the perforation, and is as much longer than its canula as I think neceſſary for perforating into the noſe, I put a probe into the canula, to ſearch for the loweſt part of the ridge of the *os unguis*; at the fore-part of which I keep the probe till the canula is preſſed ſoftly down to that part of the bone. When the probe is taken out, the canula is put in the proper direction, and the ſtilet of the trocar is then put through the canula, to be worked with half-turns of the hand till it perforates into the noſe; in doing which its own weight is ſufficient, ſcarce any preſſure of the hand being required.

So ſoon as the perforation is made, withdraw the ſtilet, to paſs a tent

ſecured

ſecured with a thread, or a piece of wire-drawn lead, through the canula into the noſe; then taking away the canula, accommodate the tent or lead to the reſt of the wound; or the canula may be taken away with the ſtilet after the perforation, and the tent or lead, or a little pipe, may be put into the hole, having the head of the tent broad, or the lead ſplit a little at its outer end, that each part may be bended down to make a head, and the pipe ſhould have little ſhoulders to prevent it from falling into the noſe: then dreſs the lacrymal ſac in the ſame way as was propoſed above, when we ſuppoſed the ſac to be laid open. Allow theſe dreſſings to remain till the ſuppuration comes on, when they are to be renewed. Whenever the inflammation is gone, by drying medicines injected at the new orifice, or conveyed into it by the tent, endeavour to harden the membrane with which the thin edges of the perforated bone ſoon cover. I uſed melroſe and a little brandy, increaſing gradually the proportion of this laſt medicine. Whenever the tent can be made to paſs this hole, without giving pain, leave off the uſe of the tent or pipe, and cure up the external orifice as ſoon as it will go together; which is very ſoon, if its lips have been gently touched from time to time with the lunar cauſtic. In this way I have cured thoſe who had this diſeaſe from their infancy, without one bit of bone exfoliating, or the leaſt weeping in the eye afterwards, or other inconvenience, not ſo much as an obſervable ſcar.

I am informed, that a gold pipe has ſometimes been left in the new paſſage; the cut fore-part of the ſac having united while it remained there.

Let us now ſuppoſe, that the ſharp matter in the lacrymal ſac has deſtroyed its membrane, and rendered the *os unguis* on which it lies carious; or that the caries having begun in the bone, the ichor of it has eroded the membrane. In this caſe, if there is a large paſſage eroded alſo through the *membrana narium*, while the teguments are whole, it may be long before the lacrymal canals can be diſcovered to be affected; and the diſeaſe will be treated as an ozæna. But if there is no ſuch paſſage into the noſe, the malady may be known by the brown-coloured ſtinking ichor diluted with tears; which may be ſqueezed out at the lacrymal points, upon preſſing the lacrymal ſac.

The method of cure here will be to open the lacrymal ſac, as in the former caſes mentioned; to ſeparate as much of the bone as is carious;

to make a perforation with the point of a lancet or biſtory, through the *membrana narium*; and then to complete the cure as directed in the preceding ſuppoſition of the bone being artificially perforated.

The ſeparation of the carious bone is ordered to be haſtened by the application of the actual cautery, tinctures of myrrh and aloes, and of euphorbium: but, in my opinion, the breaking away with a pair of forceps all that is carious, will be much more ſpeedy, and is not attended with ſuch inconveniencies as the other methods are.

It muſt have been obſerved, that I have hitherto ſuppoſed the diſeaſes of the lacrymal canals to be attended with no opening of the teguments made by eroſion, nor with any maladies of the neighbouring parts; and I believe, it will be ſeen, there is no neceſſity of inſiſting at any length upon them: for when there is an opening in the teguments, near the internal canthus of the eye, we can eaſily diſcover whether the lacrymal canals are affected, by preſſing pus out of the *puncta lacrymalia* before the ulcer is cleaned; and after the pus is wiped away, the tears will run out at the external orifice; which alſo gives a better opportunity of introducing inſtruments to diſcover the ſtate of the diſeaſed parts.

In the cure, there is nothing different from what has been formerly directed, unleſs that the opening into the ſac is more eaſily made, where the external orifice is large enough to allow the neceſſary inſtruments to be introduced; and when it is too ſmall for this purpoſe, we muſt enlarge it, by putting into it tents of ſponge made firm and hard, by being ſoaked in ſome melted plaſter, and then kept preſſed under a weight, or in a preſs, till the plaſter hardens: or this ſponge-tent may be prepared, by ſimply wetting the ſponge in water, or a diluted mucilage or glue; and then rolling pack-thread firmly round it, and hanging it up thus till it dry.

There is ſuch a great variety of diſeaſes which may accompany theſe maladies of the lacrymal canals, whether as cauſes, conſequences, or accidental attendants, that it would be to engage in almoſt a ſyſtem of phyſic and ſurgery to give a detail of them: and therefore I ſhall paſs them without any further examination.

Plate III.

Fig. 1.

Fig. 2.

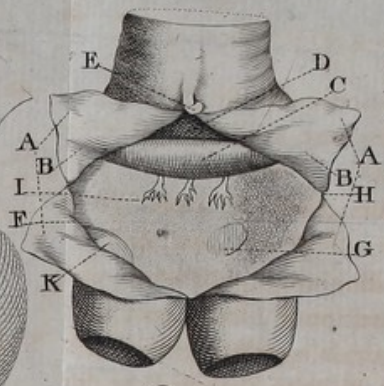


Fig. 3.

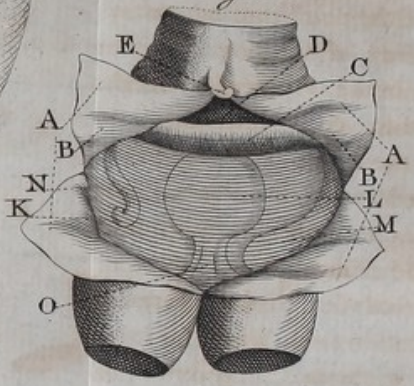


Fig. 4.

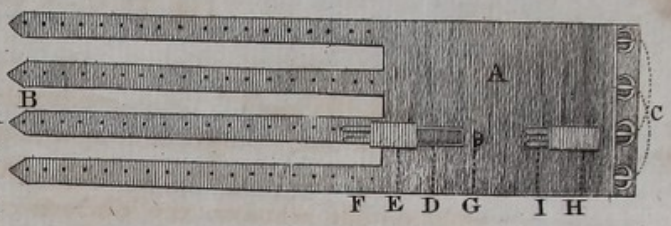


Fig. 5.

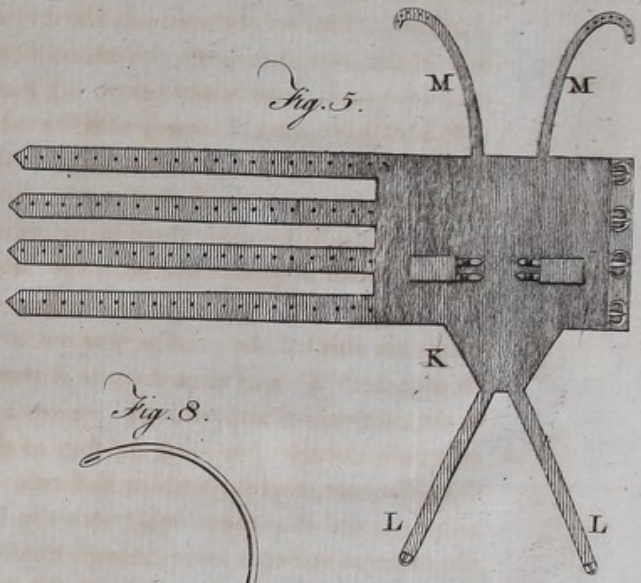


Fig. 8.

Fig 6

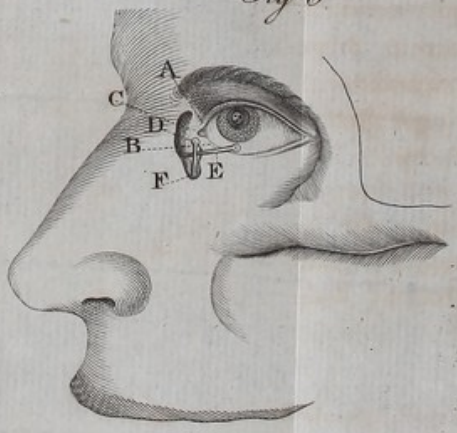
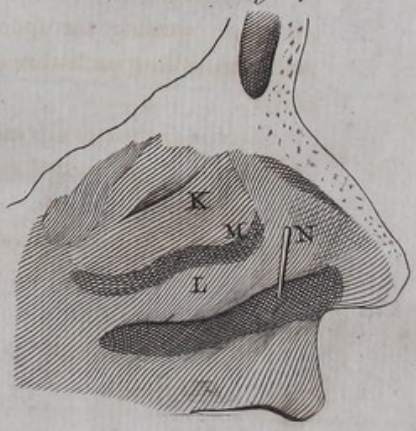


Fig. 7.



A. Bell Sculp.t

N° 30.

A Tumour of the Nose unſucceſsfully extirpated.

A Child was born with a ſmall moveable tumour on its noſe, which increaſed as the child grew; otherwiſe the child was healthy and ſtrong, having only had a ſhort fever or two, and paſſed ſome worms, before five years of age, when my advice was firſt aſked concerning that tumour. It was then ſo large as to cover all the noſe, except the noſtrils; and was ſo prominent to each ſide, that the eyes were in part covered with it. Towards the baſe, it was ſo ſoft, that, by preſſing a finger on each ſide, they felt each other; but, at the moſt prominent part, there were ſeveral hard round knots. When I ſaw it, the child complained of no pain; though I was informed that ſharp lancinating pains ſometimes ſtruck through the tumour. I held the noſtrils, while the child forced its breath that way; but ſaw not the tumour riſe any. I ſearched into the noſtrils with a probe; but could neither feel any excreſcence, nor puſh the tumour or teguments outwards. The *os frontis* was firm, and united in the middle. From all which I concluded the bones of the noſe to be complete; and therefore was of opinion, the tumour (which would make the patient very miſerable by increaſing, and would bring death at laſt) might be ſafely extirpated. Being, however, taught by Job à Meekren *, and ſome others, how deceitful excreſcences of the head, brought to the world with a child, might poſſibly be, I would not undertake the cure, till another ſurgeon, of more experience and longer ſtanding, in my neighbourhood, who juſtly has a conſiderable character, ſhould examine the tumour, and aſſiſt me in whatever was determined to be done. That gentleman joining in opinion with me, I undertook the extirpation with his aſſiſtance. When I had diſſected about half the baſe of the tumour off, I obſerved the bones of the noſe to be incomplete; and that the membrane,

* Obſerv. cap. 7.

brane of the noſe, part of which I had laid bare, was moved outwards in exſpiration, and inwards in inſpiration. Not being certain how far upwards the bones might be wanting, I diſſected all the tumour off at the lower part, but left a little of its baſe above. Having ſtopped the blooding, I dreſſed the wound in the common way.

When the tumour was examined, it appeared all of a ſubſtance little firmer than the common fat under the ſkin; except where the knots were, which were of a ſcirrhous hardneſs.

The child paſſed the firſt night pretty eaſily. Next morning the pulſe was a little quick, attended with a thirſt, and a ſickneſs at the ſtomach, which had made the patient vomit once. An emollient clyſter being injected, and emulſion given for drink, theſe ſymptoms abated. Towards the evening the dreſſings ſeemed moiſter than they commonly are ſo ſoon after a wound.

In the morning of the ſecond day after the operation, the dreſſings, child's hair, and head-cloaths, and the pillow under its head, were all wet with a watery liquor; which had a particular ſmell that I never felt in any wound before, and do not know how to deſcribe. The dreſſings being taken off, we ſaw that this liquor oozed faſt from the bared membrane of the noſe, though we could not perceive the orifice by which it eſcaped. We applied from time to time *Bol. Armen. Pulv. Helvet.* chalk, ſugar of lead, white vitriol, burnt alum, blue vitriol, quick-lime, brandy, alcohol, oil of turpentine, ſpirit of nitre dulcified, plain ſpirit of nitre, oil of vitriol, lunar cauſtic, the actual cautery. In ſhort, we applied every thing we could think of that had any chance for ſtopping this oozing of lymph, but without ſucceſs. On the ſixth day, our patient vomited a long round worm; in ſome time after fell into convulſions, and in an hour more died.

N° 31.

An Account of a PROCIDENTIA UTERI.

IN the month of Auguſt 1728, —— Scobie being ſeized with a fever, which continued ſome days, when ſhe was not full three years old, had a conſiderable diſcharge of blood by the vagina for three days: after which ſhe ſeemed to be in perfect good health about twenty days; then complained of pains in her belly, loins, and thighs, and had ſuch another evacuation. The quantity of blood voided, was judged by her mother to be as large as what ſhe herſelf commonly had in her menſes. The child ſuffered regularly ſuch returns every three weeks, or, at furtheſt, within the month, attended with the ſame ſymptoms, without any conſiderable loſs of ſtrength, or decay of her body, till the month of May 1729. But during the third monthly evacuation, which was at the end of September 1728, her mother obſerved a ſmall ſwelling riſing out from the orifice of the vagina; which diſappeared as ſoon as the hæmorrhage ceaſed. This tumour, however, came out larger at each period thereafter; but upon the child's being kept in bed three or four days, and the flux of blood ſtopping, always diſappeared, till May, that it came out of a conſiderable bulk, and did not return as uſual. From this time there were no more periodical evacuations of blood: but, inſtead of theſe, there was a perpetual dropping of a white mucus from a hole in the lower part of the tumour; which mucus was ſometimes in ſo large quantities, that if a ſwath had been applied ſome hours about it, to prevent that liquor from coming away in drops, as frequently was done, whenever the ſwath was taken off, the mucus was thrown out ſo abundantly, and with ſuch force, as made thoſe preſent to imagine it was urine which the child paſſed.

About the end of July, the parents having brought the child to the hall of the college of phyſicians, where Dr John Riddle and Dr William Porterfield

terfield were then attending to give advice to the poor; theſe two gentlemen having viewed the child, deſired the parents to carry her to me.

Being informed of the preceding hiſtory by the child's mother, I examined the parts, and found a tumour G, (ſee Pl. IV. fig. 1.) hanging out at the vagina, as big as a hand-ball, the neck of which, F, was about an inch diameter. At the loweſt part, H, the tumour was largeſt, and of a faint leadiſh colour. Behind the moſt prominent part of it, I diſcovered a hole of one-fourth of an inch diameter, by which I introduced a probe, I, ſome inches; and then the probe was reſiſted, and the child complained of pain. From this hole there was a conſtant ſtillicidium of mucus. Round this orifice the tumour felt hard and firm: but a little higher, where it was largeſt, it was ſofter, ſeeming to be compoſed of a cellular ſubſtance; at this place ſcales had frequently formed and fallen off. The neck, F, of the tumour was very ſmooth, of a ſhining red colour, and very ſolid and hard; I introduced a probe betwixt this neck and the ſides of the vagina, two inches upwards, and turned it all round the circumference of the neck. The clitoris D, nymphæ B B, and orifice of the urethra E, were natural enough: only the neck of the tumour preſſing on the urethra, occaſioned ſome difficulty in the excretion of urine; and the urine being diffuſed over the *labia magna* A A, and other neighbouring parts, had, by ſtriking againſt the large baſe of the tumour, ſomewhat excoriated theſe parts.

The child could ſcarce ſit, and ſtradled when ſhe walked; but lying abed ſhe was very eaſy. Her complexion was pale; and her body ſmall; otherwiſe ſhe was healthy. Having conſulted with the two gentlemen who had ſent her to me, and ſeveral other phyſicians having ſeen her, the diſeaſe was unanimouſly judged to be a *procidentia uteri*. Wherefore I attempted to reduce it; but the tumour was ſo large and firm, I could not accompliſh it. Fomentations and cataplaſms, firſt of the emollient and diſcutient kind, were applied; afterwards they were formed entirely of the attenuants; and laſtly aſtringents were tried. In the mean time the child underwent the general evacuations as much as her ſtrength could bear, without the tumour's yielding in the leaſt, but, on the contrary, daily increaſing; at laſt ſhe began to turn hectic, and the tumour to be diſpoſed to gangrene on its outer ſurface, which were in vain endeavoured

to

to be prevented by diet and antiſeptic medicines. I ſeveral times conſidered of the amputation; but, being ſenſible of the body of the uterus being to be cut through, and frightened by the ill ſucceſs Ruyſch and ſome others had in this operation, I had not courage enough to undertake it. The child in the mean time turned weaker; the tumour gangrened in its external ſurface; and, by the gangrened parts falling off, it was reduced to near half its former bulk. Ten days after which, (7th November), ſhe died.

On opening the abdomen next day, the bladder, K, was full of urine: the left ureter, M, was in a natural ſtate; but the right one, N, was diſtended, by urine, to four times its natural diameter; and the kidney from which it came was larger, ſofter, and paler than the other, but without any appearance of the folliculi or veſicles ſometimes found in morbid kidneys. The urine had certainly been retained in the bladder by the neck of the preternatural procidentia preſſing on the urethra; and the diſtenſion of the right ureter was owing to a ſteatomatous body, U, ſome more than an inch long and ſeven tenths of an inch broad, which lay behind the ovarium and *ligamentum latum*, and reached to the cervix of the bladder, to which it firmly adhered, and through its exterior extremity the ureter paſſed.

There was ſcarce any thing of the uterus to be ſeen, till the bladder was reclined over to one ſide; when a ſmall part of its fundus, O, appeared.

The *tubæ Fallopianæ* Q Q were nearly perpendicular to the uterus, and the ovaria T T were ſituated contiguous to them.

Having made theſe remarks, and carefully obſerved the ſituation in which the ſeveral parts were, I diſſected off the peritonæum and its cellular membrane from the bones and muſcles compoſing the ſides of the pelvis, and brought away all the parts contained in that cavity with the right kidney and ureter: and then, that a view of the whole might be had in one figure, I diſſected the left ſide of the bladder away from the peritonæum, and reclined it over to the right; after which, having with a needle paſſed threads through the ſkin where the *mons veneris* and external or great *labia pudendorum* are, I gently ſtretched the ſkin of theſe parts, and ſecured it in that poſture by help of the threads which were tied to a

probe, and two pins which I had made faſt to the table; in which poſture the engraver delineated it, having his view obliquely from the left ſide and from above. The figure he drew, and afterwards graved, will, I believe, better explain the ſituation and connection of all the parts, than any deſcription; and is the only one I know that gives a diſtinct idea of this diſeaſe my patient laboured under, a genuine *procidentia uteri* covered with the vagina, and without any inverſion of the womb.

AA The two great *labia pudendorum.*

BB The *nymphæ.*

C *Præputium clitoridis.*

D *Glans clitoridis.*

E The orifice of the urethra.

F The neck of the *procidentia* as it came out at the vagina.

G The left ſide of the tumour, which was much diminiſhed by the falling off of the gangrenous parts.

H The right ſide, which had no parts caſt off.

I A probe put into the uterus by its internal orifice.

K The bladder diſtended with urine, and reclined over to the right ſide.

LL The jagged edges of the peritonæum both on the left ſide of the bladder, and of the pelvis where it was cut, to remove the bladder to a ſide.

M The left ureter of the natural ſize.

N The right ureter greatly enlarged with urine.

O The *fundus uteri.*

PP The *ligamenta lata.*

QQ The *tubæ Fallopianæ.*

R The *fimbriæ* of the right *tuba* with its orifice in view.

S The left *morſus diaboli* ſeen on the ſide averſe to the orifice.

TT The *ovaria.*

U The extremity of the ſteatom appearing from under the right ovarium.

W. The thick *tunica celluloſa* at the ſide and back-part of the pelvis.

X The *inteſtinum rectum.*

Y The probe to which the thread ſupporting the *mons veneris* was tied.

ZZ The

ZZ The pins to which the threads ſtretching the great labia were faſtened.

After the figure was drawn, I endeavoured to diſcover, by diſſection, how far the inverted vagina or uterus had each been increaſed in their bulk to form ſuch a large tumour; but they were ſo intimately united, that I could not diſtinguiſh the one from that of the other, and therefore could not determine their proportional thickneſs.

N° 32. (A)

The URETERS obſtructed by ſmall STONES.

AN old man who had ſuffered under ſome ſevere fits of the ſtone, ſeveral ſmall ones of which he had paſſed, and who afterwards had violent hæmorrhagies at his noſe, recovered, in appearance, a very firm ſtate of health, without any complaint, and enjoyed it a conſiderable time. Being attacked with another fit of the gravel, and nothing being evacuated from the bladder, except now and then a ſpoonful of a clear limpid liquor, which had neither ſmell nor taſte of urine more than ſerum of the blood has, and no diſtenſion of the bladder coming on, was blooded, purged, bathed, and all the other methods practiſed in obſtructions of urine and ſtone were employed in vain, the obſtruction remained, he became comatous and died.

The left kidney was conſiderably leſs than natural, and was become a thin ſac; the ureter belonging to it was very ſmall, and felt hard. When cut open, it was found fully ſtuffed with a gravel of a dirty black colour, ſqueezed ſo cloſe together that no liquor had probably paſſed that way for a conſiderable time.

The right kidney was diſtended with urine to a monſtrous ſize; and the ureter was ſo large, that at firſt ſight I miſtook it for a piece of inteſtine. Upon opening it down to the bladder, I found a ſmall ſtone niched ſo firmly between the coats of the bladder, that I had ſome difficulty to bring it out; it was not above a fourth of an inch from the orifice of the ureter into the bladder.

N° 32. (B)

REMARKS

ON THE

SPERMATIC VESSELS and SCROTUM, with its CONTENTS*.

BY the public advertiſement which Valſalva gave (*a*) of having diſcovered ducts ſent from the *glandulæ renales* to the teſtes of men and ovaria of women, we were made to hope for conſiderable aſſiſtance in accounting for generation and the uſe of the *glandulæ renales*. Valſalva dying without explaining fully the diſcovery he pretended to, Morgagni (*b*) related what he found in Valſalva's papers concerning this ſubject, of which you have given an abridgement (*c*); but have not remarked with Morgagni, that Valſalva had not ſeen what he thought to be a duct of thoſe parts more than once in the human ſubject.

Soon after Valſalva's advertiſement was publiſhed, Mr Ranby (*d*) deſcribed a branch of the artery of the *glandula renalis* ſent down to the teſtes of men and ovaria of women, which he thought Valſalva might poſſibly have miſtaken for an excretory duct. You alſo took notice of this (*e*), and begged Mr Ranby to determine, Whether ſuch an artery was conſtantly or ſeldom found? Since your queſtion has not been anſwered by the gentleman to whom it was put, the remarks I have made in diſſecting the ſpermatic veſſels of a conſiderable number of human ſubjects, may poſſibly not be diſagreeable to you.

1. In

* Originally inſerted in the Edin. Med. Eſſays, Vol. V. Art. xx.

(*a*) Giornali di literati, 1719. (*b*) Comment. Acad. Bononienſ. p. 379.

(*c*) Medical Eſſays, Vol. II. Art 33. (*d*) Philoſ. Tranſact. Num. 387. § 3. Num. 395. § 12.

(*e*) Medical Eſſays, Vol. II. Art 33.

1. In the greater number of human bodies, the ſpermatic artery of each ſide riſes from the anterior part of the aorta, between the emulgent and inferior meſenteric arteries, as they are painted by Euſtachius (*a*); and having each its courſe obliquely downward and outwards, becomes, contiguous to its vein, a knotty membranous ſubſtance connecting them here more firmly together than any where elſe in their progreſs. The artery deſcending ſends numerous ſmall branches off to the cellular ſubſtance it is lodged in; and near to the ovarium in women, or ſome way above the teſtis in men, divides into two branches, as painted by Swammerdam (*b*) and De Graaf (*c*). The larger branch in men is beſtowed on the teſtis, through the ſubſtance of which its numerous branches are diſperſed every where, as may be evidently ſeen after a good injection. The leſſer branch of the ſpermatic artery in men is principally loſt in the epidydimis, though I have frequently traced its very ſmall branches diſperſed alſo on the teſticle.——The larger branch of the ſpermatic artery in women is ſent to the ovarium, and to anaſtomoſe with the other uterine arteries; the leſſer one is diſtributed to the *tuba Fallopiana* and *ligamentum latum.*

2. Numerous veins coming out of the teſtis and ovarium, unite and ſeparate ſo often, as they aſcend to be collected at laſt, with the many branches they receive from the parts they run near to, into one large vein, as to deſerve the name of *corpus varicoſum* or *pampiniforme.* The ſingle vein into which theſe numerous ſmaller veins unite, empties itſelf into the *vena cava*, immediately below the emulgent on the right ſide, and into the emulgent vein on the left ſide.

3. Where the artery and vein are contiguous, the venous branches croſs over and twiſt round the artery ſo, that at firſt view one would be in hazard of thinking they united into one canal, or opened by a large anaſtomoſis into each other; but by diſſecting carefully, and after an injection, one ſees plainly there is no ſuch anaſtomoſis.

4. Theſe veſſels, while in the abdomen, are on the outſide of the peritonæum in their whole courſe, lying in a cellular ſubſtance, over the anterior part of which the peritonæum is ſtretched.

5. Though the riſe and courſe of the ſpermatic arteries are commonly as

(*a*) Tab. 12. and 13. (*b*) Miracul. Natur. Tab. 1. 2. 3.
(*c*) De Organ. Gener. Tab. 1. 2. 12.

as I have juſt now deſcribed, yet frequently there is a variety to be obſerved here: for, in ſome bodies, I have ſeen one or both ſpermatics riſe from the aorta higher or lower than the ordinary place; in others, I have found them coming from the emulgents, or from the arteries of the *glandulæ renales*; three bodies are all in which I found this origin of the ſpermatic arteries from the arteries of theſe glands, or *capſulæ atrabilares*, as they are called.

6. Inſtead of one ſpermatic artery, of each ſide, I have ſeen ſeveral times two in one of both ſides, which had their origins in the uncertain way I mentioned the ſingle artery to have.

7. When there has been one artery of a ſide, riſing from the ordinary part of the aorta, I have ſeen it in one or both ſides make an arch upwards before it turned down to the ordinary courſe. In one ſubject, a woman, the ſpermatic artery of the left ſide aſcended from the aorta to paſs between the emulgent vein and artery of the ſame ſide, and to make a large curve to come at the anterior part of the vein, over which it deſcended to go to the ordinary courſe.

8. I do not know if it is worth while to take notice, that I have more frequently met with thoſe deviations from the ordinary ſtructure, or thoſe *luſus naturæ*, in the left than in the right ſide of the body.

9. Notwithſtanding the differences of origin or courſe of the extraordinary arteries, they kept generally, in their further progreſs and diſtribution, to what I deſcribed as the ordinary rule; that is, the ſingle arteries became contiguous to the vein near to the middle of the anterior ſurface of the pſoas muſcle, and afterwards divided into two branches to be diſtributed in the manner in which the branches of the ſpermatic artery commonly are diſtributed: and where there are two arteries on the ſame ſide of the body, they approach the vein in the ordinary place; the leſſer one, which is commonly the one deviating moſt from the general rule, ſerving the epidydimis or *tuba Fallopiana*; and the larger one being diſtributed to the teſtis or ovarium.

10. When the ſpermatic veſſels of men are paſſing out of the abdomen, they inſinuate themſelves between muſcular fibres; which may be ſaid either to be part of the tranſverſe, or of the internal oblique muſcle of the abdomen, or of both. What occaſions the difficulty in determining the muſcle

muſcle which theſe fibres belong to, is, that the courſe of the fibres of the two muſcles is much the ſame here; and that the connection of the fibres to each other is ſoo looſe, by means of the cellular membranes, as to allow us to ſeparate them as we pleaſe, by either leaving them with the tranſverſe muſcle, or raiſing them with the oblique, or giving a ſhare of them to each muſcle.

11. The ſpermatic veſſels and *vas deferens*, in going through between the fibres now deſcribed, which form a paſſage that is very eaſily dilated, carry part of the cellular membrane, in which they lay behind the peritonæum, along with them, and acquire more from the cellular membranes of the muſcular fibres.

12. Beſides the muſcular fibres between which the ſpermatics paſs, there are others which, inſtead of continuing their courſe tranſverſely from the *os ilium* to the *linea alba*, fall obliquely down on the outſide of the cellular ſubſtance involving the veſſels, and go out with them at the oval tendinous ring of the external oblique muſcle, which is compoſed of firm interlaced fibres, and is not eaſily dilated.

13. In the paſſage between the muſcles and through the ring, the ſpermatic cord obtains more cellular ſubſtance; and ſoon is immerſed in the common *tunica cellularis* under the ſkin, to deſcend to the ſcrotum.

14. Frequently a ſlip of muſcular fibres is ſent off from the external oblique muſcle of the abdomen, to join thoſe which paſſed through the tendinous ring of this muſcle, to aſſiſt in forming the cremaſter muſcle of the teſtis; which lying at firſt on the outſide of the ſpermatic cord, gradually, as it deſcends into the ſcrotum, expands its fibres round the cord over the cellular ſubſtance, and at laſt is ſpread on the vaginal coat of the teſticle, to which it adheres very firmly.

15. The cellular membranes on the inſide of this muſcle, where it covers the ſpermatic cord, loſe their cellular appearance when cut, in the ſame way as is to be obſerved in what is called the proper membrane of moſt muſcles; which, when ſtretched gently in diſſecting the muſcles, or by blowing air into it, evidently ſhows itſelf to be the ſame ſort of cellular ſubſtance as is ſeen between the ſkin and muſcles. The membranous appearance, however, which the cells within the cremaſter muſcle have when collapſed or ſtretched longitudinally, is what continues the opinion

of

of their being a vaginal coat to the human ſpermatic cord; which was ſuppoſed for a long time to be a proceſs or ſheath ſent down by the peritonæum in the human body, as well as it is in quadrupeds, which were then generally diſſected. But the difference is very conſiderable: For, in men, the ſpermatic veſſels lie entirely behind the peritonæum, and there is not any perforation or production from this membrane at the place where the veſſels are paſſing between the fibres of the abdominal muſcles; whereas, in many quadrupeds, there is a production of the peritonæum, which covers the ſpermatic veſſels, but allows them to lie looſe in the abdomen, analogous to what we ſee the meſentery does to the inteſtines; and when theſe pendulous veſſels are joined by their pendulous *vas deferens*, they enter the orifice of a tube formed by the peritonæum, at the aperture of the abdominal muſcles. This tube formed of the peritonæum, as the finger of a glove is produced from the glove, is continued down to the bottom of the ſcrotum, and contains the ſpermatic cord and teſticle, which are only connected to it at the poſterior part, where its membrane advances to furniſh them their more immediate covering, which ſerves to keep them in a right ſituation, and to ſtrengthen and protect them.

16. In our erect poſture, where the moiſture of the abdomen falls down to the lower part of its cavity, and where the bowels are always preſſing with conſiderable force at the paſſage in the muſcles, ſuch a tube continued from the abdomen would have perpetually collected liquor in it, and made us much more ſubject to herniæ; of which there is leſs danger in quadrupeds, in whom this orifice of the tube is at the higheſt part of their bellies: but becauſe, in ſtraining contractions of their abdominal muſcles, the viſcera might be puſhed out at this orifice, a moveable fatty flap is placed at the lower part of the orifice, which the bowels, preſſed upwards, muſt carry before them to cover the paſſage to prevent their getting out, and at the ſame time to defend the ſpermatic veſſels from the preſſure of the bowels; which preſſure, in our erect poſture, we are much expoſed to, and therefore ſtand greatly in need of, and are provided with a tenſe peritonæum to defend our ſpermatic veſſels from it; notwithſtanding which, the ſpermatic veins often become varicous when the belly is much ſtretched.

17. It may be worth while to remark here, that nature ſeems to attempt

a contrivance to prevent herniæ in men, a-kin to the fatty flap in brutes; whenever men are brought by diſeaſes into the hazard of herniæ, from the orifice of a tube produced from the belly. After the reduction of herniæ, a fat ſubſtance has grown out from the peritonæum at the rings of the abdominal muſcles, which prevented a relapſe (*a*).

18. Some thought that the membranous bag, deſcribed and painted by Schrader (*b*) and Bidloo (*c*), from a preparation of Swammerdam's, coming out from the peritonæum along with the ſpermatic veſſels, is a proof of the natural production of the peritonæum here; but as no ſuch bag is for ordinary to be ſeen, and we know nothing of the circumſtances of the perſon to whom this preparation belonged, while thoſe who have diſſected ſeveral people who had long wore truſſes for herniæ tell us they found the remains of the ſacs of the herniæ of the form which Shrader deſcribes (*d*), it is reaſonable to think Swammerdam's preparation was no other than ſuch a morbid ſac.

19. In place of one membranous vaginal coat from the peritonæum, ſome authors (*e*) have deſcribed three firm membranes inveſting the ſpermatic cord, which they ſay are aponeuroſes from the muſcles, through which the cord paſſes: but as theſe were only found in the diſſection of unreduced herniæ, we may eaſily imagine how this appearance might be the effect of the morbid ſtate of the parts, by the thickening of ſtretched cellular membranes, though there are no ſuch firm membranes to be ſeen in a ſound ſtate.

20. The real ſtructure of the human ſpermatic cord is, that the ſpermatic veſſels and *vas deferens* carry along with them cellular membranes from the outſide of the peritonæum, and acquire more as they deſcend; which are at firſt covered only on the external ſide by the cremaſter muſcle, and then are ſurrounded by it till they come down as far as the ſuperior part of the teſticle, when the cellular membranes terminate, and the thin fibres of the muſcles are ſpread on the vaginal coat of the teſticle; as

(*a*) Pare, livre 18. chap. 15. (*b*) Obſerv. dec. 2. obſ. 5.

(*c*) Anat. Tab. xxxii. fig. 3. & 4.

(*d*) Le Dran, Obſerv. Chirurg. Reflections ſur l'obſerv. 58.

(*e*) Du Blegny Zodiac. Medico-gallic. an. 1. menſ. Febr. obſ. 1. Memoires de l'Acad. des Sciences, 1701.

as is to be ſeen evidently after putting a blow-pipe into the upper part of the ſpermatic cord, and blowing air into the cellular ſubſtance. Rau (*a*) has given us a pretty good picture of this.

21. In tracing the ſpermatic veſſels accurately, we obſerve, that at the epidydimis they paſs between two contiguous membranes which can be ſeparated: And if we continue the diſſection of theſe membranes from each ſide of the teſticle, we bring off a large membranous bag; the part of which that immediately inveſts and adheres to the teſticle goes commonly by the name of the *tunica albuginea*, or *propria teſtis;* while the other part, being reflected down from the epidydimis, forms the looſe vaginal coat; and the part of it which covers the epidydimis, and deſcends from that to where the cremaſter muſcle begins to be firmly fixed to it, is called by ſome late writers the *ſeptum*, or partition between the ſpermatic cord and teſticle; which may be conſiderably enlarged and thickened by diſeaſes, and the addition of ſtretched cellular membranes adhering to the ſuperior part of it.

In the ſame manner as is here propoſed for bringing away the vaginal with the proper coat of the teſticle in an empty bag, the membrane of the heart with the pericardium, or the pleura with the membrane of the lungs, or the peritonæum with the meſentery expanded over the inteſtines, and with the membranes of the other viſcera over which it is ſpread, may alſo be taken out in ſo many empty bags; and therefore, in the ſtrict way of ſpeaking, none of theſe bowels can be ſaid to be contained within the membranes that are commonly ſaid to inveſt them.

22. Beſides the artery which is named *ſpermatic*, there are two others which commonly are ſent to each teſticle. One is a branch of the artery which furniſhes the *veſicula ſeminalis* and *proſtata* with blood, that runs upon the *vas deferens* as far as the epidydimis; and ſometimes I have traced its ramifications on the teſticle after a good injection: De Graaf (*a*) repreſents ſome part of this artery. The other artery is ſometimes ſent down through the rings of the muſcles from the epigaſtric: In other ſubjects, it comes out below the duplicate tendon of the external oblique muſcle, that goes by ſo many different names of Veſalius's, Fallopius's, or Poupart's ligament, Douglas's arcade of the peritonæum, &c.; and,

(*a*) Reſponſ. ad Ruyſch, Tab. II. fig. 2. (*b*) De Viror. Organ. Tab. VI. fig. 1. II.

after giving branches to the ſcrotum, enters the cellular ſubſtance of the ſpermatic cord, to go to the epidydimis and teſticle. Winſlow (*a*) has mentioned this artery.

23. Some branches of veins coming away from the *corpus pampiniforme*, being joined with others from the ſcrotum, form a vein which accompanies the artery laſt deſcribed, to empty itſelf into the external iliac vein near to the ring of the external oblique muſcle; it is generally conſiderably enlarged by veins returning the blood from the teguments of the lower part of the abdomen.

24. The oblong teſticles are ſituated obliquely; ſo that their convex longeſt ſurface is anterior and inferior, while the epidydimis fixed to the other ſide is ſuperior and poſterior; their extremity, where the thicker part or beginning of the epidydimis is, being exterior and ſuperior, and the *vas deferens* going out from the inferior poſterior extremity.

25. The membrane connecting the epidydimis to the teſticle ſinks into the root of the epidydimis at the anterior part, and ſo leaves there a furrow between the teſticle and epidydimis; whereas, on the poſterior part, the ſurface is ſmooth without any depreſſion. By means, however, of the depreſſion on the anterior part, the membranes of the two ſides come very near each other, admitting the veſſels only between them; which therefore run to the teſticle at the poſterior ſide of the epidydimis (*b*).

26. The fibres or threads of which principally the teſticle is compoſed, eaſily ſeparate from each other; and a ſingle thread can be drawn out to great length. Theſe threads are probably veſſels; but I cannot determine of what kind, never having made a coloured liquor to enter them.

27. The pellucid firmer fibres that run through the middle of the teſticle from the convex ſide towards the epidydimis, dividing it in ſome meaſure into equal portions (*c*), which are commonly eſteemed excretory ducts, I believe to be blood-veſſels, having forced a coloured liquor into ſeveral of them by injecting the ſpermatic artery.

28. The membranous ſubſtance under the epidydimis (*d*), generally called Highmore's duct, has no cavity that ever I could perceive; which ſhould certainly, however, be evident, if it was the common pipe for receiving

(*a*) Expoſition des Arteres, § 237. (*b*) De Graaf, Tab. I. & II. (*c*) Id. Tab. IV. fig. 4.
(*d*) Highmore, Diſquiſit. Anat. Tab. XI. fig. 1. lit. g. g. De Graaf, Tab. IV. fig. 4.

ceiving the liquor from ſo many excretories as are ſaid to open into it: It appears to be no more than the firm membranes connecting the teſticle and epidydimis together.

29. It has been doubted whether the *vas deferens* and epidydimis were continued tubes or not. To be ſatisfied in this, cut the *vas deferens* through where it lies on the inſide of the *veſicula ſeminalis*, and take it and the teſticle away from the body: preſs the epidydimis from its larger towards its ſmaller extremity, and from that to the cut end of the *vas deferens*, till you have ſqueezed out all the liquor you can; taking care, by ſqueezing with moiſt fingers, not to let theſe parts dry too much in doing this: then put up a long pipe into the *vas deferens*, and through it pour quickſilver: the weight of ſuch a high column of mercury, aſſiſted by your fingers preſſing from time to time towards the teſticle, will make the quickſilver go forward in the tortuous canal about half the body of the epidydimis; beyond which I never could make it paſs, being, I ſuppoſe, ſtopped there by the liquor of which the canals were full. By this preparation, one ſees clearly the tubular texture of the *vas deferens*, and the wonderful convolutions of it where it has the name of *epidydimis*.

30. When the ſpermatic cords paſs the rings of the external oblique abdominal muſcles, they are lodged in the common *tunica adipoſa*, till they enter the ſcrotum, where no fat is to be ſeen, but the cords and teſticles, involved in their vaginal coats, are immerſed into a cellular ſubſtance, the cells of which all communicate with each other; ſo that water or air forced into either ſide, or at any part, readily diffuſes itſelf through the whole of it: from whence it is evident, that there is no membranous or carnous partition dividing one ſide of the ſcrotum from the other. In ſeveral ſubjects, air only paſſes from one ſide of the ſcrotum to the other at its upper part; and in ſome, one ſide of the ſcrotum is not inflated by blowing air into the other. What has been ſhowed as a *ſeptum ſcroti*, is the effect of a faulty preparation: either the cords and teſtes have been violently drawn out at an aperture in the upper part of the ſcrotum, and their places have been filled with ſome ſubſtance to keep the ſcrotum diſtended till it became dry; or the ſcrotum has been ſlit open on each ſide at its fore-part to take out the teſticles; after which it has been ſtretched out on a board, and the penis has been ſupported to keep

keep the middle ſubſtance ſtretched till all was dry. By a preparation made in either of theſe ways, a firm ſeptum may be formed; but then it is no more than the collapſed cells all glued together in the drying, and ſuch as can be made in any part of the common *tunica cellularis* under the ſkin of lean people, where there is no fat. If we cut through the middle of the ſkin of the ſcrotum, and violently tear away one teſticle from the other, we will be likewiſe led into a miſtake concerning the ſtructure of the parts here; the collapſed cellular membrane will have the appearance of a ſac incloſing each teſticle, and we ſhall believe the two bags were only applied to each other.——The way to have a right notion of the ſtructure of the parts here, is to diſtend the cellular ſubſtance of the ſcrotum with air while the ſcrotum is entire and the teſticles are in their natural place, and then to dry them; or rather to cut the ſkin all along the middle of the ſcrotum of a recent ſubject, and then to draw the ſkin gently to each ſide, cutting gradually what we have viewed ſufficiently, and bringing the ſides of the inciſion nearer together from time to time: then we will be ſenſible that the teſticles are connected by cellular membranes, which are capable of being ſtretched to a very great extent, and when collapſed go into a very ſmall ſpace; and that the teſticles are every where in ſuch a ſubſtance.

31. What ſhould prevent the veſſels of theſe cells from ſeparating an oily liquor into them, as is done generally into the *tunica cellularis* elſewhere, I do not know: but the want of fat here ſaves us the trouble we might have from the ſtretching of the ſkin and ſpermatic cord by its weight; and we are not ſo much expoſed to bruiſes and other hurtful accidents, as if the ſcrotum was larger by the addition of fat.

I had occaſion formerly (*a*) to obſerve, that the cellular ſubſtance under the ſkin, when it has no fat in it, puts on a muſcular appearance, and wrinkles the ſkin: it does the ſame here in the ſcrotum; and theſe collapſed membranes entirely compoſe what is ſo formally deſcribed as a muſcle under the name of *dartos*. Whoever will number the dartos among the muſcles, ought to reſtore the exploded *tunica carnoſa* to its place among the general teguments of the body.

33. The cellular membranes at the upper part of the ſcrotum are firmer than

(*a*) In the firſt article of this Collection.

than lower down; and the difference becomes much more remarkable when they are ſtretched by any diſeaſe: this depends on their being connected to the top of the thigh on one ſide, and to the *os pubis* on the other, and ſome addition which ſeems to be made to them of fibres from the tendinous aponeuroſis of the *faſcia lata*, and from the ſuſpenſory ligament of the penis.

34. The ſkin and cuticula of the ſcrotum are of the ſame ſtructure as elſewhere: but the little wrinkle called *raphe*, extended along the middle of the ſcrotum on the lower part of the penis and on the perinæum, has been thought to deſerve particular notice; and by the cautions that are given to ſhun it in operations, one would imagine it to be ſomething conſiderable. To me it appears no more than the ſkin ſtretched a little leſs in the interſtice of the teſticles than in other parts, and therefore making a larger wrinkle: for whenever the water or air, introduced into the cellular ſubſtance, diſtends the ſcrotum equally, the raphe diſappears. An injury done to it, I am certain, is of no worſe conſequence than when done to any other part of the ſcrotum.

35. The principal artery of the ſcrotum on each ſide, is what comes from the crural artery; and, croſſing over the anterior part of the ſpermatic cord, ſpreads its branches every where in the ſcrotum, and a large branch or two is given to the ſkin of the penis. Other ſmaller ones it has that come down from the epigaſtric and pudenda; and I have ſeen others riſe up to it from the branch of the hypogaſtric, which ſerves the perinæum.

36. Its principal vein accompanies the larger artery, or frequently is a little higher up.

N° 33.

REMARKS

ON

INGUINAL HERNIÆ in MEN.

THE viſcera of the abdomen cannot fall down through the rings of the muſcles to form a true hernia in the groin or ſcrotum, unleſs the tenſe peritonæum covering thoſe rings (§ 16. preceding art.) is either broken or ſtretched. The former ſeems to have been the prevailing opinion in Britain when the name of *rupture*, or *burſten-belly*, was given to this diſeaſe: the latter opinion, *to wit*, that the peritonæum is thruſt down into a blind bag in which the bowels are contained, is what many operations and diſſections have proved to be almoſt conſtantly the caſe.

The ſituation of the ſpermatic veſſels (§ 4.) may let us ſee, that in herniæ the ſac of the peritonæum, with the included viſcera, muſt be always placed at the interior part of the ſpermatic veſſels; and the deſcription of the cremaſter muſcle (§ 14.) may teach us, that, in deſcending towards the ſcrotum, the ſac may either enter within the cremaſter, or may paſs over it at the internal anterior part of the ſpermatic cord, the cellular membranes of the cord in the former caſe, and of the ſcrotum in the latter, yielding to the force puſhing the viſcera down.

In theſe caſes the form and effects of the herniæ will be a little different.

When the ſac deſcends within the cremaſter muſcle, the tumour will be more perpendicular, more oblong and tenſe, becauſe of the bowels being reſtrained and confined by the muſcle. The ſeptum (§ 21.) will hinder it from deſcending to the teſticle, which (§ 24.) will be felt at the external anterior ſide of the hernial tumour; and, if the ſac with the bowels is puſhed ſo violently upon the ſeptum, as to ſtretch it, a riſing ring will be

be formed round the ſides of the teſticle, and the epidydimis is concealed.

If the hernial ſac falls without the cremaſter, it will deſcend towards the interior ſide of the ſpermatic cord; its form will be rounder, and the ſac will not be ſo tenſe as in the former caſe; it may go down as far as the teſticle, which, with the epidydimis, will be felt on its external part. If the hernia is very large, the ſac may be ſo diſtended, as almoſt to ſurround the teſticle.

The effects of a hernia on the different parts forming the tumour will be theſe.

The ſtretched ſkin will have all its veſſels, particularly the veins, conſiderably enlarged, which is a common effect of ſtretching the ſkin any where, but muſt be more remarkable here, becauſe of the ſituation of the principal vein (§ 36.), the trunk of which is much expoſed to be preſſed upon. This diſtenſion of the veſſels muſt be proportional to the preſſure on the vein, the largeneſs of the tumour, and the time it has continued. A ſmall, floating, recent hernia, will not have its cutaneous veſſels ſo much diſtended as a very large ſtrangulated old rupture of long continuance.

The cellular membranes, having their cells applied nearer to each other by the ſtretching, become firmer; and, by continuing in this condition, increaſe their thickneſs and firmneſs in the ſame way as we obſerved them to do every day in forming the ſac of encyſted tumours, and in many other caſes. Thoſe of them which are annexed to firm parts will ſuffer moſt in this way from the preſſure; ſo that we need not be ſurpriſed at ſeeing ſometimes a croſs band, at the ſuperior part of the ſcrotum (§ 33.), in hazard of ſtrangulating the hernia, or to obſerve ſeveral membranous lamellæ that appear to be aponeuroſes from the abdominal muſcles (§ 19.)

What was ſaid of the veſſels of the ſkin, may be applied alſo to the cellular membrane, whoſe enlarged veſſels will pour out liquors into the cells that are not violently ſtretched. Hence the ſcrotum becomes frequently thick in herniæ; and as the liquor is more or leſs viſcid, the thickened ſcrotum will be more or leſs hard, ſo that we may obſerve it in all the degrees between a watery ſwelling and a firm ſcirrhus.

The peritonæum will not only have the ſac containing the viſcera af-

fected in the way the parts hitherto deſcribed are, but where it is ſtretched within the belly, near to the protruded part, it may be drawn into unequal wrinkles, which will likewiſe thicken, and may grow together.

The veſſels of this depending ſac will pour out their liquors in greater quantity; and, if the abdominal liquor is collected in drops, they will drill down into the bag; on which account we meet ſo frequently with a liquor contained in the hernial ſac. When this liquor is mild, it is ſo far from being hurtful, that it is the beſt preſervative againſt the concretion of the ſac and its contained viſcera, or of the viſcera to each other. If this liquor becomes acrid, it will ſtimulate, give pain, and erode the ſolid parts.

The viſcera contained in the hernial ſac, muſt draw thoſe they are connected to within the belly, which may make theſe parts alſo to ſuffer. Thoſe in the hernia being ſtraitened in the preternatural ſac, eſpecially where the membranes are ſupported by firm parts, which prevent their ſtretching, as at the ring of the external oblique muſcle, the contracted wrinkled peritonæum, or the croſs membrane at the top of the ſcrotum (§ 33.), their veſſels will be preſſed; and the returning liquors being moſt eaſily ſtopped in their courſe, all the veſſels below this ſtraitened part will be ſtretched, and the volume of the parts to which they belong will conſequently be increaſed.

All the hollow viſcera having ſome fluid or other ſubſtance contained in them, and ſuch viſcera being often engaged in herniæ, their contents may be retained and collected in this depending part, by which the viſcera are diſtended, the veſſels are more ſtretched, and the bulk of them is increaſed. The heat of the body, and the corruption which theſe contents of the hollow viſcera are expoſed to by ſtagnating, may make a rarefaction of theſe contained ſubſtances, and conſequently a greater diſtenſion of the parts containing them.

The diſtenſion, obſtruction, and irritation, may occaſion pain; and that effort nature makes for being freed of the cauſe of ſuch diſorders which we call a Fever, is raiſed, from which there is danger of all the diſorders being increaſed; the veſſels may be more diſtended, which will increaſe the irritation and pain; the heat and corruption will conſequently increaſe, and make the diſtenſion of the parts greater; the obſtruction

may

may become complete, and therefore the parts may mortify. What is now deſcribed, ſurgeons call the inflamed ſtrangulated ſtate of a hernia, the progreſs and ſymptoms of which are told accurately enough by moſt writers on this ſubject, and therefore I ſhall not give any detail of them.

If the effort of nature ſhould prevail, and the obſtruction be removed by the fever, it muſt be either in the way of *ſuppuration* or *reſolution*; terms ſo well known, that it is needleſs to explain them.

In the more favourable of theſe two caſes, the *reſolution*, the viſcera and their contained bag, being, while in the inflamed condition, preſſed cloſe together, and no liquors being poured out, are liable to grow together; and they always acquire an addition of ſubſtance which they do not quit eaſily; ſo that they are thicker and firmer afterwards. In the ſuppuration, beſides the danger of concretion during the inflammation, the pus not having any paſſage out, may become acrid, erodes the part it touches, and may be taken into the veſſels ſo as to create various diſorders.

When there is no impediment, nature or art can make the bowels return into the belly by the ſame paſſage which they came out at; and if that paſſage can be ſufficiently blocked up, a return of the diſeaſe may be prevented.

When the bulk of the parts becomes ſo great that they cannot return by the paſſage they came out at, or there is a concretion of them to the neighbouring parts, they muſt remain in this morbid hernial ſtate till their bulk diminiſhes, or the paſſage is enlarged, or their concretions are diſunited.

The bag in which the viſcera are contained in a hernia, having little ſpringy force or contractile power to make it ſhrivel itſelf up into the belly, and being ſo thin that artful preſſure cannot be ſo well applied to it, and being immediately contiguous to ſtretched membranes which may grow to it; for theſe reaſons the bowels often return into the belly when the ſac is left behind; and, being preſſed at its upper part by the ſubſtance blocking up the paſſage through the muſcles, is made narrow there; or its ſides may grow together, while the lower part of it may be filled with water from the abdomen, or from its own veſſels (*a*); or, if this does not happen, it ſhrivels and diminiſhes. See § 18.

(*a*) Saviard, obſerv. 22. Le Dran, obſerv. 75.

When the viſcera are ſtraitened any where in their paſſage down to the hernia, the ſpermatic veſſels, which are placed behind the ſac containing the viſcera, muſt ſuffer more or leſs; and thence a varicous *corpus pampiniforme*, thickened ſpermatic cord from the repletion of its cells with liquors, water collected within the *tunica vaginalis* of the teſticles, ſwelling of the teſticle itſelf, inflammation of all theſe parts, and all the conſequences of inflammation, concretion, ſuppuration, gangrene.

It is evident how variouſly theſe different effects of herniæ may be combined, and of what different degrees each of them may be; and their deſcription may ſerve to make us know them when they happen to any patient.

Though the bowels forming a hernia are generally included in a ſac formed by the protruded peritonæum, yet it is not impoſſible that the peritonæum may be torn by a violent ſudden effort cauſing a hernia (*a*); or though the peritonæum deſcended at firſt, it may be burſted by ſome external violence (*b*), it may be eroded by pus, or fall away by gangrene (*c*).

Allowance being made for the want of the ſac, the effects of this rare kind of hernia may be eaſily underſtood by what was ſaid of the other; and the want of a tenſe bag covering the bowels, with the hiſtory of the cauſe of the diſeaſe and its progreſs, will make ſurgeons judge when this is the caſe.

What I have hitherto mentioned may happen, whatever is the bowel that forms the hernia; but there are ſome ſpecialities which attend the ſeveral viſcera engaged in this ſort of tumour, that had need to be attended to.

The inteſtines and omentum are the parts which fall moſt frequently down, the appearances and conſequences of which are well enough deſcribed in ſeveral of the moſt common books.

Inſtead of an entire piece of inteſtine being thruſt out, which commonly is the caſe, one ſide of a gut has been ſtretched out into an appendix cœca, which was protruded out at the rings of the abdominal muſcles (*d*). When this happens, the ingeſta will not be ſtopt in their paſſage towards

(*a*) Garengeot des Operat. chap. 5.

(*b*) Id. ibid. Mery, Memoires de l'Acad. de Sciences, 1701. (*c*) Saviard, obſerv. 56.

(*d*) Littre, Memoires de l'Acad. des Sciences, 1700. Mery, ibid. 1701.

towards the anus, and the patient will go to ſtool, even though a ſtrangulation of the hernia ſhould come on: whereas, when the whole diameter of the gut is ſtraitened by a ſtrangulation, the ingeſta will be ſtopt at the hernia; after the guts below it are emptied, the patient paſſes no more fæces, and the ingeſta regurgitate towards the ſtomach and are vomited.

The bladder has ſometimes been found to fall down in a hernia (*a*): the fluctuation of a liquor which can be preſſed into the body, to occaſion a deſire to make water, or to run immediately out by the common urinary paſſage, are the ſymptoms by which this ſpecies of hernia may be diſcovered.—The manner in which the peritonæum covers the fundus and back part of the bladder, and the way it is connected to the containing parts of the abdomen at its lower part, would make one reaſonably believe that the bladder will not carry a ſac of the peritonæum down before it; but that one ſide of it gradually thruſt between the peritonæum and muſcles, would be ſtretched out at the rings of the muſcles to the ſcrotum, where it would lie either behind or at the internal ſide of the ſpermatic cord; and, if it remained there any time, would grow to the contiguous parts.

Though I treat only of the tumours of the ſcrotum, it may not be altogether inpertinent to mention here, that the other ſex have had the uterus thruſt through the rings of the muſcle to form a hernia (*b*), which there would be a difficulty to diſcover if there was no child in it, whoſe ſtirrings would lead us to the knowledge of the contents of the hernia.

If the progreſs and ſyymptoms of any tumour in the groin and ſcrotum are accurately enough examined, one who is acquainted with the ſeat and nature of the different dieaſes which happen here, will ſeldom be in danger of miſtaking any other diſeaſe for a hernia, or of judging a hernia to be ſome other diſeaſe.—One of the caſes which would be moſt liable to occaſion a miſtake, is a teſticle lodged either naturally at the ring of the abdominal muſcle (*c*), without having been obſerved till ſome accident makes it ſwell and be pained, or a teſticle retracted thither by inflammation

(*a*) Ruyſch. obſerv. 98. Mery, Mem de l'Acad, 1713.

(*b*) Michael Doring de Hernia Uterina Epiſtola.

(*c*) Parè, liv. 8. chap. 18. Jac. Oeth. lib. obſ. propr. Act. Hafn. Vol. I. obſ. 156.

inflammation or contuſion (*a*.)——No teſticle being found when ſought for in the ſcrotum, the figure and greater hardneſs of the knot in the groin, and the abſence of the moſt common ſymptoms of a hernia, ſuffice for making us diſtinguiſh this caſe.

The prognoſes of herniæ depend on ſo many cicumſtances of the patients and of the ſymptoms, that I chooſe rather to paſs them altogether, than to enter upon the numerous ſuppoſitions which might be made.

That herniæ ſhould be reduced as ſoon as poſſible, all agree. To effectuate this, without cutting or eroding, is what ſurgeons call the *taxis*. For this purpoſe, ſuch a poſture of the patient's body as makes the viſcera preſs leaſt on the rings of the abdominal muſcles, and relaxes the ſkin and muſcles moſt, is of great advantage; ſuch is lying on the back, with the hips and ſhoulders raiſed higher than the loins, and the thighs bended forwards without uſing any effort of the muſcles. While the patient lies thus, the ſurgeon gently puſhes the viſcera up with his fingers alternately applied to a ſmall part of them at once, as is commonly deſcribed well enough, and therefore I ſhall not here tranſcribe the directions for doing this operation; but muſt obſerve, that ſometimes, after the bowels ſeem to be puſhed up into the abdomen, a ſoft knotty ſubſtance remains unreduced, and reſiſts all the efforts to reduction, till the patient's veſſels are emptied by venæſection, repeated purgatives, and low diet. The varicous feel which this ſubſtance had, in the caſes I ſaw, made me judge it to be the meſentery with its veſſels diſtended.

If this attempt does not ſucceed, general directions are given for removing the impediment to reduction by plentiful bleeding, emollient clyſters, fomentations, and poultices. As all theſe are calculated for the inflamed ſtate of herniæ, they do very ill, in my opinion, who preſcribe no other method: for though herniæ, eſpecially recent ones, that will not reduce, are liable to inflame and ſtrangulate, which very ſoon brings the patient into danger of his life, and therefore ſurgeons ought to be much on the watch to guard againſt inflammation; yet an over care to prevent it ought not to make them do things that may retard the reduction, or make it more difficult, ſince it is the moſt effectual preſervative againſt all the bad ſymptoms. The directions mentioned above, and almoſt

(*a*) Boneti Sepulch. Anat. l.b. 3. § 30. obſ. 3.

moſt univerſally ordered and put in practice, are, I think, in this reſpect faulty. If, for example, the obſtacle to reduction is the rarified air within the guts diſtending them, would not the warm relaxing fotuſes and cataplaſms increaſe the diſtenſion? Since the firſt publication of this paper, I have ſeen a caſe of a hernia related by Dr Huxham (*a*), who blames the repeated application of hot fomentations for the vaſt expanſion of the bowels. I have ſeen cold claret or ſnow make the diſtended inteſtines return into the belly after the antiphlogiſtics, as they are called, had increaſed the ſwelling, and the common efforts of reduction had failed.——In the ſame way, when the tone and contraction of the guts is too weak for puſhing the ingeſta, which deſcend into the part of the gut engaged in the hernia, upwards, to go forwards towards the anus, and thereby theſe ingeſta come to be collected in the hernia, and to make the inteſtine there too bulky for paſſing the ring of the abdominal muſcles, blooding and relaxing medicines will weaken the tone of the guts more, and ſo increaſe the diſeaſe: a briſk ſtimulus given by the mouth or anus, would much more effectually make a cure. I have many times made a rupture reduce, by giving powder of the jalap root and ſweet mercury, when neither hands nor emollients did any good.—Will not the ſoft flabby omentum, if it is lodged in the hernia, be always more relaxed, and ſwell more by the application of emollients? What I would recommend, then, is to examine accurately the circumſtances of the diſeaſe; and to vary the method of cure according to the nature of the obſtacle to reduction, whether it is air, fæces, increaſed growth of parts, or overſtretched inflamed veſſels: which laſt only admits the uſe of the things that are preſcribed as proper in all caſes; and, even in it, caution is neceſſary in uſing thoſe medicines.——If a perſon is old and weak, the loſs of too much blood may ſink him, and make the liquors ſtagnate in the diſtended veſſels, to bring ſpeedily a mortification.——If the patient is of a very lax conſtitution, bleeding to exceſs, and the application of emollients, may weaken the veſſels ſo as to make them continue in their diſtended ſtate.

If the viſcera will not reduce by the methods hitherto propoſed, and the ſymptoms of ſtrangulation come on, there is a neceſſity of performing

(*a*) Philoſ. Tranſact. Numb. 459. § 22.

ing the operation for the bubonocele or complete hernia; the rules for which, laid down by late writers, are well enough accommodated to the moſt ordinary circumſtances of herniæ; though it is plain, that, as theſe are various, operators muſt ſometimes change their manner of working. I ſhall not therefore give you the trouble of reading a deſcription of the operation for the hernia in the groin or ſcrotum; but ſhall make ſome remarks on parts of the operation where there is doubt what ought to be done, and on ſome of the more uncommon caſes.

When the viſcera are not confined within a ſac, which I obſerved was ſometimes the caſe, more than ordinary care is to be taken in making the inciſion through the teguments, leſt the bowels ſhould be wounded.

When the ſac is laid bare, it ought to be conſidered, whether it is to be left entire, and puſhed up into the rings after the bowels are reduced, or if it ſhould then be laid open. Circumſtances muſt determine this. If the diſeaſe is recent, with the ſac thin, and not folded into wrinkles, or ſtraitened where it is coming through the paſſages in the muſcles, or grown to any other part; if the bowels are ſound, and in no danger of gangrene, or are not grown to the ſac; if the liquor in the ſac is limpid, and no fetor or eroſion is to be obſerved; if all theſe circumſtances appear, the reduction of the ſac entire will be of ſervice to block up the paſſage, and to prevent the viſcera from being expoſed to the action of the external air.——Where theſe circumſtances do not meet, the ſac ought to be opened, for very obvious reaſons: the wrinkled or contracted ſac may continue the ſtrangulation after the ring of the muſcle has been cut (*a*); the ſac or bowels fixed by concretion will not reduce; an opened gut will let out the ingeſta; and a mortified omentum will ſlough off into the abdomen, from which there is no exit; and, ſtagnating there, they will corrupt more, and do great miſchief. The ſame effect may be expected from the liquor in the ſac, if already acrid.

If there is a conſiderable concretion of the bowels to the ſac, and this is grown to the ſcrotum, the ſurgeon had better leave the bowels unreduced, after cutting the ſtrangulating ring, than riſk the life of his patient by a tedious diſſection of the concreted parts, eſpecially if the guts or bladder are the parts grown to the ſac: for when the ſtrangulation is removed,

(*a*) Le Dran, obſ. 50.

moved, the viſcera may poſſibly ſhrivel up; or if they continue down, a cicatrice may be brought over them; in which condition the patient may live a conſiderable time.

When, in ſuch a concreted ſtate of the bowels, the ſtrangulation depends on ſome piece of a gut lately fallen down, this ſhould be reduced, while the other parts of the bowels are left down (*a*).

Though the gut in a hernia be mortified, ſurgeons ought not to give over the care of their patient, ſince there are ſeveral inſtances of ſuch people ſurviving with either an artificial anus at the ring (*b*), or nature has reunited the diſtant pieces (*c*), or ſhe has been aſſiſted by art to join them (*d*). Mr De la Peyronie's method of ſtitching the parts of the meſentery belonging to the two ends of the divided gut, ſeems preferable to Ramdohrius's practice of ſtitching the gut itſelf; for this irritates more, and the threads of the ſtitch will not come away ſo eaſily, and more readily leave an opening in the gut, than when the ſtitch is made in the meſentery.

Though nothing appears in ſight when the ſac is opened, except the omentum, the ſurgeon ought to examine carefully, whether any ply of the inteſtine is wrapped up within the caul, that they may be diſengaged from each other, leſt the gut be cut or tied, if there is occaſion to perform any ſuch operation on the omentum.

If the omentum is not abſolutely mortified, it ſhould have the chance of recovering by being reduced, ſince, at the worſt, no more inconvenience will happen from the ſeparation of what nature mortifies, than what the ligature, which muſt be made on the preſent ſuppoſition, occaſions.

It is a doubt with me, whether the omentum ought to be tied before the mortified part of it is cut off: for by the ligature more of it is deſtroyed than would be if the gangrened part ſeparated of itſelf; becauſe the liga-

(*a*) Morand, in De la Fay's notes ſur Dionis, p. 55.

(*b*) Mery, Memoires de l'Acad. des Sciences, 1701. Cheſelden's Anatomy, p. m. 69. Le Dran, obſ. 60.

(*c*) Courtial, obſ. 6. Medical Eſſays, vol. i. art. 20.

(*d*) De la Peyronie, Mercure de France, Juillet 1732. Ramdohrius Commerc. Norimberg. 1731, Spec. 26.

ture is made in the ſound part, and by the thread the omentum is drawn into a knot, which may do hurt. Suppoſing the mortified part to be cut off as near to the ſound part as the thread in a ligature is put from the place where the caul is to be cut off, would the cut veſſels in the remaining mortified part bleed? or would the gangrene more readily ſpread without a ligature than with it? The anſwer to theſe two queſtions (which I neither have experience, nor can I find any obſervations of others to aſſiſt me to anſwer) would determine what the practice ſhould be. Since what is above was firſt publiſhed, I have read two caſes (*a*), where there was no hæmorrhagy, nor further progreſs of a gangrene, after cutting away a conſiderable ſhare of the omentum on which no ligature had been put.

After the hernial ſac is emptied by the reduction of the bowels, a membranous ſubſtance will ſometimes appear, reſembling a piece of gut (*b*), which is no more than a folding or doubling of the ſac, and ought to be let alone, without fatiguing the patient with the diſſection of it.

After the bowels are reduced in appearance, the ſurgeon ought to ſearch with his finger, leſt there be any contracted ringlet, croſs bars, or productions of the peritonæum above the ring in the muſcle, which might continue the ſtrangulation of the gut, that they may be cut to make the gut quite free (*c*). Such ſtrangulating rings are moſt readily to be met with in people who have long wore truſſes, which have preſſed the ſides of the neck of the ſack together.

When the inteſtine is opened, or there is gangrene or inflammation on it, that may give reaſon to expect it will be opened when the ſuppuration comes on after the reduction of a hernia, or if it is expected that any part of the omentum will ſeparate, the peritonæum and ring of the muſcle ought to be kept open, to allow the putrid matter to be evacuated; but the ſubſtance introduced into the paſſage ought neither to be ſo hard as to bruiſe or irritate, nor ſo large as to hinder liquors to drill along it, leſt an inflammation be raiſed, and the pus, fæces, or aliment, be pent up within the abdomen, to the ruin of the patient.——But when there is no reaſon to expect the effuſion of any ſuch putrid ſubſtances into the abdomen,

(*a*) Philoſ. Tranſact. Numb. 443. ſect. 8. and Numb. 450. ſect. 2.
(*b*) Mery, Memoires de l'Acad. des Sciences, 1701. (*c*) Le Dran, obſ. 58.

men, the ſooner we can ſhut it up the better. If we could raiſe up the hernial ſac from the ſpermatic cord with little trouble, and then put a ligature round it cloſe by the ring of the muſcle, it would ſhut up the paſſage moſt effectually during the cure, and might be a means of ſecurity againſt a relapſe.

It may be ſaid in general, that the *antiphlogiſtic regimen* is to be obſerved after this operation: but regard muſt be had to the conſtitution of the patient, and circumſtances of the diſeaſe, in preſcribing it; for theſe will ſometimes oblige practiſers to alter the common method.

When the gut has been opened or divided, the patient needs to guard againſt too full meals for a conſiderable time after, or for all his life, if the gut has been divided quite croſs, to prevent the bad effects which the preſſure of a large quantity of food, ſtopping at this part of the gut, which is generally ſtraitened, might produce.

After the viſcera of a hernia have been reduced, the paſſage in the abdominal muſcles, by which they eſcaped, muſt be ſtraitened or blocked up, to prevent a relapſe. While this is doing, the viſcera muſt be hindered to come out, by the patient lying horizontally on his back, with his hips a little raiſed, and by a proper bandage.

The dilated parts have ſometimes been ſo ſtrengthened by the application of aſtringent medicines, as to keep the bowels up (*a*); generally, however, they are inſufficient for the purpoſe.

By preſſure continued long, the ſides of the peritonæum have been made to grow together (*b*); but unleſs the ring of the muſcle make a ſufficient reſiſtance, the peritonæum thus ſoldered will not do it.

If the paſſage be kept a long time from being dilated, the ſides of it gradually contract themſelves, and become firmer, ſo as to hinder the falling down of the bowels; for this purpoſe different bandages have been contrived.

The ſpica bandage, with proper compreſſes, anſwers the purpoſe very well; and is always uſed where there is wound or ulcer, becauſe it can be eaſily cleaned: but to people who are to wear the bandage long, and in the mean time are to be out of bed, and to move, without any ſore to dirty the bandage, the ſpica is inconvenient, by the trouble there is in applying

(*a*) Medical Eſſays, vol. i. art. 28. (*b*) Le Dran, obſ. 65.

and undoing it, and by the turns of it frequently ſliding out of their place; wherefore to ſuch, a compound bandage is generally applied.

The bolſters of moſt compound bandages or truſſes are much too ſoft; they can yield as much as to allow the viſcera to come out, when the patient makes any ſtrong effort that puſhes the bowels upon the bolſter; they ſhould be very hard ſtuffed, or made of cork, or ſome ſuch ſubſtance, with leather ſtretched over it.——The ſhape of theſe bolſters is generally, too, very faulty: the convexity to be applied to the ſkin is either equal from the ſuperior broad part to the inferior narrow point, or very gradually diminiſhes all the way; by which the point being applied upon the *os pubis*, the part of the bolſter above it is borne off from the ſkin, and a hollow is left juſt at the riſing of the muſcle, to allow the bowels to come out; eſpecially when, by bending the body, the upper end of the bolſter is alſo forced outwards. They ought to be made with ſuch a ſudden failure of the convexity, that they may ſit cloſe to the hollow immediately above the *os pubis*. See ſuch a bolſterre preſented Plate VI. fig. 1.; or they ought to be made thicker below than above, applying the thickeſt part immediately above the *os pubis*.

The compound bandages which are made for children, without any ſteel or other firm ſubſtance on the outer ſurface of the bolſter, can have very little preſſure on the rings, as they are commonly applied with the circular belt ſewed to each ſide of the bolſter; for their convexity ſoon becomes all external by their application; whereas, if the circular belt were brought croſs over their external ſurface, the full effect of the preſſure might be had on the rings of the muſcle. To bring the circular belt thus croſs the bolſter, the belt muſt be put lower down than it is commonly applied.

If a right-made bandage, that prevents the falling out of the bowels, is kept applied ſeveral years to children, the peritonæum and ring may become ſo firm, and the viſcera may grow ſo large, that the rupture may not afterwards return: but if the bandage of children allows the viſcera to come out ſometimes, and, in adults, where the ſtretched peritonæum and dilated ring cannot ſo well recover their former ſtate, and the bowels do not grow larger, there is always danger of a relapſe, if a conſtant preſſure be not kept on the ring, at leaſt when the perſon is in an erect poſture;

ſture; nay, I have obſerved, that moſt of thoſe who wore a bandage for this diſeaſe when children, ſuffered a relapſe if they laid aſide the bandage when they grew up.

Formerly ſeveral different operations were practiſed for blocking up the paſſage by which the bowels fall out, after they were reduced. The caſtration, *punctum aureum*, and cauterizing, were laid aſide after truſſes came to be tolerably made, till ſome years ago the cautery was revived here in Britain with great eclat, notwithſtanding its being practiſed by thoſe who were altogether ignorant of the nature of the diſeaſe, and of any reaſonable intentions of cure. By their promiſing more for its ſucceſs than could be performed by it, to wit, a complete and abſolute ſecurity againſt any return of the diſeaſe, whereas it failed in moſt or all adults it was practiſed on (*a*); and by the many blunders thoſe ignorants committed, the reputation of this operation ſunk in a little time ſo much, that it is now neglected, though it would ſeem capable of being performed ſafely and with ſome advantage.

What could be reaſonably propoſed by this method is, after reducing the hernia, to deſtroy the ſkin and fat covering the ring of the external oblique abdominal muſcle, and to make new fleſh riſe round the ſpermatic cord in the ring itſelf: by this new fleſh the ring may be blocked up; and bringing a firm cicatrice immediately over the ring, inſtead of the flexible *tunica adipoſa* and ſkin, a ſort of bolſter might be formed for reſiſting the viſcera when they were puſhed outwards.

The late operators applied for this purpoſe a cauſtic to the ſkin, without having, ſo far as I could ever learn, any rule to know when it had eroded deep enough. If their eſchar was too ſuperficial, the deſign of the operation could not be anſwered; if the cauſtic eroded too deep, the ſpermatic veſſels would be deſtroyed. I have been aſſured, that after this operation was performed, the teſticles of ſome children, who had undergone it, ſhriveled daily away, ſo that they were effectually caſtrated. When the cauſtic penetrated ſo far as the fibres of the cremaſter muſcle, would not the teſticle be drawn convulſively up towards the ring of the oblique muſcle? and would not a contrary cauſtic immediately ſtop the further action of the one firſt applied? Though it is reaſonable to anſwer

(*a*) See Houſton's Hiſtory of Ruptures.

ſwer both theſe queries in the affirmative; yet never having made the trial of the cauſtic in this way, I ſhall deſire none to practiſe it, ſince they can do what I mentioned to be intended, without any riſk, by pinching up the teguments which lie over the ring, and then making a longitudinal inciſion ſome inches in length; the middle of which ought to be over the ring, the depth of it ſuch as to bring the ſpermatic cord in view; then by the lunar cauſtic, ſmall quantities of the common cauſtic, or other eſcharotics rightly applied, deſtroy the fatty cellular membranes in the ring and under the ſkin; after which, haſten a cicatrice, by the application of ardent ſpirits, or tinctures made with them; and by this endeavour to make the cicatrice adhere to the tendon in the way cicatrices generally do to bones, part of which has caſt off where there has been any ulcer of long ſtanding near them. By lying a-bed to prevent the viſcera coming out, during the time of the cure, which allows the ring of the muſcle to contract, and by the cicatrice, I have ſeen patients walk afterwards without the bowels falling out, though they wore no bandage: but this cure is not to be depended on. For though the new fleſh, which ſprouts out from cellular ſubſtance ſuppurating, appears at firſt firm, yet it afterwards becomes as mere cellular membranes as any where elſe; as every ſurgeon muſt have ſeen who has had occaſion to examine a wound or inciſion made where a wound or ulcer formerly was: and though the cicatrice adheres firmly at firſt to the tendon, yet it gradually becomes more looſe, and is itſelf more capable of ſtretching; and therefore yields to the viſcera puſhing it with violence, as it did in one of the boys whom I ſaw very carefully treated in this way: ſo that I would adviſe nobody to throw away the bandage after they had undergone the cauterizing, otherwiſe they run an evident riſk of the hernia returning. This method does no more than make the perſons who undergo it leſs expoſed to the falling out of the viſcera, if their bandage ſhould at any time ſhuffle, or be borne up off the rings.

The laſt method I ſhall mention for blocking up the rings, is by the operation of the bubonocele; concerning which I made ſome remarks already. This has generally been thought to prove an abſolute cure; but, for the reaſons given againſt the cautery proving ſuch a cure, I join

with

with Dr de la Faye (*a*) in opinion, that it is the ſafeſt courſe to wear a bandage likewiſe after this grand operation. And Mr Amyand tells us (*b*), that he has ſeen three or four inſtances of herniæ returning after this operation; and therefore concludes, that it is only a palliative cure.

(*a*) Notes ſur Dionis, p. 61.

(*b*) Philoſ. Tranſact. Numb. 443. ſect. 8.

N° 32.

N° 34.

OF THE

TUMOURS

IN THE

SCROTUM, commonly called FALSE HERNIÆ.

SURGEONS generally give the name of falſe herniæ to the tumours in the ſcrotum occaſioned by any other cauſe than the falling down of the viſcera into it; and as theſe falſe herniæ begin below and riſe upwards, whereas the true herniæ muſt begin above and deſcend afterwards, a pretty ſure ſign is thence taken by which the true herniæ may be diſtinguiſhed from the falſe.

Becauſe theſe falſe herniæ are of different natures, and contain different ſubſtances, they are diſtinguiſhed into ſeveral claſſes, of ſome of which again there are different ſpecies, according to the particular ſeat or nature of the tumour.

I have wrote the following remarks on each of theſe falſe herniæ, without pretending to give a full and complete account of them, but with the view to put ſurgeons on obſerving more exactly the diſeaſes they treat.

Of the HYDROCELE.

WHEN water forms a tumour any where within the ſcrotum, the diſeaſe is called *hydrocele;* of which there may be reckoned ſeveral different kinds, according to the different parts the water is lodged in.

1. When water diffuſes itſelf in the cellular ſubſtance of the ſcrotum, the diſeaſe has the ſame appearances as anaſarcous or leucophlegmatic ſwellings

ſwellings in other parts of the body; allowance only being made for the looſer cellular ſubſtance, without any fat in the ſcrotum, than elſewhere.

The cauſes of this ſcrotal anaſarca are very different; one of the moſt common is a more general anaſarca ſpreading from the thighs to the ſcrotum. Any tumour preſſing the vein of the ſcrotum produces a hydrocele of this kind, in the ſame way as dropſies are cauſed in other parts by a ligature or preſſure applied to their veins. Thus a tight garter makes the foot and leg to ſwell; thus the legs of women with child are often very œdematous; thus the monſtrous ſwellings are cauſed, which ſometimes happen to the arm when a ſcirrhus in the arm-pit becomes large, &c. For this reaſon it is, that often in the true herniæ, and frequently in the falſe ones, when the tumour riſes high, the ſcrotum becomes very thick. One cauſe more which I ſhall mention, is the ſtoppage of the urine by a ſtone, excreſcence, or ſtricture in the urethra, when the urine burſts through this canal, and diffuſes itſelf into all the cellular ſubſtances of the ſcrotum, penis, and neighbouring parts.

The ſymptoms of this kind of hydrocele are common to any other œdematous or watery ſwelling, and are well enough known by all ſurgeons.

In the cure, particular regard is to be had to the cauſe; for unleſs that is removed, no cure can be expected. The more general anaſarca is to be cured; the hernial tumour is to be removed; the ſtone, excreſcence, or ſtricture, is to be taken away. And then, in the œdema of the ſcrotum, depending on the two former cauſes, the common methods are to be put in practice. But when urine is diffuſed in the cellular ſubſtance, we need make no attempt to cure it by corroborants, hydragogues, &c.: for the urine ſoon corrupts; either is not abſorbed or reaſſumed into the blood from the cells; or, if it could be taken up, it would produce a general diſorder in the body, and would leave enough of its groſſer acrid parts to raiſe inflammation and all its conſequences, abſceſſes, gangrenes, &c. The moſt ſpeedy and ſafe method of cure in the caſe of a hydrocele from diffuſed urine, is ſoon to make numerous deep ſcarifications, and to bring the wounds to ſuppuration as faſt as we can; otherwiſe we may lay our account that at leaſt ſeveral abſceſſes will be

formed, after which there will be numerous callous ſinuous ulcers to cure, of which I have ſeen ſeveral examples.

2. A watery liquor may be poured into the cellular ſubſtance of the ſpermatic cord, as well as into the cells of the ſcrotum, and is occaſioned by like cauſes. If the cellular ſubſtance behind the peritonæum becomes œdematous, the watery liquor will drill down into the ſpermatic cord; if the ſpermatic or ſcrotal veins, but eſpecially the ſpermatic, are compreſſed, or if any other way the return of the blood from the teſticle be impeded, this ſpecies of hydrocele is formed. It is therefore often to be obſerved in thoſe who have an univerſal œdema, in people whoſe abdomen is violently ſtretched by a hydrops aſcites, diſtended liver, or any other tumour in the belly, and in ſuch as have the true or falſe herniæ.

The ſymptoms of this diſeaſe are an oblong ſoft tumour in the ſpermatic cord; which, by continuing preſſure on it ſome time, may be diminiſhed or made to diſappear, the water being gradually ſqueezed up into the cells behind the peritonæum; by changing the patient's poſture, its figure changes; lying horizontally with the ſcrotum ſupported, it becomes more oblong, and of near equal dimenſions from the rings to the upper part of the teſticle; by ſtanding erect with the ſcrotum pendulous, it becomes larger in the lower part, and ſmaller at the upper.

Generally, when the cauſe of this ſwelling is removed, the tumour diſappears; if it does continue, the ſame indications of cure are to be purſued as in the former ſpecies, depending on the two firſt cauſes I there mentioned, which are ſimilar to the cauſes of this.

3. Moſt encyſted tumours are no more than a cellule of the *membrana adipoſa* diſtended by a liquor ſtagnating in it; and therefore we may expect, that ſometimes a cell or two of the ſpermatic cord may be formed into hydatides, which have been taken notice of by Albucaſis (*a*), and one or two late writers in ſurgery, as a ſpecies of the hydrocele.

The figure of this tumour is oblong, the cyſt being confined by the cremaſter muſcle; the firm cyſt and fluctuating liquor are felt, and the teſticle is ſituated below it.

The general methods of cure are nearly the ſame as are directed in the collection of water between the *tunica vaginalis* and *albuginea* of the teſticle, which

(*a*) Chirurg. pars ii. p. 62.

which is the kind of hydrocele moſt commonly deſcribed. Though tapping is the palliative, and opening the ſac is the radical cure here; yet it is to be obſerved, and indeed is plain from the ſeat of the tumour in this ſpecies of hydrocele, that neither trocar, cauſtic, nor knife, are to be applied at the bottom of the ſcrotum, as is done in the common hydrocele; becauſe, if the operation was done at this place, the body of the teſticle muſt be pierced through before any water could be evacuated. The external ſide of the ſcrotum is the moſt convenient part for making the opening in this caſe; ſhunning, if we can, the diſtended veins of the ſcrotum. When there are two ſeparate diſtinct watery cyſts here, as it is ſaid there have been (*a*), one remains diſtended when the other is evacuated by an operation, and the operation muſt be repeated or continued to open the ſecond.

The following hiſtory of a caſe of this ſpecies of hydrocele, where both diſeaſe and practice were not in the common way, may not be impertinently joined to an account of a diſeaſe concerning which you will find very few obſervations.

One who had formerly been completely cured of the common hydrocele, or water between the coats of the teſticle, by opening the whole ſac, having in the evening made merry at a bottle, was ſeized in the night-time with pain and ſwelling in the ſcrotum; which being attended with a quickneſs of the pulſe, was believed to be of the inflammatory kind, and for ſeveral days he was treated with a view to the inflammation: he was ſeveral times blooded, antiphlogiſtic purgatives were given, he was kept on a low cooling diet, and emollient fomentations and cataplaſms were applied. The ſcrotum ſwelled greatly, the ſkin of it became red, and a tumour within it roſe as high up on the left ſide as the ring of the external oblique abdominal muſcle. At laſt a fluctuation was felt in the parts where the teguments were thinneſt and moſt flexible. A trocar, the canula of which was open in one ſide, was thruſt into one of theſe parts; and, upon withdrawing the ſtilet, clear water ruſhed out. The ſurgeon had introduced the trocar ſo perpendicularly, and the teguments were ſo rigid, that, notwithſtanding the advantage of a ſcoop-handle which the canula had, he could not turn it ſo oblique as to make uſe of

(*a*) Garengeot, Operat. de Chirurg obſ. 28.

it as a director to run a biſtoury upon for opening the ſac as he intended. In this attempt moſt of the water was evacuated; the patient was therefore allowed to recruit his ſtrength ſome time, in which the ſac filled again. Then a large train of common cauſtic was laid upon near the whole length of the ſcrotum towards the outſide: and immediately after the cauſtic had had a ſufficient operation, an inciſion was made through the teguments two inches thick into the ſac about the middle of the tumour; and, a finger being introduced into the opening, one of the blades of a pair of ſciſſars was carried upon it, by which the ſac was opened firſt upwards to the ring of the muſcle, then downwards to the ſeptum immediately above the teſticle. What the quantity of water evacuated was, could not be exactly known, moſt of it being ſpilt on the floor by accident, but it was conſiderable. The wound bled pretty briſkly at firſt; but the hæmorrhagy ſtopped ſoon after the cavity and wound were filled with *charpie brute*, unformed lint; the ſcrotum was covered with compreſſes, and ſupported by a ſuſpenſory bandage.

There being no bad appearance of any kind, the dreſſings were not removed for three days, when the beginning ſuppuration and oozing water had made them wet. At the ſecond dreſſing the ſac feeling of a callous hardneſs, and there being a conſiderable thickneſs between it and the ſpermatic veſſels, the doſſils to be put contiguous to it were wet with ſpittle, and then rolled in fine powder of red precipitate mercury; the eſchar made on the teguments by the cauſtic having ſuppurating ointments applied to it.

When the eſchar came off, the ſore of the ſcrotum had a ſcirrhous appearance both in its hardneſs and unequal ſurface: however, ſeeing the cauſtic in this firſt application had no bad effect, it was reſolved to waſte the ſcrotum with it; for which purpoſe pledgits wet in ſpittle were preſſed on the powder of common cauſtic, and applied to it.

The precipitate was continued to be applied daily to the ſac till it became ſoft, granulating fleſh riſing every where, and laudable good pus coming from it. The cauſtic was renewed to the ſcrotum as often as the eſchar of the former application fell off, till it became near of a natural ſize and firmneſs.

The ſac was then allowed to heal, which it did very ſoon. Except a ſmall equal ſcar, nothing is now to be obſerved on the ſcrotum; and the patient

patietn has been ſeveral years, ſince the cure, without the leaſt ſymptom of hydrocele.

4. The collection of water between the vaginal and proper coats of the teſticle, is ſo well deſcribed, and the directions for treating it are ſo full, in the common books of ſurgery, that I need not enter into any particular detail of it. It may not, however, be amiſs to obſerve, that when tapping is to be performed for relief of this diſeaſe, the ſkin of the ſcrotum ought to be ſtretched very tenſe where it is to be pierced: and the tumour is to be made very oblong by the ſurgeon, that the inſtrument may penetrate eaſily, which it will not do when the ſkin is lax; and that there may be ſufficient ſpace between the lower part of the ſac, where the perforation is to be made, and the teſticle, to prevent any injury being done to the teſticle by the point of the inſtrument.——When the quantity of water in this hydrocele is ſmall, I think the lancet a ſafer inſtrument for making a perforation into the ſac with than the trocar, which always requires a puſh that makes the teguments and ſac yield ſo far that the point of the ſtilet comes too near the teſticle before the canula is forced through.

Conſidering how readily contiguous inflamed parts grow together, and how many inſtances there are of people having a radical cure made of this hydrocele by inflammations coming on the parts, it would ſeem no unreaſonable practice to endeavour a concretion of the two coats of the teſticle when they are brought contiguous, after letting out the water through the canula of a trocar, by artfully raiſing a ſufficient degree of inflammation. This, to be ſure, muſt be done cautiouſly, and ſo that the ſurgeon can reaſonably expect to be maſter of the inflammation; and therefore the application of all irritating medicines, the operation of which he could not immediately ſtop, or any ſingle mechanical effort, the effect of which he could not be ſure of, are not to be employed. Suppoſe the canula of the trocar was to be left in, by the extremity of it rubbing on the teſticle, an inflammation might be gradually raiſed, the cauſe of which could be taken away as ſoon as the ſurgeon thought fit. I have never ſeen this practice attempted, and therefore I mention it diffidently.

The following caſe of a ſac in the ſpermatic cord, cured in this way,

may,

may, however, encourage us to expect ſucceſs alſo where the water is contained within the vaginal coat of the teſticle.

A man who had the *paracenteſis* ſeveral times performed for the evacuation of water lodged between the vaginal and proper coat of the right teſticle, received a violent bruiſe on the diſtended ſcrotum by his horſe ſtumbling. The pain and inflammation occaſioned by this bruiſe confined him to bed ſome time, till they were removed by evacuations, fotuſes, &c. as in common inflammatory caſes. The hydrocele was no more obſerved after theſe ſymptoms went off.

Some years after, a hydrocele of the third kind here mentioned, viz. a collection of water found in a ſac of the ſpermatic cord of the ſame ſide where the former hydrocele had been, was plainly felt. An inciſion about an inch long was made into the ſide of the ſcrotum, by which near a pound of water was let out. A pipe, four inches long, of the ſhape and diameter of a female hollow catheter, with a ſmooth ſhut extremity, and openings in the ſides, as that catheter commonly has, but with a plate fixed at the other end, to ſerve as ſhoulders which ſhould hinder it from ſliding all into the cavity where the water had been lodged, was introduced and allowed to remain two days.—By this irritation, ſo violent an inflammation was brought on, as would not reſolve, but ſuppurated, and from it a very great diſcharge of pus was made. After the inflammatory ſymptoms were well off, the ſilver pipe was employed as a tent introduced into the cavity, being taken out every day to be cleaned, and again introduced, till the cavity filling up from the bottom, would no more admit it; and ſoon after the ſore was completely cured, without the leaſt return of any kind of hydrocele afterwards.

In this, and the caſe formerly related of this kind of hydrocele, and in two other ſuch caſes, I put my finger into the ſac, and felt what is called the *ſeptum*, between the ſpermatic cord and teſticle, § 21. with the epidydimis, but could not touch the body of the teſticle.

In opening the whole ſac for making a radical cure of the hydrocele, where the water is collected between the vaginal and proper coat of the teſticle, I would prefer the application of a cauſtic along the tumour to deſtroy the ſkin, previous to an inciſion into the ſac: for by the cauſtic, one has a larger opening of the teguments than by any inciſion; and a large

large enough external orifice is always to be preferred in a hollow ulcer, which this muſt become, to a confined orifice, which puts the patient and ſurgeon both to the uneaſineſs of keeping it always open enough, and runs the riſk of making a ſinuous ulcer after all. This is more eſpecially neceſſary, where a membranous bag is opened and afterwards to be filled with new fleſh; for ſuch membranes are longer in coming to ſuppuration, and in ſending out granulated fleſh, than other parts are. The time which the eſchar takes in caſting off, eſpecially when the ſurgeon applies ſpirituous medicines to prevent its ſeparation; this time, I ſay, wherein the orifice of the ſore cannot contract, compenſates for the ſlower ſuppuration of the ſac; and the inflammation that continues in the obſtructed neighbouring veſſels to the eſchar is frequently, in lax habits or parts, of uſe to promote a right ſuppuration when it is needed.

When the ſac is opened in the operation now deſcribed, the teſticle generally ſtarts out at the wound, where it is in danger of being injured; the ſurgeon ought therefore to take care to keep it within the ſcrotum. I once ſaw the teſticle left out of the ſcrotum after the operation for the hydrocele, till the granulated fleſh, riſing from the coats of the teſticle, formed a covering for it, without the patient having a bad ſymptom all the time of the cure.

I hope nobody will believe that ſuch rough treatment as I mentioned the ſac of the ſpermatic cord to have undergone in the patient whoſe hiſtory I have related lately, is ever to be given to the teſticle when its *tunica vaginalis* is opened: The teſticle will not bear ſuch irritation, as may appear from the following hiſtory. The watery diſcharge continuing, and no granulated fleſh riſing, two weeks after the operation for this ſpecies of hydrocele had been performed, the patient put waxed thread twiſted into the ſac; then ſlept ſome hours, and awaked with ſharp pain in the teſticle, which ſoon brought ſuch a ſmart fever as required four plentiful bloodings before it went off; but being ſucceeded by a mild ſuppuration, and granulated fleſh riſing from the ſides of the cavity, a complete cure was ſoon made.

Though the inflammation and fever are for ordinary ſtrong, when the teſticle is irritated; yet the patient generally muſt undergo them, before a complete cure can be made of this moſt common kind of hydrocele: for

for the oozing of water into the ſac continues till the inflammation cauſes ſome ſuppuration on the ſurface of the coats of the teſticle.

I cannot conclude my remarks on this hydrocele, without mentioning a caſe which I don't remember to have ſeen deſcribed. A young man, who never had any ſymptom of a true hernia, had the vaginal coat of the teſticles laid open to cure a hydrocele. After the water was diſcharged, a ſoft fat ſubſtance, reſembling a piece of the omentum, preſented itſelf at the wound. It was gently drawn out and ſtretched; and no veſſels appearing in it, as much of it as the ſurgeon could come at with his ſciſſars was cut away. The ring of the abdominal muſcles and the ſpermatic cord were of the natural ſize. No ſharp fever or inflammation were raiſed; but the ſcrotum became very thick, and of a ſcirrhous hardneſs; which was removed by a poultice of hemlock, and repeated doſes of mercurial purgatives, and a complete cure was made.

All theſe four ſpecies of hydrocele deſcribed above are ſometimes ſeen together, of which the following hiſtory may ſerve as a good enough example.

An old, but otherwiſe healthy man, had a hydrocele of the third ſpecies in the left ſide, without any manifeſt cauſe that he could remember; which became ſo large and weighty as required an evacuation. He would not allow the ſac to be all laid open; but was tapped with a trocar, puſhed into the external ſide of the ſcrotum, by which more than a pound of water was evacuated; then the thickneſs and ſoftneſs of the ſpermatic cord diſcovered the œdematous ſwellings of its other cells. Some months after, he obſerved the ſac filling again; which it continued to do till it was as full as formerly. He delayed having any thing done to it near two years; when all the ſcrotum, but particularly the left ſide, was greatly ſwelled; the teguments were very thick and firm: a fluctuation of liquor, however, was perceived, not only at the ſuperior external part, but at the inferior part, where the teſticle could not be felt as it had been formerly; and there was a croſs depreſſion appeared externally, which ſeemed to point out its being divided into two tumours; the alternate preſſure of the finger on the lower part did not make any ſenſible fluctuation in the ſuperior part of the ſcrotum. The caſe was therefore judged to be a complication of three ſpecies of hydrocele; and that probably the fourth,

fourth, viz. the thickening of the ſpermatic cord, which had been felt in his former illneſs, would be diſcovered afterwards. The teguments were thinneſt, and the fluctuation was beſt felt at the bottom of the ſcrotum: for which reaſon the trocar was firſt put in there, but with ſome difficulty; and ſeveral ounces of water being evacuated, the patient deſired any further operation might be delayed. He went abroad ſome days, then became feveriſh, with ſharp pain towards the lower part of the tumour: He aſked no advice for ſome days more; in which time an evident inflammatory tumour had increaſed conſiderably, and the common ſymptoms of ſuppuration were begun, which the uſual medicines advanced very quickly.

When the abſceſs was fully ripe, it was laid open by inciſion; about twelve ounces of pus were let out; and the cavity in which it had been lodged was plainly ſeen to be formed in the ſubſtance of the ſwelled teſticle.——The ulcer was treated in the common way, and promiſed to cure quickly, the cavity and remainder of the teſticle diminiſhing daily; but the fluctuating tumour in the upper part of the ſcrotum continued tenſe, but fluctuating when preſſed.——Ten days after opening the abſceſs, the dreſſings were obſerved to be much more wet than ordinary; and when they were taken away, clear water dropped very faſt out, and the ſuperior tumour appeared conſiderably ſubſided. This watery diſcharge continuing, the ſuperior ſwelling went off, and then the ulcer cured; the patient recovered perfectly, and had no more hydrocele.

I have often ſeen children that were born with a complication of hydroceles, particularly of the firſt and ſecond ſpecies, or who were ſeized with them ſoon after birth. They are very eaſily cured with any corroborants; a bit of flannel, warmed with the fumes of burning benzoin, cures them in a few days.

5. I formerly remarked, that a liquor is frequently found with the viſcera in a true hernia; which may be looked upon as a fifth kind of hydrocele. When the quantity of this liquor is ſmall, it is neither in hazard of leading us into a fatal miſtake of imagining the diſeaſe to be only a hydrocele of any of the preceding ſpecies, nor does it require any particular method of cure: but when the water is in large quantity with the viſcera, we had need to be careful not to be impoſed upon; otherwiſe, in curing

what we think a ſimple hydrocele, we may wound the bowels that are in the bag with it.

This kind of hydrocele may be diſtinguiſhed from the third ſpecies, with which it is in moſt danger of being confounded, by a hernia always preceding it, and by its generally yielding or diminiſhing when preſſed upon, the water in moſt caſes being thus ſqueezed up into the belly.

If the water in this caſe is in no great quantity, and without much acrimony, it may be preſſed into the belly; from which the medicines proper in a ſlight hydrops aſcites will aſſiſt to diſcharge it. When true herniæ can be reduced without any aperture in the teguments, there ſeldom is any more neceſſary: but when the viſcera will not reduce thus, the water may either become ſo acrid, which moſt frequently happens when the viſcera are ſtrangulated; or it may be in ſuch quantity, that we do not chooſe to truſt its abſorption from the belly; or the bowels may have blocked up the paſſage, ſo that it cannot be ſqueezed into the belly, while, by its weight, and ſtretching the parts containing it, it creates great uneaſineſs and pain to the patient, and is in danger of occaſioning diſorders in the neighbouring parts. Theſe two laſt caſes are to be ſeen in herniæ of long ſtanding. All three require the liquor to be evacuated.

Unleſs when the operation for the true hernia is performed, this evacuation ought only to be made by a ſmall puncture, leſt the bowels be expoſed and hurt by the air. Inſtead of directions for making the puncture, I ſhall relate the hiſtory of ſuch a caſe.

An old man had long laboured under a true hernia, which had not been reduced of a great many years. The tumour became at laſt of a monſtrous ſize, deſcending near to his knee, and of a proportional tranſverſe diameter: he was confined to lie on his back; he had very violent pain both in the tumour and his loins, which kept him almoſt conſtantly awake; his fleſh and ſtrength were much waſted: in ſome places a plain fluctuation of liquor was perceived with the fingers, without any of the unequal ſolid ſubſtances felt every where elſe; neither the water nor ſolid ſubſtances could be puſhed into the belly. The tumour being preſſed ſo as to make one of thoſe parts, where the fluctuation was moſt evident and the teguments were thinneſt, as tenſe and prominent as poſſible, a trocar, as

ſmall

ſmall as a crow-quill, was thruſt very ſlowly through the teguments and cyſt: whenever the bag was pierced, the ſtilet was taken out, and the canula was preſſed a little forward, through which ſix pounds of clear ſerous water ran out; then the convolutions of the inteſtines, and the knotty parts of the omentum, were plainly felt, but none of them would reduce. The patient was greatly relieved of his pain, and had no ſymptom of ſtrangulation of the bowels. No further operation was thought proper; he was allowed to enjoy the happineſs he ſeemed to have by the removal of the violent pain during the ſhort time he had to live.

6. I mentioned obſervations of Saviard and Le Dran of the hernial ſac of the peritonæum remaining unreduced after the bowels were put into their place; the ſuperior part of which being preſſed by a truſs was greatly ſtraitened, or the ſides of it were grown together, while the lower part was filled with water: this may be accounted a ſixth ſpecies of hydrocele. I never ſaw this caſe, nor do I know how it could be diſtinguiſhed from the third kind which I mentioned, unleſs the preceding hernia led one to ſuſpect its nature. There is one great happineſs, however, that though ſurgeons ſhould miſtake one ſort of theſe two hydroceles for the other, they could do no hurt, the method of curing both being the ſame.

To finiſh theſe remarks on hydroceles, it may not be amiſs to give a general caution to all young practiſers in the management of all parts that are made to ſubſide or collapſe greatly and ſuddenly after being violently ſtretched, eſpecially if the tone of the ſolids of the patient, or of the diſeaſed part, has been greatly weakened, which is for ordinary the caſe in hydropic ſwellings. The caution I would give is, to imitate or ſupply the effect of the diſtending cauſe that is removed; otherwiſe they may expect that all the weak veſſels which were formerly overſtretched will be both incapable of preventing a larger quantity than their due proportion of fluids from being propelled into them, and as incapable of making it move faſt enough forward; ſo that, unleſs when there is a free open outlet or paſſage for the liquors, the veſſels are all over diſtended with their liquors, which are in hazard of ſtagnating. In this way the lungs are affected when people die of a peripneumony or aſthma, after a ſudden diſcharge of liquor out of the thorax: thus the viſcera of the abdomen are

varicous and inflamed after tapping in the *hydrops aſcites;* thus inflammations frequently ſeize the uterus after child-bearing; thus the common teguments, diſtended by water in the anaſarca, or by pus in an abſceſs, become red, and ſometimes mortify ſoon after a ſudden diſcharge of the liquor which ſtretched them.—Moderate preſſure will prevent the influx of the liquors, and diſtenſion of the veſſels; and gently ſtimulating and corroborant medicines will aſſiſt the veſſels to recover their tone more quickly, which ought therefore to be made uſe of in ſuch caſes.

When, in ſuch a ſudden ſubſiding or collapſing of an over-ſtretched part, there are veſſels opening into any cavities, it may be expected that, for the reaſons mentioned immediately above, the open orifices of the veſſels will pour out their liquors in more than ordinary quantity, unleſs the influx of them be prevented by the means propoſed in the former ſuppoſition, and theſe orifices be alſo preſſed ſufficiently to make them reſiſt them omentum of the fluids ſtretching them. Thus violent flooding after delivery of a child, is ſometimes moderated by preſſure on the belly. Thus, when any large abſceſs is opened, pure pus runs out at firſt; then it becomes more and more mixed with blood; and at laſt pure blood is diſcharged, which ſometimes runs out in a great ſtream, not from any one veſſel, but collected from innumerable ſmall pipes opening on every part of the ſurface of the ulcer; which hæmorrhage ſtops ſoon after the cavity is filled with lint, and preſſed by a bandage. Hence the neceſſity of keeping a conſtant preſſure on a diſtended part, during and after the evacuation of water in a dropſy, or of the pus of a large abſceſs in weak people. Hence watery tumours laid open ſend out more liquor in one day than was collected in them for ſeveral months while they were ſhut and ſtretched. Hence I imagine the hæmorrhage has proceeded which Mr Jamieſon (*a*) tells us happened to a patient of his after opening a hydrocele.

HÆMATOCELE.

Blood extravaſated after a bruiſe, wound, tumour, &c. into any of the parts where I mentioned water to be collected in the hydrocele, occaſions a tumour which ſome call *hæmatocele*. Allowance only being made for

(*a*) Medical Eſſays, vol. ii. art. 14.

for the different conſiſtence and colour of blood and water, what has been ſaid of the hydrocele may ſerve alſo for this ecchymoſis.

PNEUMATOCELE.

PNEUMA, ſpirit or air, was made uſe of by the ancients to account for ſeveral phænomena of the animal œconomy, and was eſteemed the cauſe of ſeveral diſeaſes: among theſe the *hydrops ſiccus* or *tympanites*, and the pneumatocele, or windy tumour of the ſcrotum, were as commonly deſcribed in books as the *hydrops aſcites* or hydrocele; though the writings of obſervators ſhow thoſe airy tumours to be very uncommon, and ſcarce ever to be found in the way they are for ordinary deſcribed.

Air, eſcaping out of the *trachea arteria* or lungs into the *tunica cellularis*, may diffuſe itſelf every way, and among other parts may diſtend the cellular ſubſtance of the ſcrotum and ſpermatic cord (*a*)——Air blown thro' a pipe put into a hole made in the ſkin, will diſtend all the cellular ſubſtance of that part, as has been done ſometimes to the ſcrotum (*b*). When there is not ſufficient action of the veſſels or circulation of the liquors to blend intimately the different particles which enter into the compoſition of the blood, the particles of air which were reſtrained from running together, and exerting their expanſile elaſtic power, ſeparate from the other particles with which they were wrought up into the compoſition of the blood, and being collected exert the common effects of air in any part they are contained in (*c*); and, if they make their way to any part of the ſcrotum, may produce the pneumatocele. In a ſcuffle in this city, a man was wounded with a ſword in the belly, about half way between the navel and *cartilago enſiformis*; part of the omentum came out of the wound, which was reduced ſoon after. The patient was exceeding faint, and his pulſe very weak. He lived only twelve hours after the wound; in which time his ſcrotum became as large as his head, with the common ſigns of pneumatocele. When his body was examined by the ſurgeons who attended him, the abdomen was found full of extravaſated blood, which had come from

(*a*) Palfyn, Anat. Chirurg. traité 2. chap. 18. Littre, Hiſt. de l'Acad. des Sciences 1713. Mery, Ibid.

(*b*) Dionis Operations de Chirurgie, demonſtr. 4.

(*c*) Littre, Memoires de l'Acad. des Sciences, 1714.

from a wound of the *vena portarum*, through which the ſword had pierced. Moſt of the veins and cellular ſubſtance of the abdomen, as well as the ſcrotum, were diſtended with air. In ſome very putrid fevers, ſmall-pox, and gangrenes, I have frequently felt ſome parts of the ſkin crackle like parchment under one's finger, and have heard a certain ſibilus upon making inciſions through it. When carcaſſes begin to corrupt, air evidently begins to generate or ſeparate in the veſſels and cavities. From all which it is not unreaſonable to conclude, that in a very corrupted ſtate of the fluids the pneumatocele may be formed.

The ſymptoms of this kind of tumour are commonly deſcribed well enough.

When external air is introduced into the cells from the trachea or lungs, or by a pipe; after the acceſs of more air is prevented, that already in the ſcrotum may be preſſed out at inciſions made through the ſkin into the cellular ſubſtance, while the bad conſequences of the ſudden collapſing of the ſtretched parts may be prevented by the application of corroborating medicines; and it may be convenient to keep up a ſuppuration in the inciſions for ſome time after, for diſcharging any remains of the air.

When the pneumatocele depends on internal air, generated or ſeparated from the fluids, the patient muſt be in very great danger: for ſuch a corrupted ſtate of the fluids, or ſuch a weakened tone of the ſolids, as is capable of producing this diſeaſe, is ſcarce to be remedied; and air collected in the veſſels cannot well be diſcharged, and muſt terribly diſturb, if not entirely ſtop, the circulation.

The plentiful uſe of antiſeptic and corroborant medicines is plainly indicated, while the ſcrotum is treated in the manner mentioned above when we ſuppoſed the pneumatocele to be formed by external air.

VARICOCELE.

Any large tumour in the abdomen, or external force, preſſing the veins, or any large tumour of the ſcrotum ſtretching the veſſels, or impeding the return of the blood, may occaſion the veins of the ſcrotum or the *corpus pampiniforme* to be greatly dilated with blood; which being only a ſymptomatical diſorder, and going generally off when its cauſe is removed,

moved, needs no particular direction for its cure. But when, by the veins being long diſtended by ſuch a cauſe, or if from any other cauſe the coats of the veins are ſo much weakened as to yield to their contained blood, and appear in the ſcrotum tumid and knotty, when the diſeaſe is named *cirſocele;* or when the *corpus pampiniforme* feels all compoſed of large knotty ſtrings, which is the more common caſe, to which the name of *varicocele* is applied; there is a neceſſity of uſing ſome remedy: otherwiſe the ſtretching which the ſtagnating blood occaſions, creates pain, the epidydimis and teſticle ſwell, and ſome ſpecies of the hydrocele is in danger of being formed.

A horizontal poſture muſt be of the greateſt ſervice in this diſeaſe, by which the courſe of the returning blood is made much more free; whereas, in the erect poſture, ſuch a high gravitating column of blood as is in the ſpermatic veins, without valves to aſſiſt in its ſupport, muſt have very great effect on the lower part of the veſſels.—When the patient does riſe up, the ſcrotum, with its contents, ought to be well ſupported by a proper bandage, to prevent the ſtretching and pain which the weight of this pendulous part occaſions. This precaution of ſuſtaining the weight of weak tumefied pendulous parts, is altogether neceſſary, and is conſtantly to be done in all the different tumours of the ſcrotum.—If there is a general fulneſs in the veſſels of a perſon labouring under the varicocele, they need to be a little emptied by the general evacuations and topical aſtringents, and corroborants are to be applied for recovering the tone of the veſſels.—If the varices here give much pain, and threaten to cauſe ſome other violent diſorder, they may be opened and tied in the way commonly directed. I never ſaw any varicocele that required to be ſo treated.

SPERMATOCELE.

An excreſcence or ſtricture at the *caput gallinaginis* ſometimes makes the *vas deferens*, *epidydimis*, and teſticle itſelf, to be greatly diſtended with the ſecerned liquor contained in them; this ſome writers call *ſpermatocele*, which is eaſily diſtinguiſhed from the varicocele by thoſe acquainted with the diſtended parts.

If this diſeaſe is recent, the removal of the excreſcence or ſtricture cures it; but if it be allowed to continue any conſiderable time, it is in danger of

of degenerating into a ſcirrhous or carcinomatous tumour, which has a different name given it, to wit, the *ſarcocele*.

SARCOCELE.

THE general cauſe of all the falſe herniæ of which I have hitherto treated is a liquor diſtending the different parts in the ſcrotum. When the ſolid parts themſelves ſeem to increaſe, or the fluids loſe their fluid and put on a ſolid form, the name given to the diſeaſe is *ſarcocele*, under which ſeveral diſeaſes may be comprehended; and therefore I am ſurpriſed that ſome, who have much fondneſs for the technical terms, have not applied a different name to each of them. Phlegmonocele, empyocele, gangrænocele, ſcirrhocele, cancrocele, &c. would have made a fine ſtring of pompous Greek words; and then each of theſe might have been diſtinguiſhed according as the diſeaſe was in the ſcrotum, ſpermatic cord, or teſticle. The diſtinction between phlegmonocele and inflammatocele would have been juſt as proper as what is commonly made between circocele and varicocele. I am ſo far, however, from wiſhing to multiply the terms of art, that, on the contrary, if it was not for the danger of ſtudents not underſtanding readily the books that have been wrote on this ſubject, I would propoſe to lay aſide the diſtinction of true and falſe herniæ altogether, and would uſe none of the names of the falſe herniæ which prevailing cuſtom has made me employ, but would call them by the common name the like diſeaſe would have in any other part of the body: ſo that I would have treated of the œdematous tumour of the ſcrotum or ſpermatic cord; the encyſted dropſy of the ſpermatic cord, coats of the teſticle, or hernial ſac; the ſuffuſio of thoſe parts; the varices of the ſcrotal or ſpermatic veins; the tumefied excretories of the teſticle; the inflammation, ſuppuration, gangrene, ſcirrhus, cancer, &c. of the ſcrotum or teſticles.

The different diſeaſes comprehended under the name of *ſarcocele* have the ſame ſymptoms and require the ſame management as the like diſeaſes do in other parts. Having no deſign to enter upon any account of ſo many different tumours, which ought rather to be done in a general treatiſe than in ſuch a confined eſſay, I ſhall relate the hiſtory of a mortification in the teſticle, which I think uncommon; then I ſhall make ſome

remarks

remarks on the operation of caſtration; and ſhall conclude with another uncommon caſe, where the caſtration was performed.

A middle-aged man, ſoon after recovering from a fever, during which conſiderable evacuations had been uſed, was ſeized with a very acute pain in the right teſticle, attended with a quick pulſe, for which he aſked no advice for ſome days; during which the teſticle, epidydimis, and ſpermatic cord, ſwelled conſiderably: after this he was frequently let blood, emollient fotuſes and poultices were applied to the part; he was purged with cooling laxative ptiſans, and was kept under a ſtrict low cooling diet; but without any relief, except what opium ſometimes gave him. At length a fluctuation being felt on the teſticle, a train of cauſtic was laid on the ſcrotum; and as ſoon as it had its effect, an inciſion was made through the eſchar into the ſac, where about two ſpoonfuls of thin pus was contained: the teſticle being all in view, it appeared of that pale-white colour which it has in dead bodies.

Next day when the ſurgeon preſſed the teſticle, the patient was not ſenſible of its being touched, and the ſurgeon felt like a fluctuation under his finger; but upon opening the *tunica albuginea*, no liquor appeared; the convoluted fibrous ſubſtance of the teſticle ſtarted out in a very ſoft pappy condition, and putrid. A conſiderable quantity of this being cut away with a pair of ſciſſars, the ſore was dreſſed with warm baſilicon, with which a few drops of *ol. terebinth.* were mixed, and a poultice of the farines, with ſome diſſolved galbanum, was put over the whole tumour.

For ſeveral days after, more of that fibrous ſubſtance was cut off, till the bulk of what was brought thus away exceeded the ordinary ſize of the teſticle in a ſound man: the parts were well fomented, the ſuppuration was encouraged, granulated fleſh ſprouted out from the ſides of the cavity in the teſticle, the epidydimis gradually diminiſhed, the ſcrotum became thinner; and, in ſhort, the cure went on ſucceſsfully, without any accident, till the ſore was firmly cicatrized. One cannot now know which teſticle was diſeaſed, and the patient is ſenſible of no defect from it.

To perform the caſtration with the leaſt trouble and dread of hæmorrhagy, pinch up the ſkin in the groin, and make a large longitudinal inciſion, by which the ſpermatic cord may be brought in view; then take up the cord between the thumb and finger of one hand, ſo that the nails

meet at the back part, upon which paſs a very crooked needle with a thread; or rather uſe the aneuriſm needle with a handle, and the eye near the point, (ſee the figure of ſuch a needle, Plate VI. fig. 6.); tie the cord as firm as you can with flat ſtrong waxed thread; put two knots, without any compreſs, between them, and cut off the ſuperfluous part of the thread with a pair of ſciſſars: this being done, cut the ſcrotum down on the ſide next to the thigh, and, turning the edge of the ſkin outwards, ſtitch the large ſcrotal artery; after which, the ſuperfluous part of the ſcrotum, with the teſticle in it, may be diſſected away with very little loſs of blood; only care muſt be taken not to hurt the other teſticle, which will readily come in the way if the aſſiſtant-ſurgeon do not be careful to hold it up in the groin during the operation.——The part of the ſpermatic cord below the ligature is not to be diſſected away from its membranous adheſions, which ſecure the ligature from ſliding afterwards.——By what I ſaw in four ſuch operations, there is no occaſion for cutting the ring of the external oblique abdominal muſcle; for there was not any retraction of the ſpermatic cord after the teſticle was cut away in this way I have now deſcribed.

The method above propoſed, of tying the ſpermatic veſſels, makes the operation of caſtration much eaſier than when it is performed as commonly directed: but as the ligature round the cord gives more pain than ſtitching the artery alone does, and the ligature prevents the efflux of any blood or matter that may be collected in the cellular ſubſtance ſurrounding the ſpermatic veſſels, I now think what Mr Cheſelden once did out of neceſſity (*a*) ſhould be the conſtant practice. The ſpermatic artery ought to be ſtitched after caſtration, as other arteries commonly are after amputation.——The late Mr George Lauder being to perform caſtration where I was to be preſent, we concerted, that the ligature ſhould be made with a ſingle roſe ſlip-knot, to ſtop the blood flowing from the ſpermatic artery while he cut away the teſticle and ſtitched the ſcrotal veſſels: then I looſened the ſlip-knot: he ſtitched the ſpermatic artery with a needle and thread in the common way; but left the ligature looſe in the wound, to be ready for tying the ſpermatic cord, if any of its veſſels had bled afterwards. No hæmorrhagy happened; he took out the ligature at the firſt dreſſing,

(*a*) Anat. book iv. chap. 1.

dreſſing, and the wound cured very ſoon without the leaſt bad ſymptom during the time of it.

Neither the common compound ſuſpenſory of the ſcrotum, nor a long ſwath, are convenient bandages after this operation, for they do not apply neatly; a large compreſs, broader conſiderably at one end than the other, with a round hole in the middle of the broad end of it for paſſing the penis through, and with a large cut in the middle of the narrow end of it to allow the two parts to be folded over each other, ought to be applied over the unmade lint with which the wound is thick covered; and this is to be ſecured by the two ends of the T or ſling-bandage, one tail coming on each ſide of the ſcrotum to be fixed to the circular belt, which ought to be double linen or fuſtain twilted, to prevent its wrinkling into a round cord, which galls the patient.

After the operation, the cure of the wound is the ſame as of any other common wound.

A young man mounting a horſe ſtruck the right teſticle againſt the ſaddle. The pain of the blow was ſo ſharp that he almoſt fainted: but becoming ſoon eaſier, he neglected it ſeveral days; during which the teſticle ſwelled conſiderably, and the pain increaſed. The tumour and pain were, however, ſoon put away by blooding, purging, and low diet. He continued free of any uneaſineſs in the teſticle ſeveral months; after which having rode poſt ſome days, the ſame teſticle ſwelled, but without pain, which made him neglect to aſk advice for a year and half, and in the mean time he uſed much exerciſe, and lived in a full way. The teſticle having then grown very large, he was preſcribed pills made of quick-ſilver and roſin of guaiac with a low diet, which he obſerved to exceſs, by which he had the addition of the low nervous ſymptoms to his other trouble. The bulk of the teſticle ſtill increaſing, and a fluctuation of liquor being found at the lower part of it, a cauſtic was applied to the teguments there, and the eſchar of it being cut through, ſome ounces of water ran out, but with very little decreaſe of the tumour. Soon after, it increaſed conſiderably, and he ſpit ſome ſpoonfuls of blood; but as he had no cough, dyſpnœa, or pain in his breaſt, it was doubted whether the blood had come from his lungs or throat. Some time after this he complained of a weight and pain in his loins in making a little journey in a chaiſe; the-

teſticle became larger than a man could contain in his two hands; the lower and poſterior parts were as hard as a ſtone to the touch, but in the ſuperior anterior part a fluctuation of liquor was felt: there was no more ſpace between this tumour and the belly than could allow a man's thumb to be preſſed in between them, and in that place the ſpermatic cord was thick and hard: from the orifice formerly made by the cauſtic, fungous fleſh ſtood out, which felt as if a liquor fluctuated below; but upon a ſmall lancet being puſhed into it, no liquor was found: his pulſe was weak and ſlow, without any ſymptom of hectic fever: he could take ſmall quantities of broth and weak ſpoon-food without uneaſineſs; but from a little while after he had made the ſudden change of diet from full living to an exceſs of abſtemiouſneſs, his ſtomach could not bear fleſhes or any ſolid food, ſo that at this time eating a leg of a chicken made him vomit. His caſe was judged to be very deſperate, but that the only chance he had for life was the extirpation of this teſticle; which operation he underwent with great courage and little loſs of blood.

The *tunica vaginalis* was grown firmly to the *tunica albuginea* of the teſticle at the lower part; but in the ſuperior part was extended into a bag, which contained eight ounces of water: the body of the teſticle itſelf was become a moſt compact firm ſcirrhus, with ſome few begun ſuppurations in it; it weighed near two pounds.

The patient paſſed the night after the operation calmly; but would not allow himſelf to ſleep through fear of an hæmorrhagy, the blood having oozed through the dreſſings in the evening.

He was eaſy all the three following days, with rather too little fever; only complaining of a certain anxiety, oppreſſion, and faintneſs, which he ſcarce knew how to expreſs, but affirmed it was ſuch as made him ſure he muſt die ſoon, though there was otherwiſe no bad ſymptom about him.

The dreſſings being removed on the fourth day, the lips of the wound were too little tumefied, and the ſuppuration ſcarce was begun; ſome cordial nervous medicines were given him from time to time, and he had ſyrup of poppies at night.

He was again dreſſed two days after, when the lips of the wound were rather

rather too thick; the ſuppuration was begun, the pulſe was ſlow and calm; the wound was well fomented and dreſſed with digeſtive.

Next day the ſwelling of the lips of the wound was fallen, but without a kindly plentiful ſuppuration; the prepuce and the ſkin of the penis had a watery thickneſs in them; and that uneaſy ſenſation which, as I ſaid, he could not find words to expreſs, was greater.

On the eighth day after the operation, the wound looked much better than it had done; his kidneys, his belly, anſwered well in their evacuation; there was no fault in his pulſe; he took food, had no heat or thirſt, nor any complaint, except that ſomewhat which he did not know how to expreſs; and though he called it weakneſs, yet he moved himſelf with ſuch agility and ſtrength, that he even joked himſelf for calling it by that name.

On the ninth day, in the morning, the watery ſwelling of the penis was decreaſed, and the ſuppuration was more plentiful; at noon he eat ſome chicken, and drank a glaſs of wine; ſoon after he was ſeized with vomiting, then with coldneſs and fainting, which the ſtrongeſt cordials did not put away; his pulſe ſunk, and could not be felt long before ſeven in the evening, when he died. He remained ſenſible to the laſt, and ſpoke reaſonably, and with a ſtrong voice, till within a few minutes before his death, long after his pulſe was gone, and his extremities were turned cold.

When his body was opened, the meſentery was found inflated with air to a prodigious bulk, as were all the other cellular parts of the abdomen; all the veins, large and ſmall, were in the ſame condition; the auricles and ventricles of the heart were greatly diſtended, and collapſed with a great blaſt of air when cut. There was an ounce or two of pus in the cellular ſubſtance, near to the origin of the right ſpermatic veſſels; but below that the cord was ſound, with the ligature firm on it, lying without the ring of the external oblique muſcle. All the other bowels were very ſound.

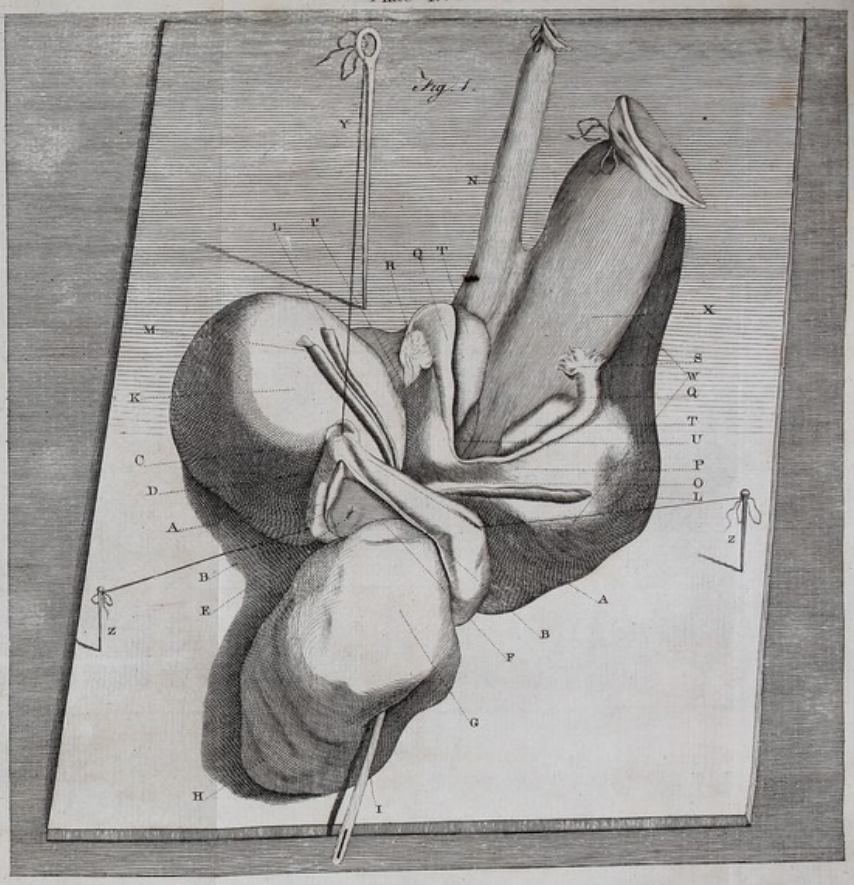
Though in conſidering the ſymptoms by which the ſeveral ſorts of tumours in the ſcrotum are known, I have mentioned only thoſe proper to each; yet I have here and there given hints, that we are not to expect

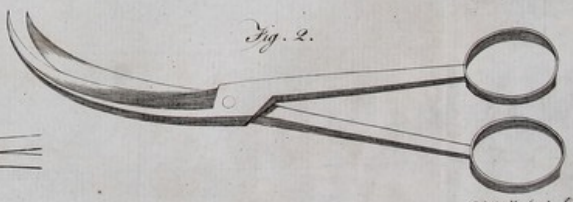
theſe

theſe diſeaſes always ſingle, but that there often are complications of them, which are to be diſcovered by the different ſymptoms belonging to each; for which reaſon, and to ſave repetitions, I did not take notice of all the complications which might happen, and can eaſily be ſuppoſed by any who is acquainted with the ſtructure of the parts, and knows any thing of the ſimple diſeaſes.

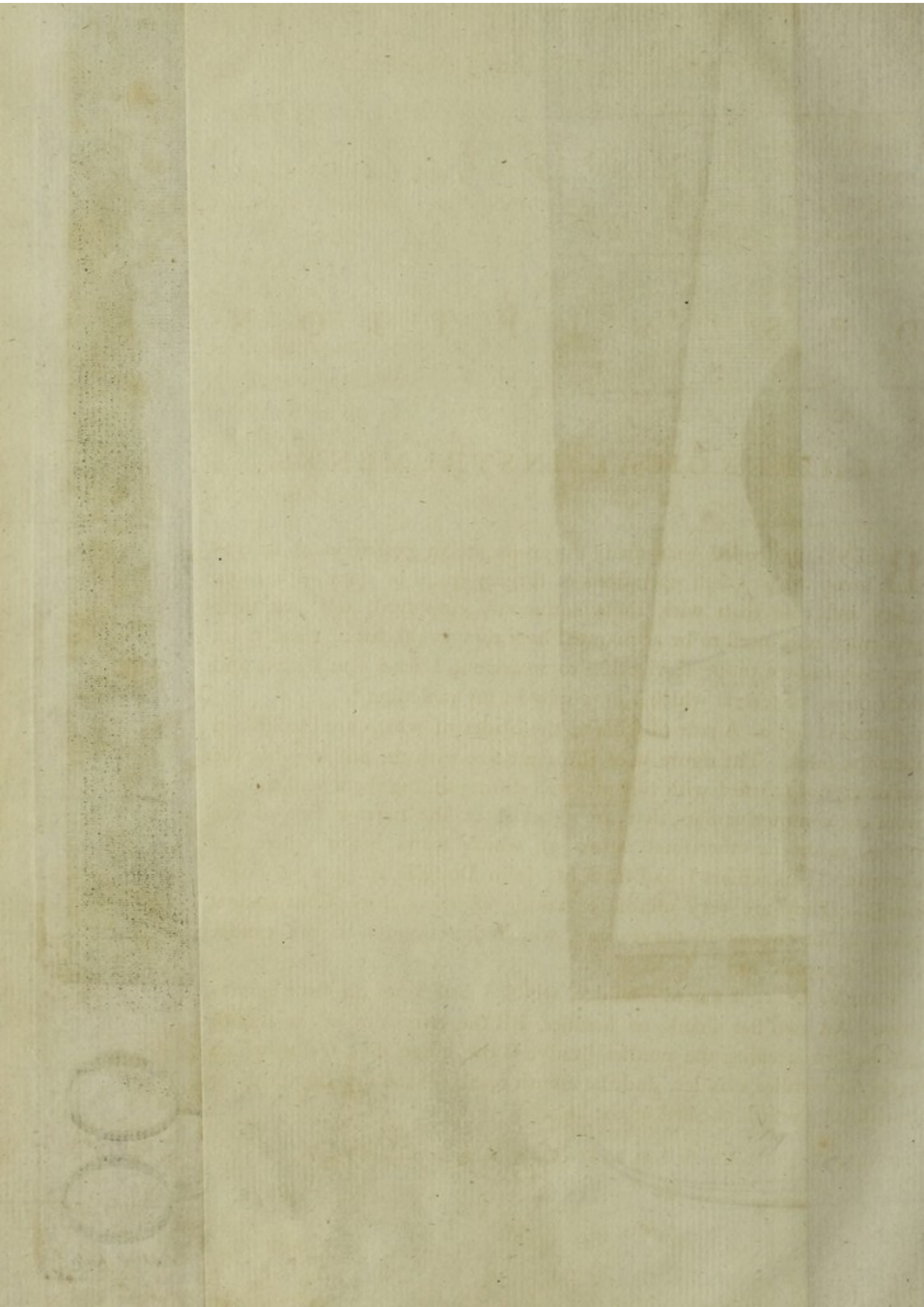
N° 35.

Plate IV.





A Bell Sculp.



N° 35.

A

DESCRIPTION

OF SEVERAL

CHIRURGICAL INSTRUMENTS.

BEING perſuaded that many ſurgeons are in poſſeſſion of inſtruments with which operations in ſurgery could be done with more ſafety and eaſe than with thoſe commonly employed, and that theſe gentlemen only need to be acquainted how they could make them more generally known to be ſerviceable to mankind, I ſend you figures and deſcriptions of ſeveral which I have now in my poſſeſſion *.

Plate IV. fig. 2. A pair of ſciſſars, the blades of which are crooked in their flat ſides. The figure is of the ſame ſize with the ſciſſars; but the engraver, not ſatisfied with this picture's diſtinguiſhing them well enough from the common ſciſſars that are crooked in the narrow ſide of the blades, made the other ſmall figure (3), which ſhews better where the curve is. This ſciſſars I had from Mr John Douglas ſurgeon in Edinburgh. They are very uſeful for taking off excreſcences from hollow parts, or for cutting in curve lines, which the common ſciſſars cannot eaſily be applied to.

Plate V. fig. 1. Is a needle-holder, which I had from the ſame gentleman. AA two flat ſhanks or handles, BB the two ſides of its mouth grooved for keeping the needles ſteady, C the hinge, D a ſpring which keeps the handles aſunder, and the mouth open, till the ſlip-ring or ſlider E is thruſt towards the end of the handles.

This

* Originally publiſhed in the Edin. Medical Eſſays, being Art. xlii. of Vol. V.

This inſtrument holds the needle more firmly, and its ring ſlides more eaſily, than the common needle-holders which I have ſeen.

Mr Douglas obſerves, that needles of ſilver pierce more eaſily in ſtitching arteries after an amputation than the ſteel ones do.

Fig. 2. A biſtoury and furrowed directory, belonging alſo to Mr Douglas. A the handle, B the blade of the biſtoury, C a button at its point, D the handle of the directory, whoſe groove is hollowed ſo as all its tranſverſe ſections are like to what is repreſented at E; and therefore the button, once entered at the end of the groove neareſt to the handle, cannot come out till it paſſes out at the other extremity.

In operating with this inſtrument, a misfortune is ſurely prevented, which ſometimes happens in opening ſinuous ulcers with the common biſtoury and directory, to wit, the biſtoury ſtarting out of the groove of of the directory.

Fig. 3. The blades of a pair of ſtrong forceps, the mouth A of which has on each ſide two ſmall ſharp teeth, which apply cloſe one to another when it is ſhut. Mr Douglas favoured me alſo with this.

In extracting bullets, the ſcrew in a canula, which ſome recommend, cannot be forced into the bullet, unleſs there is the firm reſiſtance of a bone on the other ſide; and the blades of the common forceps frequently cannot be introduced ſo far as the largeſt diameter of the bullet, without which they cannot take ſufficient hold: whereas the forceps here repreſented can be introduced into a wound ſafely when ſhut; and the blades being opened immediately behind the bullet, the teeth piercing into the lead, may have ſufficient hold to bring it out, though they be not advanced ſo far as the largeſt part of it.

Fig. 4. A trepan given me by Mr Douglas. AA two plates of braſs kept together by four pillars of braſs BB, C a handle moving a tooth-wheel which turns a pinion, to which G the ſocket for receiving a common ſaw-head of a trepan is fixed.

The figure is one half the dimenſions of the inſtrument. The ſaw will be turned more equally with this inſtrument than with the hand alone; but whether the rattling or trembling which the wheels make are ſufficient to counterbalance this advantage, I ſhall not determine.

Fig. 5.

Fig. 5. A levator of a depreſſed ſkull, which I am informed Mr Petit ſurgeon at Paris ſhewed lately in the academy of ſurgery there.

1. A the wooden handle; B the ſteel ſtalk with ſeveral holes, in which are female ſcrews; C the lever bended down from the ſtalk.

2. The *reſt*, with its feet covered with leather, and a male ſcrew fixed in the top of its arch, but ſo as to be moved on a joint.

3. Another *reſt* of the ſame make, but of a higher arch.

4. The inſtrument with its two pieces joined. This inſtrument is much preferable to the common ones employed for raiſing depreſſed pieces of the ſkull; the ſoft feet of the *reſt* will ſcarce bruiſe the teguments, far leſs are they in danger of breaking the bone on which they are placed. The force with which the inſtrument acts can be increaſed or diminiſhed according to the different hole of the ſtalk into which the ſcrew of the *reſt* is put. The farther from the handle, the longer is the vectis, and the more power the hand moving it has. The ſcrew allows the ſtalk to turn round, and the joint makes it capable of being raiſed or depreſſed.

Fig. 6. Another levator, all of ſteel, given me by Mr Douglas.

AA the handle; B a male ſcrew; C a wood ſcrew; D a runner with a female ſcrew; E a joint, by which the ſtalk F of the claw, with teeth G, moves on the runner.

Fig. 7. The wood ſcrew C, and the end of the claw G, to ſhew the claw of a different form, or forked.

When this inſtrument is uſed, the claw G is put under the depreſſed piece of bone; and then the wood ſcrew being fixed into the exterior part of it, the ſurgeon draws the bone outwards, or to any ſide, at pleaſure.

In ſome caſes, where the direction of the force raiſing the bone muſt be varied, this inſtrument will be preferable to Petit's.

Fig. 8. A ſcoop for making the perforation into the noſe in the *fiſtula lachrymalis*, belonging to Mr Douglas.

A the handle, of wood or horn; B the mouth of the ſcoop, which is made very ſharp.

To extract peaſe, cherry-ſtones, or ſuch ſubſtances, out of the noſes or ears of children, Mr Douglas employed ſucceſsfully the ſtiff adheſive paſte put on the hollow end of a ſmall piece of wood or ivory, with which jewellers draw diamonds out of the lockets in which they are ſet.

Fig. 9. An inſtrument for pulling teeth, given to me by Mr James Douglas ſurgeon to the Welſh Fuzileers; only that I have added the wooden handle A, where there was a punce in the one I had from him. B the ſtalk of ſteel, C the *reſt*, D the claw, E the hinge on which the claw moves.

When this inſtrument is uſed, the claw is put on the inſide of the tooth to be drawn with its points as near to the roots of the tooth as they can conveniently be put. The end of the *reſt* is placed on the outſide of the gums; and a finger being placed above the claw to keep it from ſliding, the patient's head is held by the ſurgeon, who preſſes down the handle to extract the tooth, by raiſing the tooth, moved in an arch of a circle, from the ſocket.

Fig. 10. Another inſtrument for drawing teeth, given to me by Mr John Fothergill phyſician at London. A, a gimblet-handle repreſented too ſmall in the figure; this I added inſtead of a ſmall croſs-bar of iron. B the ſtalk, C the convex *reſt*, D the claw, E the hinge of the claw.

While the claw is put as in the figure, the inſtrument can be applied to any tooth in the left ſide of the lower jaw, and to thoſe of the right ſide of the upper jaw; but by taking out the axis, and turning the claw to the other ſide, it is fitted for applying to the *dentes molares* of the other ſide of each jaw.

The claw being placed and held down, as mentioned of the preceding inſtrument, the gimblet-handle is twiſted round, ſo that the convex *reſt* is applied to the gum on the outſide of the tooth; and then continuing the twiſting, the action of the inſtrument is the ſame as of the former.

This inſtrument is altogether neceſſary for drawing the poſterior grinders, eſpecially in people whoſe mouth is little, and whoſe cheeks are thick, where the inſtrument fig. 9. cannot be applied.

They have both greatly the advantage of the pelican, in ſo far as their action is not ſo oblique, and they are much leſs liable to ſlide.

A propos of theſe inſtruments for the teeth, I muſt obſerve, that the punce has much better effect in puſhing from within outwards than in the common way it is applied to thruſt the roots of teeth from without inwards: This direction being often to thruſt a vault on its convex ſide, while the former method is acting on its concave ſide; and therefore the

ſtalk

Plate V

Fig. 1.

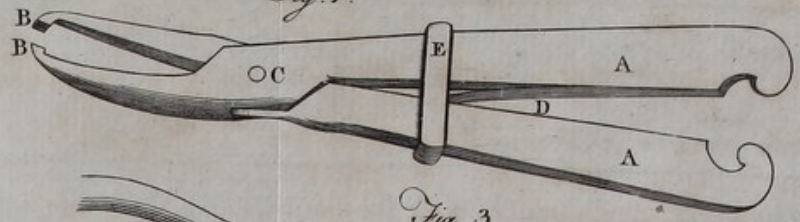


Fig. 4.

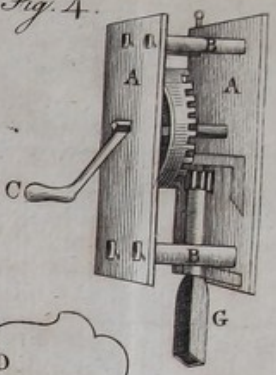


Fig. 3.

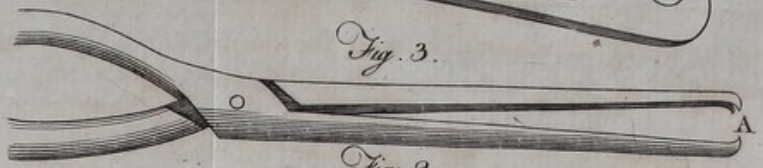


Fig. 2.

Fig. 7.

Fig. 5.

Fig. 6.

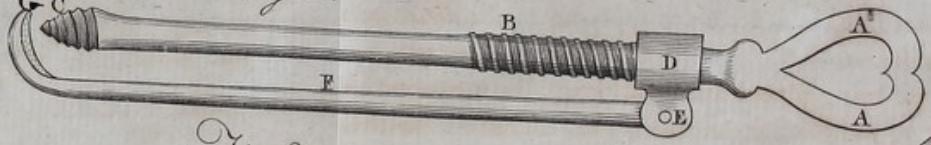


Fig. 11.

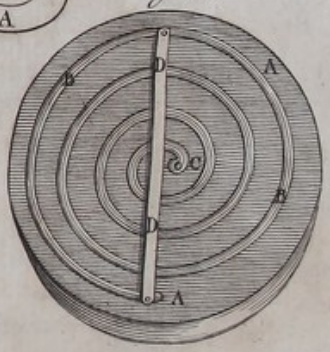


Fig. 8.

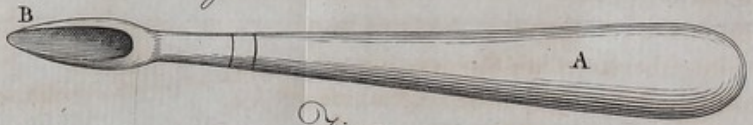


Fig. 9.

Fig. 10.

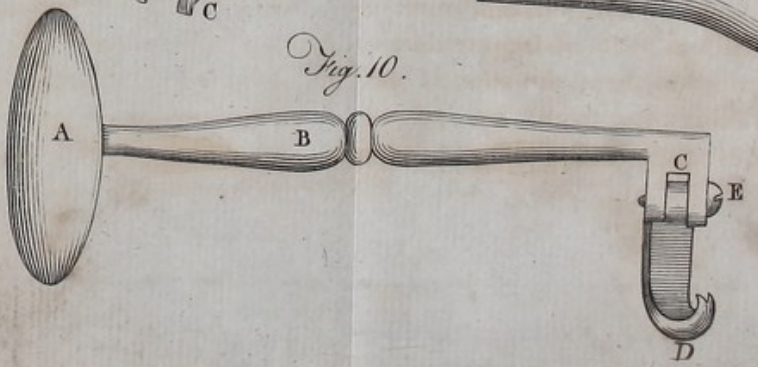


Fig. 12.

A Bell Sculpt

ſtalk of punces ought to be made longer than they are or dinarily made, that they may be put croſs the mouth.

Fig. 11. The anterior view of a bolſter for umbilical herniæ. AA, a plate of ſteel to which the convex ſtuffed bolſter is ſewed; BB a raiſed ſerpentine ſpring fixed to the plate AA, at its extremity C; DD a croſs-bar of ſteel to make the play of the ſpring equal, and to which the circular belt is ſewed.

The patient keeping his or her belly diſtended by retaining the breath, the circular belt is put ſo tight as to make the ſpring lie flat on the plate. When the belly is contracted the ſpring riſes, and nearly an equal preſſure is kept on the navel during inſpiration and exſpiration, which cannot be done without the aſſiſtance of a ſpring. One diſadvantage, however, of this ſort of ſpring, eſpecially in big-bellied people, is its riſing too high: For ſuch the ſpring may be made as in the following figure.

Fig. 12. A bolſter for the navel. AA the plate of ſteel; B a flat ſerpentine ſpring, the end C of which is fixed into the plate, and to the other extremity one end of the circular belt is ſewed to extend the ſpring as the belly ſtretches, the ſpring contracting as the belly ſubſides.

Plate VI. fig. 1. A bolſter for inguinal herniæ, conſiderably prominent at A, and thinner at B; the form of it appears better in the lateral view of it D.

The advantages of this form of a bolſter has been mentioned in the eſſay on herniæ.

Fig. 2. A ſort of *biſtoire cachée* in Mr John Douglas's poſſeſſion.

A, a narrow bladed biſtoury; B and C, two ſheaths made of thin plates of ſilver, between which is a groove wherein the blade of the biſtoury can be lodged.

The biſtoury, covered with either of them, being introduced into a ſinus, the ſilver ſheath is withdrawn, and the ſurgeon cuts with the biſtoury as he thinks fit.

Fig. 3. An inſtrument for opening *fiſtulæ in ano* which have an external orifice, but do not open into the rectum, though they run up on the ſide of it. This inſtrument was contrived by Mr Adam Drummond ſurgeon in this place.

A the handle; B the blade, of the ſhape of a joiner's former; C a noſe of

elaſtic flexible ſteel, with a button D at its crooked extremity. This noſe I added. F a button; H the handle of the directory I, the groove of which is made as that of Plate V. fig. 2.

The furrowed probe or directory being introduced into the ſinus, with its groove towards the gut, the button F is entered into the groove at its extremity; and the *former* being puſhed forward, its noſe is directed into the anus, and the whole inſtrument is puſhed upwards as far as it can go, that is, till its button is ſtopt by the ſhut extremity of the groove of the directory, the edge cutting all the parts placed between the ſinus and cavity of the gut, without any danger of hurting any part elſe.

One difficulty I found in uſing this inſtrument was its edge not cutting well, becauſe it was only puſhed againſt the parts, without running along to act as a ſaw does, which is the only way a cutting inſtrument has a right effect. To remedy this, I would propoſe to have the edge oblique from E to G, where the button ſhould be put.

But there is ſtill another inconvenience in the uſe of this inſtrument, to wit, the noſe being ſtopped by the rugæ of the rectum. A finger placed on the noſe, when it is introduced into gut, might however prevent this.

Fig. 4. Another inſtrument for the ſame purpoſe, given to me by Dr Charles Ayton Douglas of Finglaſſie in Fife.

A the handle; B the blade of a ſharp-pointed biſtoury; C a thin plate lodged in a narrow ſheath E of a directory, the handle of which is D; F a ring; G the cylindrical grooved directory.

When this inſtrument is employed, the blade of the biſtoury is introduced into the ſinus with ſuch a ſheath of ſilver as is repreſented fig. 2. or by putting a probe point of wax upon it, the edge of the blade being placed towards the rectum, into which the furrowed directory is introduced as far as the ring F, which is a ſtop to it. Then the plate C is brought to ſlide into the ſheath E, by which the point of the biſtoury is guided when preſſed into the gut to enter the groove of the directory; and, being kept there, the two inſtruments are drawn out, the blade of the biſtoury cutting all that is between the ſinus and the cavity of the gut.

After deſcribing two inſtruments for this operation of laying open ſinuſes which run upon the outſide of the laſt gut, I muſt warn young

ſurgeons

ſurgeons not to be fond of undertaking this operation, eſpecially if the ſinus goes any conſiderable way up, and there is a thick bridge betwixt it and the gut. The reaſon of this caution is not ſo much on account of the hæmorrhage which ſometimes happens after ſuch an inciſion, nor through fear of the patient's not retaining the fæces after the cure; for ſurgeons generally get the hæmorrhage ſtopt, and the new fleſh joins the divided parts of the ſphincter ſo well, that it does its office ſufficiently: but I have ſeveral times ſeen a moſt obſtinate diarrhœa come on ſome days after the operation, which hurried the patients to their graves.

On which account, many years paſt, I have diſſuaded all thoſe who aſked my advice for ſuch a fiſtula, from allowing the operation to be done; and have cured all of them, whoſe conſtitution did not require the drain by the fiſtula, by cauſing the orifice of the fiſtulous pipe to be made ſtraight with the pipe itſelf, encouraging the growth of fleſh with injections of digeſtive diluted with oil, or with ſuch like incarner, and keeping an emollient poultice on the part, without allowing tents, doſſils, or probes, to be put into the ſore. Under this management ſeveral recent ſinuſes have filled all up, and got a firm cicatrix.—When hope of the parts uniting fails, I then deſire drying injections, ſuch as of lime-water, melroſe, brandy, and at laſt of pure alcohol, to be made, that all the ſinus may be fully dried and ſkinned over. Such dry pipes give no uneaſineſs or trouble, and gradually become much ſhorter.

Fig. 5. Two views of a ſteel grooved catheter for performing lithotomy, in a manner a-kin to Celſus's, or upon the gripe, invented lately, as I am informed, by Mr Le Cat ſurgeon and lithotomiſt at Rouen. Both figures are one-third of the ſize which the inſtrument ought to be made of.

The ſuperior figure repreſents the inſtrument when it is to be introduced into the bladder. A, a female head or ſquare ſocket; BB two rings which ſerve as handles to it; C the round hollow part of the catheter; D a joint; E its point, where there is a ſecond joint; F a ſquare male head, which can be fixed at any place of the ſocket by the ſcrew-nail H; G a ring which ſerves as a handle to the male head, to the further extremity of which a flexible wire is fixed.

The lower figure repreſents the ſame inſtrument, when the male ſquare head

head is puſhed quite down into the ſocket. A, BB, C, D, E, G, H, denote the ſame parts which were marked by them in the former figure. I is the flexible elaſtic wire puſhed out by thruſting down the male head F, and raiſing with it the grooved part L, to which it is joined by a joint at K.

This inſtrument is introduced into the bladder, when it is as repreſented in the ſuperior of the two figures, which, towards its point, is nearly of the form of a common ſilver catheter. Then the male head being puſhed down, and conſequently the moveable part of the other extremity being raiſed, as in the lower figure, they are ſecured in that form by the ſcrew-pin H. The inſtrument is gently drawn outwards, till the part I, being reſiſted by the ſphincter, as it is called, of the bladder, hinders it from being drawn further out of the urethra, when the inſtrument is raiſed up towards the *os pubis* of one ſide, by which the convex furrowed part L is made to preſs outwards, and may be felt between the *muſculus accelerator urinæ* and *erector penis:* ſo that the operator, after an inciſion through the teguments, cuts into its groove, and upon it enlarges his inciſion, and introduces his conductors and forceps to extract the ſtone.

Since publiſhing the deſcription and figure of this catheter, the Royal Society at London has inſerted Mr Le Cat's own account of this inſtrument, in their Tranſactions, N° 476. § 11. which differs from the one I gave, in his deſiring all from the handle to near the firſt hinge D to be made of ſilver, and all beyond that to be made of hard gold; but as he complains of this bending in performing the operation, the ſteel one is preferable.—The inconveniencies, he ſays, he found in operating with this catheter, and the death of the three patients who were cut when he uſed it, will probably make others unwilling to employ it.

Fig. 6. An aneuriſm-needle, which is fitter for that operation than the common one. A its ſtalk, fixed into a wooden handle, which is not repreſented here; B the curve, which is much larger than ordinary; C the eye very near the point.

The handle allows one to hold it firmer; the large curve makes it apply better to the artery, which lies in a cavity; the eye near the point gives occaſion for puſhing leſs of the inſtrument behind the artery; and

the

the ſharpneſs of the point makes it eaſily pierce the thickened membranes, which requires a very ſtrong puſh of a blunt needle.

Fig. 7. A chiſel with which the fingers or toes may be cut off, given me by Mr John Douglas, ſo often named above.

A the concave mouth, the edge of which is very ſharp; B the head; C the handle, ſtanding tranſverſe from the head.

When the common chiſels, the ſtalks of which are long and perpendicular to the mouth, are uſed, the ſurgeon is always afraid of hurting his own hand when he ſtrikes with the mallet, and therefore does not probably give ſuch a ſmart ſtroke as he would otherwiſe: and if he does not ſtrike perpendicular, he beats the chiſel out of his own hand, miſſes the right amputation of the member, and bruiſes himſelf; all which inconveniencies are prevented when a chiſel of the form here repreſented is employed.

N° 36.

N° 36.

An UNCOMMON ANGINA.

A MAN, thirty-four years of age, ſubject all his life to plethoric indiſpoſitions, eſpecially in the ſpring, and to catarrhs when the leaſt expoſed to cold, who had not uſed any fermented drink or heating food for ſeveral years; on account of a ſlight hæmoptoë that had more than once ſeized him, and had retrenched ſome of his ordinary diet for near two months, to prevent his vernal plethora; having ſat ſeveral hours in a chamber without a fire, and with an open window, while the weather was very cold and the air foggy, about the middle of January 1732, complained, as ſoon as he roſe from his ſeat, of being ſtiff with cold and very weary, with pains in moving all his muſcles, and perpetual yawning: To free himſelf of the uneaſy coldneſs, he immediately went home, ſat near a fire, and drank tea, but could not remove the ſhiverings and wearineſs. Upon going into bed, he was ſeized with the appearance of an aguiſh paroxyſm, which had made a regular courſe before morning.

Next day he was a little feveriſh, and ſtill complained of pains through all his body; and therefore took his uſual cure in ſlight maladies of that kind, viz. a laxative ptiſan, in which tamarinds and ſenna had been boiled; which operated gently, and gave him conſiderable relief.

The day following, he was almoſt free of all his former complaints; but his right amygdala was ſwelled and painful, for which the ptiſan was repeated.

In the morning of the fourth day, the amygdala was leſs, and freer of pain; and, except a little bitterneſs in the mouth, he had ſcarce any other uneaſineſs: but, in the afternoon, the left amygdala became painful on the leaſt attempt to ſwallow; and his pulſe turned quick, but not very ſtrong. He was let blood at a large orifice of a big jugular vein, to the quantity of ſixteen ounces; after which his pulſe became very quick, ſtrong, and full.

full. On this appearance of plethora, eight ounces more were taken away, and the patient then inclined to faint; but in a quarter of an hour after, his pulſe was very near as ſtrong and quick as ever. The pain of the left amygdala was ſo far from being diminiſhed, that it continued increaſing; and all the teeth in the ſame ſide of the lower jaw, that were otherwiſe very ſound, were alſo violently and conſtantly affected; but the pains were moſt exquiſite when he ſwallowed. In the mean time, he could open his mouth as wide as ever; and nothing preternatural could be obſerved in his fauces, except a ſmall ſwelling of the right amygdala, and an eryſipelatous redneſs of the uvula, *velum pendulum*, and left amygdala, without any tumour. After he went to bed, the pains were ſo racking, eſpecially when he ſwallowed his ſpittle, (which he could not poſſibly prevent doing frequently, whatever care he took to the contrary), that though he is a man who is tolerably patient under pain, he made the whole bed ſhake with his tremblings, and large drops of ſweat appeared on his ſkin at each attempt. About midnight he could lie no longer; but, putting on his cloaths, he received the fumes of warm water into his mouth; and the pain remitting ſomewhat, while he endeavoured to hinder the occaſions of its violent increaſe, by leaning his head forward, opening his mouth, and ſo allowing the ſaliva to run out, he paſſed the reſt of the night in a drowſy nodding way.

Next morning, his deglutition was performed with great difficulty and pain; and he was ſo hoarſe he ſcarce could be underſtood when he ſpoke, but had no difficulty of reſpiration; and the fulneſs and ſtrength of his pulſe were leſs, but its quickneſs remained. His throat had the ſame appearance as the night before. The purgative ptiſan was repeated. The fumes of warm water were often made uſe of, and an emollient cataplaſm was applied externally on the pained parts.

In the evening, the pain was eaſier, and the pulſe rather better, but the hoarſeneſs continued. A bliſtering plaſter was applied on his neck and back, and emulſion was prepared for his drink.

The plaſter did its office well; and the patient, notwithſtanding his pain in ſwallowing, drank two bottles of emulſion in the night, which prevented any ſtrangury till near noon of the following day, when the chamber being overheated, and the patient thereby put into a ſweat, the

ſtrangury came on violently; of which he was relieved, after ſome hours, by carrying away the fire, and injecting an emollient clyſter with turpentine. The emollient poultice was in the mean time renewed; the fumes of water were frequently applied; and a mild reſolvent gargariſm aſſiſted the evacuation of mucus, which began now to be ſecerned in more than ordinary quantity in the fauces. In the evening, the patient ſeemed by his pulſe to be pretty free of fever, and all his troubleſome ſymptoms were conſiderably removed.

The bliſtered parts diſcharging plentifully the two ſucceeding days, he ſeemed to mend apace; but ſtill continued the poultice, fumes, and cataplaſm.

On the third, which was the ninth of his diſeaſe, finding in the morning the pain increaſed, he took the laxative ptiſan, and plied the topical medicines; but through the day the ſymptoms gradually increaſed, till, in the evening, his pain in the left amygdala and teeth was rather more violent than ever, the hoarſeneſs was worſe than formerly, his pulſe was low and quick, he was drowſy, and paſſed little urine. No ſwelling could be ſeen on the left pained ſide, and he breathed freely. He drank largely of warm poſſet made with Rheniſh wine, and chewed long-pepper with the teeth of the affected ſide. His urine ſoon came in great plenty; he diſcharged large quantities of mucus at the mouth, and in two or three hours was much freer of pain; his pulſe turned ſlower, and the dozing went off. The gargariſm was renewed, with the addition of ſome *aq. theriac.* and *ſp. nitr. d.*; and *theriac. andromach.* was added to the cataplaſm.

By the uſe of theſe medicines, he was greatly recovered in the two following days; and nothing remaining the third, except a little bitter taſte, a trifling ſwelling in the right amygdala, and a weakneſs in the left ſide of the fauces. He went abroad to his uſual labour of diſſecting in the forenoon, and prelecting in the afternoon; which he continued to do for a week, uſing a ſpare diet and applying the topics; in which time he got quite free of all uneaſineſs, except a dull pain of the left ſide of the fauces, eſpecially in yawning; and he imagined all the food he ſwallowed paſſed only by that ſide, where ſometimes a little of it ſtopped, and was with ſome trouble preſſed back again into the mouth.

To

To remove this weakneſs, the patient one evening gargled his throat with claret-wine and a little *aq. theriac.* mixed. This night he was ſenſible of a ſtraitening in his breath; and in the morning when he awaked, he was quite hoarſe, breathed with more difficulty, and in coughing his head and eye-balls felt as if ſtrongly girded, his face became very red, and he began to hiſs in breathing. All theſe bad appearances went greatly off, after breathing in the fumes of warm water and drinking warm tea. In a few hours after, he ſwallowed pills, compoſed of *mercur. d.* and reſine of jalap, which operated mildly, and leſſened all the cauſes of complaint conſiderably; and a ſecond ſuch doſe, taken two days after, removed all of them entirely, except a little weakneſs of the left ſide of the fauces, and an obtuſe pain there in yawning, which remained ſeveral weeks after.

In the hiſtory of this diſeaſe, I have given a ſtrong hint who the patient was; and ſuſpect the common frailty of enlarging on one's own misfortunes may have diſcovered ſufficiently that it is my own caſe I have related.

What was the particular ſeat of this anomalous angina? Will the uſes aſſigned to the digaſtric muſcles in a former article (N° 5.) be of uſe to diſcover it?

N° 37.

An ASTHMA, with uncommon Symptoms.

MR JAMES URE, whoſe buſineſs as a writer, or ſolicitor at law, engaged him frequently in company and good-fellowſhip, was ſometimes troubled with a palpitation at his heart, a trembling in his hand, and faintneſs; being always ſubject to a cough, and having generally very little appetite for food, with two or three looſe ſtools a-day. In October 1730, the 55th year of his age, having catched cold, a cough ſeized him, with which he brought up a ſmall quantity of very thick ſlime, and complained of a difficulty of breathing: he loſt all appetite for food, his belly became bound, his urine was in ſmall quantity, and he could not feel his own pulſe.

He allowed theſe ſymptoms to continue eight days without aſking any advice; but finding them continue, and rather increaſe, he conſulted Dr William Porterfield and me, October 20. Beſides the above-mentioned ſymptoms, we obſerved his difficulty of breathing increaſe ſo much upon lying down, that he was obliged to ſleep in a ſitting poſture. His feet and legs were very œdematous. We could feel no pulſe in the arteries of his wriſt, neck, temples, or ham, but only a ſort of trembling under our fingers; which we then attributed to ſome irregularity in the diſtribution of his arteries, notwithſtanding his affirming, that, when in health, he had a pretty ſtrong pulſe in the very parts we felt. The veins of his arm and neck were very large, and ſtretched with blood. He could take no ſort of food; but had a thirſt, which was not violent; nor was his tongue dry, or his ſkin hot. When the cough attacked him, he forced very little pituit up; but his breathing became exceeding laborious, his face turned very red or purple, and he complained of a violent headach. When he was free of the cough a little while, he walked, ſpoke, complained of little, and aſſured us he was ſcarce weaker than in health.

To

To prevent the bad effects of the cough, twelve ounces of blood were immediately let: he bled freely, and did not turn faint. In the evening, a terebinthinate purging clyſter was injected, which purged him gently. He was deſired to take any ſort of mild food which his ſtomach could receive. Rheniſh wine and water were given for drink, into which he frequently dropped forty guts of the following mixture: ℞. *Elixir pectoral. unc.* i. *Tinctur. caſtor. drach.* ii. *Sp. ſalin. aromat. drach.* iii.; and every two hours he ſwallowed two ſpoonfuls of the *oxymel pectoral.* of the Edinburgh diſpenſatory. At bed-time he took this bolus: ℞. *Sperm. cet, ſcrup.* i. *Sal. ſuccin. gr.* v. *Conſerv. roſ. ſcrup.* i. *Syrup. alth. q. ſ. ut fiat bol.*

Next morning there appeared no change in his condition; and he took *P. ipecacuan. gr.* xxxv. *Oxymel. ſcillit. unc.* i. This emetic operated ſix times without increaſing his headach or difficulty of breathing, and brought a good deal of ſlime with the water he drank. He ſeemed a little relieved after this vomit, and continued the uſe of the medicines preſcribed the day before. At night a bliſtering plaſter was applied to his neck and ſhoulders; he took his bolus, and had a cooling emulſion for drink.

The bliſter roſe well; but the pain of it made him ſo unable to move next morning, that we could not give the purgative we had determined to order. His urine was in larger quantity, with a good ſediment; notwithſtanding which, his legs were rather more ſwelled, and the other ſymptoms continued. His bolus was again given in the morning; he ſtill drank water with Rheniſh wine; and he was deſired to take frequently a ſpoonful of the following mixture: ℞. *Aq. hyſſop. puleg. a. unc.* iii. *Cinnam. ſ. v. raphan. compt. a. unc.* i. *Gum. ammoniac. drach.* ii. *Sal. ſuccin. drach. ſem. Oxymel. ſcillit. unc.* ii. *Syrup. alth. unc.* i. *M.*

He continued much in the ſame way all the 22d and 23d; only his legs and thighs ſwelled more, and he began to complain that his cloaths were too tight for his belly.

In the morning of the 24th, he took this purgative bolus: ℞. *Pulv. rhei elect. ſcrup.* i. *Aquil. alb. pulv. jalap. a. gr.* v. *Syrup. de rhamn. q. ſ. ut ft. bol. capt. e ſyrup. violar.* This purged him mildly; and the quantity of his urine increaſed conſiderably, and his belly and legs became leſs ſwelled, which relieved him ſomewhat of the orthopnœa.

Next

Next day he began to uſe a medicated wine: ℞. *Rad. irid. Florent. ſcill. acor. ver. helen. raphan. ruſt. a. unc. ſem. Gentian. drach.* ii. *Rub. tinctor. unc. ſem. Cortic. ſambuc. ebul. a. unc. ſem. Herb. marub. alb. m.* ii. *Abſinth. rom. centaur. min. a. m. Sem. bacc. juniper. unc.* i. *ſem. Sal. tartar. drach.* iii. *Inciſ. et contuſ. ſ. a. M. ut. ſt. malia infundend. in vin. Liſbon lib.* vi. *Colatur, capt. unc.* ii. *mane et hora 5ta veſpertina.* All this day and the following, his urine paſſed plentifully, with a large ſediment; the ſwellings diminiſhed, and his cough and breathing were eaſier. In the evening of the 26th, while I ſat by him, he ſurpriſed me with putting his wriſt into my hand to feel his pulſe, which was full, ſtrong, ſlow, and equal; but two hours after, I could again feel no more than the very weak trembling I formerly mentioned.

The 27th the purgative bolus was repeated. On the 28th, his pulſe returned, and continued afterwards firm and ſtrong, till he recovered his former health; which he did in a little time, by the uſe of the medicated wine, pectoral mixture, and the purgative ſometimes repeated.

About a month after, having got the cold again, his ſymptoms began to return with the ſame ſtate of his pulſe: but upon taking the former emetic and the purgative, they went off; and, to prevent a ſecond relapſe, he got ſtrengthening chalybeate medicines, with the ſtimulating gums, for ſome time.

In the beginning of January 1732, he was again attacked with the aſthma, and want of pulſe; which were removed with two doſes of the purgative. After a cough, which continued ſome days in the beginning of February, his pulſe could not be felt during twenty-four hours; but it returned after the operation of a purgative bolus.

Soon after my patient retired to the country, where he has continued in very good health; and being lately in town, reviſed this account of his caſe, and allowed me to communicate it.

N° 38.

An ESSAY on the JAUNDICE.

WHERE theories are only applied to the reſolution of ſome ſpeculative queſtion, it is of uſe to expoſe the falſe colouring; but where they are employed to explain the nature of diſeaſes, and either immediately, or by very ſpecious conſequences, are introduced to influence the therapeutic part of phyſic, they ought to be thoroughly examined, that we may either have a valuable truth confirmed, or the world may be put out of the hazard of being ſeduced by a dangerous error. It is with a view of being ſerviceable this way, that I propoſe to examine the cauſes of a very common diſeaſe, the JAUNDICE, which is treated of by the generality of ſyſtematic authors in phyſic in a manner that is capable, in my opinion, of being attended with bad conſequences.

One of the moſt frequent cauſes of a jaundice is ſaid, by ſome authors of the greateſt reputation, to be an obſtruction of the extreme capillary veſſels of the liver; and this obſtruction may, according to them, depend on inflammation, ſcirrhus, pituita, &c. I ſuſpect, on the contrary, that no obſtructions in the extreme branches of the hepatic blood-veſſels are capable of producing this diſeaſe, unleſs in ſome particular caſes where they may act as a remote cauſe; of which I ſhall have occaſion to make mention afterwards.

I would found this negative proof on the nature of all the ſecreted liquors; which never appear in the compound maſs of our fluids, but only begin to diſplay their different properties after they are ſeparated from the other juices by the ſecerning organs; and even then they do not ſeem to partake of the qualities generally aſcribed to them, and by which they are known, until they are farther prepared, and are thrown into ſome large canals, where their quantity gives us an opportunity of examining them.

them. If, after they are thus ſecerned and prepared, they be again mixed with the other liquors, without undergoing ſome new change in their compoſition, they do indeed evidently ſhew themſelves by their effects. Since then the particles fit for the compoſition of any of our liquors cannot be ſaid to enjoy the properties of ſuch liquors, I cannot ſee why thoſe that enter into the compoſition of bile ſhould be ſuppoſed to produce the effect of bile, without having been ever ſeparated. We ſee plainly, on the ſtoppage of the ſecretions of other liquors whoſe colour, ſmell, and taſte, are capable of making us diſtinguiſh them, that they do not ſeem to ſhow themſelves in their natural form any where elſe. Thus, for inſtance, in an hydropic perſon, whoſe urine is ſuppreſſed by the compreſſion or obſtruction of the veſſels of the kidneys, and whoſe belly and *tunica celluloſa* are thence greatly diſtended, we do not find that the waters extravaſated into theſe cavities have the real marks of urine in them; nay, in the diſcharges of the ſkin and kidneys, which are ſo ſuccedaneous to each other, we cannot obſerve urine drilling through the ſkin, nor any thing like ſweat in the liquor diſcharged from the bladder. From theſe, and other ſuch examples, I ſhould imagine an obſtruction of the blood-veſſels of the liver, conſidered only as ſuch, to be incapable of mixing bilious particles with the other fluids that are to circulate through the whole ſyſtem of veſſels; and therefore incapable of producing a jaundice.

But ſeeing reaſoning *à poſteriori* is much more convincing in ſuch matters than any other, I would next obſerve, that if particles fit for compoſing bile were ſuppoſed capable of producing all the effects of bile, it would then neceſſarily follow, that whenever ſuch particles were ſent in large quantities from the *vena portarum* into the *vena cava*, a jaundice would be formed; conſequently this always would happen when any conſiderable obſtruction is made in the liver. Daily practice, and heaps of obſervations handed down to us, ſhow, however, that violent inflammations and great abſceſſes have been in the liver, and that the whole bowel has been ſcirrhous, without any appearance of a jaundice. The examples are ſo numerous, I need not quote authors: See only Bonetus's Collections. The concluſion, therefore, that neceſſarily follows from

theſe

theſe facts, is in the negative to the allowing obſtructions to be an immediate cauſe of the jaundice.

It may be alleged, that hitherto I have too abſtractedly conſidered obſtructions as a ſtop put to the paſſage of the liquors through the extreme veſſels; whereas I ought to have had regard to the neceſſary conſequences of ſuch an obſtruction, which it may be thought would ſolve all the phænomena upon my own principles. Theſe conſequences are the diſtenſion of the obſtructed canals, and the compreſſion they muſt make upon the adjacent parts; among which there muſt be ſeveral that contain the bile that has been ſecerned, which will therefore be forced back again into the blood-veſſels to occaſion a jaundice.

That I may give my opinion diſtinctly on this ſubject, it will be neceſſary to conſider the different parts of the liver where ſuch an obſtruction may be ſeated.

If the obſtruction is made in the concave ſide of the liver, in parts ſituated near to the large biliary ducts, and if the ſwelling is very great, I ſhall allow it may ſtop the paſſage of the bile into the gut, and ſo may ſerve as a remote cauſe of the jaundice. I am not however convinced, that this effect will follow from the compreſſion of the hepatic ducts, unleſs the cyſtic bile be alſo prevented from flowing into the duodenum. My grounds of doubting whether the hepatic bile can occaſion this diſeaſe, are the following. Both by the taſte of the liver at ſome diſtance from the gall-bladder, and by trials made of the hepatic bile when collected, we plainly find it to be a very mild liquor, with a very ſmall proportion of the proper bilious particles. Next, we ſee moſt of the drains of the body capable of tranſmitting bilious particles along with their other fluids: Thus the ſpittle of icteric people is bitter; and their urine, and ſometimes their ſweat, tinges linen yellow. Laſtly, the quantity of bile conſtantly refunded to the maſs of blood along with the finer parts of our food is conſiderable, and probably ſome of it has not its compoſition changed by the force of digeſtion; yet there is no appearance of its mixture in a natural ſtate. From theſe obſervations, one would be apt to ſuſpect the bilious lymph of the liver to be capable of gradually mixing with the blood, without manifeſting itſelf, eſpecially ſince it can ſo quickly be ſent out of the body by the excretories; nay, though this ſhould not happen,

we can ſcarce ſuppoſe ſuch a high colour, ſtrong taſte, and violent effects, ſo quickly produced by the hepatic bile, as is daily ſeen on the firſt diſcovery of the jaundice. To theſe arguments might be added the deficiency of proper obſervations or experiments to prove the jaundice produced without the cyſtic bile.

When obſtructions of any kind occaſion a tumour any conſiderable way within the liver near the branches of the *porus biliarius*, it may in part ſtop the courſe of the bile in theſe branches, from which it may be taken up by the ramifications of the *vena cava:* But the conſequences of ſuch bile will be of ſo much leſs effect towards creating a jaundice than in the foregoing ſuppoſition, as the quantity of bile hindered from flowing to the common duct is leſs; and, in confirmation of this not being an adequate cauſe to produce this diſeaſe, we have numerous examples of tumours of all ſorts obſerved in the liver upon diſſection of bodies that had no icteric ſign.

In reſpect of both the ſuppoſitions I have made, it is to be remarked, that a conſiderable tumour muſt be formed, before the ſides of the biliary canals incloſed in their ligamentous ſheath can be compreſſed ſufficiently to have the effects which I have granted; and when the tumour is large enough, it muſt firſt ſtraiten the branches of the *vena portarum*, which are larger than the contiguous biliary ducts: therefore, before theſe ſuffer, the quantity of bile ſecerned muſt be much diminiſhed; and if the leſſening of this liquor is in the ſame proportion with the ſtraitening of the veſſels, the bile will paſs; if the ducts cannot tranſmit all of it, the quantity interrupted will be but ſmall, and its effects will be little.

The laſt ſuppoſition neceſſary to make, is the obſtruction of the veſſels remote from the larger biliary ducts, where, the tubuli being ſmall, a leſs diſtenſion of the obſtructed canals will have greater effect on them. From what has been already ſaid, it will ſeem at leaſt neceſſary to ſuppoſe the obſtruction pretty univerſal through the liver, in order to obtain ſuch a conſequence as is commonly diſputed for. But then it is alſo obvious, that the obſtructed veſſels are the very canals that ought to ſupply the liquor which is to be ſecerned; and therefore the ſecretion will be prevented, which is alſo brought about by the compreſſion which the tumefied veſſels make on the ſmall tubes from which the biliary canals riſe, that

that is, on the ſecerning organs themſelves. If then there is any truth in what I argued for, of unſecerned particles, which might prove proper enough materials for compoſing bile, not being capable of cauſing a jaundice, though they continue mixed with our maſs of blood, it will follow, that neither on this third ſuppoſition will a jaundice be produced. Nor will it be amiſs to ſupport this reaſoning, by repeating the mention of the many examples recorded of the liver being entirely ſcirrhous or ſuppurated, without the perſons ever having a jaundice.

This view of obſtructions in different parts of the liver, give, I imagine, ſome reaſon to think ſuch a cauſe unfit to produce a jaundice, whatever other bad effects ſuch obſtructions may have in diſturbing the animal œconomy.

Whatever fate attends the doctrine of obſtructions of the liver, muſt affect the practice of curing the jaundice; and if this diſeaſe is ſo far from having obſtructions for a frequent cauſe, that they cannot occaſion it, then *deobſtruent*, *aperient*, *reſolvent*, *&c.* medicines, and their different claſſes, adapted to the particular nature of the obſtructing matter, will appear to be rather contrived for removing or mitigating ſome concomitant ſymptoms and palliating ſome effects of the jaundice, than deſigned to make a radical cure of the diſtemper.

By what has been above hinted, it will be readily conceived, that the only cauſe I would argue for as capable of producing a jaundice, is the ſtopping of the bile in the *ductus communis choledochus*, or in the cyſtic duct, and perhaps in the hepatic ducts of ſome few perſons whoſe hepatic bile is much ſtronger than it commonly is found.

Such an obſtruction may depend on a great variety of cauſes, ſuch as large tumours or abſceſſes in the concave part of the liver, or in any other parts in the neighbourhood of the large ducts; violent inflammations, or other tumours, in the courſe of theſe ducts; the growing together of their ſides; violent ſpaſms in the duodenum, by poiſons, or in the hyſteric diſorders; very great inflammations and diſtenſions of that gut, which often have the appearance of colics; and principally ſtones or concretions falling down from the gall-bladder.

Practical anatomiſts ſufficiently ſhow, how frequently concretions are to be found here; ſcarce any of thoſe who have handed down what they ob-

ſerved in diſſecting human bodies, have omitted to give hiſtories of this kind. Only remark what a great variety are deſcribed by Morgagni (*a*): And, in another book, *Bonetus's Sepulchret. Anat.* we read a collection of numerous examples of this diſeaſe, the jaundice, proceeding from this cauſe, ſtones; and ſeveral of the greateſt practiſers in phyſic have have taken notice of ſtones paſſing commonly when the jaundice was going off. On theſe accounts it is ſurpriſing, ſo little regard is had now-a-days to theſe concretions, in the ætiology and cure of this diſeaſe, as to find them mentioned only *en paſſant* as a poſſible cauſe, without any directions to endeavour their expulſion in completing the cure; which I can only attribute to their being paſſed unobſerved, becauſe of the troubleſome diſagreeable office of ſearching for them.

Let us with all this conſider, how exactly the falling down of a ſtone from the gall-bladder into the duct, explains all the phænomena that commonly happen in the jaundice, which no other cauſe will do, and we ſhall have reaſon to look on concretions as a much more frequent cauſe of this diſeaſe than is generally thought. If a ſmall ſtone falls into the duct, a conſiderable ſhare of the bile may ſtill paſs; and, though the patient's urine becomes higher coloured, the ſkin remains untinged; the gall-bladder gradually is filled with bile, which gives a ſenſe of weight in the right hypochonder; the ſecretion is diminiſhed in the liver by the greater reſiſtance now made to the evacuation of the bile; and the quantity of blood returned to the *vena cava* is greater, which makes a fulneſs in all the veſſels of the body, giving the ſenſe of repletion and laſſitude, with an inclination to ſleep. When a large enough quantity of bile regurgitates, the jaundice appears; and, according to the change of ſituation of the ſtone, the diſeaſe will have remiſſions or increaſe. If the concretion is ſo large as to preſs on the ſides of the duct, it occaſions pains about the lower part of the ſtomach. If the irritation it makes is great, the pains become more acute and lancinating; and the ſtomach ſympathizing, as in the *calculus renum*, the patient vomits. If this irritation continues, the part where the ſtone ſticks will be inflamed, and the neighbouring parts ſoon come alſo to be affected. By the inflammation and pain, a fever may be raiſed. When the ſtone obſtructs the duct entirely, the excrements

(*a*) Epiſtol. Adverſar. Act. Phyſico-medic.

excrements cannot be tinged yellow; nor will the inteſtines do their duty, becauſe of the defect of bile, which, being reaſſumed into the maſs of blood, tinges the urine, ſkin, eyes, &c. When the ſtone falls quickly into the duct and totally obſtructs it, the perſon becomes ſuddenly icteric. If the ſtone is ſoon puſhed forwards into the inteſtine, the diſeaſe is as ſoon removed by the paſſage of the bile being again free. If more ſtones ſucceed each other ſoon, the diſeaſe will appear to have had remiſſions. If there is any conſiderable interval between their falling down, ſo many periodical returns will be made of the diſeaſe. A diarrhœa often cures this diſeaſe, or rather a diarrhœa is the conſequence of the cure; for as ſoon as the concretion falls into the gut, the bile that was dammed up follows in a great ſtream, and occaſions the diarrhœa, at which time the ſtone or ſtones will be found among the fæces.

Concretions not only exactly thus account for the appearances of the jaundice, but by them only the effects of ſeveral plain antecedent cauſes can be underſtood. This diſeaſe, for example, has been brought on by violent anger, riding, reaching to vomit, fits of an ague, and ſeveral other convulſions or agitations of the body, which we cannot imagine to be any other reaſonable way produced, than by a ſtone's being puſhed down by theſe ſhocks of the body into the duct from the gall-bladder, where it lay floating before. Which leads me naturally to think phyſicians frequently liable to be deceived, when they ſuppoſe ſpaſms, inflammations, colics, acrid ingeſta, &c. bringing on a jaundice, by the ſole conſtriction of the biliary duct, without the help of any concretion: for in theſe caſes, either the cauſes could not be ſo permanent, *e. g.* the ſpaſms would not continue ſo long as the diſeaſe does; or theſe cauſes ſeem not capable to bring on the diſeaſe ſo ſoon after their own appearance, ſuch is the inflammation; and if the diſeaſe was owing to ſeveral of the cauſes mentioned, it would not go off ſo ſoon as frequently it does. It is much eaſier, therefore, to conceive, how ſuch forcible cauſes bring down a concretion, which proves the immediate cauſe of the diſeaſe.

If then ſtones are found moſt frequently to give riſe to this diſeaſe, without the acceſſion of any of theſe other cauſes which I have accounted capable of producing a jaundice; and if theſe other cauſes are ſo well fitted for bringing down looſe concretions, ſo often to be met with in the gall-

gall-bladder; it will follow, that the firſt thing a phyſician ought to conſider, when called to an icteric patient, is, whether any other cauſe manifeſtly ſhews itſelf without any indications of a ſtone; and according to the particular nature of that morbid cauſe, he muſt preſcribe: but if either the ſymptoms of a ſtone's being engaged in the biliary paſſages are blended with the others, or if there is not evident reaſon for not ſuſpecting ſtones to have any ſhare in occaſioning the diſeaſe, which ſeldom will happen, particular regard is to be had to ſuch concretions in the indications of cure.

I know it has been objected to the notion of bilious concretions ſo often producing a jaundice, that in icteric bodies no ſtones have been found in the ducts though ſought after, and in other bodies ſtones have been ſeen fixed in the ducts without any preceding jaundice. To the former objection, it may be anſwered, that I have already allowed other cauſes to be capable of giving riſe to this diſeaſe; and many caſes can be ſuppoſed, where, though ſtones occaſion it, yet we cannot expect they ſhould be found. To name one inſtance among many, if an exhauſted patient ſhould die by the diarrhœa, which ſo frequently comes on when the concretions drop into the gut, it would be in vain to expect to find them. The other objection will as little prove what is intended by it, unleſs ſeveral other particular circumſtances are accurately obſerved; as, for inſtance, If the ſtone was lodged in the duct long enough to occaſion the diſeaſe, or if it has been only forced down by the agonies of death: If it is large enough, and ſo ſituated as to hinder the courſe of the bile; or if it ſtill might allow this liquor to paſs: If the liver is ſound, and fit to ſecern good bile; or if it is otherwiſe diſeaſed, and has either performed little or no ſecretion, or has ſeparated a liquor different from bile. For if theſe circumſtances come out in the latter of the alternate ways I have propoſed them, this obſervation will have no weight as an objection.

But to return to the method of cure: I have already given reaſons why I think phyſicians are to act, in far the greater number of icteric caſes, with a view to ſtones that are to be expelled: and this will ſtill appear more neceſſary upon reconſidering the other cauſes, ſeveral of which do not admit of a cure, or at moſt we can promiſe very little upon our ſucceſs in treating them; ſuch are all large tumours ſituated near the great biliary

biliary ducts, poiſons, &c. If theſe therefore are cut off, and if moſt of the other cauſes do not diſtinguiſh themſelves ſufficiently from concretions, it will not be thought improper to affirm, that jaundice ought to be treated, rather more than can be ſaid of any other diſeaſe, with one general indication of expelling ſtones; and the ſpaſms, inflammations, tumours, &c. are only to be looked on as ſo many concomitant ſymptoms, to which regard is indeed to be had in the management of the patient, while the main indication is to be purſued; and medicines are to be applied in very near the ſame form and intention as are uſed in caſes of ſtones lodged in the ureters, which bear a very ſtrong analogy to the ſubject which I have juſt now treated of.

N° 39.

N° 39.

DESCRIPTION AND USES OF THE INTESTINUM DUODENUM.

ANATOMISTS having generally copied Veſalius's (*a*) deſcription and picture of the *inteſtinum duodenum*, which appeared to me very faulty, I cauſed the engraver draw that inteſtine in its natural ſituation ſeveral years ago *. Since that time, I have read two authors, Santorini (*b*) and Winſlow (*c*), who have deſcribed this gut more accurately than Veſalius: but neither of them having given any figure of the parts, and my deſcription differing conſiderably from theirs, as will appear upon comparing them, I reſolved to ſend you this paper, that the exact ſituation of this inteſtine might be more generally known; by which many phænomena in the animal œconomy and diſeaſes may be underſtood and explained.

From the pylorus, which is raiſed upwards and backwards from the ſtomach, the duodenum deſcends obliquely to the right ſide, with the anterior lamella of the omentum fixed to its inferior part, and the little omentum proceeding from the oppoſite part to connect it to the liver. After this, the duodenum is involved for about an inch and a half in a doubling of the omentum, and then enters into the duplicature of the meſocolon,

(*a*) De Corp. Hum. Fabric. lib. 5. cap. 4. (*b*) Obſerv. Anat. cap. 9. ſect. 7.

* Originally publiſhed in the Edin. Med. Eſſays, being art. xi. of Vol. IV.

(*c*) Expoſition. Anat. traitè du bas ventre, ſect. 105. &c.

meſocolon, where it cannot be ſeen without diſſecting away that fatty membrane. It deſcends in this cellular ſheath till it is almoſt contiguous to the great ſac of the colon, which properly is the human cæcum. In this deſcent the colon lies before it; the biliary duct, hepatic artery and nerve, *vena portarum*, and emulgent veſſels, are behind it; the liver, gall-bladder, and right kidney, are on its right ſide, and the pancreas is on the left. This gut makes ſeveral turns in this progreſs; for it is raiſed into a convexity forwards, where it paſſes before the veſſels of the liver. Immediately after, it bends backwards, and to the right ſide, till it approaches the right kidney; and then turns forward, and a little to the left, in its courſe towards the great ſac of the colon. The duodenum then makes a conſiderable curve to the left ſide, where it is involved in a cellular ſubſtance, which may be looked on as the common root of the meſentery and meſocolon, through the membrane of which it may be ſeen commonly, even in very fat bodies, without any diſſection. In the concave left ſide of this curve, the thick extremity of the larger pancreas and the little pancreas are lodged; the ſuperior meſenteric artery and vein coming through the notch between the larger and leſſer pancreas hang looſe before the gut here; and the *ductus communis cholidochus*, after paſſing behind the gut a little higher, unites commonly with the pancreatic duct, very little above the loweſt part of the curve; and after paſſing obliquely through the coats of the gut, the two ducts open by one common orifice in the poſterior part of the duodenum. After the curve juſt now deſcribed, the duodenum is involved in the root of the meſentery, and mounts obliquely within it towards the left ſide, with the *vena cava* behind it; and after a courſe of about four inches there, riſes forwards, to acquire a proper meſentery, or to commence jejunum; the membranes of the root of the meſentery ſeeming to make a ring at which the gut comes out, though they are really continued on the inteſtine, and form its external membranous coat.

That the duodenum may be all expoſed to view, without changing its natural ſituation in a body lying ſupine, it is neceſſary to cut through the great arch of the colon below the bottom of the ſtomach; and after turning the cut extremity of the left ſide over on the left ſhort ribs, to take hold of the other extremity of the colon; and having ſeparated it with a

pair of ſciſſars from the ſtomach and liver, taking away with it as much of the omentum and meſocolon as obſtruct the view of the duodenum and pancreas, to lay it likewiſe on the right loin. When the colon is removed, obſerve where the roots of the meſentery and meſocolon cover the duodenum ſo much as to prevent your ſeeing its courſe: at ſuch places cut theſe membranes with a very ſharp ſcalpel, directing the inciſions according to the length of the gut, and then cautiouſly ſeparate the membranes to each ſide, till all the inteſtine is in view. Laſtly, draw the ſmall guts gently down, raiſe the liver, and ſuſpend the fundus of the ſtomach as much as is neceſſary to allow a full view of the whole courſe of the duodenum.

Thoſe who have ever diſſected the human body, muſt be ſenſible how difficult it is to lay the duodenum of an adult all in view, without diſturbing its ſituation; and the taſk of keeping all the parts in the ſame fit poſture till a painter delineates them, is ſtill much greater: Therefore, though the preceding deſcription is taken from the adult body, I choſe to lay the body of a fœtus, which I had preſerved ſeveral years in acidulated ſpirit of wine, before the engraver, to draw the picture from; and afterwards I compared this picture with ſeveral adult bodies, to make ſure of there being no eſſential difference.

In Plate VI. fig. 8. are repreſented,

AA the liver, larger proportionally than in the adult, and raiſed ſo that its concave ſide is in view.

B The umbilical vein entering the liver.

This vein is commonly deſcribed and painted as paſſing to the *vena portarum*, without ſending off any branches: but in all the human fœtuſes or young children which I have diſſected, after their veſſels were injected, I always ſaw the umbilical vein giving off veſſels to the liver, in its paſſage through it towards the *vena portarum*.

C The gall-bladder full of bile, of a more pyriform ſhape than it is for ordinary in an adult.

D The ſtomach diſtended with air.

E The remains of the omentum.

FF The extremities of the divided arch of the colon laid to each ſide.

G The

G The pylorus where the duodenum begins, and the little omentum connects it to the liver. From this to H it is covered by the omentum. Between H and I this gut is lodged in the cellular ſubſtance of the meſocolon, thence to K it is covered by the common root of the meſocolon and meſentery. It runs involved in the meſentery to L, where there is an appearance of a ring; but inſtead of being turned down afterwards, as here repreſented, becauſe of the guts being drawn ſo much down to have a full view of the duodenum, this gut makes the curvature delineated in fig. 9.

M The large pancreas with its duct, which is more hid by the ſtomach in an adult.

N The little pancreas with its duct.

O The meſeraic artery and vein cut as they paſs in the niche between the larger and leſſer pancreas.

P The *ductus communis cholidochus* appearing on the left ſide of the gut, where it is about to join the pancreatic.

Q The right kidney.

R The ſmall guts.

From the deſcription of the duodenum, it muſt appear, 1. That ſince it is involved in the cellular fatty ſubſtance of the omentum, meſocolon, and meſentery, without having the firm external membrane braced upon it as the other guts have, it muſt therefore more eaſily yield to any diſtending force: and having the whole ſubſtances thrown into the ſtomach with the bile and pancreatic juice poured into it, it muſt receive more than any other inteſtine; and then whatever enters it muſt go out with ſome difficulty, becauſe its extremity next to the jejunum is fixed in a courſe almoſt perpendicular upwards. So that, upon the whole, it is no wonder that this inteſtine is frequently found of ſo much larger diameter than the other guts, as to be called *ventriculus ſuccenturiatus* by ſeveral authors.

2. The aſcending courſe of the extremity of this gut, and the influx of the bile and pancreatic liquor into the moſt depending part of it, where the food muſt make the longeſt ſtop, are wiſely contrived, both for the more eaſy influx of theſe liquors, and for a ſufficient quantity of them

being mixed with the food, to perform well the neceſſary offices for which they are deſigned in digeſtion.

3. A pendulous inteſtine here would, in our erect poſture, have drawn the ſtomach out of its due ſituation, and might have twiſted or over-ſtretched the biliary and pancreatic ducts, ſo as to have ſtopped the courſe of the liquors in them; and therefore it is ſo firmly tied down in its whole courſe, that it cannot change its ſituation.

The duodenum of brutes is likewiſe placed in ſuch a manner as to anſwer the ſame uſeful purpoſes; though in many of them this gut would appear to one who does not conſider the different poſtures and way of life of animals, to be ſituated in an oppoſite manner to the human body. To ſhow how general this contrivance is, I ſhall curſorily mention a few examples.

Apes, whoſe poſture is for moſt part erect, or nearly ſo, have theſe parts diſpoſed in nearly the ſame way that man has.

In dogs, cats, cows, ſheep, and moſt other quadrupeds whoſe poſture is horizontal, the pylorus and beginning of the duodenum are firmly connected to the liver; after which a conſiderable piece of gut, with a meſentery, hangs pendulous, and then the gut is faſtened to the loins and back-bone; therefore the pendulous part muſt be loweſt in them. The biliary duct opens into the duodenum where it is tied to the liver. The pancreas is long, and lodged in the meſentery along the pendulous gut, and its duct is near the middle of that gland.

Hens, ducks, geeſe, and other fowls, whoſe poſture of body is neither erect nor horizontal, but oblique, have the beginning of the firſt ſmall gut well ſecured to the liver, from which the gut runs near to the podex, and returns again to near the ſame place where it began at, to be again tied to the liver; all between theſe two connections being pendulous. The pancreas is fixed between theſe pendulous parts, and its ducts open into the part of the gut where it had returned back to the liver, as the biliary ducts alſo do, but with a direction oppoſite to the courſe of the aliment in the gut. After the entry of theſe ducts, the inteſtine runs a good way along the concave part of the liver towards the membranous diaphragm, being fixed to the liver and to the air-membrane which lines

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Plate VI.

Fig. 1.

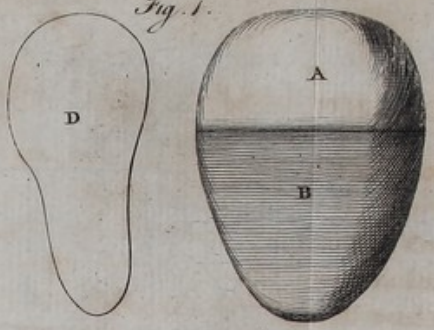

Fig. 2.

Fig. 3.

Fig. 5.

Fig. 4.

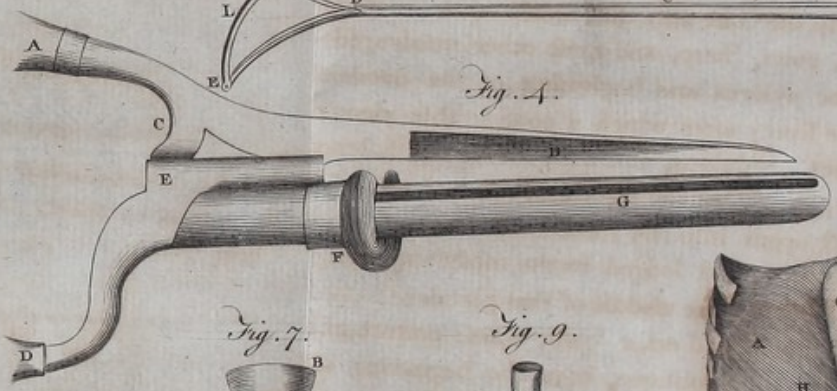

Fig. 8.

Fig. 7.

Fig. 9.

Fig. 6.

the abdomen. At length the gut makes a curve to the right ſide, and takes its courſe towards the podex.

In cod, haddocks, and ſuch fiſh, the cæcula, which are eſteemed analogous to the pancreas of other animals, ſurround the firſt gut, ſoon after it comes from the ſtomach; and then the inteſtine is faſtened to the liver, where the biliary ducts open into it.

I deſignedly here leave the reader to follow out the ſame contrivances in this comparative anatomy as were mentioned in the human.

If then we conſider what quantities of different ſubſtances enter the duodenum, ſome of which have rough hard parts, to rub violently on its ſides; others have ſharp ſaline particles, to prick and corrode; others are irritating rancid oils; others, in their digeſtion, generate great quantities of diſtending air; others, by their moiſture and watery nature, are apt to relax the fibres; others, harden theſe fibres too much: If, I ſay, we conſider this, we need not be ſurpriſed that this gut, the duodenum, ſhould be more ſubject to maladies than any of the reſt; eſpecially as it has not ſuch a firm covering of an external membrane, to aſſiſt it to reſiſt the forces overſtretching its fibres, as the other guts have. And if the gut itſelf ſuffers, how ſoon muſt it diſturb many other functions of the animal œconomy, by the preſſure it may make, when overſtretched, upon ſo many large veſſels, nerves, and other organs, to which it is inſeparably contiguous; or by communicating its afflictions to thoſe parts which ſympathize with it by means of the common origin of their nerves; or by ſtopping the influx of theſe two abſolutely neceſſary liquors, the bile and pancreatic juice?

Any tolerable account of diſeaſes, from ſuch cauſes as I have juſt now mentioned, would lead me far beyond the bounds of any eſſay you could admit of; and therefore I ſhall do no more than, with Santorini (*a*), recommend to practiſers to have ſuch in their view, when they treat patients who labour under diſeaſes of the epigaſtric or hypochondriac regions, that they may not confound thoſe which have their ſeat in this gut with others which require very different treatment. This is the more neceſſary, becauſe authors generally take little or no notice of the duodenum as the ſeat or cauſe of any particular diſeaſe.

(*a*) Obſerv. Anatom. cap. 9. § 7.

N° 40.

Miſcellaneous Remarks on the INTESTINES.

THE preceding account of the duodenum has called to my remembrance ſome remarks that are commonly neglected, which I think may be made on the other chylopoietic viſcera.

The inteſtines are generally deſcribed as being covered all over with an external membranous coat, which is ſaid to be derived from the peritonæum. But it ought to be remarked, that a conſiderable part of the circumference of the human inteſtines is not covered with ſuch a membrane: For the meſentery being formed by the peritonæum produced on each ſide, and including a conſiderable quantity of cellular ſubſtance, in which much fat is frequently contained, together with the numerous *glandulæ vagæ*, the large meſeraic arteries and veins, and the nerves and lacteals, and the fatty cellular ſubſtance being thick till after the membrane of each ſide is continued ſome way upon the gut, all the ſpace there between the membranes, which is always more than the diſtance between the inſertion of the arteries that riſe on each ſide of the gut, that is, a fourth at leaſt of the circumference of the gut, muſt have no ſuch firm membranous coat covering it; and therefore will more eaſily yield to any ſtretching force, which may be of uſe in allowing the guts to be more enlarged than otherwiſe they could be without overſtretching their veſſels.

It is in this ſpace between the inſertion of the blood-veſſels that the longitudinal fibres of the guts can be ſeen moſt diſtinctly and eaſily; becauſe the cellular ſubſtance is ſeparated with little trouble, or collapſes ſo much as not to hinder the view of the muſcular fibres under it; whereas, in the part of the inteſtine oppoſite to the meſentery, the external membranous coat, whoſe fibres are very like to thoſe carnous ones, adheres

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ſo firmly to them, that it cannot eaſily be diſtinguiſhed or ſeparated from them.

I need ſcarce obſerve, that the circular fibres of the guts are often ſo interlaced, that one can ſcarce trace the ſame muſcular fibre round the whole gut.

It is now generally enough known, that all the ſubſtance between the interior ſide of the circular muſcular fibres of the guts and the villous coat, which uſed to be divided into the vaſcular, nervous, and glandular coats, can, by blowing into a piece of gut whoſe interior ſide is turned out, be raiſed into a *tunica cellularis*, with numerous veſſels running every where through it, without any fat in it; where, however, it would appear there is ſome ſecretion performed: for, by injecting water into the arteries, theſe cells are filled with it; and frequently, after making injections of groſſer coloured liquors, I ſee a ſecretion performed, by the cells being here and there diſtended with the white injected ſubſtance, while the colouring powder does not paſs with it, but is left behind. When this ſecreted liquor hardens, it forms a number of ſmall round or oblong tubercles, which I have ſeen ſeveral willing to imagine were Peyer's glands filled with the injection; and this Ruyſch (*a*) ſeemed likewiſe to think. I cannot yet bring myſelf to that opinion, becauſe water diffuſes itſelf ſo equally every where, and the injections which harden do frequently the ſame for a large ſpace: at leaſt, theſe make it evident, that if Peyer's glands are ſometimes injected, there are alſo veſſels which convey liquors into this internal cellular membrane; which may lead us into a more reaſonable account of the very great diſcharges of mucus after an excoriation of the guts, and of the large extended hard tubercles that are frequently ſeen within their muſcular coats, and of ſeveral other phænomena of diſeaſes, than otherwiſe we could give.

In a piece of gut diſtended with air in the manner mentioned for demonſtrating its internal cellular coat, we ſee the villous coat in its membranous form, and without the downy, papillous, and mamillary appearance which an inverted undiſtended inteſtine floating in water has.

Upon obſerving this villous membrane when it is ſtretched, remarking how thin and flexible the cuticula becomes upon the lips, with the continuation

(*a*) Epiſtol. 11. reſponſ. & ſparſim.

nuation of the ſame membrane in the mouth, tongue, fauces, œſophagus, ſtomach, and inteſtinal canal; and upon comparing the properties which the moſt external common covering of the body has, with thoſe of this villous membrane; we muſt be convinced they are very much of the ſame kind, if not the ſame continued ſubſtance. I do not know that all the properties of the cuticle have been conſidered by the authors who deſcribe it, far leſs that a compariſon has been made between it and any of the internal membranes, to ſhow their analogous uſes and advantages; therefore beg to be allowed to conſider them a little in this way.

The cuticula is notourly pervious to liquors going out of the body, and to others coming into it; ſo is the villous coat of the inteſtines; and both of them have other paſſages through them, whereby they allow certain ſubſtances to penetrate to the nerves which they cover. Thus a numbneſs is brought on the ſkin by immerſing any part of the body in ſeveral ſorts of liquors, and pain is raiſed by ſubſtances which do not deſtroy the cuticle; thus ſapid objects affect our tongue, and the different ſenſations ariſe which we frequently feel from the contents of the ſtomach and inteſtines.

The external epidermis, by being expoſed to a variety of different forces acting upon it, is of very different thickneſs and firmneſs in ſeveral parts; but it is naturally formed ſo flexible, as to allow a ſufficient impreſſion of tangible objects on the nerves below it. The internal membrane of the guts is leſs expoſed to a variety of ſuch cauſes, and therefore is more uniform; but can be changed in the ſame manner by like cauſes: And hence frequently we find the interior ſurface of the ſtomach and guts of a callous hardneſs, and almoſt inſenſible; while for ordinary it is very ſenſible, and ſo flexible, that by being connected to ſuch a looſe cellular ſubſtance as already deſcribed, it hangs floating, and aſſumes any ſhape the contractile fibres of theſe cells give it, whether of large rugæ, called *valves*, or of ſmaller papillæ of different forms.

Thin watery ſaline liquors waſh away the cuticula; thick mucaginous ſubſtances protect it againſt them and the bad effects of friction: therefore, wherever the cuticula is expoſed to ſuch injuries, its defence is likewiſe provided. Thus the eye-lids are defended againſt the tears and their mutual colliſion, by the ſebaceous matter ſeparated in their glands;

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the nipples, arm-pits, glands, urethra, perinæum, &c. are all protected in the ſame way. When their defence is wanting, we ſee the troubleſome conſequences, excoriation, pain, inflammation, &c. The internal membrane of the guts, being more expoſed to the action of watery liquors, has a much more plentiful ſupply of the protecting liquors, and is always, in a ſound ſtate, lined over with mucus. Whenever therefore this mucus is carried off too quickly, as in diarrhœæ and dyſenteries, or is not ſecerned in ſufficient quantity, as in inflammations, or other obſtructions of the inteſtinal veſſels, we may eaſily judge what the conſequences muſt be, and are led to ſupply by art what nature then is deprived of.

A certain moderate degree of friction makes little or no change upon the cuticula, nature eaſily ſupplying what is carried off. When it is greater, but gradual, and not ſo violent as to deſtroy its texture, or to ſeparate it from the parts it is connected to, the effect is not a little ſurpriſing; the cuticula becomes thicker, ſtronger, and firmer, as we ſee every day in the ſoles of the feet, and in the hands of labouring people. When ſudden violent friction is applied to the cuticula, either it is rubbed imperceptibly off, or it is ſeparated from the ſkin. This daily experience alſo ſhews every one. The villous coat of the inteſtines is not expoſed to ſuch accidents as the external ſurface of the body, and is better defended by the ſlime from the bad effects of rubbing forces, while the abraſion or ſeparation of this villous coat may well paſs ſo unobſerved, that one cannot give examples to prove circumſtances in it analogous to thoſe mentioned in the cuticula. The moſt ſurpriſing and leaſt to be accounted for phænomenon, to wit, the thickening and hardening of the cuticula by friction, may, however, be alſo ſeen in the inteſtines, when any hard concreted ſubſtance is lodged a conſiderable time in any particular part of the guts; for then the internal ſurface of the inteſtines becomes there thick and hard.

The epidermis ſeems to ſerve for contracting the extremities of the cutaneous veſſels, probably by forming their extremities; for whenever it is ſeparated, theſe veſſels throw out their liquors in much larger quantities than ordinary. I know the writers on this ſubject generally expreſs themſelves in ſuch words as would perſuade their readers they thought the cutaneous liquors were all thrown out of their veſſels between the ſkin

and cuticula, and thence gradually eſcaped through the interſtices of the cuticular ſcales. But if this were the caſe, there would perpetual bliſters be raiſed in the depending parts of the body, if not all over the ſurface of it; and the liquor in bliſters would eſcape through theſe interſtices, which it does not. The ſame effuſion of liquors is made into the inteſtines, upon the ſeparation of the villous coat, in the end of conſumptions, and in other diſeaſes, where the tongue and throat ſhow the excoriated ſtate of the alimentary canal.

When any part of the cuticula is ſeparated from the ſkin, but ſtill is continued with the adherent ſcarf-ſkin, it becomes thicker, eſpecially if ſoaked with liquors. Thus the cuticle of bliſters, and what ſeparates from the edges of wounds and ulcers, is frequently very thick. The ſame thing happens in the alimentary tube, as is evident in aphthæ. And this obſervation only can account for the tubular thick ſubſtances frequently voided at the anus; which have been taken for pieces of the guts, becauſe of their ſhape and firmeſs.

The epidermis is the moſt incorruptible and leaſt ſubject to eroſion of any part of the body. In abſceſſes, the pus has little other effect upon it than to ſeparate it from the ſkin, and to tear it by its weight, but not to diſſolve it. In gangrenes and ſphaceli, it remains uncorrupted, after all that it covers is converted into a putrid maſh; nay, it can allow the common *lapis ſepticus* to penetrate through it, and deſtroy the parts below, without ſuffering a ſolution of union in its own ſubſtance. Poſſibly this may be owing to its having no proper veſſels or liquors. Whatever the reaſon of it is, it is certain the *tunica villoſa* of the inteſtines enjoys the ſame properties; which are of the utmoſt advantage in both, conſidering how many ſubſtances of different natures are applied to them; ſome of which would certainly diſſolve them, if they were capable of diſſolution, and would expoſe us to the inconveniencies of pain, inflammation, effuſion of liquors, &c.

Becauſe theſe membranes of which I have treated, though indiſſolvable, are however ſeparable from the parts they cover, the conſequences of which ſeparation are ſo bad, therefore they are the moſt eaſily and quickly regenerated of any organs in the body that are not of the ſame ſtructure.

Whoever

Whoever calls to remembrance the analogous ſtructure and uſes of the moſt internal coat of all the hollow viſcera, of the arteries, veins, &c. will ſee that I point at concluding all of them of the ſame nature with thoſe I have now inſiſted on.

I never ſaw the *appendix vermiformis*, of any of the human fœtuſes which I have diſſected, diſtended with meconium; and therefore cannot allow it to ſerve as a reſervoir of the fæces during geſtation, which ſeveral authors have imagined; but muſt join with thoſe who aſſign it the uſe of furniſhing mucus to lubricate the internal ſurface of the great ſac of the colon, and to moiſten the fæces in it, that they may more eaſily be puſhed forward out of this part of the gut where there is the greateſt difficulty in their progreſs, and where, by ſtagnating too long, they may bring on troubleſome ſymptoms; witneſs the diſeaſe called *placenta inteſtinalis* in women with child, which I have ſeen more than once in hazard of being miſtaken for ſome other diſeaſe that required a very oppoſite method of cure to what ought to have been uſed. The numerous mucous lacunæ obſervable in the human appendix, and the like ſtructure in the cæca of brutes, are proof enough of the appendix ſerving the uſe mentioned, both in the human fœtus and adults.

It will be ſaid, that the appendix being ſo much proportionally larger in the fœtus than in the adult, ſeems to indicate ſome other uſe it is alſo of to the fœtus. But this proportional leſſer ſize of this little gut in an adult will appear to depend upon the preſſure it ſuffers, and being emptied ſo frequently of its contents; whereas in a fœtus there is no reſpiration to ſqueeze it, and the meconium in the ſac of the colon prevents its being emptied; ſo that the liquor ſeparated by its glands being collected there, ſoftens and relaxes its fibres, and diſtends it.

The neglect of conſidering what the different forces are, which act upon the ſeveral organs of the body, while in a fœtus-ſtate, and after birth, has, in my opinion, contributed to many diſputes, which might eaſily have been put an end to by accounting for the phænomena, which were the ſubject of them, in this way of reaſoning. I ſhall mention one re-

markable difference in the circulation of the blood, and ſome few conſequences from it.

Though the heart and arteries of animals are able, by their action, to keep up a circulation in the larger veſſels, yet, without aſſiſtance from ſome other powers, they cannot propel the liquors with velocity enough, and in ſufficient quantity, through the ſmall veſſels. Theſe aſſiſting powers, after birth, are the alternate preſſure of reſpiration and the actions of the muſcles. We can obſerve at any time how much the circulation is quickened, by increaſing theſe; and, on the contrary, how much all the ſecerning organs are infarcted and ſtretched by their almoſt ſtagnating fluids, whenever one of them, muſcular motion to wit, is little exerciſed. Thus creatures turn fat when they have not exerciſe. Hence a recruit of all the neceſſary liquors in time of ſleep. Hence the ſtrong ſlow pulſe of ſleeping people. Hence the deſire of continuing ſleep, after a perſon has ſlept beyond his ordinary time. Hence the ſmall waſte of ſuch creatures as continue long in a dormant condition without any ſupply of food. Hence a dry parched mouth in the morning, which is ſoon relieved by chewing. Hence a ſtiffneſs and lazineſs after abſtaining from exerciſe too long. And a great many other phænomena, which will occur to any upon the leaſt reflection.

Since then the heart and arteries of fœtuſes have little or no aſſiſtance from any alternate preſſure in propelling their liquors, their ſecerning organs (where, of all the parts of the body, there is the greateſt complication of veſſels, divided into the ſmalleſt ramifications, with the leaſt firmneſs and conſequently reſiſtance in their ſolids) muſt all be infarcted and diſtended, and therefore of a larger proportional ſize than in the adult, as we ſee their brains, liver, pancreas, kidneys, breaſts, *&c.* are. So that the thymus and *glandulæ renales*, about which ſo much inquiry has been made, have ſo far nothing but what is common to other glandular parts.

It probably will be alleged, that the thymus and *glandulæ renales* loſe more of their proportional ſize in the adult than the other organs named. Admitting this generally received fact, though, upon comparing them with the brain and ſome others, I doubt it ought not to be admitted as commonly ſtated; admitting, I ſay, this fact, it will not bring us under any neceſſity of being obliged to ſearch out ſome particular uſe they

ſerve

ſerve in the fœtus: for a view of their circumſtances, as to ſituation and preſſure, will account for all the differences obſervable in them. To underſtand this aright, it may not be amiſs previouſly to conſider one or two cauſes that may influence the growth of animal organs.

1. Then, it will not, I believe, be denied, that the growth of the parts of the body will be greateſt where they are leaſt confined and leaſt expoſed to preſſing forces. The brain is at firſt incloſed in membranes, and is prodigiouſly large in proportion to the other members: as the bones of the ſkull become firm, its proportional ſize diminiſhes; and after they are fully joined, its proportional increaſe is very little. The teſticles, on the contrary, are at firſt confined within the abdomen, and very ſmall; afterwards, when they fall down into the looſe bag the ſcrotum, they increaſe much faſter.

2. The greater the force is with which our fluids are thrown into parts, or the greater the reſiſtance is to the ſecerned or to the returning liquors, whether that reſiſtance is owing to external preſſure, ſmallneſs or unfavourable ſituation of the veſſels, or to the viſcidity of the fluid, *cæteris paribus*, the bulk of a part will be increaſed. A hand ſwells, upon preſſing the veins of the arm. A tumour in the urethra, near the *caput galinaginis*, occaſions a ſwelling of the teſticles.

To apply theſe principles to the thymus and *glandulæ renales*, we need only call to our remembrance the ſituation of the one, in the double mediaſtinum, between the heart with its large veſſels, and the ſternum, with the lungs on each ſide. The other lies on the muſcular appendix of the diaphragm, covered before by the chylopoietic organs. Neither of them have any excretory canal, except the lymphatic veſſels be eſteemed ſuch. The veins of both have a ſhort courſe, and that of the *glandulæ renales* is remarkably large.

The greater preſſure which the thymus ſuffers after birth, from the increaſed action of the heart and of the lungs, is altogether evident. The immediate play of the diaphragm upon the other ſhows as evidently that there are ſcarce any glandular parts in the body, the change upon which as to preſſure is greater after birth, compared to what it was before, than in theſe two; and therefore, by our firſt propoſition, they ſhould ſuffer in their growth upon this account. But to this is to be added the thinneſs of the

fluids

fluids ſent from them, and their ſhort courſe in large veſſels, which are almoſt peculiar to them; by which their veſſels muſt be leſs diſtended, and conſequently their increaſe leſs, by propoſition 2.

Having endeavoured thus to account for the leſſer proportional ſize of theſe organs in the adult, I would join in opinion with thoſe gentlemen who aſſign them the office of lymphatic glands, both before and after birth, ſerving to dilute the chyle and thick blood, that is ſoon after to be returned to the heart.

HAVING thus exerciſed the common privilege miſcellany writers aſſume to themſelves, of digreſſing at pleaſure, I chooſe to conclude with a ſubject ſomething nearer to what I began with.

At the part of the meſocolon, which connects the ſigmoid flexure of the colon near the left cavity of the ilia, where in moſt adult bodies there is an infundibuliform *cul de ſac*, or thimble-like cavity, I could never obſerve in children more than one part of the meſocolon laid over the other, becauſe of the great flexure of this gut at this place: and therefore I conclude the cavity to be accidentally formed by the growing together of the contiguous parts of the meſocolon; and that it is as needleſs to aſſign uſes to it, as it would be to ſhow how uſeful the concretion of the lungs and pleura is, which ſeldom miſſes to be obſerved greater or leſs in adult bodies.

N° 41.

A TYMPANY*.

THE keeping of the regiſter of patients, their diſeaſes, &c. having fallen to my ſhare in the management of the Infirmary or hoſpital for ſick poor lately erected here, neceſſarily obliges me to peruſe with care the journal of all the caſes treated in the hoſpital, and recorded by the phyſicians and ſurgeons; among which there are ſeveral (notwithſtanding the ſmall number of ſick which the fund of the Infirmary is yet able to maintain) that would not be unworthy of a place in your collection of medical obſervations. I affirm this with more aſſurance than can generally be done in behalf of hoſpital-caſes, becauſe the journal does not ſimply contain the name of the patient and diſeaſe, the receipts of medicines preſcribed, and the time of the cure or death; but the preceding hiſtory of the patient and diſeaſe, with the particular complaints and ſymptoms, are recorded at their admiſſion; and every day after, all the changes happening to the ſick, with the evident effects of the medicines, are inſerted; at the ſame time the phyſicians are not confined, in ordering the diet of their patients, to the common fare of the houſe, but are allowed by the managers to cauſe whatever food or drink they think moſt fit to be given, and ſuch of the managers who are viſitors in their turns take care that theſe orders are executed.

Having permiſſion from the managers, I have made an extract from the journal of the following caſe, only changing the form of a diary, and abridging what I imagine your deſign does not require, but was neceſſary in ſuch a record. If this ſpecimen of hoſpital practice is acceptable to you, your yearly volume may always be ſupplied with ſome caſes from the ſame collection.

MARGARET DOG, aged 22 years, was ſeized with a tertian ague in January

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nuary 1729; and being then ſervant in a public-houſe, had no care taken of her, but was allowed to follow every idle preſcription that was offered by any of her acquaintances. Among a great variety of very uncommon medicines, ſhe was perſuaded to drink great quantities of brandy and powdered pepper in warm ale; which changed the intermitting fever into a moſt violent continued one, in which ſhe was delirious ſeveral days: and as this went off, the ague returned; but with two, three, four, and ſometimes five paroxyſms in a day, which ſhe often attempted to put away with all the vulgar ſpecifics brought her. The diſeaſe, however, continued obſtinately till Auguſt, when ſome doſes of the bark were given her: after which ſhe was attacked with ſharp pains in her loins and belly, beginningly commonly about the right *os ilium*, and riſing upwards to croſs over by the ſtomach to the left ſide, attended with gripes, borborygmi, and ſwelling of the whole belly; and for ſome weeks one of her legs trembled, became hot, and ſweated at the ſame hour each day, while nothing like ague was felt through the reſt of her body. The pains continuing, her belly became ſtill more diſtended, and ſometimes was ſtretched in a very ſhort time to a great bigneſs; and then gradually ſubſided without evacuations of any kind, but always remained more ſwelled than ordinary. When winter came ſhe mended, and was for ſome time almoſt free of her uneaſy ſymptoms: but in the beginning of the ſpring, her pains and ſwelling returned; and after ſuffering them ſeveral weeks, ſhe repreſented her caſe to the phyſician and ſurgeon then in attendance at the Infirmary, and was received as a patient there on the 24th March 1730.

Her ſymptoms at this time were, a more than ordinary conſtant ſwelling of her belly; but ſometimes increaſing ſo monſtrouſly, that the ſkin ſeemed to be in great hazard of being torn; and her breathing was much ſtraitened: The ſwelling gradually decreaſed without any evacuation; The returns and degree of this ſwelling were very uncertain; and when the belly was moſt detumified, one could feel ſeveral unequal protuberant balls every where, but eſpecially at the ſides of the abdomen. Her ſtomach was good; ſhe had no thirſt; and her urine was in ſufficient quantity in proportion to her drink. She was very coſtive; her menſes

had

had returned at irregular periods for ſome preceding months. There was no œdematous ſwellings in her legs, nor complaints of any parts elſe.

At her firſt admiſſion, ſhe took ſeveral doſes of purgatives; which operated ſufficiently, but brought little or no wind along with the fæces, and altered the ſtate of her belly very little. On account of her being irregular in her menſtrua, and a ſuſpicion of pituita in the *primæ viæ*, ſhe was next ordered ſome doſes of calomel, which produced very little change; and during two months thereafter, ſhe was conſtantly taking large doſes of the antihyſteric medicines, either by themſelves, or mixed with purgatives. The antihyſteric plaſter was kept always applied to her whole belly, and once or twice the ſemicupium was uſed, but without any appearance of the diſeaſe being cured, or certainty of the remiſſions ſhe now and then had being owing to any particular medicine; for though the ſwelling did not increaſe for two or three, nay, nine days following, more than once; yet the hardneſs and tumours of her belly did not entirely remove, her coſtiveneſs always remained, ſhe had no paſſage of wind any way, and the medicine that at one time ſeemed to relieve her was of no effect in the next return. From the time of her admiſſion ſhe had her menſes only twice, viz. May 17th and June 21ſt.

During this period, there are ſome facts remarked in the journal which ſeem worth obſerving. 1. Several times, upon the ſwelling's falling, ſhe complained of a headach, once upon the detumefaction complained of pains through all her body, once of a giddineſs, twice had a nauſea and vomiting, and in the laſt threw up green bile; and once her ſtomach ſwelled greatly, when the reſt of the abdomen ſubſided. 2. During the flowing of the menſes, ſhe did not ſwell, but became very big upon their ſtopping. 3. Blooding and emetics, which were made uſe of for ſome accidental urgent ſymptoms, had no very ſenſible effects in making the principal diſeaſe either better or worſe. 4. She never had paſſage of wind any way, except a little belching ſome days before the firſt monthly evacuation.

Some time before the laſt eruption of the menſes, the purgatives were given more ſparingly, and the doſes of the antihyſterics of the ſtrongeſt kind, ſuch as *aſafœtid. ol. C. C.* &c. mixed with ſoap, were enlarged and given more frequently, and accompanied with the hotter antiſcorbutics,

as they are commonly called, *e. g. Rad. raphan. ruſtic. recent. zinziber*, &c. infuſed in ſtrong-ale with ſteel. The patient was ordered to uſe frequent and ſtrong frictions to all the trunk of her body and extremities, and to exerciſe moderately. Immediately before the menſtrua began to flow, clyſters of the ſame kind of medicines were injected. The courſes were in ſufficient quantity; but as ſoon as they ceaſed, her belly increaſed in its circumference four inches and a half, but ſoon ſubſided; and then ſhe complained of pains, which a gentle ſweat carried off. Borborygmi were for the firſt time obſerved, on the ſame day, June 25th; and having taken ſome *tinctura ſacra* at night, ſhe paſſed ſome blood next day by ſtool. This again was the firſt appearance made by the hæmorrhoids, which ſhe had been formerly ſubject to.

The two following days her ſaponaceous antihyſteric and antiſcorbutic medicines being ſtill continued, ſhe had ſuch exploſions of wind ανω και κατω, that none of the other patients would remain in the ſame room, nay ſcarce on the ſame floor with her. Her belly became leſs and ſofter than it had been from the firſt attack of the diſeaſe; her medicines, (with a doſe of *ſyrup. de rhamno* at proper intervals, ſtill were continued, only the proportion of ſteel was increaſed; her flatulent diſcharge went ſucceſsfully on; and though for ſome time the ſwellings returned, ſhe was ſtrong enough to do the work of another ſervant of the Infirmary who had fallen ſick; and having continued a conſiderable time in that ſtation of ſervant to the hoſpital, ſhe ſtill uſed her medicines, till there had been no relapſe for ſeveral months; ſince which ſhe has been in very good health, notwithſtanding her having gone from the Infirmary into ſervice, where ſhe wrought hard, fed indifferently, and commonly walked bare-footed.

N° 42.

HISTORIES of ſucceſsful INDULGENCE of bad HABITS in PATIENTS.

THE old axiom in phyſic, That ſudden great changes are dangerous, has been diſputed by ſome moderns, who adviſe to give over immediately bad habits. I have ſeen numerous examples where it was neceſſary to have regard to them, and even to indulge patients in them, if we expect to make a cure. At preſent I ſhall mention only three.

I. A cook, in an eating-houſe, quarrelling with a ſervant-maid, ſhe ſtruck him with a large knife, and cut through a great ſhare of the right pinna and ſeptum of the noſtrils, ſo that it hanged down towards his lip. He had bled a long time, and was very faint by loſs of blood before his noſe was ſtitched. His wife was allowed to give him ſome white-wine among the water-gruel he was ordered for drink, or to make ſome ſack-whey for him. He, however, continued very low and faint, with ſickneſs at his ſtomach, and headach, for three days; till his wife told me his ordinary way of living was to drink a good deal of ale, wine, and brandy, every day; and unleſs I would allow her to give him more and ſtronger liquor, ſhe did not expect he would recover. I did not forbid her; which ſhe interpreted an allowance, and gave a gill or four ounces of brandy with ſome of our ordinary ale. He was much better next day; and with this doſe every day, recovered daily till he was quite well.

II. A man having broke the bones of his leg, after the fracture was reduced, I ordered him to have no drink given him, except water and milk, water-gruel, or ſuch like. He did not ſleep well in the night. Next morning I found his pulſe very quick, but low, and with complaints of pain in his head, thirſt, &c. Imagining ſome drunken companions I ſaw

come to viſit him had given him ſome ſtrong liquors, I ordered him to be more ſtrictly watched by ſuch who I was ſure would obey me; and he was kept to the low diet rigorouſly. He did not, however, ſeem relieved at night; ſlept none all night; and next morning he was altogether delirious, got out of bed, kicked away the box in which his leg had been put, his tendons were ſtarting, and he ſcarce knew any perſon; his pulſe at the ſame time intermitting, and being very low. One then preſent, whom I knew to be a very complete drunkard of the low claſs, aſſured me I would kill him if I did not allow him ale and brandy; for that the patient had for ſeveral years outdone him in irregular living. I conſented to allow a little. That night he was much better, and next morning was altogether free of fever, delirium, &c. when they acknowledged he had got a Scots quart of ale and a gill of brandy the preceding day, which had made him ſleep well and ſound. This daily allowance of ale and brandy, then, he had all the time of his cure; which went afterwards on without the leaſt accident.

III. A diſtiller of ſpirit of wine at the Weſt-port, ſitting upon the edge of a tub into which the boiling remains of a ſtillful of wine had been put, ſlid back into it; by which his hips, thighs, ſcrotum, penis, and belly, were miſerably burnt, the ſkin of theſe whole parts turning quickly black and hard. I endeavoured to promote a ſuppuration by ſcarification, ſuppurating ointments, and poultices; and as his pulſe was quick, ordered him to be blooded, and kept on a low diet. Next day he was much diſpirited, with great anxiety, and a low quick pulſe. The third day he was near as bad as what I mentioned the former patients to have been, when his wife inſiſted to be allowed to give him of the ſpirits he diſtilled; which he got, and ſoon became better, the ſuppuration coming on the teguments, which cured very well; his wife, near the end of the cure, acknowledging ſhe had given a mutchkin or pound of ſpirits every day.

N° 43.

UNEXPECTED CURES.

IF practiſers in phyſic and ſurgery have ſometimes uneaſy minds on account of patients the nature of whoſe diſeaſes they cannot judge with certainty, if they are diſappointed now and then in the effects of medicines, and if they have the galling mortification of the ſick dying unexpectedly; they have, on the contrary, frequently the comfort and pleaſure of being ſurpriſed with the great relief which their patients, in very obſcure, or even in diſeaſes which they are ignorant of, receive from medicines, which either a very diſtant analogy to ſome known diſeaſe, or the neceſſity of mitigating ſome urgent ſymptom, have made them preſcribe; nay, the event ſometimes is proſperous when the medicines are differently applied, or have other effects than the preſcriber intended. Though people ſhould be very cautious in laying down any general rule in practice, and ought not to found it on one or two obſervations; yet I muſt think ſuch unexpected cures as I have hinted at, deſerve to ſtand on record, that, if the medicines employed are not of a very offenſive nature, they may again be tried in ſimilar caſes; ſo that ſick people may have ſome more chance for their recovery than the common methods give. The following may ſerve as a ſpecimen of ſuch caſes, of which many more might be given; and it is not doubted but that every practitioner can add to the number.

I. A middle-aged healthy man having bruiſed the extremity of the penis, the part of the prepuce where the frenum of the glans is was raiſed into a large cryſtalline tumour. Topical aromatic fomentations and ſuffumigia being applied to it, and cathartics being given, without its yielding, a ſmall ſeton was put through it, with the view of allowing ſome of the watery liquor to ooze out, and of bringing on a gentle ſuppuration. Inſtead of this, it occaſioned ſharp pain, and a violent inflammation;

which

which made it neceſſary to take out the cord, and to apply an emollient poultice of bread and milk. Next day after this, the tumour was greatly diminiſhed; and the ſecond day it diſappeared, without a return.

II. A young man had a great many pale-red excreſcences, of a very unequal ſurface, with ſmall necks, on the interior ſide of the prepuce; and when the prepuce was turned back, coxcomb excreſcences were likewiſe ſeen on as much of the glans as he could uncover. The account which he gave of his diſeaſe to Dr James Dundas and me, was, That, having a ſmall wart on the edge of the prepuce, he cut it away with a razor; ſoon after which theſe excreſcences began to appear. Mercurial ointments, aſtringents, eſcharotics, and ſeveral other medicines, had been tried in vain, and he had undergone ſix weeks ſalivation without any benefit; though he averred ſolemnly, that he was ſure they were not owing to any venereal cauſe.

I tied a ſilk thread very tight round the neck of one of them: he complained of ſharp pain while the nooſe was drawing, which ſoon ceaſed; and in two days the tumour dropt off, leaving the ſurface of the part it roſe from ſmooth and ſound. I deſired a young ſurgeon, who had ſeen me make this ligature, to take the other excreſcences away in the ſame way. When this young gentleman attempted next day to put a ligature on one of theſe excreſcences, he was timorous, and the patient was not obſequious; ſo that the ligature was not made tight enough to mortify the tumour. The patient felt very ſharp pain all that day; and by next morning a very conſiderable inflammation was raiſed; for which he was blooded plentifully, and emollient fomentations and poultices were applied to the part. After two days the inflammation abated, and the excreſcences were all conſiderably diminiſhed; and, as the inflammation went off, they ſhrivelled: So that, after eight days, during which the emollients were continued, it could not be known where the excreſcences had been.

Whether was it the inflammation, or the emollient applications, which made the cure in theſe two caſes? In my opinion, it was the inflammation; and I am confirmed in it by the ſucceſs which I have ſeen of ſtimulating medicines in ſlow cold ſwellings.

III. A man who had been ſubject to the gout, was by accident burnt ſuperficially

ſuperficially in the face and hands. After the burnings were all ſkinned, a ſpongy excreſcence, the baſe of which was equal to a ſixpence, roſe out from the point of his noſe; and ſuch another, as broad as a ſhilling at its baſe, roſe out from the right cheek. They were both of a pale-red colour, and of a granulated ſurface, throwing out from imperceptible pores a thin liquor, which fell down in drops ſo faſt, that a conſiderable quantity of it could have been collected in a ſhort time. After different plaſters, ointments, aſtringents, &c. had been tried to no purpoſe, I covered the excreſcences with the fine cotton of old linen, ſcraped with a knife, and wet with alcohol. I deſired the cotton might not be taken off, but that it ſhould be wet three or four times a-day with the ſpirit. After this application, the oozing of liquor decreaſed, and in two days ceaſed altogether. The cotton adhering to the excreſcences, they ſhrivelled, and at laſt became ſmooth and plain with the other parts of the ſkin, leaving only a little redneſs for ſome time.

IV. A young man of a weak conſtitution and thin habit, having fallen from a height, was bruiſed in a great many parts of his body, and particularly in the hypogaſtric region. He complained ſoon after of a ſharp pain in the penis and region of the bladder. Thoſe he adviſed with, ſuſpecting theſe pains might be cauſed by ſome remains of a virulent gonorhœa which he had two years before, injected ſome acrid medicines into the urethra; which increaſed the pain, and occaſioned a conſiderable inflammation in the penis. When the inflammation was removed, he had great difficulty in making water, with ſharp pain along the whole urethra when it did paſs. He then took ſeveral doſes of ſweet mercury, drank the decoction of the woods, and continued ſome time the uſe of gummous pills with ſome grains of mercury in them. The ſymptoms becoming, however, worſe, I was conſulted about him four months after his fall.

He complained of a torturing pain at the root of the penis, and in the glans, when he attempted to make urine, which let fall a white furfuraceous thick ſediment in great quantity when it cooled. I adviſed mild mucaginous medicines, and an emollient healing injection, with fomentations to the pained part. Theſe made him a little eaſier, but did not remove his diſeaſe; and he was ſeized with feveriſh paroxyſms, which had

had the full type of ague, but without regular returns. Theſe waſted his ſtrength and fleſh ſo faſt, that there was a neceſſity to ſtop them; with a view to which, and to his original diſeaſe, the following electuary was ordered: R. *Pulv. patrum, drach.* ii. *Gum. Arabic. drach.* i. *ſem. Sal. nitr. drach.* i. *Pulv. milleped. unc. ſem. Sal Jov. Londin. ſcrup.* i. *Syrup. diacod. q. ſ.* Of this he took the bulk of a nutmeg twice a-day. The aguiſh paroxyſms went off gradually, and the other ſymptoms became milder, till he was free of all his complaints in ſome weeks; and he has continued free of them ever ſince.

V. Alexander Strachan, gardener to Mr Erſkine of Grange, had a colic, which continued a day in the beginning of February 1734; after which a painful tumour was obſerved towards the left ſide of the epigaſtric region, which ſoon increaſed, and extended itſelf over that whole region. He took ſome purgative medicine, after which he had a conſtant diarrhœa.

When he was received into the Infirmary 6th March 1734, a ſuppuration ſeemed to be ſo far advanced in the tumour, that the ſurgeons felt a fluctuation of liquor lodged deep, and the left part of the tumour pointed outwards. He complained of a ſharp pain in the left ſhoulder; and the ſkin of his face had that leadiſh colour which is almoſt peculiar to people whoſe livers are ſuppurated. His pulſe was quick and low. He had no deſire for food; and, upon taking it, the pain of the epigaſtrium was much increaſed. He had perpetual thirſt, ſlept ill in the night, and ſweated much in the morning, with a diarrhœa ſtill upon him.

To promote the ſuppuration, a poultice of oat-meal boiled in water, with ſome baſilicon and bruiſed raw onions, was applied to the epigaſtrium, and renewed thrice a-day. Some drops of laudanum were given at night, to ſtop the diarrhœa and to procure reſt. Mild food and drink were ordered.

The ſuppuration ſeemed to advance outwards for four days; the doſe of the laudanum being gradually increaſed to check the diarrhœa, which frequently returned, but without any pus in his ſtools.

On the fifth day, the tumour was evidently diminiſhed, ſofter, and leſs painful; but he was faint, for which he had ſack-whey allowed him to drink ſometimes.

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His poultice and laudanum were continued, the tumour gradually diminiſhed, and his hectic ſymptoms went off, without any obſervable evacuation of pus; ſo that, April 26. he was diſmiſſed heal and ſtrong.

VI. A child eight months old was ſuddenly ſeized with violent epileptic fits; after having had ſeveral, was let five ounces of blood at the jugular vein; and ſoon after, being put into a cradle, covered over with a cloth, loſt a conſiderably larger quantity of blood, the cloaths about her being all wet, and the child in a faint and very pale. She continued weak and pale ſeveral days; but never has had any return of the epilepſy, though ſhe has ſince that time undergone all the common eruptive diſeaſes.

VII. A woman in the decline of life, and of a broken conſtitution, had been ſeveral weeks in a rheumatic fever; out of which ſhe narrowly eſcaped, after repeated blood-lettings and other medicines. Two years after, ſhe was ſeized with the ſame ſymptoms which had appeared in the beginning of the former fever, to wit, anxiety, thirſt, vomiting, pains of the whole body, and particularly of the head, with a high quick pulſe. She was taken ill in the morning, and in the evening fourteen ounces of blood were let at the vein of the arm; which gave her little or no relief. In the night-time, the blood burſt out again at the orifice of the opened vein, and, beſides wetting all the bed-cloaths, was lying in clots at her ſide before it was taken notice of. A clean bandage being then applied, ſhe fell aſleep, and waked next morning free of all complaints.

VIII. In January 1739, a ſharp pain ſtruck into my right eye, then gradually ſeized all that ſide of the face, contracted the eye-lids, made the tears ruſh out, and affected all the teeth of the upper jaw. It began between ten and eleven o'clock in the morning, increaſed till about four in the afternoon, decreaſed till ſix, and then went off, without a critical evacuation of any kind, ſo far as I could obſerve. In the paroxyſm, my pulſe had no diſorder in it; and in the intervals, I was as well as ever. The inconveniency of confinement at that ſeaſon of the year, and the hope of each fit being the laſt, made me ſuffer theſe periodical pains ten days, without trying to remove them by any medicine.

The pain increaſing daily, and making me at laſt unable to do my work, I let ten ounces of blood, and took a vomit a little time before I

expected the paroxyſm would begin. The vomit operated ſeverely, but did not prevent the return of the pain; which continued till the medicine began to go downwards, when I was relieved: And having purged twenty times before night, I had no more return of the diſeaſe.

Since that time, I have cured ſeveral of this diſeaſe, by giving them a vomit, and a briſk purgative, ſoon after this operation was over, if there was no appearance of the emetic's acting alſo as a purgative.

IX. A man brought a quartan ague and the French pox from England. The ague was in vain attempted to be cured by the common remedies; and, in the mean time, the pox advanced, the nocturnal pains increaſed, and the foul ulcers in his throat ſpread. His phyſician (from whom I have this account) gave him five grains of ſweet mercury at night, immediately after the fit of the ague was over; repeated the doſe next morning and evening, and the morning of the following day. After taking theſe four doſes of mercury, he had a fit of the ague, which was more ſevere than any he had formerly undergone; the fever being higher, with delirium, but without any other bad ſymptom. After the fit was over, the mercury was repeated as formerly till the ſalivation roſe. He never had more appearance of the ague; and the venereal ſymptoms diſappeared by the uſe of the mercury.

I was willing to borrow this caſe, becauſe, ſo far as it relates to the ague, it was an unexpected uncommon cure of a diſeaſe little known in this country; the quartan agues not having been ſeen here, except produced in other countries, until within the laſt ten years; in which they have been obſerved in ſome parts of the country, but have not been general.

N° 44.

Of the Effects of the Peruvian Bark in Gangrenes, Ulcers, and Small-pox *.

THAT no man ought to be tempted, by any view of private reputation or gain, to conceal what can be for the general benefit of mankind, is a principle which I know the gentlemen of your ſociety maintain, and their practice is conformable to it. Letters which I have received from ſeveral gentlemen at a diſtance from this, informing me that I have got an infallible ſecret for the ſmall-pox, and begging I would ſend them ſome of the medicine, whatever price it is, make me afraid of having a character you juſtly think ſo condemnable. Relating what I know on the ſubject in public lectures and private converſation, is not ſufficient, it ſeems, to keep away this imputation from me; I am therefore obliged to apply to you to publiſh the obſervations I have made on the uſe of the Peruvian bark in the ſmall-pox, which is the only medicine I have employed in this diſeaſe that is not commonly preſcribed.

After the good effects of the bark in gangrenes were known, I had occaſion to uſe it ſeveral times in that diſeaſe with ſucceſs; and ſometimes, by neceſſity or choice, gave it in an injection by the anus, rather than by the mouth, as I had likewiſe formerly done in agues. The quantities given in clyſters were larger, but the effects were the ſame. One cure of a gangrene made, I think, by the bark in clyſters, ſeems to me ſo remarkable, that I muſt give you the hiſtory of it.

A young gentleman, very healthy in appearance, had ſtrained his left hand, but had no uneaſineſs in it for ten or twelve days; at the end of which he was ſuddenly ſeized with a very ſharp pain near the *os piſiforme* of the wriſt, and ſoon after the teguments on the anterior part of the me-

* Edin. Med. Eſſays, Vol. V. Art. x.

tacarpal bone of the little finger ſwelled: He neglected to aſk advice for two days; then ſome ſtudent who ſaw it, obſerving a mortification begun, ſcarified the ſkin, fomented the part, and applied ſome digeſting ointment with oil of turpentine; which dreſſings were continued alſo the third day.

On the fourth day, when I ſaw him firſt, the teguments covering the ſhort muſcles of the little finger were all mortified; his pulſe was ſo low that with difficulty I could feel it, and it was ſo quick that I could not number the beats of it. He had a general tremor over all his body, and the *ſubſultus tendinum* was very frequent; he had a conſtant anxiety, reſtleſſneſs, and delirium; his tongue was parched and dry; and whatever food or drink he ſwallowed, was vomited almoſt before it got down to his ſtomach. The gangrened parts were again ſcarified and fomented, their edges were dreſſed with warm *ung. baſilicon*, to which a ſmall proportion of oil of turpentine was added, and a poultice of *theriaca Andromach.* was put over all. Soon after, his great guts were emptied by a laxative clyſter; and as ſoon as the operation of this was done, five ounces of warm milk and a drachm of the powder of Peruvian bark were injected, which he retained. Four hours after, the milk and bark were repeated, and two ſuch more injections were given in the night-time.

Next morning he had no raving, tremor, ſubſultus, or vomiting, and his pulſe was ſtronger and ſlower. The hand was dreſſed as the preceding day, and the injection with the bark was repeated. In the afternoon it was changed, upon the patient's deſire, for a bolus of half a drachm of the bark, which was repeated every four or five hours. The fever ceaſed; the gangrened parts began to ſeparate next day; and the bark being continued ſeveral days, the cure went on without any further accident, except that he was put to a good deal of pain one day by an application of ill-prepared *aqua phagedænica*. This I mention, to have an opportunity of warning the younger ſurgeons not to make uſe of that medicine, unleſs when the lime-water is ſtrong enough to make the ſolution of the corroſive ſublimate mercury to turn turbid, and to precipitate in form of a very fine red powder; for, if the lime-water be effete, and remain clear after the ſublimate is mixed with it, inſtead of a very mild medicine, they are to expect all the effects of unaltered corroſive mercury.

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In all the gangrenes where the bark was given with ſucceſs, I obſerved that it brought on a mild ſuppuration; which I ſaw become worſe when the uſe of the bark was interrupted, and then turned of a good kind when the bark was again given. This made me join in opinion with others, that it would alſo be of good ſervice in ſeveral ſores where the ſuppuration was faulty: Experience proved we judged right; ſo that the bark became a common and a beneficial medicine in this town for all ſores.

This effect of the bark, in procuring a kindly mild ſuppuration, led me to imagine it might be ſerviceable in the ſmall-pox of a bad kind, where either a right ſuppuration did not come into the puſtules, or petechiæ ſhewed a diſpoſition to a gangrene; and I had the pleaſure to ſee the effects I expected from it in ſeveral variolous patients to whom I gave the bark: The empty veſicles filled with matter, watery ſanies changed into thick white pus; petechiæ became gradually more pale-coloured, and at laſt diſappeared; and the blackening of the pox began ſooner than was expected. I no ſooner had the good effects of the bark in the ſmall-pox aſcertained by trials, than I ſpoke of it to other gentlemen in practice here; ſome of whom had reaſoned in the ſame way I had done, and had been giving it to their patients with ſucceſs; ſince which I have had thanks from ſome of my friends in the country to whom I recommended this practice.

I gave at firſt the decoction, and then the extract, of the bark: afterwards I forſook theſe weaker preparations for the fine powder, which was mixed with ſome mild rich ſyrup, and an aromatic diſtilled water; both which may be varied as the patient prefers one ſort of taſte to another. In this form, from ten to forty grains were ordered to be ſwallowed every four or five hours.

But as ſeveral children could not be prevailed on to take it by the mouth in any form I could contrive, and, through fear of having this medicine given, would taſte neither food nor drink, there was a neceſſity of uſing the other form of clyſters. Previous to giving the bark this way, the great guts were unloaded by a laxative injection; and then from half a drachm to two drachms of the jeſuits powder was injected, with a ſmall quantity of warm milk; to which ſome diaſcordium, or ſyrup of poppies,

was

was added, if the clyſters were retained too ſhort time. Theſe injections were repeated morning and evening, or oftener.

I have hitherto only given the bark in the ſmall-pox after the eruption, and continued it till the blackening was completed; but am perſuaded, from the effects I ſaw of it in mitigating the ſecondary fever, that, if it is given during the eruptive fever, it might be of uſe in determining the ſmall-pox to be of a favourable kind.

I hope what I have ſaid will not be underſtood as if I recommended the bark as an infallible univerſal remedy in thoſe diſeaſes, and the only one that needs to be employed in them. So far from meaning any ſuch thing, I have ſeen it fail more than once in both gangrenes and ſmall-pox; and, in general, I know no medicine which is not capable of doing hurt to patients under ſome particular circumſtances of the very diſeaſe for which it is given with the moſt ſucceſs. Thus in the ſmall-pox, when the lungs are violently infarcted, I would not conſent to give the bark: I have ſeen patients in this condition almoſt ſuffocated after a ſmall doſe of it.——They would alſo, in my opinion, do very ill who would truſt entirely to the bark, neglecting the other medicines which have been uſed to advantage in the different circumſtances of this diſeaſe. The bark would not ſurely moderate a very high, full, hard pulſe, with high breathing and inflamed brain, in either eruptive or ſecondary fever of the ſmall-pox, as blood-letting would do: The bark could not clear the ſtomach and bronchiæ of viſcid phlegm, as an emetic would: It would not, ſingle, calm the general ſpaſm, or relax the ſkin to make way for the eruption, as when aſſiſted by a tepid bath: Nor would it raiſe a ſinking pulſe, or diſcharge a load of viſcid humours, as the ſtimulus of a bliſter, and the ſuppuration after it, will frequently do. In ſhort, I pretend to recommend it no further than as an excellent aſſiſtant to nature, in what the ancients called the concoction and maturation of the morbid matter; the effects of which appear in moderating the fever, and bringing a kindly mild ſuppuration, which are indeed grand articles in the cure of gangrenes, ulcers, and ſmall-pox.

N° 45.

Anomalous Appearances of an AGUE*.

BY your allowing the caſe I formerly extracted from the records of the Infirmary here a place in your firſt volume of Medical Tracts †, I have reaſon to think other examples of hoſpital-practice, if tolerably well choſen, will not be diſagreeable to you. I have picked out the following hiſtory, becauſe of its being ſo near of kin to the one I ſent you laſt year; both being the effects of an ill-managed ague, with ſome anomalous appearances common to them; but at laſt the ſymptoms come out very different; and the manner of their being carried off is ſingular in each, and uncommon in both.

ISABEL DURIE, of a low labouring ſtation of life, was always irregular in her menſtrual evacuations, being ſometimes obſtructed for a whole year together; and was frequently attacked with a vomiting of blood, for which ſhe had uſed a great variety of medicines; but never was relieved till 1727, which was the 37th year of her age, when ſhe took ſome purgatives, and had the bloody vomitings only twice ever ſince. In November 1728, after a regular courſe of the menſes, ſhe was ſeized with a quotidian ague, which continued all the winter, and waſted her fleſh and ſtrength greatly. Towards the ſpring the paroxyſms became very irregular, both in their time and type; ſhe had a conſtant nauſea and want of appetite, with pains through all her body. From the firſt attack of the ague her menſtrua ceaſed to flow; nor had ſhe any appearance of them ever ſince that time.

In the ſummer of 1729, ſhe uſed many common cures for her ague, ſuch as vinegar, the roots of the *bellis minor*, *cortex Peruvian.* &c. with which ſhe put it off for ſome little time, but always ſoon had irregular returns.

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* Originally inſerted in the Edin. Med. Eſſays, being Art. xix. of Vol. II.

† Ibid. Vol. I. Art. xxxi. or N° 41. of the preſent Collection.

In March 1730, inſtead of ſuffering the common cold and hot fits, ſhe was ſeized with a violent trembling, or rather ſhaking, of her arms, or of her head, or of her legs, or of all together; which obſerved no certain period of time, either in their continuing or intermiſſion, but attacked her three or four times one day, then took the form of quotidian, and afterwards intermitted ſeveral days, and ſoon again appeared in ſome of its former ſhapes.

On account of theſe anomalous ſhakings and flying pains in her head, neck, breaſt, and belly, ſhe was admitted into the Infirmary on the 15th of Auguſt 1730. Her pulſe was then little altered from the ordinary healthy ſtate, even in the time of the tremblings; which, however, were ſo violent, that a ſtrong man could not hold one of her hands from ſhaking. Her appetite and digeſtion ſeemed to be good; her belly did its office ſufficiently: her urine was in large enough quantity, and of a good colour, without any lateritious ſediment. There were no preturnatural ſwellings to be obſerved any where in the patient's body.

When ſhe was firſt taken in, her diſeaſe ſeemed to yield conſiderably, and at laſt to be almoſt cured, by the uſe of muſtard-vomits (*a*) repeated every three or four days, and by taking two drachms of *crude ſal ammoniac* every morning. But in the beginning of September, the pain of her ſtomach returned, and the irregular ſhakings ſoon ſucceeded, and did not yield to the former medicines. She was therefore ordered frequent and large doſes of the ſtinking gums, galbanum and aſafœtida, with *ſal. C. C.* and an aloetic purgative was now and then given her. Theſe at firſt relieved her; but ſoon loſt their effect, all the ſymptoms returning with their former violence. Her vomits and ſalt were again tried; which failing, ſhe took the hotter alexipharmics, and theſe were ſucceeded by the ſtrengthening ſtomachics: but though ſhe acknowledged herſelf relieved always for a day or two, on the change of the medicines, ſhe was ſoon as bad as ever.

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(*a*) This being a little out of the common road of practice, would be the better of being a little explained. The powder of muſtard-ſeed is made into the conſiſtence of a loch, with warm water, in which a little ſea-ſalt has been diſſolved. Of this a common ſpoonful, ſometimes two, diluted in tepid water, are given with an empty ſtomach; and operates as well as an emetic, and proves an excellent remedy in moſt of the nervous diſorders. I have ſeen its good effects in the Infirmary, and among my private patients ſince I was taught it there.

The phyſicians and ſurgeons being ſo often diſappointed, and her caſe appearing to prove a very tedious, if not incurable, diſeaſe, while recommendations were preſented for ſeveral other diſeaſed people who needed immediate aſſiſtance, ſhe was diſmiſſed on the 8th October.

She lived at Leith after this, where ſhe had no aſſiſtance, but ſometimes came to town here to aſk my advice; by which I became acquainted with the ſequel of her hiſtory. Her tremblings and pains continued in the ſame way, notwithſtanding ſome nervous medicines I gave her, till the middle of December, when her right arm ſwelled conſiderably at the joint of the elbow, with very racking pain, and her tremblings left her. By my advice, emollient poultices of bread and milk, with ſome althea ointment, were applied: they relieved her ſomewhat of the pain; but the ſwelling of the joint increaſed, and a ſlow ſuppuration at laſt came on in April following. When the abſceſs was opened a little below the olecranon, a conſiderable quantity of watery pus was evacuated, and ſhe had ſome dreſſings delivered her; but having no ſkilful hand to apply them, and not being in condition to come frequently to town, her ſore degenerated into two fiſtulous ulcers, which continue ſtill to diſcharge a ſmall quantity of a thin ichor. Her fore-arm is bended and rigid, with little or no motion in the elbow: but ſhe has been all this time free from the bloody vomitings, flying pains, tremblings, and all other complaints, except the trouble of her arm.

This woman's diſeaſe went off in but a very indifferent manner, ſhe having loſt almoſt the whole uſe of one arm: yet it is the moſt favourable caſe of that kind that I have either ſeen or heard of among my acquaintances; for no other, of ſeveral whom I could name, under thoſe irregular ſhakings, after an ill-managed ague, have at all recovered. I ſaw one who has ſuffered a tedious continued fever, with the advantage of only a few weeks remiſſion from ſhaking.

N° 46.

Remarks on Chalybeate Waters *.

THE ingenious account of ſeveral ſteel-waters in ſome of our northern counties, given by my worthy friend Dr Thomſon phyſician at Montroſe, [Med. Eſſays, Vol. II. Art. vi.], raiſed a deſire in me to be informed of the moſt remarkable mineral waters of that kind which are to be met with ſo frequently all through Scotland; and as my view was only to know ſo much of them as was neceſſary in practice, I propoſed to diſcover, by my friends and correſpondents, what their real or comparative ſtrength was, and how well they would carry and preſerve without loſing their virtues, whereby phyſicians might judge which of them was moſt proper in the various diſeaſes and circumſtances of patients, and which muſt be drunk at the fountain, or would ſerve as well when kept.

It was neceſſary, in ſuch an inquiry, that there ſhould be ſome general method by which all the trials ſhould be made, otherwiſe there would be an inſuperable difficulty in making the compariſon of them. The writers on this ſubject have contented themſelves with telling us, that ſuch waters ſtrike a red, purple, violet, or black colour, when galls or ſuch other aſtringents are mixed with them; and that this change of colour is a ſure mark of a chalybeate water; and ſome have ſaid, that the deepeſt colour ſhews the greater proportion of ſteel. To ſatisfy myſelf of the truth of this, I diſſolved artificial *ſal martis* in a ſmall quantity of fountain water; and then dropping more or fewer guts of this ſolution into a given quantity of common water, I found that, by the mixture of the tincture of galls, I could form all the different colours mentioned, the larger quantity of the ſolution always requiring the greater number of drops of the tincture to bring it to all the colour it would take, and that being

* Originally publiſhed in Edin. Med. Eſſays, being Art. vii. of Vol. III.

being as conſtantly deeper than the others where fewer drops of each had been employed. If words could expreſs the numerous degrees of colours between the pale-red and the black, the lighteſt and deepeſt of theſe mentioned, the ſimple experiment of bringing ſteel-waters up to the deepeſt colour they could ſtrike with galls might be ſufficient to determine the different proportions of ſteel in each; but as the variety of colours cannot be expreſſed in words, and I wiſhed to come to the knowledge of nearly the real quantity of ſteel contained in any given quantity of each water, there was a neceſſity of having ſome general ſtandard to which all might be brought. To obtain this, I obſerved the quantity of ſteel employed in preparing *ſal martis*; ſaw how much ſalt was got, what the reſiduum of earthy parts was; made a ſmall allowance for ſome evaporating during the efferveſcence of the *limatura martis* with the oil of vitriol; and concluded, that the proportion of ſteel in the artificial ſalt or vitriol of iron, was very little more than a third part. Next, I diſſolved a certain quantity of this *ſal martis* in fountain-water, weighed the powder that precipitated from it, weighed the whole ſolution; and then, putting ſome of it into a ſmall glaſs, I dropped it *guttatim* into another glaſs, counterpoiſed exactly in a ſcale, till I ſaw how many drops of this liquor weighed two drachms; after which, by common arithmetic, it is eaſy to know how much ſalt, and conſequently very near how much ſteel, it contained in any given number of ſuch gutts. To ſave my friends the trouble of making ſuch ſolution, I prepared 20 ounces, which contained an ounce of the *vitriolum martis*, except a ſcruple which was precipitated; and 142 gutts of this ſolution weighed two drachms: therefore every ſuch gutt contained $\frac{1}{284}$ of a grain of ſalt, or $\frac{1}{568}$ of a grain of ſteel. The difference of the bulk of the drops let fall from different glaſſes ſhould not, at this rate, make a very conſiderable error; but to prevent this as much as I could, I choſe all the glaſſes as near to the ſhape, ſize, and thickneſs of the lips of the one I firſt uſed as I could get them.

To make a compariſon, then, of any chalybeate water with this ſolution; into a determined quantity of ſuch water, pour drop after drop of a ſtrong clear tincture of galls, allowing a ſufficient time between each drop for its having its full effect, till it is obſerved that the addition of more tincture makes no change on the colour of the water; and to make

ſure of the number of the gutts of the tincture that are requiſite, let the experiment be repeated ſeveral times. Then having the ſame quantity of common water as was employed of the mineral water, in a glaſs of the ſame dimenſions, thickneſs, and tranſparency, with that made uſe of in the preceding trials, pour into it the number of drops, diſcovered by them, of the ſame tincture of galls, and mix them well; after which, in the ſame cautious manner, drop in the ſolution *guttatim* till their colour is the ſame with that of the mineral water. When once the quantity of ſolution, equal to the contents of the ſpaw, is known, pour a due proportion of it into common water, and let ſeveral people examine whether the taſte of it is not the ſame with what the mineral water has. I have thus made fountain-water ſo like to ſeveral chalybeate waters, that none could diſtinguiſh them.

I prefer tincture of galls to their ſubſtance for making the foregoing experiments, becauſe it produces its effect much ſooner and more equally than the powder, and a leſs proportion of the virtue of the galls can be added at once; which, from an obſervation communicated to me by Dr John Taylor phyſician here, and verified by me afterwards in ſeveral ſteel-waters, and in common water impregnated with *ſal martis*, would ſeem very neceſſary to be regarded: for if too large a proportion of galls is at once poured into ſuch waters, for example, if 60 or 100 drops of a tincture of gall is thrown into a water that requires only eight or nine to bring it to its deepeſt colour, it will be ſo far from making it ſtrike the colour ſtronger, or ſooner, that, for ſeveral hours after, no change will be obſerved on the water; and at laſt it gradually becomes of a deep ſea-green colour, inſtead of the purple or violet it would otherwiſe have turned into. It is not impoſſible that good chalybeate waters have been ſometimes condemned as containing no ſuch mineral, or of being impregnated with copper, by a mixture of too much galls at random.

Recent tincture of galls is certainly preferable to that which is long kept; but I can aſſert, that after I had kept ſuch tincture till it was covered with a thick moſs, or was mouldy, as we call it, a-top, and had a viſcous thick ſediment, it ſtill produced the common effects on ſteel-waters.

I would propoſe, that the compariſon above deſcribed ſhould be made with

with freſh water at the ſteel ſprings in different ſeaſons; and ſhould be repeated once a-week with water that is right put up in bottles, well corked and ſealed, in theſe different ſeaſons, till it becomes vapid by keeping; by which the proper ſeaſons for bottling the mineral waters, and the time each will preſerve, can be much more exactly known than it is poſſible to determine by the ſmell and taſte of them.

It will be alſo requiſite to obſerve what time it is before the galls ſtrike the colour fully after they are put in, and to remark how long this colour remains in an open glaſs; for it appears reaſonable enough to think, with the French academiſt Mr Geoffroy (*a*), that more time will be neceſſary to ſtrike the colour fully, but that it will remain longer in ſuch mineral waters where the ſteel is moſt intimately diſſolved and blended with the other principles.

To make the account of the ſpaws complete, their other contents ought to be ſought after, by mixing different ſubſtances with them, remarking the changes they undergo in ſmell, colour, &c. by keeping, and by extracting their ſalts and earths after evaporation.

By theſe means it is, that I was in hopes to have furniſhed you with a pretty complete liſt of the moſt remarkable ſpaws in this country, with the comparative ſtrength of each, and the time they kept; but being diſappointed of ſeveral I expected, while information of others I had not heard of are often brought me, I ſhall reſerve what I have received, till I can preſent you a more full account, which your publication of this invitation will probably ſoon enlarge, by acquainting the gentlemen who have the opportunity of examining ſuch waters, of the common method they ſhould all take in their inquiries, and to whom they may addreſs their diſcoveries. In the mean time, allow me here to annex ſome experiments, which thinking on this ſubject led me to make.

I had obſerved, as above, a ſtrong reſemblance between our ſteel-waters, and common water in which a ſmall quantity of *ſal martis* had been diſſolved. But the natural ſpaw waters, when expoſed to the open air, very ſoon loſt their chalybeate taſte, and would not ſtrike a purple colour with galls: when expoſed to heat, their virtues were much ſooner loſt; and in the cloſeſt veſſels they, in no long time, became vapid: whereas

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(*a*) Memoires de l'Acad. de Sciences, 1724.

ſal martis bears heat, and being expoſed to the air, without perceptibly loſing any thing. I ſuſpected this difference might in part depend upon the ſmaller proportion of the vitriolic principles in the chalybeate waters, and ſome change they might thereby undergo in the water; and therefore, having added to ſome bottles of water as much *ſal martis* as had been found to make it of the ſame taſte and to ſtrike the ſame colour with chalybeate waters, I corked ſome carefully up, others I put bad corks into, and a third ſort I left open. The water in theſe two laſt loſt its taſte and virtues in about a fortnight, with little other change than becoming a little muddy, and having a ſaffron-coloured powder at bottom. The ſecond kind kept ſome time longer, but had a little of a ſtinking ſmell before it became vapid. The water that was carefully corked and roſined kept well; but acquired a pretty ſtrong ſmell of rotten eggs, exactly like to what ſeveral ſpaws had when kept; and when the bottle was left open, the ſtinking ſmell went ſoon off, and ſoon after the chalybeate virtues were not to be obſerved, and the bottom of the bottle was covered with the ſaffron-coloured powder, which is generally to be ſeen alſo in bottles where natural chalybeate waters have been kept any time. So far, therefore, the difference between the natural and artificial ſteel-waters ſeemed only to be in the greater volatility of the natural ones.

Several of our own chalybeate waters, and the two foreign ones of greateſt reputation, Spaw and Piermont, ſeemed to me an exception to the reſemblance I had found between the diluted ſolution of *ſal martis* and the natural ſteel-waters; for the colour they ſtrike with galls is very faint, while their taſte and other effects are remarkably ſtrong. This put me on trying to find ſome artificial way of imitating them: for this end, I mixed filings of iron, oil of vitriol, and water, in a florence bottle, which I laid on its ſide; and immediately fitted another to it, in which I had put ſome fountain-water. The fumes that roſe upon the efferveſcence of the oil of vitriol with the ſteel, came over into the other glaſs. After the violent efferveſcence was over, I took away the glaſs with the water, which was quite limpid, but had a ſtrong emyreumatic ſmell; its taſte was pungent at firſt upon the tongue, and then the acidulous taſte prevailed. When tincture of galls was mixed with it, it became of a red-purple but faint colour, which held a great many days without any obſervable

ſervable precipitation. Next morning, the empyreuma of the remaining water was gone, and it had a very agreeable briſk ſpaw taſte: In leſs than a day after, this alſo went off; a ſmall quantity of the ſaffron-powder was fallen to the bottom of the glaſs, and the galls had no effect on the water.

On a ſuſpicion that this artificial water would give evident ſigns of acidity, whereas the ſolution of *ſal martis*, and ſome of the ſpaws that ſtrike a black colour, rather appear alkaline, by changing ſyrup of violets and clove-julyflowers into a green colour, I mixed it with theſe ſyrups, without changing the one into red, or heightening the colour of the other. It is true, it did not make them green, neither do the more ſpirituous ſpaws.

The ſucceſs of this experiment, which was beyond my expectation, led me to try if I could not diſcover what it was that evaporated, and what was precipitated in theſe waters. I ſuſpected the menſtruum to fly off, and the ſteel to be left behind. To know then if this ſaffron-coloured reſiduum was ſteel, I poured oil of vitriol on it, which made no remarkable efferveſcence: I then added water, and let them ſtand two days, when ſome of the powder ſeemed to be diſſolved. Upon mixing tincture of galls with it, the colour did not change; but upon further addition of ſpirit of hartſhorn, a great efferveſcence followed, and a ſudden coagulum of a deep red purple ſubſtance was made. This change of colour I at firſt imagined to depend on the reſiduum; but upon mixing the other ingredients without any reſiduum, the ſame coagulum was formed; and therefore, if the powder precipitated from the mineral water is the particles that compoſed iron, they are greatly changed. The reſemblance of the ruſt of iron to this powder, made me try how theſe experiments would hold with it; and they came out in the very ſame manner: nor would ruſt, or the powder, when ſuſpended in water, ſtrike any colour with galls, though the *crocus martis* of the ſhops did.

What flies off in the evaporation is evidently the menſtruum, in which the irony particles were diſſolved, which carries away ſome of the principles of the iron with it. From ſeeing the effects of acids on iron, obſerving the effects of that almoſt univerſal menſtruum of the air upon this metal, and finding vitriol of iron naturally formed, we have reaſon to judge that the menſtruum of the irony particles in chalybeate waters is

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alſo an acid: And conſidering how much ſulphur enters into the compoſition of iron, what a ſtrong ſtinking ſmell (which can only depend on ſulphur) mineral waters have before they turn vapid, and how much the ſulphur of iron is deſtroyed before the iron turns into ruſt, which again reſembles the powder precipitated in theſe waters; all this would perſuade us, that the menſtruum carries the ſulphur along with it, and leaves only the earthy parts, with a ſmall proportion of ſulphur.

May not ſteel-waters be impregnated with common groſs vitriol, or with the more ſubtile fumes of iron diſſolved in the natural menſtruum, or with both in different proportions?

Will not the leſs volatility of ſome chalybeate waters, and the quicker precipitation of their irony particles after the mixture of galls, ſhow the ſulphur not to be ſo much freed from the earthy particles, as in others that precipitate more ſlowly and are more volatile?

Will not the common obſervation, of air generated in all effervеſcencies, fermentations, putrefactions, and wherever a conſiderable change is produced in the compoſition of bodies, account for the quantity of elaſtic air obſerved in chalybeate waters, in the more ſpirituous when recent, in others when the putrid ſmell ſhows the ſulphur to be more diſengaged?

Are not the different kinds of ſteel-waters to be preſcribed, according as there is occaſion for a ſubtile penetrating ſulphureous ſpirit to pervade the ſmalleſt veſſels, or according to the quantity of an abſorbent aſtringent earth that is required to be joined with this ſpirit?

Where different ſpaws are not to be had, may not the ſame water be made to anſwer each of theſe intentions, according to its being more or leſs kept, or expoſed to the air or heat?

N° 47.

REMARKS on the INTERCOSTAL MUSCLES.

TAUVRY * ſhowed the miſapplication of Mr Bayle's propoſed demonſtration of the action of the internal intercoſtal muſcles, from his inattention to the ribs not keeping in the ſame paralleliſm when they are raiſed as when they are depreſſed, becauſe of the greater motion of the lower than of the higher ribs; and he took notice of the ſame demonſtration, proving equally that the anterior part of theſe internal intercoſtals muſt act in inſpiration, as Bayle would have their poſterior part to act in exſpiration. But neither he, nor any other writer of my acquaintance, has applied this demonſtration of Bayle's; which, granting the paralleliſm of the ribs to remain the ſame, is a good one, to account for the defect of the internal intercoſtals between the ſpine and the angle of the ribs, and for the deficiency of the external intercoſtals from where the ribs begin to turn upwards to the *ſternum*; a fact which anatomiſts are now all agreed in. The application of the demonſtration to this purpoſe, is the intention of this paper.

Let AB (Plate VII. fig. 1.) be the ſpine, CD the ſternum, EFGH and IKLM two ribs; then EK and GM are lines in the direction of the external intercoſtal muſcles, and FI and HL are in the direction of the internal intercoſtals.——Now, ſays Bayle, if both ribs riſe, the angle FEI muſt be enlarged; and its hypotheneuſe FI, the fibres of the internal intercoſtal, muſt be longer; whereas muſcles generally are ſhortened when they act.——Near to the ſpine, where the ribs cannot be brought nearer at one time than another, this reaſoning is juſt; and therefore the internal intercoſtals are not placed nearer to the ſpine than where the motion

* Anat. Raiſonn. Part II. chap. 14.

of the ribs is large enough to allow the lower rib to approach ſo much to the one above it, as to do more than compenſate for the elongation of the hypotheneuſe of the angle FEI; *i. e.* the internal intercoſtal is only to be found farther forward than the angles of the ribs.

Near to the ſternum, the cartilages cannot be brought nearer; and therefore when they are raiſed up, HL, the fibres of the internal intercoſtal, may be ſhortened, becauſe the angle HMI is made leſs: But if there were fibres of the external intercoſtal here, as GM, they would be made longer; becauſe the angle GHM is enlarged by raiſing the ribs; and therefore no external intercoſtal muſcles are placed at this fore-part of the thorax.

N° 48.

N° 48.

PROOFS

OF THE

CONTIGUITY of the LUNGS and PLEURA.

THE experiment of opening the thorax without hurting the lungs of living animals, while the trunks of their bodies are immerſed in water, through which no bubbles of air riſe after the perforation, as propoſed by the ingenious Lieberkuhn, and executed by the illuſtrious Haller *, is a deciſive one, if rightly performed, for proving no air between the pleura and lungs. But as an unwary operator may wound the lungs in perforating the thorax, when air would certainly riſe in the water, from which the exiſtence of air in the thorax might be concluded, and ſeveral other circumſtances may, and have cauſed the concluſion from this experiment to be diſputed; it may not be amiſs to mention ſome eaſier ways of proving the non-exiſtence of air in this place. Such are the following.

1. Diſſect the teguments and intercoſtal muſcles from the pleura of either a dead man or quadruped without wounding this membrane, in which there is no difficulty; then, pull up and depreſs alternately the ſternum and ribs as often as you will, the lungs are ſeen contiguous all the while to the pleura; but on making a ſmall puncture through this membrane, the lungs, if they are not grown to the pleura, which is often the caſe in the human ſubject, fly from the pleura, and are no more ſeen.

* Opuſc. de Reſpirat.

2. This connection of the lungs and pleura, more or leſs of which is ſeen in moſt human bodies, implies ſtrongly a natural contiguity of theſe two parts.

3. Lay bare the pleura, without wounding it, between two ribs of any living quadruped, which requires no great dexterity; and then the contiguity of the lungs and pleura may be ſeen, though the lungs are conſtantly ſliding and changing place along the pleura, and though this membrane is in different ſtates. While the creature inſpires, it is concave; during exſpiration, it is convex and prominent outwards: for this plain reaſon, that while inſpiration is performing, the air does not paſs ſo quickly at the narrow glottis as to fill the lungs at once with air of denſity and weight equal to the atmoſphere; and, during exſpiration, the air cannot eſcape ſo faſt at the glottis as to prevent its more than ordinary condenſation and expanſility in the lungs than the external air has.

If we were to find accurately what weight the pleura could raiſe when it is made convex during exſpiration in the preceding experiment, would not this determine how much more preſſure, than that of the atmoſphere, the part of the lungs within this elevated pleura, on which this weight is ſuſtained, is expoſed to?

Would not the preſſure on the ſame part of the lungs, during inſpiration, be nearly as much leſs than the weight of the atmoſphere, as is the weight raiſed in exſpiration; ſince it is the ſame glottis which allows the air to paſs in both caſes?

Is not the force by which the inſpiratory organs, acting with the greateſt energy of the mind, exceed the power of the exſpiratory organs uninfluenced by the mind, conſiderably leſs than the weight of the atmoſphere; ſince if, after exſpiration, we prevent the entry of the air by the glottis, we cannot dilate the thorax as in inſpiration, though there is ſtill a good deal of rarefying air in the lungs?

Do not the inſpiratory organs, during inſpiration, overcome the reſiſtance of the exſpiratory organs, and likewiſe that ſhare of the preſſure of the atmoſphere which the air, ruſhing into the lungs, does not balance?

Are not the ribs arched, and the ſpaces between them narrow, to prevent ill effects from that unbalanced part of the atmoſphere during inſpiration?

N° 49.

The CURE of a fractured TENDO ACHILLIS.

OUR predeceſſors were either not ſubject to the breaking or tearing the *tendo Achillis*; or it was miſtaken for a ſprain, or ſome ſuch other diſeaſe, by phyſicians and ſurgeons: for it is rarely taken notice of in books; and the oldeſt and beſt practiſers here aſſure me, they had not obſerved it, or heard of it, till between twenty and thirty years ago; ſince which, this accident has happened to a conſiderable number of people of this country, of whom I know ſixteen, and ſeveral of thoſe have broke the tendons of both legs. Amongſt the reſt, I have been a ſufferer this way; and upon a compariſon with my brethren in affliction, my cure is the moſt complete of any I know; there being neither pain, ſtiffneſs, weakneſs, nor obſervable ſhrivelling, in my left leg where the *tendo Achillis* was broken; whereas moſt of the other gentlemen have ſome of thoſe uneaſineſſes, and ſeveral have all of them. On this account, I think it my duty, for the benefit of future patients, to make my method of management as public as I can.

When my tendon was torn, it cracked as loud as if I had ſuddenly broke a nut under my heel; which the company believed had happened: and I had ſuch a ſenſation, as made me imagine that the heel of my ſhoe had ſtruck a hole in the floor, which is the feeling that ſeveral have had as well as I; while others complain as if they had received a ſmart ſtroke with a ſtone or cane on the part. I ſuſpected immediately what the caſe was: and therefore, after feeling where the hollow was, between the ends of the broken tendon, I took the left foot in my right hand, with which I extended the foot ſtrongly; and, as ſoon as I was put in a ſeat, preſſed down the calf of my leg with my other hand: In which poſture

I kept them till Meſſ. John Douglas and James Ruſſel, ſurgeons of this place, came; and after being ſatisfied of the rupture, by preſſing their fingers into the hollow between the two ends of the tendon, they applied compreſſes, and a bended board on the upper part of my foot and fore-part of my leg, which they kept, as near as they could, in a ſtraight line by a tight bandage made with a long roller.——This dreſſing became ſoon too uneaſy for me to bear; and the board was liable to ſhuffle, whatever care was taken in the application of the bandage: therefore I changed it for the following compound one, conſiſting of two pieces. See Plate VII.; where

Fig. 2. Is a foot-ſock or ſlipper, A, of double quilted ticking; from the heel of which, B, the quilted ſtrap *c*, is of ſuch a length as to come up above the calf.

Fig. 3 A ſtrong quilted calf-piece L, with pye-holes MM on each ſide, through which a lace (fig. 4.) is to be paſſed; and with a buckle N, ſo placed on its back-part, that, when the lacing was on the outſide of the leg, the buckle was in the middle of the lower part. Two rows of pye-holes are here repreſented on one ſide, either of which is to be uſed according to the thickneſs of the leg.

Having then wrapped ſoft flannel, ſmoked with the fumes of benzoin, round my foot and leg, I put on, as in fig. 5. the foot-ſock A, and calf-piece L, and bringing the ſtrap C through the buckle N, I could by it extend the foot, and pull down the calf to what degree I thought fit, and there ſecure it with the buckle.

This bandage anſwering my intention quite well, I wore it night and day; drawing the ſtrap tighter when I inclined to ſleep, and relaxing it when I was fully awake and on my guard: at which time, likewiſe, I placed my foot on a ſtool, in the poſture repreſented at S; and frequently ſhifted the calf-piece, or made the lacing of it looſer, to prevent the ſwelling of my foot, which it was in danger of occaſioning when it became too tight by being drawn down by the ſtrap.——After a day or two, I found my toes uneaſy, from the foot-ſock preſſing them; and therefore I undid the ſewing of it at the toes, from *d* to *d*, and have cauſed it always ſince to be made open there for others who uſed it.

During two weeks, I made no motion nor effort with my foot; but

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was carried in a chair, running on caſtors, from one part of my houſe to another. After this, I began to move the foot backwards and forewards ſo gently as not to give pain, and gradually increaſed thoſe motions; but always ſtopped the flexion of the foot, or extenſion of the leg, whenever I felt the leaſt uneaſineſs. Frequently I continued theſe motions for half an hour together with the diſeaſed limb; but kept the other as much at reſt as I could.

When I began to walk, I always put the left leg ſome way before the right, that the left foot might be well extended; making uſe of a cane in my right hand, to prevent any danger of falling.

The void between the two ends of the divided tendon became inſenſible in a few days, except that a ſoftneſs was felt there more than any where elſe: but this part turned gradually thicker and harder, till a knot was formed in it; which one, in feeling through the teguments, would have thought to be a piece of cartilage as large as a middle-ſized plum, which has greatly decreaſed and become ſofter for ſome years paſt, ſo that at preſent it is much leſs perceptible than formerly.

Some weeks after the accident, I began to pour cold water on my leg and foot, cauſing them to be well rubbed immediately after: but the water, inſtead of ſtrengthening the member, as I expected it would have done, made it cold and weak; for which reaſon I ſoon forebore the uſe of it, and cauſed the leg to be rubbed twice a-day ſtrongly with *unguentum altheæ*, or ſome ſuch greaſy ſtuff, to protect the ſkin from excoriation by the friction. This manœuvre was continued till I began to employ the limb freely.

Being obliged to go abroad after ſix weeks, I put on a pair of ſhoes with heels about two inches high, and applied the machine which I am juſt now to deſcribe, in the day-time, inſtead of the former bandage; which, however, was always put on at night for a month more.

The new machine, fig. 6. was a piece of ſteel, the middle ſtalk of which A is narrow but ſtrong. The ends BB are thin, broad, and concave, adapted to the convexity of the foot and fore-part of the leg. Three ſtaples, *ccc*, ſtand up from the fore-part of the ſteel, one being in the middle of each of the broad ends, and the third in the middle of the ſtalk. All the ſteel, except the ſtaples, was covered with chamois leather;

ther; and the concavities of BB were well buffed, as the ſofter rupture-bands commonly are.

After I had put on my ſhoes and ſtockings, one end of this machine was put on the broad part of my foot, nearer the toes than the buckle of the ſhoe; and the other end was placed on the fore-part of the leg: then one ribband, or a thong of leather, (fig. 7.) was put round the foot, and another (fig. 8.) round the leg, to paſs through the two ſtaples near the ends of the machine, and there ſecured with ſtraps or buckles, but without being drawn tight.—A third ſtrap or ribband, (fig. 9.) having its middle D applied in the hollow of the foot, immediately before the heel, had its ends paſſed on each ſide of the foot, through a ſinus or nooſe EE, of a fourth thong of leather F, that came round the quarter-heel of the ſhoe, to be afterwards put through the middle ſtaple; where, after theſe ends GG were drawn as tight as was thought convenient for extending the foot, they were ſecured with the buckle or with knots. (See the application in (fig. 10.) I wore this machine always in the day-time for five months; though, as it is inconvenient by ſhuffling out of its place ſometimes, I think a thong of leather ſewed at one end to the upper middle part of the quarter-heel of the ſhoe, and faſtened at the other end to a garter put above the calf of the leg, would ſerve inſtead of it without inconvenience.——All that time I never walked the ſtreets, but was carried in a chair.—In going down ſtairs, I always put the diſeaſed leg firſt down at each ſtep; and in coming up, I put the ſound leg foremoſt: by which I ſhunned the ſtretching and retearing of the new-ſoldered ſinew, which I knew, from what others had ſuffered, might have made the caſe worſe than it was at firſt.——The habit I had got of walking after this manner in ſtairs, became ſo much a ſecond nature, that I had afterwards difficulty to learn to go up and down in the ordinary way with the feet alternately.

I continued the high-heeled ſhoes for two years, cauſing my boots to be made after the ſame faſhion when I began to ride; but have gradually ſince retrenched their height, till now I wear them of the common make.

During all that time, too, I mounted my horſe at the right ſide inſtead of the left one, that I might ſhun the rearing my whole weight, by the force

force of the weakened gaſtrocnemii muſcles; and to prevent the accident of ſtraining them in caſe the horſe ſtumbled, I kept the left foot deep in the ſtirrup. In walking up-hill, I put that foot a-croſs; and, in ſhort, guarded againſt every other ſtretching ſtep or motion.

On comparing the ſize of the calfs of the two legs at preſent, the left one is a little ſmaller than the right one, eſpecially in the morning; but ſo little, that it is ſcarce perceptible: through the day, the difference becomes leſs.——The *tendo Achillis* that was broken, is, as moſt other tendons cured after breaking, conſiderably thicker and harder than the other; but one muſt be told it is ſo, before he can diſcover it by the eye.

N° 50.

HISTORIES

OF

Tophaceous Concretions in the Alimentary Canal.

1. A HEALTHY boy, about twelve years of age, began to complain of colic-pains; which increaſing with frequent gripes, *borborygmi*, and vomiting, had ſuch an effect, that his parents aſſerted he was ſcarce of ſo large a ſtature, after ſix years of his diſeaſe, as he was at the beginning of it. Vomits, purges, vermifuges, attenuants, and a variety of other medicines, had been given in that time, without any benefit.

His father, one of the town-officers or ſerjeants, having then aſked my worthy friend and colleague Dr Plummer's advice, he deſired my aſſiſtance. We were told by the lad, who was greatly emaciated and very weak, that ſome years paſt he had not had the vomiting, but found a hard painful tumour above the left groin, which ſometimes ſhifted place a little, where he fancied often he felt ſomething like the ſtriking of two hard bodies on each other. He had been of late much fatigued with teneſmus. Sometimes he had no excretion of fæces for ſeveral days; and often he could ſcarce make any water, and that only in drops. During two days before our viſit, the teneſmus was conſtant; and he felt ſomething hard within the rectum near to the anus, which he and ſeveral others had endeavoured in vain to bring away with their fingers.

On extracting this ſubſtance with a forceps, ſuch as is uſed for extracting

ing ſtones from the bladder, he was much eaſier than he had been of a conſiderable time. Next day he paſſed two other balls; and on each of the two following days, a ball, which he could not force out at the *anus*, was extracted with the forceps. After this he had no uneaſineſs, and ſoon became a heal ſtrong young man.

The largeſt of theſe five balls, which was the firſt extracted, is five inches in circumference, and ſomething globular, but with ſeveral prominences and flat ſurfaces. Moſt of the flat parts had a ſmooth ſhining tartarous thin coat; the reſt of it was more rough, and of a ſpongy appearance. The two laſt brought away are leſs in bulk, and without ſo much tartarous cruſt. The two ſmall ones are all covered over with the ſhining tartarous cruſt, which in ſeveral places is prettily variegated with different ſhades of an aſhy colour. One of them has ſome reſemblance in its ſhape to the ſhell of a tortoiſe: the other, or ſmalleſt, may be compared to two pyramids joined by a common baſe.

The ſecond in ſize, and the ſmalleſt, are cut through near to the middle, where there is a ſmall flat bone, that probably has been the nucleus about which theſe balls were formed, though they are not of the ſame ſhape.

We were informed by the parents, that they had often chid their ſon for ſwallowing the ſmall bones of ſheep and lambs feet; the ſinewy parts of which, when boiled, the family frequently took for food.

2. A man who had been long tortured with a painful hard ſwelling in his belly a little above the right groin, which frequently cauſed vomiting and diarrhœa, though at other times he was very coſtive, aſked my advice when he was very weak and emaciated. The ſeat of this tumour, the kind of feel it had through the containing parts, and its tumbling, as the patient ſaid, from one place to another when he changed poſtures, made me ſuſpect a concretion to be lodged in the great ſac of the colon.

In hope to puſh it forwards in the colon, I cauſed his great guts to be filled with whey injected by the anus, and then directed himſelf and aſſiſtants to preſs repeatedly the tumour upwards. This manœuvre being ſeveral times renewed without ſucceſs, I preſcribed a briſk purgative, and ordered the injections with the preſſure to be repeated as ſoon as the cathartic began to operate. But this and ſeveral other ſuch operations failing, my patient died.

Having obtained leave to examine his body, my conjecture proved to be right; for in the *caput coli*, there was a ball of more than ſeven inches circumference, with a depreſſion at oppoſite ends. The inteſtine had contracted ſo much at the ſide of the ball next to the cavity of the colon, that I could not force it through the aperture there, but was obliged to cut the ſac in which it was lodged to take it out.

The ball had no tartarous cruſt on its ſurface: and when it was cut through, its nucleus was a chalky or limy ſubſtance about the ſize of a common pea.

3. Dr John Stevenſon phyſician gave me a concretion ſix inches in circumference, the nucleus of which is a plum-ſtone, taken out of the inteſtines of a boy of five years old. Though the ſtone had been ſwallowed long before the boy's death, the kernel of it was freſh when the ſtone was taken from the middle of the ball. A clyſter had brought away ſeveral other plum-ſtones from this boy ſome months after the plums had been eat.

4. Dr Stevenſon alſo gave me another ſuch concretion, which has four flat ſides with ſeveral depreſſions in them, meaſuring about five inches in circumference, formed alſo on a burnet plum-ſtone, which he took out of the inteſtines of a girl.

5. From the ſame gentleman I likewiſe had a third concretion pretty like to, but a little larger, than the one deſcribed and painted by Dr Simſon in Med. Eſſ. vol. i. art. 32.; which, with three ſuch others, he took out of the inteſtines of another patient. Each of them had a ſmall ſtone in the middle, the patient having formerly ſwallowed ſmall ſtones and pebbles for what he called a colic in his ſtomach.

The Doctor tells me, that all theſe three patients waſted, without being ſick or loſing their appetite. They were fond of fleſh for food, and were averſe to ſlops. They ſeldom were free from *borborygmi*, which made the abdomen to change almoſt conſtantly its appearance, the parts of it riſing and ſinking as the air went from one place to another.

6. In a ball of this kind, eight inches one way and ſix the other, taken from a gentleman's inteſtines, whoſe hiſtory I do not know, the nucleus is a little round piece of wood about the ſize of a common hazle-nut.

None of the balls mentioned in theſe four laſt hiſtories have any tarta-

rous

rous cruſt; but they and all the other cut ones have the appearance of being compoſed of ſtrata ſurrounding the nucleus, their colour differing in ſhades from a dark ruſty to a pale aſhy colour. Their ſubſtance, except where there is tartarous cruſt, reſembles a fine hat or chamois leather when cut.

7. In the collection of curioſities kept by the ſurgeons of this place, there is a ball taken out of the ſtomach of a horſe, which is nearly ſpherical, and nineteen inches in circumference. Its ſurface has ſomething of the mulberry form, being compoſed of a great number of hemiſpherical knobs, about a quarter of an inch diameter, contiguous to each other. Their outward ſhell looks like a thin cruſt of ſandy clay; but within this the ſubſtance has the ſame matted appearance as the human concretions have.

8. Balls are alſo frequently formed in the ſtomachs of cows. Three of them which were given to me, are almoſt exact ſpheres of a black colour, compoſed of an external hard tartarous cruſt, which is about one twentieth of an inch thick. Within this there is nothing but ſhort black hairs matted compactly together. The circumference of the largeſt is 9 inches; of the ſecond, 6; and that of the third is $5\frac{1}{2}$.

N° 51.

REMARKS

ON

PROCIDENTIÆ ANI, INTUSUSCEPTIO, INFLAMMATION, and VOLVULUS of the INTESTINES.

AT ſtool, more or leſs of the inſide of the *rectum* is generally thruſt out beyond the verge of the *anus*, which aſcends when the preſſure of the diaphragm and abdominal muſcles ceaſes. If the protruded inteſtine is not then retracted, it is ſqueezed by the *ſphincter ani*, ſo that the return of liquors from the part of it which is beyond this ſtricture muſt be rendered difficult; on which account, this part ſwells, becomes of a colour more red than natural, and a larger than ordinary quantity of ſlime flows from the ends of the veſſels that open on its inverted villous ſurface. This ſtate is called *procidentia ani;* a diſeaſe to which children, old people, thoſe weakened by diſeaſes, or ſuch as are attacked by *teneſmus* from whatever irritating cauſe, are more ſubject than others.

The ſpeedy reduction of the inverted protruded part of the inteſtine, is the effectual cure; nor ſhould time be loſt, as is often adviſed, in trying to diminiſh the ſwelling by warm fomentations and poultices; which relax the veſſels, and rarify the liquors, and therefore produce an effect very different from what they are intended to have. If the prolapſed inteſtine is ſo much ſwelled, that it cannot be made to paſs through the contracting ſphincter, inciſions may be made in its ſurface, by which part of the ſlime and blood contained in the cellular membranes may be ſqueezed out to diminiſh its volume, and thus to make it capable of returning again within the body.

The

The practice of the nurſes and other good women, in making the reduction of a *procidentia*, is very faulty. They apply a warm cloth to the protruded part of the gut, and preſſing on it endeavour to thruſt it all up at once. Before the inteſtine ſwells, this operation ſometimes ſucceeds with children whoſe ſphincter is weak. But dry cloths or fingers are liable to adhere to the villous coat, and give great pain in taking them off. The cloths or fingers applied here ought always to be beſmeared with oil, unſalted butter, or axunge, to prevent this adheſion. The bulk of the prolapſed part is often ſo great, that it is impoſſible to make it all paſs at once through the ſphincter, and a fruitleſs attempt of reduction generally increaſes the ſwelling. The reduction ought to be made by preſſing a ſmall part of the ſides of the orifice, with a greaſy finger; and when that part is thruſt within the orifice, another finger is applied to what is then the verge of the orifice to puſh it upwards, while the firſt applied finger is withdrawn: by ſuch an alternate ſucceſſion of two fingers, the whole may be introduced in moſt caſes without inciſions, ſo that this diſeaſe is ſeldom fatal; and for that reaſon, the patient is generally too much neglected after the reduction is made, which is ſometimes attended with bad conſequences.

If, after the reduction, the part continues to be pained, and the patient's pulſe is quick, blood-letting and a low and cooling diet are neceſſary to prevent inflammation and its conſequences. In all caſes, too much coſtiveneſs, and its contrary a diarrhœa, eſpecially with *teneſmus*, are equally to be guarded againſt; ſeeing a return of the *procidentia* may be cauſed by either of them. The relaxed parts are to be braced by ſtrengthening topical medicines. In the aſtringents commonly preſcribed, I can have no confidence; their effect goes no deeper than the ſkin: but ſtimulants, ſuch as ardent ſpirits, or tinctures of the aromatic reſins made with them, give a ſpring to all the parts, and excite a glowing heat whenever they are applied ſo as to touch any part of the extremity of the gut, which they can always be made to do.

I have ſaid that this diſeaſe, the *procidentia ani*, is ſeldom fatal; and the reduction of the prolapſed part of the inteſtine into the body is generally regarded as a cure of it: but that this is not true, when the doubling of the inteſtine is high up, will appear from the following hiſtory.

A large-ſized ſtrong healthy boy, a year and an half old, after a diarrhœa of ſome days, with teneſmus, was obſerved to have a *procidentia ani*, which was treated two days by the women who attended him; after which Mr Adam Drummond, ſurgeon in this place, was called to his aſſiſtance. He reduced the *procidentia* frequently; but it ſoon returned, which made him deſire I ſhould be conſulted.

The inverted inteſtine ſtood out four inches from the *anus*, without being much ſwelled or of a deep red colour, and the child ſeemed to have no other diſeaſe. Mr Drummond moſt eaſily introduced all the tumour into the body; but ſoon after it was puſhed out again, upon the child's having a deſire to ſtool, notwithſtanding a ſervant's keeping a finger on each ſide of the *anus* near to each other, while ſome liquid excrement was paſſed. After the reduction was again made, I put my finger which is long up the *rectum*, puſhing the orifice of the inverted gut on the point of it; and then found the orifice of the inverted gut reſembling the feel of the *os tincæ* of an unimpregnated womb reſting on it, which I could throw up ſome way further with a ſudden jerk of the laſt point of the finger, but without being able to invert it. We then cauſed a large quantity of milk and water to be injected with force, while the two ſides of the *anus* were preſſed firmly on the pipe of the ſyringe introduced by the *anus* into the *rectum*, to prevent the liquor's recoiling, in hope that the liquor would carry the inverted gut before it, to cauſe its return to the natural ſituation. This operation being repeated ſeveral times in vain, the *procidentia* always returning with the *teneſmus*, a very long probe of whale-bone was made, ſponge was faſtened round the probe, and this was wet in oil; the probe was introduced into the orifice, which, I ſaid, reſembled an *os tincæ*, the ſides of which reſted on the ſpunge; and with this the inteſtine was puſhed a great way up into the body in the direction of the *rectum*, but without ſucceſs. Several attempts of the ſame kind failing, we deſpaired of a cure; and the child, ſome time after, being attacked with ſevere vomiting and perpetual *teneſmus*, died in a few days.

Mr Drummond, who opened the body, told me, that the inverſion began a little below the upper part of the ſigmoid flexure of the colon; and that the meſcolon was torn away from the inverted part.

When a doubled part of an inteſtine is extended into the cavity of this alimentary

alimentary canal, without appearing externally at the *anus*, it is called *intuſuſceptio*, which I am perſuaded is a much more frequent diſeaſe than is generally thought. I have ſeen ſeveral whom I judged to have died by it, and ſhall now relate the caſes of four people whoſe bodies were examined after death.

1. A middle-aged woman, during ſixteen months before her death, ſuffered greatly from colic-pains, diſtenſion of her belly, vomiting, and *teneſmus*. In the latter part of her life, when I firſt ſaw her, ſhe had no ceſſation from pain, except by the force of *opium*.

In the great arch of the *colon* was a doubled part of that gut, ſeven inches long. The containing inteſtine had a very ſlight adheſion to the inverted doubled part contiguous to it. The doubled part was of a dark red colour, but not very hard. The paſſage for the *fæces* through it was very narrow, not allowing a finger puſhed with force to paſs.

2. A woman about fifty years of age lived two years with ſuch ſymptoms as were narrated in the preceding caſe. We found a doubled part of the *colon* four inches long in the left loin, with the ſame appearance as deſcribed in the former hiſtory.

3. A girl ſeven years old, after eating a carrot and ſome currant-berries, had a colic, which continued, with a diſtended belly, vomiting, and paſſing little *fæces*, from July till the middle of December, notwithſtanding various medicines were given.

Mr Malcolm Surgeon in Dalkeith, whoſe patient ſhe was, being allowed to open her corpſe, cut out the affected part of the inteſtine, and ſent it to me. The end of the *ilium*, *valvula Tulpii*, *caput coli*, and *appendix vermiformis*, were raiſed twelve inches within the *colon*, to which they had a ſlight adheſion. The outer ſurface of the contained inteſtines was dark coloured, and very unequal. The orifice of the prolapſed part was not at its end, but at one ſide an inch and a half from the end, with a ſoft flexible prominence at each ſide of the aperture, which I judge to have been *Tulpius*'s valve. The doubled parts were ſo grown together, that I could not diſtinguiſh one from the other. The paſſage within them was ſo ſmall and crooked, that I could not puſh a probe through it; but, cutting it open gradually, I found it was ſtill pervious.

4. Dr Cullen, Profeſſor of Medicine in the Univerſity of Glaſgow, communicated the following caſe to me.

A boy about twelve years of age complained of wandering colic-pains, which he imputed to blows received on his belly from ſome of his companions. Theſe pains returned frequently, with *diarrhœa*, and ſometimes bloody ſtools, for near a year, when his parents conſulted Mr James Muir ſurgeon in Glaſgow about him. The boy was then much emaciated, had a quick pulſe, and was ſo weak as to be confined to his bed. Two weeks after this, a livid membranous ſubſtance, paſſed by the boy at ſtool, was brought to Mr Muir; who, obſerving it to be tubular, tied one end of it, and, blowing into the other, diſtended it into ſuch a convoluted tube, thirteen inches long, as repreſented A B C, fig. 11. of Plate VII. which I cauſed to be drawn from the original which was ſent me. As it has the meſentery D connected to all its concave ſide, it appears to have been an entire piece of gut, and not the villous coat only. Beſides this large portion of inteſtine, there were ſeveral ſhreds and ſmaller pieces paſſed by the patient; notwithſtanding which, Mr Muir ſaw afterwards among the the boy's *fæces*, ſkins of potatoes which he had eat after theſe parts of the inteſtine came away, ſo that they had not made any diſcontinuity in the alimentary canal. The ſymptoms continuing, the boy died in ſix weeks.

Mr Muir opened the body of his patient, in preſence of ſeveral gentlemen of the faculty; who ſaw what I am now to deſcribe, with the aſſiſtance of a figure, which I cauſed to be taken of the dried preparation of the inteſtine ſent me.

The folds of the inteſtines and *omentum* were all glued together by a fatty curdy matter. Within four inches of the valve of the *colon*, the *ilium* A B C, fig. 12. Plate VII. formed into the uſual curve by the meſentery D, ſuddenly roſe perpendicularly at E, where it was much contracted and had the appearance of a cicatrice. When the inteſtine was opened, this contracted part of it was found much thicker and harder than it was any where elſe, eſpecially on one ſide, where it ſtood ſo far into the cavity as to leave a very ſmall paſſage for the aliment. Along this contracted part, the meſentery F was firm and thick. After this, the inteſtine G became of a natural enough form and make.

The gentlemen in Glaſgow were, I think, juſtly of opinion, that the part

part of the inteſtine inflated by Mr Muir, delineated fig. 11. was an intuſuſcepted part fallen away by gangrene from the inteſtine at E in fig. 12. where, if there was a concretion, as is related in caſe 3. it might have ſeparated without leaving any diſcontinuity in the alimentary canal.

I have ſeveral times ſeen an *intuſuſceptio* in the ſmall guts of children, a little below which I obſerved ſeveral worms; but the inverted part was neither ſwelled nor diſcoloured, which made me think this diſorder had happened ſoon before death. In one of them a *lumbricus teres* had paſſed the half of its length through a hole made in the gut; but, as there was no redneſs or other mark of inflammation at this part, I judged the perforation to have been made by the worm after the death of the ſubject.

There is little difficulty in conceiving how a piece of a gut ſhould enter doubled into the part below it, and how it may be gradually protruded downwards to a conſiderable extent by the food or fæces in their deſcent towards the anus: but it is not eaſy, when this diſeaſe begins, to diſtinguiſh it from a variety of other diſorders which happen in the alimentary canal; or to find a remedy when it is ſuſpected, eſpecially if the intuſuſceptio is in the ſmall guts: and from the obſervation above narrated of the child with the fatal procidentia ani, it would appear difficult to cure it; nay, if the doubled parts of the inteſtine are grown together, as in moſt of the hiſtories, a reduction of it is impoſſible. Nature ſeldom will perform what I imagine ſhe did in the laſt caſe, ſeparate the doubled part, and unite what contained it. Nor do I believe any will be ſo hardy as to adviſe the amputation of the affected part of the gut.

It is ſurpriſing how the people in the preceding hiſtories lived ſo long as they did, with ſuch large doublings of the inteſtine, and its meſentery preſſed together within another piece of inteſtine, when the common inflammation of the inteſtine often kills ſoon thoſe it attacks; of which I could give numerous examples, but ſhall relate only one. A gentleman of weak nerves, and ſubject to flatus and pain in his ſtomach, was ſeized with a colic-pain about ten o'clock at night, for which he ſwallowed a ſmall quantity of an ardent ſpirit. At three in the morning, twelve or fourteen ounces of blood were let from a vein in his arm, and a laxative clyſter was injected, and operated well. At eleven that forenoon I firſt ſaw him, when his friends thought him much better, being free of pain;

but as his belly was greatly ſwelled and very tenſe, his pulſe quick, ſmall, and intermitting, his eyes languid, his countenance faded, and a cold clammy ſweat was over all his body, I made the prognoſis of his having very few hours to live. He died before five of the afternoon, ſo that his diſeaſe killed him in eighteen hours; and I have heard of others who died in leſs than twelve hours after the firſt appearance of inflammation.

The common practice of taking ſpirituous liquors, or the warm carminatives, when people feel colic-pains, is often unlucky, and public warning ſhould be given againſt it; for tho' relief is found from ſuch things in the windy or ſpaſmodic colics, which is not a deadly diſeaſe, yet they hurry on the inflammatory ones ſo faſt, that they ſoon prove mortal. I muſt likewiſe think, that writers on the inflammation of the inteſtines do not repreſent ſtrongly enough the languor and low ſmall pulſe which ſuch patients generally have more than in moſt other diſeaſes. It is ſuch that I have ſeen ſeveral caſes where people of ſkill, deceived by theſe ſymptoms, have been afraid to order blood-letting, leſt the patient had not ſtrength to bear it, and thereby neglected this evacuation till it was too late. When there is a fixed pain in the ſtomach or inteſtines, with a quick though ſmall pulſe, no time is to be loſt; blood ought immediately to be let plentifully, and veneſection ſhould be repeated till the pulſe becomes full and free, which is a hopeful ſign of a cure's being made, tho' neither pain nor fever have yet ceaſed.

The intuſuſceptio or inflammation, but eſpecially the latter, is generally the cauſe of what is commonly called the iliac paſſion or *miſerere*; for the volvulus or twiſting a part of the inteſtines into a knot, which was formerly ſaid to be the caſe, is generally thought now, when anatomy is more cultivated, and inſpection of morbid bodies is more univerſally allowed, to be an imaginary evil.——See Eſſays and Obſervations Phyſical and Literary, Vol. II. Art. xxviii.

Plate VII.

Fig. 4.

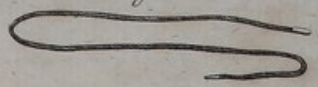

Fig. 2.

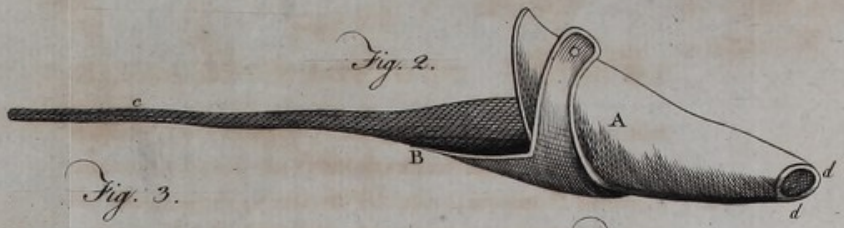

Fig. 1.

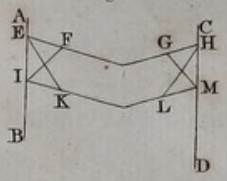

Fig. 3.

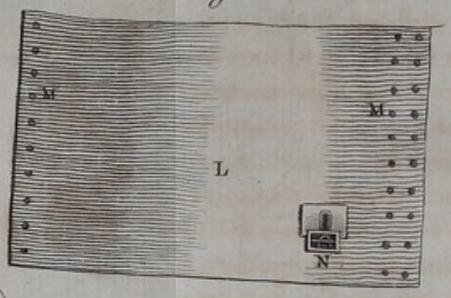

Fig. 11.

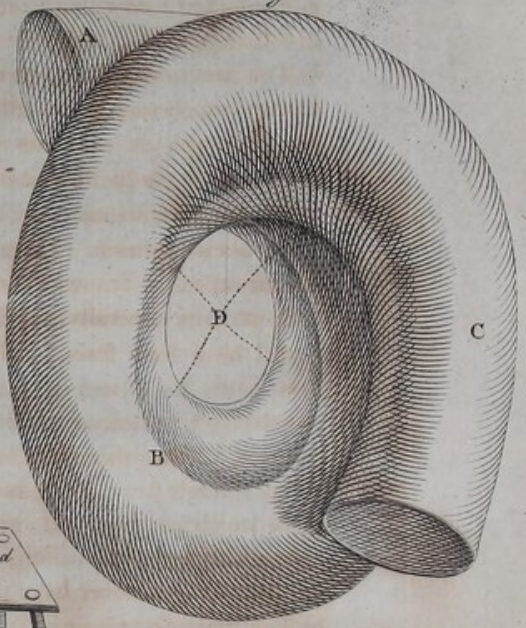

Fig. 5.

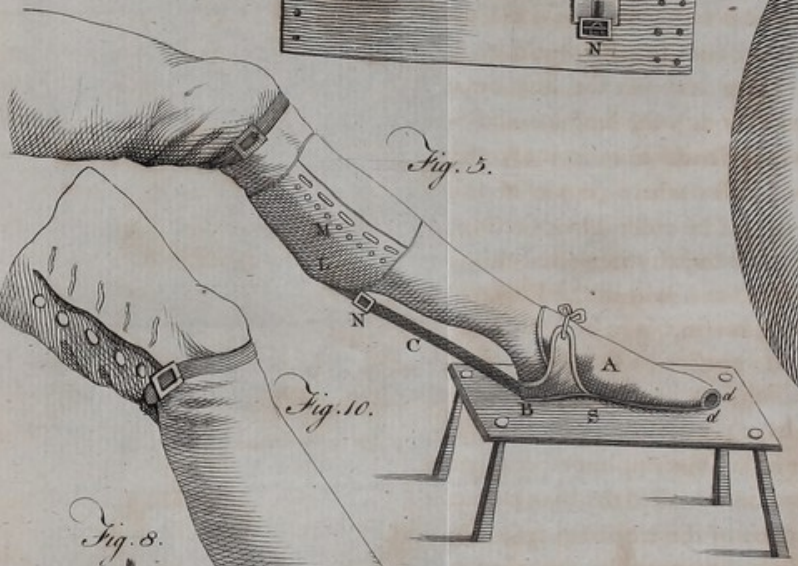

Fig. 10.

Fig. 8.

Fig. 7.

Fig. 9.

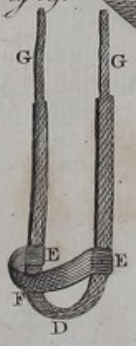

Fig. 12.

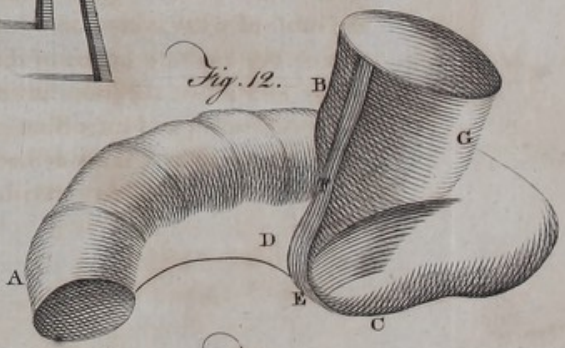

Fig. 6.

A Bell Sculpr.

N° 52.

A CHILD eſcaping at a RENT of the WOMB into the ABDOMEN.

IN March 1744, I was deſired by Mr Ramſay ſurgeon here, to witneſs the examination of the body of a woman who died in child-labour without being delivered. The account given me of this woman was, that ſhe was about 35 years of age, and had born two dead children, and a living one. Being at her full reckoning, her pains had begun on Tueſday morning, and continued in a natural way, the child advancing towards the birth, and ſome of the waters coming away all that day and Wedneſday, till Wedneſday evening, when, ſitting in a chair in labour, ſhe gave a ſudden ſpring from the chair, complaining of violent pain in her belly. The child never was felt afterwards by thoſe who attempted to aſſiſt her delivery. She conſtantly complained of violent pain in her belly, with her ſenſes and judgment entire, till Friday morning, when ſhe died. On Saturday her body was opened.

After cleaning away with ſponges a conſiderable quantity of blood floating in the abdomen, we ſaw a ripe child and its ſecundines lying in the lower part of it, a little to the right ſide. The child, placenta, and umbilical rope, were entire, and the membranes were as uſual after birth. The woman's uterus had its fundus raiſed as high as the navel, with its ſubſtance ſoft and ſpongy as is common in pregnants, nothing preternatural appearing in its fore-ſide: but when the fundus was turned down and forwards towards the oſſa pubis, a large rent four inches long was ſeen towards the neck of the womb; which being again put into its natural ſituation, was opened its whole length, in the middle of its fore-part, when we had a better view of the rent, extending from very near the

the *os uteri* upwards, a little obliquely to the right ſide. The *os uteri* was then very little open. The *cervix*, which is diſtinguiſhable plainly from the *fundus* in a woman not with child, was here extended into the ſame common ſac with it. The inner ſurface of the womb was all ſmooth, ſeeming to be covered with a fine villous membrane. From the larger ſize of the ſinuſes at the back and upper part of the womb, I judged the placenta to have been formerly applied there.

N° 53.

N° 53.

ACCOUNT

OF THE

INOCULATION of SMALL-POX in SCOTLAND.

To the Moſt Worthy DEAN, and Learned DELEGATES, of the Faculty of MEDICINE at Paris, appointed to inquire into the Advantages or Diſadvantages from INOCULATION of the SMALL-POX.

LEARNED GENTLEMEN,

IN the beginning of November laſt, I received the letter, dated in September, which you did me the honour to addreſs to me, deſiring my anſwers to five queſtions you propoſe concerning inoculation of the ſmall-pox, to aſſiſt you in forming a right judgment of the advantages or diſadvantages of that operation.

As I thought this a ſubject of ſuch conſequence to mankind, that it was every perſon's duty to contribute all in his power towards aſcertaining the good or bad effects of its practice, I immediately communicated the contents of your letter to all the phyſicians and ſurgeons of this place, and wrote to gentlemen of medical practice in the different counties

of

of Scotland, whoſe aſſiſtance I begged to have in forming proper anſwers, to which my own private knowledge was altogether inadequate.

By looking at the table inſerted in the anſwer to your ſecond queſtion, you will ſee what a public ſpirit my countrymen have ſhewed: and I am perſuaded, it is my fault that that table is not more complete, by my omitting to inform many other medical gentlemen of your deſire; which I flatter myſelf will be imputed to my want of memory, or knowledge of their names and reſidence.

One intention of mentioning here this general correſpondence, is to plead ſome apology for my anſwer to your letter being ſo long delayed.

QUESTION I.

Has Inoculation been long practiſed in your country, and with what ſucceſs?

Here are two articles which require to be ſeparately conſidered.

In anſwer to the firſt of theſe, to wit, *How long has Inoculation been practiſed in this country?* I ſhall relate the hiſtory of its practice here.

The inhabitants of Scotland generally have the ſmall-pox in their infancy or childhood; very few adults being ſeen here in this diſeaſe. Whether this is owing to any particular conſtitution of the air, or of the people, or to the diſeaſe not being ſo much dreaded as to cauſe any to fly from the place where it is, or to the great intercourſe which muſt be among the inhabitants in the towns, of which ſeveral, nay many families, enter to their houſes by one common ſtair, while in the villages the peaſants are generally aſſiſtant to their neighbours of whoſe family any is ſick, it is not now neceſſary to inquire.

When ſmall-pox appear favourable in one child of a family, the parents generally allow commerce of their other children with the one in the diſeaſe: nay, I am aſſured, that in ſome of the remote highland parts of this country, it has been an old practice of parents whoſe children have not had the ſmall-pox, to watch for an opportunity of any child of their neighbours being in good mild ſmall-pox, that they may communicate the diſeaſe to their own children, by making them bed-fellows to

thoſe

thoſe in it, and by tying worſted threads wet with the pocky matter round their wriſts.

The operation of inoculation, as now practiſed, was not however known in this country, till Mr Charles Maitland ſurgeon, after making trials on criminals, and ſucceſsfully inoculating the children of the Royal family at London, introduced this practice into England: and then returning to this his native country in 1726, went firſt among his relations in Aberdeenſhire, where he inoculated ſix children of gentlemen; of whom one labouring under a hydrocephalus, or water in the head, concealed from the operator, dying, there was ſuch a prejudice raiſed againſt this practice, that it was baniſhed from that part of the country during the ſubſequent twenty years, and with difficulty was again introduced there by Dr Roſe phyſician at Aberdeen.

In the ſame year 1726, Mr Maitland inoculated four children of a noble family in the weſt of Scotland, who all recovered well; while a fifth child of the ſame family, who was thought too young and weak to undergo this operation, being ſent to a diſtance before the other four were inoculated, there took the natural ſmall-pox and died.

The firſt place, however, where the practice of inoculation became frequent was Dumfries, a town where the natural ſmall-pox were generally of a remarkably bad malignant kind. Here it was begun about the year 1733, and has been employed ever ſince that time.

Gradually it was introduced into the other parts of Scotland; but ſo ſlowly, that moſt of thoſe in the table inſerted in anſwer to Queſt. II. were inoculated during the ten or twelve years preceding 1764.

The firſt and moſt general prejudice againſt inoculation, was its being deemed a tempting of God's providence, and therefore a heinous crime; for it was creating a diſeaſe by which childrens lives might be in danger. But parents who had loſt ſeveral children by the natural ſmall-pox, conſidering the probable advantages which artificial infection, by *giving the choice of the age and ſtate of the patient, of the ſeaſon, and the management as to diet, exerciſe*, &c. *before the ſmall-pox form*, has over the common natural way of catching this diſeaſe, and ſeeing the ſucceſs of it in their neighbourhood, looked on it as a ſalutary means of ſaving their childrens lives; and therefore, thinking the neglect of ſuch means to be criminal, had ino-

culation performed in their families *. The greater number of the gentry, and moſt of the medical gentlemen, ſee the latter ſcruple, or neglecting what they think proper means, in the ſtrongeſt light, and have their children inoculated; but the former one, the tempting of Providence, weighs more among many of the populace, who will not allow the ſmall-pox to be artificially implanted.

According to the one or the other of theſe two oppoſite ways of thinking, prevailing in different parts of this country, inoculation is admitted or refuſed; and this probably is one principal reaſon of the difference of the numbers in the table already referred to.

The ſcruple of tempting Providence being thus oppoſed, and in a manner balanced, by the other, of neglecting ſalutary means; thoſe averſe to inoculation now inſiſt on other conſiderations, which they think ſhould determine us againſt ſuch practice.

1. Inoculation, ſay they, may, and probably does, introduce ſmall-pox where they would not otherwiſe come, and therefore ſhould not be allowed.

The anſwer given to this argument by the oppoſite party is, That ſince very few of mankind now eſcape this diſeaſe, it muſt, ſooner or later, come to every place; and therefore, if it is true in fact that a much greater number loſe their lives by the natural than by the artificial infection, it is of more ſervice to introduce the ſmall-pox in a favourable way and ſeaſon, than paſſively to allow them to deſtroy multitudes: and they add, that on a compariſon of thoſe who have died of inoculated ſmall-pox, with thoſe who have died of this diſeaſe taken in the natural way, it is evident that there is a much greater proportion of the latter than of the former.

2. To invalidate the force of the preceding argument, That the ſmall-pox muſt come, ſooner or later, to every place, the oppoſers of inoculation inſiſt, that ſince this diſeaſe was only introduced into Europe about a thouſand years ago, it might again be baniſhed from it, by carefully guarding

* Several of my correſpondents have ſent me hiſtories of families, where the parents, having loſt ſeveral of their children by the natural ſmall-pox, cauſed all their ſubſequent children to be inoculated, without loſing one; and who are all alive after ſeveral years ſince the inoculation.

guarding againſt the introduction of infection, or by medicines which might deſtroy or change the parts of the human liquors that ſerve as fuel to the fiery poiſon of the ſmall-pox.

Their antagoniſts readily admit, that the baniſhment of the ſmall-pox would be of the greateſt benefit; but they think the execution of it impracticable. For if it were propoſed to be done by excluding from ſociety all who had any chance of a cauſe of infection about them, commerce among men would ſoon be entirely put a ſtop to; and even from what is ſeen in countries where there ſeems to be very little chance of infection being conveyed by ſuch communication, the ſmall-pox rage: Thus in our iſland of Shetland, where none arrive except after a voyage at ſea, and theſe are generally adults, who have already undergone this diſeaſe, it often is moſt general and violent.

If, to prevent contagion, a law was made, obliging all infected with this diſeaſe to be immediately put into hoſpitals at a diſtance from other houſes, this could not be done in proper time to thoſe infected in the natural way: for the infection is generally communicated ſome days before any ſymptom of the diſeaſe appears; nor can the fever preceding the ſmall-pox be always diſtinguiſhed from any other.

If the ſeeds of this diſeaſe could be deſtroyed by medicines which would not hurt the human conſtitution, the inventor of them would be a moſt univerſal benefactor to the human race; but unluckily there is not yet any ſuch known. Boerhaave's antimonial and mercurial medicines, the antiphlogiſtic method, Lobb's Æthiops mineral, &c. have been tried without having the deſired effect *.

3. Several think, that by the bills of mortality containing as great

 numbers

* Juniper being a plant unſuſpected of having any thing poiſonous in it, there could be no harm in making ſome experiments with it, on account of the two following facts communicated to me. A lady, when the ſmall-pox raged in her neighbourhood, bathed all her children daily in a bath made with juniper, and burnt juniper-wood in their rooms. Not one, of eight or nine children thus uſed, ever had the ſmall-pox, though, when adults, ſeveral of them attended their own children while in the diſeaſe.——On my telling this to a gentleman, he aſked me, if this might not poſſibly be the reaſon why none of a pariſh where juniper grows in great quantity were infected by the plague, ſo deſtructive to Scotland about the time of the Reſtoration, while the neighbouring pariſhes ſuffered greatly? which he aſſured me he had been well informed was fact.

numbers ſince inoculation was introduced as they did formerly, it may be concluded, that there is no ſaving of lives by this operation.

To this the following anſwers are made.

[*a*] From obſervation and plain facts, it can be demonſtrated, that the proportion of thoſe who die by inoculated ſmall-pox is much ſmaller than of thoſe who ſuffer this diſeaſe in the common way; and ſeveral of my correſpondents affirm, that, after a ſtrict inquiry, they are certain, a greater proportion of thoſe who recovered from the ſmall-pox after being inoculated, are in life and well, than of thoſe who received the infection without art.

[*b*] Inoculation has not hitherto been ſo general in any place as to make a conſiderable annual difference in the bills of mortality.

[*c*] In conſidering theſe bills, a variety of other circumſtances muſt be attended to: ſuch as, whether more inhabitants have reſorted to the place, or retired from it;—whether there have been more or fewer dangerous epidemical diſeaſes;—whether the proviſions have been equally good in the years when compariſons are made, &c. &c.

As the diſputants of both ſides would probably wiſh to ſee ſome examples of theſe bills, I ſhall give a table of the burials in the Grayfriars church-yard, where the dead of this city, Edinburgh, are interred; and of St Cuthbert's, or the Weſt-kirk yard, where thoſe of the ſuburbs and part of the country in the neighbourhood are buried, ſubjoining the number of thoſe among them who died of the ſmall-pox.——In this table I have put in one column the ten years before inoculation was much practiſed here; and in the oppoſite column are the ſubſequent ten years, when it has been more frequently, but far from being generally, performed, as is evident from the table itſelf, compared with the firſt article of the table of inoculated, in anſwer to Queſtion II.: for from this it appears, that 713 only have been inoculated in Edinburgh and Leith, of whom ten died; whereas in the table of burials in the two cemeteries mentioned, there have been 1185 burials of thoſe who died of ſmall-pox during the years when inoculation was moſt frequent, which ſhews that a very ſmall proportion of thoſe who had ſmall-pox was inoculated.

Years.

Years.	Total of Burials.	Dead of Small-pox.
1744	1345	167
1745	1463	141
1746	1712	128
1747	1200	71
1748	1286	167
1749	1132	192
1750	1038	64
1751	1241	109
1752	1187	147
1753	1105	70
	12709	1256

Years.	Total of Burials.	Dead of Small-pox.
1754	1215	104
1755	1187	89
1756	1316	126
1757	1267	113
1758	1001	52
1759	1136	232
1760	1123	66
1761	903	6
1762	1305	274
1763	1160	123
	11613	1185

From this table we are informed, that in each of theſe ten years, about one tenth of the dead in Edinburgh and St Cuthbert's pariſh were killed by the ſmall-pox.

What the number was of thoſe who recovered from the ſmall-pox I could not obtain information; and therefore cannot aſcertain what the proportion is of thoſe who die in this fatal diſeaſe, to thoſe who recover out of it *: but from the Edinburgh and Leith article of inoculation above-mentioned, and this table, one may be convinced, ſay the friends to inoculation, that a much greater proportion die by natural than by inoculated ſmall-pox; for by dividing the ſum-total of the burials in theſe twenty years by the number of years, there are 1216 inhabitants of Edinburgh and St Cuthbert's who die each year. If one twenty-eighth inhabitant dies yearly, there are in theſe diſtricts 34,048 people; or, if one thirtieth perſon only dies, the number is 36,480. Now, if the number of thoſe who recovered is to the 1185 who died of the ſmall-pox in the laſt ten years in the ſame proportion as in thoſe who were inoculated, which is nearly as 71 to 1, then the number who ſuffer the ſmall-pox every

* It is hoped, that when the Reverend Clergy are informed how ſatisfactory the knowledge of the proportion of thoſe who recover from natural ſmall-pox is to thoſe who die of it, will be to numbers of people who wiſh to compare them with the proportion of the inoculated, they will ſhew the ſame public ſpirit as the medical gentlemen have done, and tranſmit to me the numbers of their pariſhioners who ſurvive the ſmall-pox or die in them, that I may publiſh them as an appendix to the preſent work.

every year is 8413; that is, near to one fourth of the inhabitants; which cannot be ſuppoſed of a diſeaſe which people have only once in their lives.

From the above table of burials, it would ſeem, that the total number of burials, as alſo of thoſe who died of the ſmall-pox, has been fewer in the laſt ten years, when inoculation has been more frequent than formerly: but this decreaſe, eſpecially of the total number, might poſſibly be owing in part to the greater number than uſual of men who then went from this place to the army and navy in the late war; whereas the burials were increaſed in the preceding ten years by thoſe who died here of their wounds received at the battle of Preſton in 1745, and by the mortality from the malignant putrid fever which the ſoldiers quartered in town had ſome time after that, and which they communicated to ſeveral of the inhabitants. Hence in the preceding table, the total number of burials is much larger in 1745 and 1746 than in any other two years of the twenty in that table; while the numbers of thoſe who died of the ſmall-pox during theſe two years is near to the middle proportion of all the other twenty years, but larger proportionally than the ſum of the laſt ten years: which laſt circumſtance ſeems favourable for inoculation; while ſome of the preceding obſervations ſhew how neceſſary it is to conſider the different circumſtances in calculations, ſuch as I have been now mentioning.

4. The fear of communicating other diſeaſes than ſmall-pox, by the application of variolous matter when inoculation is performed, has deterred many from allowing this operation.

This objection muſt be conſidered in the anſwer to your Queſtion V.; where it is directly aſked, Whether other diſeaſes have been thus communicated? and therefore I muſt here refer to my anſwer to that queſtion.

Having thus ſtated the principal arguments employed for and againſt inoculation, I ſhall not draw any concluſion, but leave the determination of this affair to better judges, who are appointed by public authority for this purpoſe, and proceed in my hiſtorical narrative relating to this country; to which I am to confine myſelf entirely, in all the parts of this

this anſwer to the queſtions propoſed by the judicious Delegates, without pretending to give any argument or opinion of my own.

Thoſe who adviſe and practiſe inoculation in Scotland have generally avoided to let it be performed on children whoſe parents were unhealthy, or who had themſelves a bad conſtitution, or who were labouring under other diſeaſes, or even eruptions on the ſkin: and ſome will not allow inoculation while there are confluent malignant ſmall-pox frequent, or any other diſeaſe is very general; but cauſe great care to be taken in avoiding infection till a ſeaſon of the mild diſtinct ſmall-pox comes, and no epidemic diſeaſe rages.

Several, conſidering how much more liable very young children are to convulſions (the moſt frequent dangerous ſymptom in the inoculated ſmall-pox) than thoſe farther advanced in life, decline performing inoculation to very young infants.——While others think this diſeaſe commonly more favourable ſoon after birth, before there is any chance of its interfering with teething, which is another frequent cauſe of convulſions; and therefore adviſe inoculation to be performed early in life *.

Mild weather being generally allowed to be the moſt favourable in feveriſh diſorders, inoculation is commonly performed in the ſpring, or beginning of ſummer, and in harveſt; ſo as to avoid the ſultry heat of ſummer, or freezing cold of winter †.

Theſe precautions are not, however, always obſerved; the importunity of parents, the greater hazard from natural infection when it cannot be ſufficiently guarded againſt, and a variety of other circumſtances, have prevailed over practiſers to inoculate children, notwithſtanding ſome of the objections above-mentioned being applicable to their caſes.——What my

* That a more certain judgment may be formed of the time of life when children are moſt expoſed to convulſions from inoculation or natural ſmall-pox, I muſt beg my medical correſpondents to ſend me the ages of the children, their patients, who underwent convulſions which they judged to be owing to ſmall-pox. It is of importance to be known; and the practice of no ſingle perſon can ſo well determine it, as numerous obſervations can.

† I have, however, good information of 112 being inoculated in the middle of winter, in ſome of our moſt northern iſles, where there was ſcarce fuel enough to prepare victuals, and many of the inoculated went abroad bare-footed in ſnow and ice; yet not one of the whole number died.

my correſpondents complain moſt of is, the parents or relations not allowing inoculation to be performed till they ſee the natural ſmall-pox very frequent and mortal in their neighbourhood, when they abſolutely inſiſt on its being done.——Some of my friends write me, that notwithſtanding this diſadvantage of the bad natural ſmall-pox being in their neighbourhood, they have had the pleaſure of ſeeing all their inoculated patients recover, while ſcarce one of three, or even of ten, was ſaved of thoſe who had the ſmall-pox by natural infection.

When inoculation was firſt introduced into this country, thoſe who were to undergo it were prepared for the operation by blood-letting, purgatives, aperients, and low diet: but the gentlemen of practice obſerving that the eruption did not proceed ſo well in children thus weakened, as in thoſe who had not undergone evacuations, they are now generally omitted; and a mild cooling diet to the patient, or its nurſe, with a gentle laxative to empty the inteſtines, are the principal preparations.—Some however give *Æthiops mineral*, or ſuch other very inactive preparation of mercury, previous to inoculation; and think that thereby the violent ſymptoms of this diſeaſe are prevented.

The purulent matter employed for inoculation is taken from healthy children of ſound parents, then under the diſtinct, mild, fully-ſuppurated ſmall-pox, and as recent as it can be obtained.

When inoculation was firſt practiſed here, the operators made inciſions through the ſkin in more than one part of the body, and then filled the little wounds with cotton or lint wet with pocky matter: by which they thought two good intentions were anſwered; *firſt*, to make the effect of this matter in producing the expected diſeaſe certain; and, *ſecondly*, to diſcharge a conſiderable ſhare of the variolous matter, formed in the patient's blood, by the ſuppuration at theſe parts being plentiful, which freed them from more dangerous effects of the ſmall-pox. But this practice being blamed for the tumours, inflammations, and tedious ſuppurations, which ſometimes came after theſe wounds thus treated, a ſlight ſcratch is now generally made in the ſkin of one arm, into which a little piece of ſmall thread paſſed through pocky matter is put, and kept there ſome days by a bandage, which is found as effectually to produce the diſeaſe of

a mild kind, and does not ſo often ſwell, inflame, &c. as when the former method was followed.

Poſſibly ſtill gentler methods will be uſed: for we know that inoculation has ſucceeded when the pocky matter was applied to the ſurface of the ſkin from which the ſcarf-ſkin had been taken by a very ſmall bit of bliſtering plaſter.——In a letter tranſmitted to me, a gentleman informs me, that he gave the ſmall-pox of a good kind to a child by rubbing a little recent pocky matter on its ſound ſkin.—To confirm what I mentioned formerly of the Highland practice of communicating the ſmall-pox, I have received from a good hand the hiſtory of a perſon in the Iſle North Uiſt, entirely ignorant of medicine, who, being informed of the ſucceſs of inoculation in Sky, and ſeeing the ſmall-pox generally very favourable, put threads thro' ſome variolous puſtules, and applied them to the arms of two of his own children; who having mild diſtinct ſmall-pox, he made uſe of the matter from them, in the ſame manner, to the children of ſeveral of his neighbours; who all recovered from the ſmall-pox without any bad ſymptom.

Some of my correſpondents inform me, that fewer of their patients have failed of infection by inoculation ſince they have been in uſe to repeat the application of pocky matter ſome days, than formerly when they applied the matter only the firſt day.

So ſoon as inoculation is performed, the patients are generally confined from expoſure to much heat or cold, and they are not allowed violent exerciſe, nor rich ſtrong food or drink.

The fever and eruption of the ſmall-pox of thoſe infected artificially, are between the ſixth and fourteenth day after inoculation has been performed.—When theſe appearances are ſooner or later than the days now mentioned, the infection is thought to be from the air, and not by inoculation.

All the practiſers of inoculation agree in aſſerting, that there are much fewer confluent ſmall-pox, and much leſs danger of the ſecondary fever in this diſeaſe, when communicated by this operation, than when it is owing to the common natural infection.—Some of my correſpondents affirm, that when the malignant confluent ſmall-pox were epidemic, and very fatal in their neighbourhood, they became much milder and leſs dangerous ſoon after theſe gentlemen had inoculated a number of children in

that part of the country, with good matter taken from thoſe who had the diſeaſe in the moſt favourable way.

More of the patients who died of inoculation were killed by convulſions, near the time of the eruption of the pimples, or upon their ſubſiding on the ſecond or third day after their firſt appearance, and by eryſipelatous or raſhy eruptions, with ſpaſms when the ſmall-pox were blackening *, than by any other cauſe.—Some of the inoculated had the ſame appearances as in the bad confluent natural ſmall-pox;—and a few had other uncommon ſymptoms, the hiſtories of which I am to give in my anſwers to ſome of the other queſtions.

The general management of the inoculated, after the fever began, was, to give them the antiphlogiſtic or cooling diet, and plenty of weak antiputreſcent drink;—to guard againſt heat as well as cold;—and to keep both the mind and body as much in a ſtate of reſt as could conveniently be done. ——In great numbers of theſe patients no more was neceſſary: But when the fever was high, or too low;—when the eruptions collapſed, or did not fill in due time, or with right matter;—when convulſions, inflammatory eruptions, &c. ſupervened;—the practice was varied according to circumſtances, of which it would be impertinent in me to give an account to ſuch maſters of the ſcience of medicine as I now write to.

After the ſmall-pox blackened, and the patient's ſtrength or other circumſtances would allow, repeated purgatives were given, to carry off any remains there might be of the diſeaſe.——If any apparent diſorder was at this time obſerved, the proper practice to remove it was employed.

If I have been too prolix or minute in this hiſtorical narrative, I flatter myſelf, that the Learned Delegates will impute this fault to my zeal for their ſervice.

I ſhall now proceed to the ſecond article of Queſtion I.

With what Succeſs was Inoculation performed?

In

* When the ſkin of variolous pimples begins to ſhrivel, and the matter contained in it to change from the white to a darker colour, the ſmall-pox are ſaid here in Scotland to begin their blackening; and they are in a blackening or blackened ſtate till the dry cruſts ſeparate from the ſurface of the body.

In the letters of moſt of my correſpondents, mention is made of ſome on whom inoculation was performed without the effect of producing ſmall-pox:—Of theſe the greater number ſuffered nothing but the little operation;—in a few, the ſmall wound inflamed and ſuppurated ſome days.——I cannot ſpecify the number in whom inoculation failed to produce the deſired effect, becauſe many of my aſſiſtants did not inform me in how many they ſaw this failure; and I did not think the omiſſion of ſuch conſequence as to deſerve the trouble of their writing a ſecond letter on that account: but, on the whole, they ſeem to have been at leaſt as numerous as thoſe in the column of the dead in the anſwer to Queſtion II.

Though my friends neglected the numbers of thoſe who ſuffered ſcarce any inconveniency from the failure of inoculation, yet they are particular as to thoſe who underwent any other trouble from this operation; and theſe are the following.

In three inoculated, a fever was obſerved at the common time; but went off without eruption *.

One, whoſe hiſtory ſhall be afterwards related, had no variolus eruption; but ſuffered greatly from an abſceſs in the arm-pit.

One, on the ſixth day of inoculation, had eryſipelas on the face, which went off without any variolous puſtules appearing.

Of twelve infants, inoculated within a fortnight of their birth, not one had the ſmall-pox; but in ſome of them a raſh appeared about the time when the variolous eruption uſes to be ſeen.——Children five months old, inoculated at the ſame time, and with matter from the ſame ſubject, had the ſmall-pox in the regular manner †.

Several who had no ſmall-pox from a firſt inoculation, had this diſeaſe by repeating the operation once or twice.

* In a letter from a gentleman of long practice, it is affirmed, that thoſe who have a fever excited by natural or artificial variolous infection, without eruption, are as little ſubject ever after to true ſmall-pox as thoſe in whom this diſeaſe proceeded in the ordinary form; and that he had frequently foretold this, and was not once diſappointed.—I beg other practiſers would inform me what they have obſerved as to this fact.

† What was the ſhorteſt time after birth when the ſmall-pox were produced by inoculation is wiſhed to be known.

Some in whom the inoculation had failed to produce the deſired effect, underwent, after ſome time, the ſmall-pox in the common natural way.

A few in whom the inoculation had been repeated without effect, have now had communication ſeveral years with thoſe in the ſmall-pox, without being infected by it.

The ſucceſs as to life is next to be related, in anſwer to

QUESTION II.

Did ſome of the Inoculated die?

That ſeveral inoculated died, is certain; and of theſe the greater number loſt their lives by that infection; while ſome who had the operation performed on them, and died ſoon after, were thought to have been killed, or to have had their danger greatly increaſed, by other cauſes.

To ſtate, in an eaſy view, the proportion of thoſe who died, I have formed, out of my public-ſpirited correſpondents letters, the following table. In the firſt column of which the names are put of the gentlemen who are my informers.—In the ſecond column are the names of the places where they reſide, in and near to which their practice principally is. —The third column contains the numbers of thoſe who recovered from ſmall-pox which they had by inoculation.—And, in the fourth, is the number of all the inoculated who died, without making any allowance for the other cauſes which were alleged to have brought on the fatal cataſtrophe.

TABLE

TABLE OF INOCULATION.

Correſpondents.	*Reſidence.*	*Recovered*	*Dead*
The phyſicians and ſurgeons of	Edinburgh and Leith.	703	10 = 1/71
Meſſ. William Hutchiſon, John Cuningham, Calderwood	Dalkeith	52	1
Mr Thomas Dallas, Mr Archibald Scot	Muſſelburgh	14, 12	
Mr John Forreſt	Tranent	16	1
Mr Charles Macky	Ormiſton	28	
Dr James Lundie	Haddington	100	2
Mr James Hamilton	Dunbar	38	
Dr William Balderſton, Mr James Wood	Berwick	29, 21	
Dr John Millar	Kelſo	34	1
Dr Ormiſton	Kelſo	6	
Mr Thomas Davidſon	Kelſo	9	
Dr Robert Mercer	Selkirk	24	
Mr William Laing, Mr Thomas Rutherford	Jedburgh	17, 7	
Mr William Scott	Hawick	31	
Mr John Dunſe	Langholm	8	
Dr George Grieve	Peebles	2	
Dr James Hunter	Moffat	70	
Dr Ebenezer Gilchriſt	Dumfries	560	9
Dr Alexander Campbell	Ayr	75	2
Dr Jaſper Tough	Kilmarnock	24	
Dr John Cumming	Irvine	260	1
Mr Lachlan Campbell	Cambelton	65	1
Mr James Flint, Mr Swan	Dumbarton	150, 59	2
Mr Alexander Moliſon	Port Glaſgow	95	1
Mr H. Maclean	Port Glaſgow	5	1
Mr Nathaniel Wilſon	Greenock	25	
Mr Graham, Mr Gilbert Lauſon	Paiſley	17, 12	1
Dr John Gordon	Glaſgow *	200, 64	2
Mr John Moore	Glaſgow *		
Mr Thomas Hamilton	Glaſgow *	50	
Mr Robert Wallace	Glaſgow *	32	
Mr Ninian Hill	Glaſgow *	50	
Meſſ. Maxwell & Parlane	Glaſgow *	60	2
Mr John Crawford	Glaſgow *	300	1
Mr James Muir	Glaſgow *	200	2
Dr John Cook	Hamilton	13	
Mr William Leckie	Broich	16	
Dr Walter Stirling	Stirling	208	
	Carried over,	3751	40

Correſpondents.	*Reſidence.*	*Recovered*	*Dead*
	Brought over,	3751	40
Mr James Oughterſon	Falkirk	38	1
Mr Robert Kirkland	Gogar	85	1
Mr Robert Spotſwood	Cramond	5	
Dr James Smith, Meſſ Glaſford & Clerk	Borrowſtounneſs	12, 5	
Dr John Stedman, Mr William Gulland, Mr William Stenhouſe	Dunfermline	48, 5, 20	1
Dr Henry Miller	Kirkaldy	42	
Dr Thomas Simſon	St Andrew's	42	4
Dr George Bethune Rigg, Robert Menzies	Coupar of Fife	11, 5, 30	2
Mr James Paterſon	Carpow	4	1
Dr Robert Wood	Perth	73	
Mr Neil Menzies	Perth	8	1
Mr Patrick Niſbet Davidſon	Perth	19, 2	1
Mr Lindeſay	Crief	6	
Mr James Spence	Dunkeld	15	
Dr Ogilvie	Forfar	30	
Mr John Stevenſon	Arbroath	30	
Dr John Mudie, Dr Aikman	Montroſe	7, 3	
Dr Alexander Roſe	Aberdeen	49	3
Dr Thomas Livingſtone	Aberdeen	28	1
Dr Forbes	Aberdeen	10	
Dr Burnet	Aberdeen	9	
Dr Andrew Skene	Aberdeen	31	
Dr David Skene	Aberdeen	30	
Dr James Saunders	Bamff	310	1
Dr Seton, Dr Finlay	Fraſersburgh	17, 5	
Mr David Brodie	Elgin	2	
Mr Forbes	Nairn	8	
Dr John Alves, Mr Alexander Munro	Inverneſs	25, 10	1
Mr John Maclean	Sky	188	10
Mr Neil Beton	Dingwall	10	
Mr Hugh Macfarquhar	Tain	23	
Dr Alexander Mackenzie	Milnmount	55	
Mr Alexander Mackenzie	Dornoch	127	1
Dr William Sinclair	Thurſo	245	3
Dr Hew Sutherland †	Orkney	60	1
Mr John Gifford	Shetland	16	
	Total,	5554	72 = 1/78

* My ingenious friend Dr Alexander Stevenſon phyſician in Glaſgow, to whom I am obliged for collecting the liſts and obſervations ſent me from that city, and the towns in its neighbourhood, had always ſurgeons employed when he attended inoculated patients, who are all in the liſts ſent by the ſurgeons, and therefore his name could not be inſerted in the table.

† My worthy friend Dr Sutherland unluckily died before I began this inquiry. The number I have put to his name I am certain of by the information received from Mr Mackenzie of Dornoch, who was his aſſiſtant when he firſt began this operation: but in another letter, the authority of which I cannot ſo much rely on, it is aſſerted, that Dr Sutherland inoculated 600, of whom only one died; but whether 112, inoculated in the North Iſles by Mr Mackenzie, are included in this number, I cannot determine.

Without

Without any regard to the uncertain account of Dr Sutherland's practice, or to the different cauſes which the practiſers of inoculation thought contributed to the death of their patients, it appears from this table, that ſcarce one of ſeventy-eight dies of ſmall-pox thus artfully excited; whereas, from Dr Juryn's and Dr Sceuchzer's accounts of the proportion of deaths to thoſe who recover of ſmall-pox taken by the common natural infection in ſeveral parts of England, we ſee that one of ſix dies; and of thoſe inoculated in England, during the firſt eight years after inoculation was practiſed there, one of fifty died, when no allowance was made for other cauſes.

Theſe cauſes ought, however, to be conſidered, and the caſes of ſuch patients to be fairly ſtated, that every one may judge what allowance is to be made for them in determining the proportion of thoſe who recover from inoculation to thoſe who die of it.——I ſhall therefore here relate what has been communicated to me by my correſpondents concerning this ſubject, arranging them, according to the cauſes, into claſſes; whereof [A] is the bad conſtitution of the patient, and improper time of inoculation;—[B] is the bad management of the inoculated;—[C] the natural, not the artificial infection, being the cauſe of death;—[D] other ſupervening diſeaſes killing the patients.

[*A*] *Bad conſtitution and improper time.*

1. A child of a very weak ſickly conſtitution was inoculated contrary to the declared opinion of the ordinary phyſician of the family, who at the ſame time conſented to the operation being performed on other two children of the ſame family; who recovered very eaſily, though the firſt-mentioned died.

2. A child too luſty, and under fits of teething, was inoculated contrary to the opinion of the operator; and falling into a convulſion two days before the ordinary time of eruption, died in it.

3. 4. Two in ſuch bad ſtates of health, that the inoculators refuſed for ſome time to perform, but were at laſt prevailed on to do it by the earneſt ſolicitation of the parents, who flattered themſelves that their childrens conſtitutions might be mended, as others of their acquaintance had been, are in my column of dead.

One

5. One always very ſickly, and ſubject to frequent raſhes and other cutaneous eruptions, which were concealed from the operator, was inoculated, while a very mortal confluent ſmall-pox was very frequent in the neighbourhood, and died.

6. A child under teeth and itch, concealed from the inoculator, died.

7. 8. A child under a ſevere cold and teething, and another while in a common fever, were inoculated, and died.

9. A child whoſe head was larger than ordinary, and of a family where eleven of fourteen children had died of diſeaſes in the head, is in the column of the inoculated who died.

[*B*] *Bad regimen or management.*

10. A child, whoſe mother was its nurſe, became feveriſh on the third day of eruption, which cauſed violent anxiety in the mother; a raſh, with coſtive belly, was then obſerved, and the child died on the ſecond day after it.——At the ſame time another child, who had a nurſe of little anxiety, fevered alſo on the third day, but recovered well.

11. A very anxious mother kept her child, contrary to the advice of the inoculator, in a very cloſe warm way, from the day of inoculation till it died.

12. An attendant clandeſtinely gave large quantities of ſtrong food and ſweet-meats to an inoculated child, who fevered and died.

13. A nurſe of an inoculated child who died, was diſcovered to have drunk immoderately of malt-liquor during the proceſs of inoculation.

14. One indulged in animal-food and fermented liquors, and who was overheated by running in the open fields ſome days after being inoculated, is in the column of the dead.

15. The nurſe of an inoculated child who died, was ſuſpected to have been tainted with the *lues venerea* by her huſband; who was afterwards diſcovered to have had this diſeaſe at the time ſhe was nurſing this child.

[*C*] *Natural infection.*

16. 17. While very bad confluent epidemical ſmall-pox raged, three daughters of parents whoſe families had ſuffered greatly by natural ſmall-pox, were inoculated at their intreaty, after being prepared with *Æthiops mineral*,

mineral and ſome doſes of cathartics. The arms of the two eldeſt, where the inciſions were made, never inflamed, nor did the little wounds ſuppurate. They ſickened on the eighth day of inoculation; and ſoon after the eruption ſhewed itſelf of a bad kind, and on the ninth day thereafter they both died.—In the ſame week twelve other children, who had the ſmall-pox from the common natural infection, died in the ſame little ſtreet.—The third child's arm inflamed, and diſcharged matter eight days, and then healed.—Upon her two ſiſters pox being ſeen of a bad kind, ſhe was removed to a houſe at a diſtance from her father's, where ſhe fevered on the twenty-fourth or twenty-fifth day after her inoculation, and had a great number of diſtinct, but watery ſmall-pox, from which ſhe narrowly eſcaped with her life.

18. 19. While the epidemic ſmall-pox with petechiæ raged, four children were inoculated, of whom two became ſick on the ſixth day, with all the ſymptoms of the then epidemic, and died.—The other two ſickened two days later, and had very mild ſmall-pox.

20. A child ſickened immediately after inoculation, and variolous puſtules appeared on the third day.—On the fourteenth a mortification was ſeen at the inciſion in the leg, with ſwelling and inflammation on all that thigh and leg.—There were afterwards two returns of theſe ſymptoms, and eryſipelatous ſwellings appeared in other parts of the body, and at laſt death put an end to all the troubles.—Another child inoculated with the ſame pocky matter as was employed to raiſe the ſmall-pox in the preceding caſe, fevered at the ordinary time, and recovered, without having any bad ſymptom.

21. A child ſickened the third day after inoculation, and the ſmall-pox were ſeen on the ſixth, of a moſt virulent kind, which cauſed death; while another inoculated with the ſame matter, had the ſmall-pox at the ordinary time, and altogether favourable.

22. 23. While the ſmall-pox were frequent, and of a very bad kind, one inoculated child fevered on the third day, and the puſtules appeared on the ſecond day after this; and another fevered on the fifth day after the inciſion.——The ſmall-pox in both were very confluent; and one of the patients died on the eleventh day after the firſt appearance of eruption, and the other died on the tenth day after inoculation..

24. One

24. One who had communication with a family where very bad natural ſmall-pox then were, being inoculated, the puſtules made their appearance between the third and fourth day after inoculation.—The ſmall-pox were of a very bad kind, and the patient died.

25. Five were inoculated with long-kept matter on the fourteenth day thereafter. One of theſe fevered, and in two or three days more the ſmall-pox appeared. This patient did well, and recovered.——Three of the five fevered ſix weeks after the inoculation. One of theſe had numerous but diſtinct ſmall-pox, and recovered: but the other two had the bad confluent kind; of which one died, and the other was much pitted.—The fifth of the inoculated had no ſmall-pox.

26. A girl inoculated on Monday, ſickened on Tueſday, and died on Friday, covered with livid ſpots, but without any variolous puſtules.—Three others of the ſame family, inoculated at the ſame time, firſt ſickened on the eighth day.—One of them had purple ſpots, with the ſmall-pox;—the ſecond had them of a milder kind;—and the third had them in the moſt favourable way. They all three recovered.

27. The arm of an inoculated child healed ſoon without inflammation, or any other bad ſymptom, till after twenty days, when it ſickened, and had confluent ſmall-pox, of which it died.—Two brothers of this child inoculated at the ſame time with it, had the ordinary courſe of mild ſmall-pox by inoculation, and recovered ſoon.

[D] *Supervening diſeaſes.*

28. In a child who had been inoculated, two teeth appeared about the time of its death.

29. In a ſeaſon when eryſipelas was very frequent, a child was inoculatted for the ſmall-pox. Next day, an eryſipelatous ſwelling was ſeen on the ſcarified arm.—The fever and ſmall-pox were mild; but the eryſipelas gradually extended itſelf over the arm and a conſiderable ſhare of the trunk of the body.—The ſmall-pox being few, diſtinct, and filled with good matter, blackened on the ninth day after their firſt appearance; but the eryſipelatous œdematodes having continued to extend itſelf, the patient died on the twelfth day.——Others who were inoculated with mat-

ter taken from the ſame perſon, had the ſmall-pox of a good kind, without eryſipelas, or any other bad ſymptom.

30. While eryſipelas and a ſlight kind of the malignant ſore throat were frequent, a child being inoculated, was ſeized with a ſcarlet eruption, and died.—A ſiſter of this child, who formerly underwent the ſmall-pox, having her ears pierced at this time, was alſo ſeized with the ſcarlet fever.

31. 32. Four children were inoculated at the ſame time.—On the evening of the day of this operation, an elder ſiſter of theirs, who had formerly the ſmall-pox moſt ſucceſsfully by inoculation, ſhewed ſome ſymptoms of the *tuſſis convulſiva*, (kink or hooping cough). Whenever her being in this diſeaſe was aſcertained, ſhe was ſent from home to a friend's houſe, where ſhe had this cough ſo violently, that with difficulty her life was ſaved.—One of the inoculated had the ſmall-pox regularly, and not above ſixty in number, which maturated properly; but ſymptoms of the kink-cough gradually increaſing during the progreſs of the ſmall-pox, it became ſuffocating at their blackening, and ſhe died ſoon.—The youngeſt child inoculated had mild ſmall-pox and cough; but ſoon after the blackening of the pox an eryſipelatous eruption appeared near the inciſion for inoculation, and then ſpread over her arm to different parts of the body. This, with the continuing convulſive cough, put an end to life in a few days after the death of the child in the preceding hiſtory.

33. On the third day after a girl was inoculated, meaſles, with their preceding and concomitant ſymptoms, appeared; and were ſo violent, that ſhe died on the twelfth day.—Her brother had the ſmall-pox by inoculation in a favourable way, at the ſame time; but on the ſixteenth day, when the ſmall-pox were fully blackened, he was ſeized with the meaſles, which were ſevere but not mortal.

34. 35. 36. Three of the patients whoſe hiſtory is related in my anſwer to Queſt. V. to wit, the one with cramps in her bowels and tumours in her limbs,—the child whoſe clavicles became carious,—and the one who died ſcrophulous, being inſerted into the column of the dead, notwithſtanding its being alleged that the ſmall-pox were not the cauſe of their deaths, ſhould be added to the caſes above related, on which judgement is to be paſſed by thoſe who conſider this ſubject; and according to

inoculation

inoculation being acquitted of more or fewer deaths laid to its charge, it will appear more or leſs beneficial.

Thus, if the death of all the thirty-ſix patients whoſe caſes have been juſt now mentioned, is attributed to no other cauſe than inoculation, every ſeventy-eighth perſon of thoſe who have the ſmall-pox by inoculation dies of that diſeaſe, as you ſee added to the ſums in the table. But if any think the other cauſes mentioned rather to have cauſed ſome or all of theſe deaths, then ſuch number being ſubtracted from the ſum total of deaths, the proportion changes in favour of inoculation: As, for example, if four are ſubtracted, the proportion is one of 82; if the ſubtraction is of 8, the proportion is $\frac{1}{87}$;—if of 12, the proportion is $\frac{1}{93}$;—if of 16, it is $\frac{1}{100}$;—if of 20, it is $\frac{1}{107}$;—if of 24, it is $\frac{1}{113}$;—if of 28, it is $\frac{1}{120}$;—if of 32, it is $\frac{1}{127}$; if all the 36 were admitted to die of other diſeaſes, one of 155 would only have been killed by the ſmall-pox: and in this calculation no regard is had to the 540 or 428 patients, who, beſides the 60 entered in Dr Sutherland's name into the table, were ſaid to have been inoculated ſucceſsfully by him.

QUESTION III.

Did ſome who had undergone Inoculation take the natural Small-pox afterwards, and at what time?

It was already obſerved, that the greater number of thoſe who had the operation of inoculation performed on them without being infected by it, were afterwards ſubject to ſmall-pox from a ſecond or third inoculation, or by infection in the natural way: but my correſpondents almoſt all agree with me in affirming, that they never ſaw any attacked by *true* ſmall-pox after they had the *true* kind, whether communicated by art or nature; and I have good information of freſh variolous matter having been applied to the little ſores which continued open, and running, after the blackening of the ſmall-pox was complete, without cauſing new puſtules, or any other obſervable phenomenon.

I have been ſeveral times told by parents and relations, that the children then under my care in the *true* ſmall-pox had formerly undergone

that diſeaſe: but upon my deſiring them to recollect, whether the ſame individual pimples had, in the former diſeaſe, remained turgid till at leaſt the ſeventh day of their eruption, as they might ſee the preſent ones would do; or whether there was only a ſucceſſion of pimples, each of which collapſed on the third, fourth, or fifth day after the eruption of each, and by their ſucceſſion there was an appearance of turgid pimples on ſome part of the ſkin during eight, nine, or ten days; they acknowledged, that each of the pimples in the former diſeaſe ſeemed ripe, and collapſed, before the ſeventh day; and thence I concluded that former diſeaſe to have been one of the *baſtard* kinds of ſmall-pox.

One hiſtory was indeed wrote to me, of a child who was ſaid to have died of the natural ſmall-pox a year or two after having this diſeaſe by inoculation; which had induced many to refuſe inoculation to their children or friends.—Luckily the names of the parents were mentioned, which gave me the opportunity of making a ſtrict inquiry into this caſe; and now, from undoubted good evidence in my poſſeſſion, I can relate it.——In October this child had the inciſion made, and pocky matter applied to the little wound in its arm; but neither fever, inflammation, ſmall-pox, or any other diſorder, were produced, and the inciſion healed in a few days:—the parents therefore reſolved to have the child inoculated in the mild warmth of the following ſpring; but, unfortunately, in the month of March, the child was attacked and killed by the ſmall-pox catched by the common natural infection.——Other children of the ſame parents have ſince had the inoculated ſmall-pox in a very favourable way, and have frequently ſince that been expoſed to infection without any ſort of diſorder.

QUESTION IV.

Do you know that other Diſeaſes have been ingrafted with the Small-pox by Inoculation?

I never ſaw other diſeaſes communicated by inoculation; and my correſpondents agree with me in this negative; nay, one of them informs me, that variolous matter taken from a child in the natural ſmall-pox, who

who at the ſame time had the hooping or kink cough, was employed for inoculating another child, who thereby had the ſmall-pox, but ſuffered no *tuſſis convulſiva.*

I muſt, however, here relate a hiſtory ſent to me, which is thought to infer the ingrafting other diſeaſes by inoculation for the ſmall pox.—A phyſician who had a number of patients in an epidemical *raſh*, cauſed his own child to be inoculated; and being attentive to its welfare, viſited it often.—On the eighth day after inoculation, the *raſh* appeared on the child; but going ſoon off, the ſmall-pox roſe, and were of a very good kind.—Matter taken from this child's pox was employed to inoculate other children; who had the *raſh* and the ſmall-pox in the ſame way as the former one.—The matter taken from theſe had the ſame effect on another ſet of children:—and theſe, I am told, but not on ſo good authority, infected a third ſet in the like manner.

As the firſt child mentioned in this hiſtory had the *raſh* from its father, or the epidemic conſtitution of the air, many think, that the *raſh* in the other children was rather owing to contagion communicated in ſome ſuch way, than to the variolous matter with which they were inoculated.

QUESTION V.

Whether did many, after Inoculation, labour under various Diſeaſes which ſeemed to be owing to this operation? and whether did this happen more frequently or ſeldomer than from the natural ſmall-pox?

The ſides of the little inciſion made for inoculation generally ſwell, inflame, and ſuppurate, and a diſcharge of matter continues from them till the ſmall-pox are gone.

Theſe little ſores have ſometimes continued running weeks or months after the ſmall-pox.

In ſome the ſwelling of the arm has been conſiderable, and the glands of the arm-pit have ſwelled and become hard; but both theſe ſymptoms generally diſappeared as the ſmall-pox ripened.——In a few the axillary glands ſuppurated; but in a mild way, and ſoon healed.——One hiſtory

ſtory of a ſuppuration in this part, which I formerly referred to, ſeems worthy to be related. An inoculated child was ſeized with a fever on the fourteenth day after inoculation; on the ſeventeenth, little pimpliſh ſpots were ſeen, but diſappeared next day, and no puſtules could afterwards be obſerved. The child continued very feveriſh and in pain during a month: at the end of which a large tumour was diſcovered in the arm-pit; which being fully ſuppurated, was opened next day, and then all the bad ſymptoms ceaſed.——This child has not yet had *true* ſmall-pox, though, during near three years ſince the boil in the arm-pit, it has been ſeveral times in the way of infection; but it has ſuffered the *baſtard* ſmall-pox, with a ſmart fever before their eruption.

Two hiſtories are ſent me of children who, in the fever before the eruption of inoculated ſmall-pox, had ſuch coldneſs in their feet and legs, as ſcarce could be removed by any applications, but went off as the pimples appeared.

The convulſions about the time of the eruption and ſubſiding of the inoculated ſmall-pox formerly mentioned, is the moſt frequent bad ſymptom in this diſeaſe; and by them more of thoſe in the column of dead loſt their lives than by any other cauſe.——On the other hand, ſeveral of my correſpondents remark, that thoſe who ſurvive the convulſions at the eruption of the ſmall-pox, brought on by nature, or by art, have generally few and very favourable ſmall-pox.—An exception to this is wrote me of a young lady, who, after convulſions, had a very bad confluent ſmall-pox; at the *blackening* of which the convulſions returned, and killed her.—By the ſhock of ſuch convulſions from ſmall-pox, another young lady was made incapable of ſpeaking or walking; and now, after ſeveral years, ſhe has not the right uſe of the members affected.

Two of the inoculated had tubercles, like thoſe occaſioned by the bites of buggs, ſome days before the eruption of the ſmall-pox; but they went off as the pocky pimples advanced.

Raſh, and ſuppurating tubercles, in different parts of the body, have been obſerved after the artificial ſmall-pox blackened; and ſome of my correſpondents think that this oftener happens in ſuch as had very few puſtules than in others.—Theſe ſymptoms have generally been eaſily removed. But there are two examples ſent me of ſuppurations which were

tedious

tedious in the cure.—One of theſe patients had a nurſe ſubject to inflammatory eruptions, and who, in the time of the child's inoculation, had ſores on her neck and upper part of her breaſt, which ſhe artfully kept long concealed.

One inoculated patient, ſubject formerly to inflamed eyes, had them worſe after the artificial ſmall-pox.

Some alleged, that the misfortunes in the following caſe were owing to inoculated ſmall-pox; others attribute them to a different cauſe. That you may be able to determine this queſtion, I ſhall give the hiſtory of the patient, as it is communicated to me. Six of one family were inoculated, and all of them had a very favourable good ſmall-pox, and recovered ſo well as to be let go abroad to their childiſh plays. About three weeks after the blackening of theſe pox, three of the inoculated, and ſeveral others of the family who had the ſmall-pox ſeveral years before, were ſeized with an eruptive fever, which was then epidemical in the neighbourhood. The fever was generally mild, ſcarcely confining any to bed: but was rather more ſevere to a girl, the eldeſt of the inoculated, than to the others; and the eruptions, which had ſomething of the meaſly appearance, going off ſuddenly from her ſkin, ſhe was ſeized with ſpaſms in her bowels, and trembling of her whole body, which went off, and returned periodically, with violent pain in the toes of the left foot, and at laſt ended in a paralytic affection and mortification of that leg. She ſtruggled more than three months under a train of misfortunes, and then died. She is in my column of dead; but is one of the three laſt-mentioned exceptions to the number in that colum.

One had a ſlow ſwelling on the ankle, which was ſome months in healing.

One was ſubject to glandular ſwellings and excoriations of the feet, after having undergone the inoculated ſmall-pox.

A child of parents of a ſcorbutic habit, whoſe hands were generally hard and ſcaly, with chops in them, being inoculated, had about ſixty ſmall-pox, with little or no uneaſineſs till the fifth day of the eruption; when, being carried through the houſe, and to the open air at the door of it, ſhe was ſeized with a violent fever, which continued three weeks. In the courſe of this fever, ſeveral abſceſſes formed, containing a ſanious matter;

matter; and in two of theſe the clavicles ſeemed to be carious. By the diſcharge from theſe ſores, ſhe ſunk and died. This is another exception to the column of the dead.

A gentleman told me, that he had ſometimes ſuſpected *ſcrophula*, king's-evil, to have been a conſequence of inoculation: but being aſked what the conſtitution of the parents of the children thus affected were, he ſaid ſome of them had been ſcrophulous; and the others, whoſe hiſtory he had no ſuch acceſs to know, were of the make and countenance which I deſcribed thoſe ſubject to ſcrophula generally to have.

One of my correſpondents writes me, that a ſcrophulous boy, whom he unwillingly inoculated at the earneſt ſolicitation of the parents, has had a better conſtitution and fewer running ſores, ſince he recovered from the artificial ſmall-pox, than he had before that diſeaſe.

Several of my correſpondents aſſure me, that not a few children, who were delicate and unhealthy, had their conſtitutions greatly mended, after undergoing the inoculated ſmall-pox; and that the knowledge of this was the motive inducing ſeveral parents to inſiſt on the inoculation of children whom the inoculators did not think proper patients for undergoing ſuch an operation.

An ambiguous caſe, or at leaſt about which there have been different opinions, I muſt refer to your judgment A girl, four years old, the child of ſound parents, being inoculated, fevered at the ordinary time, and continued in the fever three days; during which the lips of the wound ſwelled, inflamed, and diſcharged fetid ichor. The fever then abating, the little ſore ſuppurated plentifully, ſeveral thick ſloughs caſting off, by which the orifice was conſiderably enlarged, and ſome few puſtules appeared round the edges of it; but whether theſe were owing to local infection, or to a ſticking-plaſter applied there, the obſervator could not ſay. The ſore continued to diſcharge matter plentifully two months, and then gradually healed. The child remained in perfect health fifteen months, when ſome ſwellings of the ſcrophulous kind appeared. Several months after ſhe became hydrocephalous, and died. She is alſo in the column of the dead; but is the laſt of the exceptions referred to from the anſwer to this Queſtion V.

Theſe hiſtories of all who were ſuſpected to have diſeaſes in conſequence

quence of inoculation, that have come to my knowledge, are the only anſwer I can give to the firſt part of your fifth Queſtion, viz. *Whether did many, after inoculation, labour under various diſeaſes which ſeemed to be owing to inoculation?* But as to the ſecond part of that queſtion, *Whether theſe diſeaſes happened more frequently or ſeldomer after inoculation than from the natural ſmall-pox?* my correſpondents ſeem all to agree, that there are not near ſo numerous or various bad conſequences after inoculation, as after the ſmall-pox by natural infection; and when I aſſure you, that I have been ſo fortunate, or perhaps timorouſly cautious, that not one of thoſe whoſe inoculation I adviſed had a dangerous ſymptom during the diſeaſe, nor a bad conſequence from it, you will conclude that I muſt be of the ſame opinion with them.

Having thus anſwered the judicious queſtions of the Learned Delegates in the beſt manner I could, I ſhall conclude this long epiſtle with my moſt earneſt and ſincere wiſhes, that the preſent inquiry may be as beneficial to mankind as the Delegates intend it. I am,

Moſt Worthy Dean,

Your and their moſt obedient humble Servant,

EDINBURGH, June 27. 1764.

ALEX. MONRO.

Nº 54.

De Cuticula Humana.

APUD omnes in confeſſo eſt, nullo expreſſiore, ſimulque ad aſſenſum extorquendum efficaciore argumento, evinci ſummi Numinis exiſtentiam, quam eo quod ex mundi rerumque quæ in eo ſunt contemplatione nobis ſubminiſtratur: Qui enim tam elegantem machinam excogitarit, infinita ſapientia; et qui excogitatam perfecerit, immenſa item potentia præditum eſſe neceſſe eſt. Data mihi provincia eſt, ut ex tam vaſta a ter maximo hoc Conditore factorum operum copia, perexiguæ cujuſdam partis fabricam explicare adniterer. Id ſcilicet muneris mihi impoſitum eſt, ut corporum animatorum, præſertim vero humani, ſtructuram et conſtitutionem perveſtigarem, ejuſque notitiam aliis pro virili impertirem. Fieri autem omnino non poteſt, quin qui hanc ſcientiam vel a limine ſalutarit, alacri, lubentique animo agnoſcat, non minus vere quam eleganter a pſalmographo dictum, Nos verendum, atque mirificum in modum factos eſſe. Niſi enim omni prorſus cogitatione ſimus deſtituti, non poſſumus non corporum noſtrorum artificium admirari, ſimulque gratiſſimo ſenſu affici, tantæ illius ſolertiæ ac concinnitatis, qua univerſa ipſorum organa ad varias quibus opus eſt vitæ actiones peragendas ſunt efformata: idque ita demum ut in ſingularum partium ſtructura diſpoſitione et nexu, noſtræ voluptatis, incolumitatis, conſervationiſque interea ratio habeatur. Quod ad illuſtrandam ſummi Creatoris bonitatem, ſapientiam, potentiamque, et ad grati animi noſtri atque ab eo dependentiæ ſenſum nobis inculcandum exemplum in præſentia mihi conſtitui, eſt Cuticula Humana: Argumentum quidem a diligentibus etiam machinæ animalis indagatoribus, levi brachio tractatum, a vulgo autem parvi aut nihili penſum, ne dicam contemptui habitum. Quo autem

hæc

hæc res ab aliis minus curata aut æſtimata fuerit, eo magis mihi animus additus eſt, ut eam diſſertationis meæ materiam ſeligerem; præſertim cum quæ inde generatim ſum ducturus conſectaria (quem præcipuum dixi a me finem propoſitum) plus firmitatis habitura videri queant, ſi ex re minus favorabili, juſto ratiocinio, ſint collecta. Haud parum etiam, ut id argumentum mihi pertractandum deſumerem, apud me valuit, quod ea pars corporis noſtri ſit omnibus notiſſima, et quum extimum ſit illius operimentum, ſatis aptus eſt carcer ex quo prælectionum curriculum inchoans dimittatur.

Eſt autem (ut ad rem aggrediar) cuticula, tenuis illa cutis per univerſam corporum noſtrorum ſuperficiem expanſa, quæque toties in veſiculam aquoſa liquore refertam attollitur. Latini *cuticulam*, ſive parvam cutem, vocitant: a Græcis *epidermis*, ſive cutis tegumentum, nuncupatur: unde et Galli, noſtrique Britanni, Græco vocabulo vernacule reddito, *ſurpeau*, et *ſcarf-ſkin*, eam appellant.

Cuticulæ color, nigerrimis etiam Ethiopibus æque ac formoſiſſimis in Europa natis hominibus, albus eſt. Hujus rei ſatis idoneum indicium attulere rei anatomicæ cultores, qui extimum hocce cutis integumentum, tam in hybridis quam in veris Æthiopibus, ab aliis ei contiguis partibus ſeparando, eam quam intuentibus præ ſe fert cuticula nigredinem, a tralucente, quam ea operit, ſubſtantia tractam eſſe; ea autem detracta, albidum protinus colorem ſe manifeſte oſtendere deprehenderunt. Hujus rei ratio poſtea reddetur.

Cuticula flexilis eſt, ad formam figuramque partium quibus connexa eſt ſeſe accommodans, viribuſque rerum ſibi applicatorum ita cedens, ut neque partium quas tegit motus impediatur, neque impreſſiones partibus hiſce ab aliis corporibus impactæ prohibeantur. Vix altera manus alteri imponi poteſt, quin hujus flexilitatis ſigna ſe nobis videnda exhibeant.

Cum vis quælibet diſtendens huic vivi hominis membranæ ſenſim adhibetur, natura eam extenſili nullis limitibus circumſcripta, abſque partium dilaceratione, pollere compertum eſt. Rei fidem firmant, commodaque inde orientia oſtendunt lactantium fæminarum ubera, pregnantiumque uteri, ſæpenumero etiam monſtroſi illi morbidique tumores, qui per totum corpus aut partem ejus aliquam paulatim induci ſolent.

Quin et epidermis haud modicam extenſionem etiam ſubito illatam

pati poteſt, quanta ſcilicet ad neceſſarias vitæ functiones obeundas requiritur. Quod ſi ſubita hæc extenſio ultra eum quo tunc gaudet tonum cuticulam dilatet, ipſius non minus atque aliæ corporis partes a ſe mutuo ſegregantur ac diſrumpuntur.

Ut cuticula vi extenſili, ita et contractili imbuta eſt. Poſtquam enim ea magnopere tenſa eſt, ad priſtinam ſuam dimenſionem una cum cute ſe reſtituit: unde et ejus contractionis quantitas dignoſci poteſt, adeo ut ſi cutis lævis ac plana haud evadat, cuticula rugis obſita permaneat. Cæterum hujus quam in corporibus deprehendimus flexilitatis, extenſilitatis et contractilitatis cauſas phyſicis rerumque naturalium indagatoribus exponendas relinquentes, non poſſumus tamen hic non animadvertere quam apte, ſapienterque hæ huic membranæ inditæ ſunt proprietates, quæ eam ad partes quibus tot et tam varii motus peragendi ſunt, protegendas, ac porro ad cedendum ſeque deinde reſtituendum, etiam in caſibus morbidis, perinde ac in communibus vitæ functionibus, habilem atque opportunam præſtent.

De contractili autem cuticulæ indole, dignum in primus eſt obſervatu, eam cuticula corpori detracta, etiam poſt extenſionem quamdiu ſe cumque ea extenſio continuat, proprietatem retineri: cum pleræque aliæ corporum noſtrorum partes, ſi extenſæ donec areſcant ſerventur, omni tum ſe reſtituendi poteſtate orbæ fiant. Hujus rei periculum ipſe feci: detractam enim cuticulæ partem, quæ in tabula extenſa per decennium ſervabatur, protinus rugoſam fieri, ſeque contrahere deprehendi.

Si partes ſubter cuticulam illæſæ cuſtodiantur, diſcindi aut alio quovis modo deſtrui poteſt ipſa cuticula abſque ullo moleſtiæ ſenſu, unde haud immerito cuticula ſentiendi exſors perhibetur. Huic autem hujuſce membranæ inſenſibilitati maxima vitæ noſtræ felicitas accepta referenda eſt. Corpora noſtra nimirum innumerarum aliarum rerum vim excipere, ab iiſque duriter premi neceſſe eſt. Id autem ſi parti tactus ſenſili accideret, fieri non poſſet quin in perpetuo cruciatu angoreque vitam ageremus. Hi certe quibus vel medicaminibus vel uſtionibus cuticula eſt derepta, non ſine affectu commemorare poſſunt, quanta commoda, ex ſpreta hac membrana prius, reportarint.

Ex ea qua gaudemus, dum cuticula integra eſt et incolumis, accurata tactus ſenſatione, cum eo quem illa dirempta perpetimur dolore, comparata,

parata, ipſaque experientia docemur, unum hujus cuticulæ uſum eſſe, ut idoneum inde medium ſubminiſtretur, per quod organa noſtra tactus ſenſui inſervientia eo quo par eſt modo ab ſibi abjectis afficiantur; ita, ſciz. ne ſenſus nimium hebes ſit, noſque adeo ad judicium de illis recte ferendum inhabiles reddat; neque e contrario nimis ſit acutus, qui propterea unam univerſe moleſtam ideam excitet, quem dolorem nominamus, in quo variæ rerum tangibilium formæ, quas alias ab aliis diſtinguere opportebat, in unum confuſæ, deperditæ atque abſorptæ ſunt.

Quantum in præſens recordari poſſum, ex omnibus corporis partibus cuticula corruptioni minime obnoxia eſt. Nihil utique, ignem ſi excipias, novi, a quo diſſolutio aut interitus ei arceſſatur. Aqua, oleum, ſales varii, ſpiritus, ſubſtantiæ etiam maxime cauſticæ et erodentes, a cute eam dirimere quidem valent; at integra interim atque illibata manet ejus textura, ac niſi vis mechanica etiam adhibeatur, ne vel illa partium ipſius a ſe mutuo diſſociatio conſequetur. Oleum vitrioli, lapidem ſepticum, aut ſi quid aliud eſt rebus animatis magis exitiabile quis admoveat, periculoque facto, quod a me dictum eſt verum comperiet. Dicat chirurgus quiſpiam, an cuticulam quavis undecunque collecta puris materie, qualiſque alias ſolidiſſima corporis oſſa carioſa ſit redditura, eroſam unquam ſit conſpicatus. Quæ ei ſubjecta eſt materiæ pondus et extenſio eam dilaniare poteſt, at ejus acrimonia illam erodere non poteſt. In violentiſſima gangræna, et univerſarum quas in vivo homine tegit partium ſphacelo, et in ſupremo corrupti cadaveris ſtatu, non alia ratione diſſolvitur, corrumpitur aut immutatur cuticula, quam qua ſimpliciſſima quacunque illius a cute ſeparatione id efficeretur.

Jam igitur mecum reputate, auditores ſpectatiſſimi, quanta vel ex hac una cuticulæ proprietate commoda hauriamus. Perpetuo nobis hæc undique circumfuſa eſt atmoſphæra, in qua infinitæ pene diverſorum corporum, omnia corrumpentes, particulæ innatant. Lignum, ferrum, ſaxa duriſſima, aëri expoſita, conſumuntur: corporum autem noſtrorum ſuperficies ab eo non afficitur. Nollite vero exiſtimare id a jugi ulla partium cuticulæ renovatione proficiſci. Exponantur ſimili quo cuticula modo aliæ corporis partes in quibus manifeſta eſt hæc renovatio, effectuſque multum diverſos conſequi experiemur. Cuti etenim cruſta vel cortex obducitur, quam ab ea ſeparari vel decidere opportet. Vulneris aëri expoſita

ſuperficie

ſuperficies putredinem contrahit, quæ nulla arte ſanari poteſt, niſi eam ſuperveniens ſuppuratio tollat. Ligamenta, cartilagines, imo et oſſa ſolidiſſima denudata, aërique objecta, putrida evadunt. Sola igitur eſt corruptionis expers cuticulæ natura, quæ nos ab omnibus malis quæ aër in quo vivimus et movemus nobis adferret, a cunctiſque calamitatibus quas (id quod neceſſe eſt fieri) tot aliæ ſubſtantiæ noſtrorum corporum ſuperficiei quotidie applicatæ generarent, incolumes præſtat.

Quamvis autem cuticula diſſolutionis aut corruptionis vix ſit capax, violenta tamen frictio, partium cohærentiam diſrumpendo, ſtructuram illius diruere poteſt. Quod iis quotidie evenire videmus qui tibias manuſve lapidibus vel aſpera arena deſtringunt. Cum vero non adeo prorſus violenta ſit frictio, ſed ejuſmodi duntaxat quæ partes e cuticula contectas fortiter vellicare et proritare valeat, ab iis ſe partibus cuticulas ſejungit, atque in veſiculas aquoſo liquore refertas intumeſcit: quod probe nec ſine ſuo damno ſentiunt ii, qui labore haud aſſueti opificum inſtrumentis utendis manus admovent. Omnes fere cujuſcunque generis ſubſtantiæ, veluti æſtus, acres ſales, ſpiritus, olea, &c. quæ cuticulæ applicatæ ſimilem in cute proritationem efficiunt, ſimilem, cuticulam in puſtulas inflandi, effectum ſortiuntur. Hac quam nobis præbent ejuſmodi puſtulæ utilitate haud ſatis animadverſa, ad noſtri corporis fabricam vitii inſimulandam, proclives ſumus, eo nimirum quod hunc in modum cuticula extumeſcat. Quod niſi cuticula talibus ex cauſis non extumeſceret, multo graviores nobis patiendæ eſſent injuriæ. Abſque enim harum puſtularum interventu, dura illa ferramenta dolorem longe majorem nobis accirent, violentamque ac diuturnam in partibus cuticulæ ſubjectis inflammationem excitarent. At noxii aliarum proritantium ſubſtantiarum effectus, his quaſi umbonibus oppoſitis a cætero corpore defenduntur et propulſantur. Quocirca optima cum ratione exiſtimandum eſt, hanc epidermidis proprietatem bene prudenterque inditam, noſtræque incolumitati ac ſaluti tuendæ comparatam eſſe.

Cum cuticula a cute ſeparatur, cito ea renaſcitur, ſive alia cuticula, omnibus quæ priori inerant qualitatibus imbuta, eopſe in loco efformatur. Ea nimirum eſt benigniſſimi Conditoris cura et providentia, quæ cutem, cujus ſenſus acutiſſimus eſt, nudam atque integumento vacuam, atque adeo injuriis doloribuſque opportunam, non paſſa eſt remanere. Cum autem cutis etiam abrepta eſt, et alba illa rigida, ſenſuque orba ſubſtantia,

quam

quam *cicatricem* appellamus formam accipit, nulla quæ eam operiat cuticula (utpote cujus tum nulla utilitas) una effingitur. Extima quidem cicatricis facies inſenſili aliquatenus et incorrupta cuticulæ natura, ſed longe minore gradu atque ipſa cuticula gaudet. Atque hinc eſt, quod truncorum poſt amputationem extrema, omneſque aliæ cicatrices, frictionibus, offenſionibuſque expoſitæ, ad plagas, dolores, ulceraque ſuſcipienda propenſiores ſint, quam nativa corporis, cuticula contecta, ſuperficies. Cum igitur cuticulam cute ſalva remanente ſemper redintegrari, ea vero deperdita nunquam refici conſpiciamus, fidenter nobis colligere licet cuticulæ formationem a cute pendere, hancque illius parentem cauſamque plane neceſſariam eſſe.

Superficiem noſtri corporis claro luce intuentibus ingens ſe oſtendit numerus pororum, per quos tenuis ac limpidus liquor ſe perpetuo emittit; ex communi autem experimento, quo ſubſtantias cuticulæ applicatas in maſſam ſanguinis penetrare comperimus, conſtare videtur, alia eſſe orificia tenues itidem exileſque particulas recipientia. Etenim ſi ad perennem illum ex iis quæ ſupra memoravi orificiis ſcaturientem rivum animum attendamus, neutiquam exiſtimandum eſt, particulas extrinſecus advenientes adverſus hunc rivum introrumpere poſſe.

De his orificiis ita ut plurimum loquuntur rei anatomicæ cultores, quaſi ea nihil aliud eſſent præterquam ſimplices in cuticula pori per quos liquores, in ejus ſuperficiem projecti, permeant, eodem nimirum pacto quo aqua linteola ſuperfuſa filorum interſtitia pervadit. At una et altera ſatis vulgari ſimpliceque obſervatione, rem ita ſe habere non poſſe, perſpicuum efficitur. Ac, 1mo, varias novimus ſubſtantias, quales ſunt viſcida balſama, oleaque, quæ eos quos in cuticula aſpicimus poros obturare queant. Quod ſi vera eſſet hæc de poris doctrina, admotis viſcidis hiſce ſubſtantiis cuticula a liquoribus ſubtus effuſis in bullam attolleretur; at innumeris documentis cognitum habemus nullas ejuſmodi bullas attolli, ac proinde qui per cuticulam emittuntur liquores, neutiquam ſubter eam prius effuſos eſſe. 2do, Cum cuticula in veſiculas attollitur, ſiquidem quod hi volunt verum eſſet, neceſſario per hos poros liquor tranſiret. At haud paulo ſecus ſeſe res habet, niſi enim liquoris pondus aut extenſio, aut vis externa adhibita cuticulæ partes dilanient, nulla ei elabendi facultas permittitur. Quapropter certo ſtatuendum orificia ea per quæ liquores

cuticulam

cuticulam altrinſecus pervadunt, canalium eſſe ab interioribus partibus continuatarum extremitates: qui canales diffracti liquores ſuos inter cuticulam parteſque ab ea tectas effundunt: et quum cuticula naturam extenſilem ſit adepta, eam opportet in bullas attolli, e quibus nequeat evadere liquor, eo quod cum reliquiæ vaſorum cuticulæ adhærentes tenuibus admodum orificiis, lateribuſque perquam flexilibus gaudeant, a liquoris veſiculis contenti preſſione vaſorum potius latera in ſe mutuo collapſura ſint, quam pendula ipſorum orificia ingreſſurus ſit liquor.

Lewenhoekius, calculo eo de re inito, in cuticulæ ſpatio non ampliore quam quod ab uno arenæ granulo tegi poſſit, 125,000 orificiorum (quod omnem pene fidem ſuperat) numeravit. An ſatis accurate nec ne vir ille celeberrimus rationes ſuas ſubduxerit, ad inſtitutum noſtrum parum intereſt. Utcunque enim ſe res habeat, ſat certe nobis ſuffecerit, ut inde commonſtretur, quam oppido exiles, et proinde ſummo artificio elaboratos hos canales, quorum ea ſunt orificia, eſſe opporteat. Et quidem tam exquiſita eſt eorum fabrica, ut non niſi difficillime oculis eos ſubjicere valeamus, idque poſt quam poſſumus maximam in cuticula a cute ſeparanda cautionem adhibitam, præeunte etiam tegumentorum corporis idoneo et permodico putrefactionis gradu, aut per lenem humidumque calorem facta præparatione, quæ cuticulam paulum laxare, non autem a cute eam penitus dirimere debeat. Hac demum ratione, ea vaſcula nullam aliam præterquam candidorum ſummeque exilium ingenti numero filorum, ægre aliorum ab aliis internoſcendorum, ſpeciem exhibent.

Jam vero conferamus horum canalium, per quos præcipue ſi non unicè cuticula cuti adhæreſcit, exquiſitam ac tenellam fabricam, cum effectibus quos in vaſa noſtra, ea contrahendo arctandoque, edit irritatio; aut cum corrumpentium noſtrorum liquorum eroſione; aut denique cum ea quæ frictioni adeſt extendendi lacerandique potentia, non erit cur admiremur, quod hi canales diſrumpantur, et in violentis cutis inflammationibus, re aliqua duriter eam morſicante vel irritante admota, accedenteque exiguo putrefactionis gradu, liquores effundant; et ut rem paucis abſolvam, quod puſtulæ illæ, in quas tot variis ex cauſis cuticula attollitur, tam crebro ſe conſpiciendas exhibeant.

Quum ea tantum vaſa cujuſque partis propria anatomici appellant, quæ ramos in ea diſtribuunt, fluidaque in illius ſubſtantiam ad ipſam ibi augendam,

augendam, nutriendamve permanſura, devehere videntur, hi quos deſcripſi canales cuticulæ *vaſa* vocitari nequeunt; atque haud ſcio an microſcopiorum vel injectionum ope ulla cuticulæ humanæ propria vaſa unquam in conſpectum ſint producta. Quin contra credibile videtur vaſa ejuſmodi oculis cerni non poſſe. Cum enim nulla alia eſſe queant, præterquam tunicarum horum quos dixi tenuium canalium vaſa; iique canales non ampliores ſint quam ut aquam, oleum terebinthinæ puriſſimum, aut aliud id genus tenue fluidum, per ſe idque difficiliter admodum percolari patiantur, liquoribus colore aliquo tinctis omnino excluſis; neutiquam expectandum eſt, multo tenuiora ſuarum tunicarum vaſa particulas recipere poſſe, quæ lucis radios ea vi, ut ſe nobis conſpicuos ſiſtant, reflectere queant.——Non me latet a quibuſdam proditum, vaſa in elephanti cuticula, rubrum ſanguinem continentia aſpecta fuiſſe. Sed in materia adeo incommoda, verbiſque tam generalibus facta eſt narratio, ut ei non plus fere fidei ſit adjungendum, quam ei quod ab aliis nonnullis affirmatur, qui in humanæ cuticulæ vaſa injectiones ſe facere poſſe perhibuerunt. Sed neque eorum quos deſcripſi canalium cuticulam penetrantium magnitudo amplis illis quæ in cuticula ſunt vaſis hilum plus in elephantino quam in humano corpore reſpondet, utpote quod liquoribus ſuis per ipſius cuticulam perpetuo emanantibus non irroretur hujuſce animalis ſuperficies.

Cæterum ex exilitate quæ cuticulæ humanæ inſunt vaſorum, tam eorum quae, ſi qua habet, ei propria ſunt, quam illorum quae ſolum eam perforant, quibuſque pellucidos tantum liquores admittunt, clare intelligimus quamobrem fiat, ut Maurorum juxta ac Europæorum cuticula candidum colorem ſit nacta. Cum porro conſideramus quantillam eorum etiam ſubtilium ac pellucidorum fluidorum portionem cuticulæ compoſitionem ingredi oporteat, quodque perforantes canales in externa ſuperficie patulas habeant extremitates, per quas tenues liquores effluant, et cum illi diſrupti ſunt, ſe etiam in cutis ſuperficiem exinanire queant; quod vaſa dein propria ſi quæ ſunt, adeo compreſſioni rarefactionique ſint expoſita, ut ea contrahi ſi non ſolida fieri neceſſe ſit: haec, inquam, cum conſideramus, haud prorſus ratione abſonum videri forſan poſſit, ut exiſtimemus hunc fluidorum defectum unam ex cauſis eſſe, cur cuticula minus quam aliae corporis partes corruptioni ſit obnoxia.

Non magis nobis in promptu eſt nervos ad cuticulam pertinentes veſtigiis perſequi, quam proprias ipſius arterias et venas acie cernere. Ex iis autem quæ de illius inſenſibilitate ſupra diximus, perſpicuum eſt, aut nullos ei nervos eſſe, aut, ab rigido ſiccoque ad quem redacti ſunt ſtatu, eos ad objectorum imagines menti exhibendas prorſus inhabiles reddi.

Nullus eſt, quod novimus corporis noſtri liquor, qui cum in vaporem eſt ſolutus, vel tenuiores ejus partes a cæteris ſunt ſecretæ, vel etiam cum per aliquod tempus in quavis ſubſtantia deſederit, non aliquam poſt ſe fæcem aut maculam relinquat: unde nobis colligere fas fuerit, liquores qui canales cuticulam perforantes perpetuo tranſeunt, quaſdam etiam in ejus ſuperficie particulas ſuperſtites relinquere. Magis autem perſuaſum habemus id plerumque evenire, cum manifeſtas pelliculas a reliquiis horum liquorum crebro formatas conſpicimus. Unius vero ex proprietatibus quæ has fluidorum reliquias comitantur, ſe prodit indicium, cum obſervamus, affuſis per diutinum tempus in cuticulam liquoribus aquoſis, præſertim ſalſuginoſis, aut acrem ſaponaceamque indolem nonnihil participantibus, cutem tam facile irritari. Hinc eſt quod lacrymantibus genæ rubræ evadant, doleant et turgeſcant; quod infantium inguinibus natibuſque urina ſua cutem deterat, &c. Hæc autem vix alia ex cauſa proficiſci queant, quam quod liquores illi linimentum a liquoribus cutaneis relictum diſſolvant et abſtergeant. Id ulterius ex eo confirmatur, quod ubi ſolito magis adeſt cutis amittendæ periculum, ut in palpebris, papillis, &c. naturali illic linimento cuticulam larga copia inſtructam reperiamus: atque ex eo etiam, quod lenia, unctuoſa, mucaginoſaque medicamenta naturalis illius linimenti locum optime ſupplere, aptiſſimeque ad hæc a detrita cute data incommoda vel præcavenda vel reſarcienda adhiberi ſentiamus. Annon hoc linimentum plurimum præſidii conferre poſſit, ne cuticula depereat, neque cutis a variis particulis acribus in atmoſphæra fluitantibus, aut aliarum ſuperficiei noſtri corporis admotarum ſubſtantiarum contactu nimis inclementer accipiatur? Nonne et hoc linimentum panniculi ope defricando efficitur, ut omnia medicamenta acria, præeunte hac in locis quibus adhibenda ſunt frictione, fortius quam ea omiſſa vim ſuam exerant? Poteritne etiam fieri ut acetum, utpote liquor acer ac ſalinoſus linimentum diſſolvens abſtergenſque, cantharidum potentiam,

tentiam, hac potius quam ulla alia quæ ei aſſignari poteſt qualitate promoveat?

Extenſam aliquam cuticulæ particulam vel nudo vel perſpicillis adjuto oculo intuenti, ea tanquam uniformis membrana apparet, rhomboidicam, quadratam, vel aliter figuratam partium ſubtus poſitarum ſpeciem referens. In iis autem corporis partibus, quæ adverſus frictionem munitæ, vel ei parum expoſitæ ſunt, ut in capite ſub capillorum radicibus, inter digitos pedum, &c. et juxta cicatricum cute deperdita latera, furfuraceam invenimus ſubſtantiam ex plurimis ſquamis conflatam, perfrictaque panniculo alia quavis in ſuperficie corporis parte, panniculum illum ſubſtantiis ſquamularum inſtar coöpertum reperimus. Ex qua rerum facie, atque ex ea quæ illam inter externaque plurimorum piſcium, anguium, ac nonnullorum etiam quadrupedum, ſimilitudine intercedit, a pleriſque concluditur, cuticulam humanam ex innumeris itidem ſquamis, aliis alias extimo ſuo limbo ſupertegentibus, eſſe compoſitam. Utcunque tamen cohibere me nequeo, quin exiſtimem non tantum huic argumento, quantum vulgo creditur, roboris ineſſe. Squamæ enim ſub capillorum radicibus interque pedum digitos repertæ, nihil aliud forte ſunt quam lemæ ex viſcoſis linimenti particulis, ibidem ubere copia promanantis, conflatæ. Quæ autem circa cicatricum margines viſuntur, in earum autem medio deficiunt ſquamæ, confici poſſunt ex liquoribus per cuticulæ cicatricem ambientis poros deſtillantibus, qui a cicatrice ipſa non ſuppeditantur; communeque illud linimentum quo in exilium ſuorum pororum interſtitiis cuticula obtegitur id eſſe poteſt quod panniculo deterſum eſt. Ne tamen mera poſſibilitate inniti videar, obſervare licet arefactam oculorum ſaniem, narium mucum, aurium ceram, præputii liquorem, &c. eandem ſæpe ſquamoſam imaginem repræſentare. Huc adde, quod quandocunque aquoſorum liquorum affuſione, vel partium frictione, linimentum in cuticulæ ſuperficie arefieri non permittitur, veluti in interiore palbebræ vel oris latere, &c. nihil quidquam ſquamis ſimile animadvertere eſt.

Quod a ſquamis piſcium ad ſquamas in humana cuticula conſtituendas deſumitur argumentum, parum utique ponderis habet. Nam præterquam quod iniquum ſit ſtatuere unius cujuſvis ſpeciei vel generis animalis ſtructuram in aliis omnibus locum obtinere, multi piſces ſunt, et ex

his etiam ii in quibus corporum tegumenta humani ſpeciem præ ſe maxime ferunt, qui ſquamoſi eſſe non dicuntur. Quin et in illis qui ſquamis operiuntur, nonnullæ partes cuticulæ ſunt, ea, v. g. quæ oculos tegit, in quibus nullæ ſquamæ conſpiciendæ ſunt. Quod ſi analogia in his locis pateret, expectandum itidem foret, ut humanarum ſquamarum magnitudinem formamque, certa lege quemadmodum in piſcium genere, diſpoſitam invenimus, quod acerrimi humanarum ſquamarum aſſertores nulli affirmaverint. Quoniam igitur nullo ſatis firmo fundamento ſquamoſa hæc cuticulæ humanæ textura ſubnixa eſt, mihi animus inclinat, ut eam potius rear nihil aliud eſſe præterquam vaſorum ſupra memoratorum extremitates ſibimet arctiſſime conjunctas, et in unam expanſam membranam coagmentatas; furfuracea autem illa corpora, quæ ab ea decidunt vel defricantur, adventitia, non tamen inutilia, acceſſoria a liquoribus illuc formata, minime vero cuticulæ propria eſſe, ejuſque partes conſtituere.

Si hoc pacto fabricatam cuticulam agnoſcamus, multo nobis proclivius erit rationes reddere, de perſpirationis, modicæ frictionis ope, incremento; de puſtularum natura et ortu; de cuticulæ, poſtquam ea ſublata eſt, redintegratione; de jugi illa quæ in cutis ſuperficie, irritantibus vel erodentibus rebus continenter adhibitis, ſervari queat liquorum effuſione; multiſque aliis ejuſmodi phænomenis, quam communi illa ſquamarum doctrina fieri poſſit. Quo majorem doctrinæ, quam ſuſtinere conatus ſum, fidem conciliem, phænomenorum ſtatim memoratorum raptim rationes percurrere liceat. Frictione augetur perſpiratio, illa quippe vaſorum extrema a viſcidis quibus illigata ſunt liquoribus exſolventur.—— Eorumdem vaſorum, dum cutem inter cuticulamque tranſeunt, diſruptionem, ſive a violenta nimis frictione, ſive a convulſiva, quam in ipſis vel in cute concitat irritatio, contractione factam, conſequitur effuſio liquorum, qui cum nullos poros ſquamarumve interſtitia, per quæ ipſis tranſeundum ſit, habeant, cuticulam a cute attollent, puſtulæque aut veſiculæ efformantur. Diſruptorum horum vaſorum, niſi quod impedimentum injiciatur, extrema ſe exporrigent, fibraſque ſuas in mutuum occurſum extendent, decreſcentibus interea ipſorum cavitatibus, fibriſque ſuis areſcentibus firmioribuſque evadentibus, redintegratur cuticula. Huic fibrarum extenſioni obſtat eroſio, earumque in unum coalitionem prohibet,

prohibet, continenter igitur adhibitis erodentibus, extrema vaſorum irritata, lacerata, dilatata, jugi fluore effundunt liquores.

Quæ hactenus a me de cuticula ſunt dicta ei in univerſum ſive omni ejus parte conveniunt. Animadvertendum tamen eſt cuticulam natura ſua, etiamque ſi nulla cauſa externa interveniat, multum diverſæ in diverſis corporis partibus craſſitiei eſſe, ac pro majore minoreve ipſius tenuitate vel ſpiſſitudine flexiliorem eam rigidioremve fieri. In labiis quidem admodum tenuis eſt, in extremis digitis majorem paulo et mediam quaſi nacta eſt craſſitiem, in pedum vero plantis multo adhuc craſſior eſt: pro modo nempe officiorum, quibus diverſis hiſce in locis fungendis eſt deſtinata. Pedum eſt corporis onus ſuſtentare. Fieri autem nequiret, quin, quæ ab hoc onere facienda ſit preſſio, ſenſibilibus quas cuticula tegit partibus noxam ſit illatura, niſi ea craſſior, proindeque ad eas defendendas aptior formaretur. Digitos idonea ad res eos tangentes alias ab aliis diſtinguendas ſenſibilitate præditos eſſe oportet, ſimulque adverſus duras, inequales, et aſperas harum rerum ſuperficies munitos. Ad id muneris obeundum, optime omnium hoc in loco comparatus eſt medius craſſitiei gradus. Labia aſpero noxiorum corporum tactui parum expoſita ſunt, proptereaque parva defenſione egent; verum opus eſt ut perquam flexilia ſint, quo multas neceſſarias actiones, ut loquendi, cibum capiendi, et ſimilium, recte exſequi poſſint.

Neque in diverſis tantum corporis partibus, ad uſus quibus inſervitura eſt idoneam hoc pacto nacta eſt cuticula naturam: verum facultas ei preterea eſt data primigenam ſuam indolem immutandi, ita ut ad quamcumque vitæ rationem, ſive ſponte arreptam, ſive ex neceſſitate nobis impoſitam, ſeſe accommodet, atque adeo pro majore quæ ei ſuſtinenda eſt frictionis preſſioniſve menſura, craſſior ea rigiorque evadat: dummodo tamen non tanta ſit hæc frictio preſſiove, quanta ejus ſtructuram labefactare, eamque a partibus quas tegit divellere poſſit. Si ultro vel coacti multum deambulamus, brevi temporis ſpatio pedum noſtrorum cuticula adeo craſſa fit ac robuſta, ut nos a dolore moleſtiaque ſentienda ſoſpites tueatur. Si fors ferat, vel ſummo mortalium Moderatori ita ſit viſum, ut duro manuum labore vita nobis toleranda ſit, ita effictæ ſunt hæ manus, ut quantumlibet aſperis rigidiſſimorum duriſſimorumque ferramentorum frictionibus ſuſtinendis, imo et omnia conſumentis ignis impreſ-

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ſionibus retundendis, cito pares fiant. Si denique ea nobis data ſit vivendi conditio, ut, ad cibaria paranda, onera humeris portare neceſſe ſit, ab ea quam tenera cuticula nobis antea pepererat moleſtia paulatim liberamur, hæcque onera quaſi leviora brevi tempore evadunt.

Quas in morbis cuticula ſubit mutationes ultra modum variæ ſunt. Liquores aquoſos in puſtulis continendo, aut purulentam abſceſſuum materiam abſorbendo, mollior ea efficitur, magis extenſilis, ſpiſſior, laceratuque facilior. In febribus ardentibus ſæpe arida fit, rimas agit, et fruſtulatim defluit: ut quis propemodum dici poſſit, ſerpentium more, exuvias ſuas poſuiſſe. In lepra, una cum acri ſalinaque materia in aſperas ſquamiſque ſimiles placentas quaſi pinſitur; quæ pulchram nitidamque venuſtiſſimæ cutis ſuperficiem in formam fædæ pellis elephantinæ ſpeciem referentem commutant. Verum in his aliiſque omnibus quæ diverſæ ei ſuperveniunt mutationibus, commodo et utilitati noſtræ optime proſpectum eſt. Liquores quippe noſtri corporis extra vaſa ſua delati, cum ſtagnatione ſemper acres fiant, cutem quidem deſtruere, ſed non item cuticulam erodere potuerint: at eam laceratu facilem reddendo, paratiorem proinde efficiunt ad cedendum ipſorum evacuationi, cui vel ſuum pondus vel preſſio externa occaſionem praebet. Particulæ inſuper acres quæ in febre per cutem effluunt, eam quam dixi in cuticula duritiem fiſſuraſque creant, ejuſque ſeparatione uberi perſpirationi (quæ in ejuſmodi caſibus maxime ſalutaris ac neceſſaria evacuatio eſt) via ſternitur. Poſtremo, cum tam acres humores in elephantiaſi evacuandi ſint, feliciter obtigit, quod in tam inſenſili parte ſedem ſuam figant, quæ nullo cum noſtro detrimento ſe ſeparare, tamque cito reficere, poſſit.

Atque hæ præcipuæ ſunt cuticulæ, quatenus ea ſuper corporis noſtri ſuperficiem extenditur, proprietates et phænomena. Ex his nonnullorum cauſas, quoad mihi rationes ſuppetebant, explicare ſum adnixus: quædam ſimpliciter memorare, nullo eorum rationes reddendi facto conatu, ſatis habui; conſultius nimirum ratus, me ejuſmodi incepto imparem fateri, quam parum certas conjecturas proferendo, meam, coram tam illuſtri caetu, temeritatem prodere. Reliquum erat ut externi hujus corporum noſtrorum tegumenti, quatenus illud ad partes internas continuatur, veſtigia perſequerer. Verum cum id ultra conſuetos hoc in loco perorandi limites me longe abduceret, hic finem facio; ſpem interea fovens

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de hac me materia tantum dixiſſe, quantum ei quod mihi propoſui inſtituto ſatisfacturum videatur. Hinc certe illuſtri quaſi exemplo commonſtratum habemus, quam mirifice ſapienterque noſtri corporis fabrica ſit contexta. Hinc perſpicuo documento oſtenditur benigniſſima maximi Creatoris clementia, qui, flexilem hanc inſenſilemque membranam inter corpora externa acutumque tactus organum interponendo, efficit ut tangendi voluptate, abſque doloris mixtura, frueremur; qui hoc nobis beneficium ſartum, tectum conſervavit, indita ſciz. cuticulæ noſtræ ejuſmodi natura, quæ a rebus alias quaſlibet corporis noſtri partes devaſtantibus corrumpi nequeat; qui varias quibus vita nobis agenda eſt rationes proſpiciens, huic corporis operimento indolem ſuam fabricamque mutandi, ſeque ad eas attemperandi, facultatem impertivit. Hoc pacto ſe cuticula extendit vel contrahit, craſſior tenuiorve evadit, ſe ſeparat redindegratque, quatenus ſaluti utilitatique noſtræ maxime conducat. Quin tanta nos proſecutus eſt mundi Fabricator indulgentia, ut in his etiam caſibus in quibus noſtra ipſorum culpa, et (quod cum mærore fatendum eſt) immoderata cupiditate et ſtultitia, pœnam commeriti ſumus, ad nos miſeria liberandos cuticula inſerviat; id eſt, proprietatibus ſuis a dolore, aliiſque diris quibus in morbis alioquin objectaremur eos comitantibus malis, ſoſpitet atque defendat.

AN

No 54.

AN

ESSAY

ON

COMPARATIVE ANATOMY.

ORIGINAL ADVERTISEMENT

TO THE

ANONYMOUS EDITION.

THE following Sheets were found among the Papers of a Phyſician lately deceaſed, and ſent by a Friend of his to the Bookſeller, with liberty to print them. As the ſubject appeared uſeful, they were preſented to two eminent Phyſicians in town for their approbation: One of them was ſo good as to write the following Letter, which, with difficulty, we obtained leave to print, as it will ſerve for a Preface to the whole. From what he there ſays, in relation to the Subject and Treatiſe, we preſume the publiſhing it muſt be a Service done the Public.

A

LETTER, &c.

SIR,

I HAVE read over the papers on COMPARATIVE ANATOMY, which I now return you with thanks by this bearer. You deſire my thoughts on the ſubject and treatiſe; and indeed the pleaſure I had in the peruſal makes your demand but juſt. What is called *Comparative Anatomy* was certainly the firſt branch of the ſcience that was cultivated; and from it the earlieſt anatomiſts formed their notions and ſyſtem of the human body. The natural prejudices of mankind, and, in ſome ſenſe, common humanity, oppoſed any attempts to be made in the other way. As the firſt phyſicians were philoſophers, and this part of natural knowledge more immediately related to medicine, they particularly applied to it. Democritus, who, according to ſome, was the maſter of Hippocrates, ſpent much time in diſſecting brutes and examining their ſeveral parts. He applied himſelf with ſuch eagerneſs to this ſtudy, as to incur the cenſure of madneſs. His deſign was to examine the nature of the bile, and learn the ſeat and cauſes of diſeaſes. That this ſcience was much improved by the times of Hippocrates, is very apparent from his writings, which are intermixed with reaſonings drawn from it; and ſome parts of his phyſiology are only applicable to brutes. Theſe paſſages appear to us exceeding obſcure, often falſe and contradictory; and have for that reaſon been rejected by ſome very great critics. But is not this owing to our own ignorance? We do not well underſtand the then received ſyſtem of anatomy, and his terms and names do not correſpond to ours. The ſmall tract *de Vulneribus Capitis*, is, I think, as great a maſter-piece in its kind as the *Coacæ Prædictiones*. Yet the firſt has been eſteemed by ſome lame and imperfect, and afforded occaſion for many diſputes and wranglings; and all this becauſe not underſtood. Anatomiſts, however, have done by Hippocrates in moſt caſes as the critics with Homer, made him the maſter of all human and divine ſcience. Not a new diviſion of a bone, or diſpute about a proceſs or articulation, but has been referred to his judgment; and he has often been made to explain what he never dreamt of. Galen, the father of anatomiſts, is, for the ſame reaſon, in many places, become an obſcure writer. He is accuſed and defended by the greateſt ſucceeding maſters. Veſalius, the great reſtorer of anatomy, will not allow accuracy or truth in many of his deſcriptions; they are, according to him, taken from brutes, and obtruded on the world for human.

The other anatomiſts treat Veſalius much in the ſame manner; and, with uncommon ſagacity and unwearied application, have found out variations and *luſus naturæ* in particular parts, that they may eſtabliſh Galen's deſcriptions, and condemn thoſe of Veſalius. This is particularly the caſe with Euſtachius in his Treatiſe on the Kidneys. How ſhall we now underſtand Galen, and judge between theſe great anatomiſts? It is Comparative Anatomy alone can extricate us from this confuſion; as it will teach us when Galen and others deſcribed and reaſoned from brutes, and when not. We ſhall then find, I believe, that the greateſt part of his deſcriptions was taken from brutes, which he transferred by analogy to the human body, and ſo are inaccurate; that a few were taken from the human ſubject, and are not capable of being otherwiſe applied. This ſtudy he himſelf recommends with great earneſtneſs to his ſcholars; and it is obſervable, that the moſt eminent anatomiſts firſt diſcovered their genius by an early attachment to it. This was particularly the caſe of Veſalius and Valſalva *.

As the firſt knowledge the ancients gained in anatomy was from the diſſection of brutes, ſo they formed the names and terms of art from the moſt natural appearance the part afforded, and that in different animals. Thoſe names were applied to the correſponding parts in the human body, and retained by ſucceeding anatomiſts to avoid a multiplicity of words. This, however, produces one bad effect, that it muſt miſlead us in our conceptions, as thoſe names are often very improper epithets in the human ſubject. The author has elegantly remarked ſeveral of theſe. The name of *right* and *left* ventricle is apt to give a wrong idea of the poſition of the heart; and the aorta *aſcendens* and *deſcendens* has impoſed on ſome of the maſters in anatomy, who, it is plain, have taken their figures from the name. Diſputes have ariſen about the *appendix vermiformis*, &c. which are all cleared up when we once view the part in the animal whence the name was taken. A ſhort technical dictionary, with an account of the ſubjects whence the names of the ſeveral parts were derived, would be of great uſe to ſtudents, and is one of the deſiderata in anatomy †.

The intention of nature in the formation of the different parts, can nowhere be ſo well learned as from this ſcience; that is, if we would underſtand phyſiology, and reaſon on the functions in the animal œconomy, we muſt ſee how the ſame end is brought

* Gaudebat enim avicularum, aliorumque animalculorum diſſectionibus; eorumque exta curioſius, quam pro illa ætate, rimabatur: quam ego præſignificationem, non in Veſalio tantum, ſed in aliis quoque pueris fuiſſe ſcio, qui, cum adoleviſſent, anatomiæ penitus ſe dediderunt. *Morgagni Comment. de vita Valſalvæ.*

† Such a treatiſe might in a great meaſure be collected from Sylvius's works, and Fœſius's *Oeconomia Hippocratis*. Camerarius did ſuch a work under the title of Διασκευη ονομαστικη; but it is a rare book.

brought about in other ſpecies. We muſt contemplate the part or organ in different animals, its ſhape, poſition, connection with the other parts, &c. and obſerve what thence ariſes. If we find one common effect conſtantly produced, though in a very different way, then we may ſafely conclude that this is the uſe or function of the part: this reaſoning can never betray us, if we are but ſure of the facts. The writers in phyſiology have generally taken another route, and one favourite theſis or other ſerves to explain the whole or moſt of the ſyſtem. An innate and concocting heat, acids, menſtruums, &c. have all had their ſucceſſive reigns and patrons: and in truth, phyſicians ſeem not to have ſufficiently conſidered the importance of this ſtudy to form a complete phyſiology, which muſt ever be the great baſis of their art. They have beſtowed pains in examining the human body, diſſected minutely its ſeveral parts, traced out (perhaps often invented) a new diviſion of a muſcle: But how little has phyſic been promoted by all this? The moſt accurate deſcription of the human ſtomach, with all its veins, arteries, nerves, &c. will never rightly explain digeſtion. What muſt we then do? Examine it in the other ſpecies of animals, mark there its differences and the effects, compare theſe with the human; and then ſhall we, in ſome meaſure, be able to judge what are the principal inſtruments, and how they are employed in this compound action. Any other way of reaſoning (as the author well obſerves) will never bring us to the ſolution of a philoſophical or medical problem. It muſt indeed be confeſſed, that this method is tedious and ſlow; many obſervations muſt firſt be made, and the labour of ſearching and examining gone through, before we can have proper materials to build on. Yet theſe are the hard conditions on which the knowledge of natural cauſes is to be obtained; which, as a great genius ſays, *Tam facile ſolertia vinci poſſunt, quam ſolent conatibus vulgaribus difficulter cedere.*

Of this kind of reaſoning we have many beautiful inſtances in the following papers. Such is the account of the poſition of the Duodenum; of the cauſe of our preferring the Right Arm; of the circulation of the blood in the Fœtus; the hiſtory of the Thymus and Thyroeid Glands, their uſe and mutual proportion; the uſe of the Spleen, &c. This laſt he explains in ſo ſhort and maſterly a manner, that you will find more argument in the few lines upon it than is to be collected from whole treatiſes on the ſubject. But as his deſign was to give a deſcription of the ſeveral ſpecies, or rather their principal differences, he chiefly confines himſelf to this. So in the anatomy of the dog he compares the different poſition, ſhape, length, &c. of the ſeveral parts with the correſponding parts in man; and from that one circumſtance, the difference of an erect and horizontal poſture, explains all the variations. This reaſoning then gives ſolution to many difficulties in the human anatomy; why the Spleen is ſo firmly attached to the Diaphragm; why the Omentum reaches only ſo far; why the poſterior part of the Bladder is only covered by the Peritoneum, &c. There have been diſputes about the fiſſure in the human liver, and different accounts given. Theſe all vaniſh, when we

conſider

conſider this viſcus in different animals. We then find that there are more or fewer diviſions, according to the greater or leſſer flexility of the ſpine. The ſame rule holds with regard to the diviſions of the lungs. This reaſoning likewiſe excludes the pretended uſe of the ligament in the human liver. And in ſhort we can underſtand but little of our own ſtructure unleſs we ſtudy that of other animals: we ſhall then find, that the ſeveral variations are relative, and depend on the different way of life; that is, one leading ſpeciality draws after it a great many more, in which nature is always an œconomiſt, and takes the ſhorteſt route.

The beautiful gradation of nature in the different orders of beings is very remarkable, and ſtrikes the mind firſt as being moſt obvious; but when we take any one ſpecies, the caſe there is ſtill the ſame, and we obſerve as ſurpriſing a difference. Thus in the animal kingdom, ſome are provided with lungs, when others are deprived of theſe breathing organs; ſome have a muſcular diaphragm and ſtrong abdominal muſcles, others a mere membrane. It muſt be very entertaining to learn how theſe differences and deficiencies are adjuſted and ſupplied: it is then from this ſcience alone we can underſtand that ſimplicity of nature which is much talked of, and but little underſtood. Hence likewiſe we muſt learn what to think of animals perfect and imperfect.

Anatomiſts have made a noiſe about the different ſtructures of the ſame part in the human body, and been at great pains to make collections of thoſe *Luſus Naturæ* as they call them; which becauſe they are rare, are for that very reaſon of no great conſequence to be known. The epithet, however, is extremely proper; for the moſt remarkable of them are tranſitions from the order or law of nature that obtains in one ſpecies to that of another. Thus it has been obſerved (though very rarely) that the liver was ſituated in the left hypochondrium: but, as our author remarks, it is not peculiar to it to lie on the right ſide in animals; for in fowls it lies equally in both, and in fiſhes moſtly on the left.

It is ſurpriſing that we have no tolerable treatiſe on this ſubject, which is in itſelf ſo entertaining and ſo conducive to promote Medicine. Thoſe who have made attempts this way, have only collected and ranged in order ſome particular ſpecies, ſuch as Birds or Fiſhes. They have likewiſe with great labour given us figures and deſcriptions of them; but all this is little elſe than mere amuſement. It is the ſtructure of their internal organs we ſeek after, and the manner how the different functions of the animal œconomy are performed. Their hiſtories of theſe are every way defective and erroneous. There is indeed noble hints to be found in the writings of ſome our modern anatomiſts, particularly thoſe of the immortal Dr Harvey. That great man well underſtood the importance of this ſcience to advance medicine; and accordingly employed the moſt of his time in diſſecting animals of different tribes, and making experiments on them: by which means he made the greateſt diſcovery that ever was in the

ſcience,

ſcience, and laid the foundation of the preſent ſyſtem. He had certainly left us other treatiſes on this ſubject, had he not been interrupted by the civil wars. The phyſicians who lived then, imitating his example, made many new experiments on the bodies of brutes, changing their juices by transfuſing of new liquors, accurately marking the effects, &c. that all this might be transferred to the human body: And indeed, from the application of theſe reaſonings to the obſervations they made on morbid bodies, the ſcience ſeemed faſt advancing to that phyſical certainty which can be attained from experiment and obſervation. But alas! this ſpirit died with theſe great men, and theory and calculation came in its place. Mathematics, it was ſaid, could alone bring the ſcience to certainty, and throw out conjecture. The quantity and velocity of the blood, the force of the heart, diameters of the veſſels, &c. were ſubjected to meaſure and number, and diſeaſes next were to be accounted for, all in a mathematical manner.—This method however did not ſucceed according to wiſh: for, firſt, thoſe great geniuſes diſagreed widely in their calculations, and differed from one another; whence, in place of certain concluſions, we had only wranglings and diſputes: not to mention, that ſome of them made ſuch eſtimates as muſt plainly appear ridiculous at firſt ſight *. This, you will ſay, proves nothing; it was the fault of the artiſts, who aſſumed wrong hypotheſes for their calculations, or were not perhaps accurate enough in their obſervations. True; but whoſe fault was it to adapt figure and number to a ſubject which refuſes them, through its numberleſs deviations from fixed laws and conditions?—Is an animate body a mere bundle of hard conical elaſtic tubes, and the heart a pump forcing the liquors through? Are then all the veſſels exact cones, or have any two anatomiſts agreed in their meaſures of them? Do they not yield every way? and are they not continually obſtructed in different places? Are there not many different attractions prevailing for the ſeveral ſecretions, and many different forces acting on the veſſels at the ſame time, which can never be determined? &c. Theſe and ſuch like conſiderations will ſoon convince us how little the practice of medicine is to be promoted by thoſe ſpeculations †. If theſe gentlemen meant by mathematical reaſoning

* The ingenious Dr Pitcairn was the chief man in theſe parts who gave into this way. He ſuppoſes the force of the muſcles to be in a compound ratio of their length, breadth, and depth; that is, as they are homogeneous ſolids in the ratio of their weights. Whence knowing the force of any one muſcle, we can by the rule of Proportion (from their weights) determine that of another. This he applies to the ſtomach, and by the computation its muſcular force is equal at leaſt to 117088 lb. weight.—That muſcles are in that proportion, is a mere hypotheſis, for which the Doctor does not offer the ſmalleſt proof; and had he aſſigned five ounces as the weight of the ſtomach, he had been nearer the truth. This is one glaring inſtance, how much theory and whim may prevail with the greateſt of men over common ſenſe.

† The authority of Hippocrates is often adduced in this argument, for which they cite two paſſages.

ſoning phyſical experiments, then no one ever doubted of this, no more than they do of the uſe of mathematics in natural philoſophy itſelf. But as this ſeems not to be their ſenſe of the matter, they ſhould point out a few diſeaſes which this ſcience has explained, and wherein it has corrected the received practice.—But I am quite got from the ſubject to what is foreign. To return then, Comparative Anatomy has hitherto been treated but by pieces. Thus ſome, writing on the human eye, have examined the eyes of other animals; and ſo with regard to the heart, &c. Some have given us the deſcription of one particular animal, others of another. But no one author, as I know of, has given us a ſyſtem of this ſcience where we might have a ſummary view of the moſt material differences in the ſtructure of animals. There are indeed compends of this ſcience, if you will, which are eſteemed by many, and were wrote with the noble deſign of illuſtrating the wiſdom and goodneſs of our Maker. But thoſe who compoſed them were not anatomiſts themſelves, ſo could only collect from others, which they often do without any judgment: for how voluminous ſoever their works may be, yet if you will ſtrip them of their repeated exclamations, citations of authors and books, the many ſtrange and ſurpriſing ſtories, all told however by creditable vouchers, you will have little left behind beſides an indigeſted chaos of hiſtories and deſcriptions, ſome true and many falſe. The argument however was popular, and they could not fail of pleaſing.

The author of theſe few ſheets is certainly a great maſter of the ſubject; and has here laid down an uſeful plan, which it will not be difficult for others to complete. The deſcriptions, it is eaſy to ſee, are all taken from the life; and his reaſoning is plain and concluſive. Theſe are intermixed with many practical obſervations in Medicine and Surgery, which muſt equally inſtruct and entertain the Reader.——You have now a few looſe reflections on this ſubject, wherein I have entirely confined myſelf to that light in which it is here treated. I ſhall only remark one thing more, that the author's modeſty is at leaſt equal to his capacity and knowledge; a rare quality to be met with in an anatomiſt! Read him on the ſubject of the Human Allantois, and obſerve his concluſion of the argument. You muſt then ſay, it had been happy for the public, if half ſo much candour and ſelf-diffidence had prevailed in the diſputes among the learned. The world had been more inſtructed, and they more juſtly eſteemed.

I am, Sir, Your moſt humble Servant.

paſſages. In the one he recommends the ſtudy of Aſtronomy, as neceſſary to a phyſician; and in the other, that of Arithmetic and Geometry.—The firſt he did from his belief in the influence of the ſtars; and the ſecond from his veneration for the Pythagoric numbers, in the myſteries of which he founded his theory of the criſes in acute diſeaſes: Both theſe conſiderations then are foreign to the purpoſe, nor is there in any of his genuine writings the ſmalleſt veſtige of this kind of reaſoning. On the contrary, Celſus ſays of him, *Primus ab ſtudio ſapientiæ medicinam ſeparavit.*

AN

ESSAY

ON

COMPARATIVE ANATOMY.

The INTRODUCTION.

THE principal advantages of Comparative Anatomy are the following. Firſt, It furniſhes us with a ſufficient knowledge of the different parts of animals, to prevent our being impoſed upon by ſuch authors who have delineated and deſcribed ſeveral parts from brutes as belonging to the human body. Secondly, It helps us to underſtand ſeveral paſſages in the ancient writers in medicine, who have taken many of their deſcriptions from brutes, and reaſoned from them: their reaſonings have often been miſapplied (and conſequently wrong explained) by the moderns, through a fooliſh fondneſs to ſupport their own inventions, or give an air of antiquity to a favourite hypotheſis. The third and great uſe we reap from this ſcience, is the light it caſts on ſeveral functions in the human œconomy, about which there have been ſo many diſputes among anatomiſts: Theſe will be in a great meaſure cleared up by exhi-

biting the ſtructure of the ſame parts in different animals, and comparing the ſeveral organs employed in performing the ſame action, which in the human body is brought about by one more complex.

In this view, it is altogether needleſs to inſiſt on thoſe parts whoſe uſe is eaſily underſtood when once their ſtructure is unravelled. Thus, for inſtance, if we be acquainted with the action of the muſcles in general, it will not be difficult to determine the uſe of any particular muſcle whoſe origin and inſertion is known, if we at the ſame time conſider the various connections of the bones to which it is fixed, and the different degree of mobility they have with reſpect to each other: In the ſame manner, if we know the uſe of the nerves in general, we can eaſily aſſign the uſe of thoſe nerves which are diſtributed to any particular part. There is then no occaſion for a complete Oſteology, Myology, &c. of the ſeveral animals we ſhall treat of; nor need we trouble ourſelves about the ſtructure of any of the parts, unleſs when it ſerves to illuſtrate ſome of the forementioned purpoſes.

That the firſt uſe we propoſed from examining the ſtructure of the parts in brutes is real and of conſequence, is evident from looking into the works of ſome of the earlieſt and greateſt maſters of anatomy, who, for want of human ſubjects, have often borrowed their deſcriptions from other animals. The great Veſalius, although he juſtly reproves Galen for this fault, is guilty of the ſame himſelf, as is plain from his delineations of the kidneys, uterus, the muſcles of the eye, and ſome other parts. Nor is antiquity only to be charged with this, ſince, in Willis's *Anatomia Cerebri* (the plates of which were reviſed by that accurate anatomiſt Dr Lower), there are ſeveral of the pictures taken from different brutes, eſpecially the dog, beſides thoſe he owns to be ſuch.

We ſhall give ſeveral examples of the ſecond uſe in the ſequel of the work.

The animal kingdom, as well as the vegetable, contains the moſt ſurpriſing variety; and the deſcent in each is ſo gradual, that the little tranſitions and deviations are almoſt imperceptible. The bat and flying-ſquirrel, though quadrupeds, have wings to buoy themſelves up in the air. Some birds inhabit the waters; and there are fiſhes that have wings,

and

and are not ſtrangers to the airy regions; the amphibious animals blend the terreſtrial and aquatic together.

The animal and vegetable kingdoms are likewiſe ſo nearly connected, that if you take the higheſt of the one, and the loweſt of the other, there will ſcarce be preſerved any difference: For inſtance, what difference is there betwixt an oyſter, one of the moſt inorganiſed of the animal tribe, and the ſenſitive plant, the moſt exalted of the vegetable kingdom? They both remain fixed to one ſpot, where they receive their nouriſhment, having no proper motion of their own, ſave the ſhrinking from the approach of external injuries. Thus we obſerve a ſurpriſing chain in nature.

As there is then ſuch a vaſt variety, it is not only needleſs, but impoſſible, to conſider all of them particularly. We ſhall take only ſome of the moſt remarkable genera; and hope, from what will be ſaid of them, any of the intermediate degrees may be underſtood.

In treating of QUADRUPEDS, we ſhall divide them into the carnivorous and herbivorous. As an inſtance of theſe laſt, we ſhall take the ruminant kind. The FOWLS we ſhall divide into thoſe that feed on grain, and thoſe that feed on fleſh. The diſtinction we ſhall make in treating of FISHES, ſhall be of thoſe that have lungs, and thoſe that have them not. The firſt indeed are with difficulty procured, and at the ſame time differ very little from quadrupeds.

As the ſtructure of inſects and worms is ſo very minute, and lends us but little aſſiſtance for the ends propoſed, we purpoſely omit them.

In inquiring into the ſtructure of different animals, we ought to be previouſly acquainted with the form of their body, manner of life, kind of food, or in ſhort with their natural hiſtory; which will lead us to account for the reaſon of their different ſtructure, and thence explain the actions of the human body.

Of QUADRUPEDS in general.

ALL quadrupeds have a covering of hair, wool, &c. to defend them from the injuries of the weather; which varies in thickneſs according to the ſeaſon of the year, and difference of the climate. Thus in Ruſſia and the northern countries, the furs are very thick and warm; while the little Spaniſh lap-dogs, and Barbary cows, have little or no hair at all.

The *cutis* and *cuticula* in quadrupeds are diſpoſed much in the ſame way as the human, only more elaſtic. Immediately under this there is a very thin cutaneous muſcular ſubſtance, called *panniculus carnoſus*, which is common to all quadrupeds, the porcine kind excepted: this principally covers the trunk, ſerving to ſhrivel the ſkin, in order to drive off inſects, their tails and heads not being ſufficient for this purpoſe, while their extremities are employed in their ſupport and progreſſion.

It has probably been from obſerving ſome muſcles of the human body, ſuch as the platyſma myoides, cremaſter, and frontales, and the collapſed tunica celluloſa of emaciated ſubjects, to reſemble this thin muſcle, that ſome of the older anatomiſts reckoned ſuch a panniculus among the common teguments of the human body. This Carolus Stephanus has well obſerved.

Moſt part of quadrupeds want clavicles, whereby their anterior extremities fall upon their cheſt, ſo as to make their thorax proportionally narrower than the human. This ſmall diſtance of their anterior extremities is very neceſſary for their uniform progreſſion: Apes indeed and ſquirrels have clavicles, to allow them a more full uſe of their extremities in climbing; but when they ſit down on all-fours, they walk but indifferently.

The ANATOMY of a DOG.

WE may firſt obſerve of this animal, as indeed of moſt quadrupeds, that its legs are much ſhorter in proportion to its trunk, than in man, the length of whoſe ſteps depends entirely on the length of his inferior

inferior extremities: however, to balance this, the trunk of the animal is proportionally longer and ſmaller, and his ſpine more flexible, by which he is able at each ſtep to bring his poſterior extremities nearer to his anterior. His common teguments are much a-kin to thoſe of other quadrupeds: Only they allow little or no paſſage for ſweat; but, when he is over-heated, the noxious and ſuperfluous matter finds an exit by the ſalivary glands, for he rolls out his tongue and ſlavers plentifully.

The pyramidal muſcles are wanting; to ſupply which, the rectus is inſerted fleſhy into the os pubis.

The *omentum* reaches down to the os pubis; which, conſidering the poſture of the animal, we will find to be a wiſe proviſion, ſince its uſe is to ſeparate an oily liquor for lubricating the guts, and facilitating their periſtaltic motion. So in our erect poſture the natural gravity of the oil will determine it downward; but in the horizontal poſition of theſe creatures, if all the inteſtines were not covered, there would be no favourable derivation of the fluid to the guts lying in the poſterior part of the abdomen, which is the higheſt: and beſides, had the omentum reached much farther down in us, we had been in continual hazard of an epiplocele; which the dog is not ſubject to, as his viſcera do not preſs ſo much on the rings of the abdominal muſcles. The inferior and anterior lamella of the omentum is fixed to the ſpleen, fundus of the ſtomach, pylorus, liver, &c. in the ſame way as the human; but the ſuperior having no colon to paſs over, goes directly to the back-bone. This ſerves to explain the formation of the ſmall omentum in the human body; which is nothing but the large omentum, having loſt its fat, paſſing over the ſtomach and colon, where it reaſſumes its pinguedo, ſo proceeds, and is firmly attached to the liver, ſpine, *&c.* The ſtriæ of fat are pretty regularly diſpoſed through it, accompanying the diſtribution of the blood-veſſels to guard them from the preſſure of the ſuperincumbent viſcera.

This animal's ſtomach, though pretty much reſembling the human in its ſhape, is ſomewhat differently ſituated. It lies more longitudinal, as indeed all the other viſcera do to accommodate themſelves to the ſhape of the cavity in which they are contained; that is, its inferior orifice is much farther down with reſpect to the ſuperior than the human: by this means the

the groſs food has an eaſier paſſage into the duodenum. Again, the fundus of the human ſtomach, when diſtended, ſtands almoſt directly forwards, which is occaſioned by the little omentum tying it ſo cloſe down to the back-bone, &c. at its two orifices; but it not being fixed in that manner in the dog, the fundus remains always poſterior: this alſo anſwers very well the ſhape of the different cavities, the diſtance betwixt the cardia and fundus being greater than that betwixt the two ſides. It ſeems to be much larger in proportion to the bulk of the animal than the human, that it might contain a greater quantity of food at once; which was very neceſſary, ſince this animal cannot at any time get its ſuſtenance as men do. The turbillion is not ſo large, nor is there any coarction forming the *antrum Williſii* as in the ſtomach of man. It is conſiderably thicker and more muſcular than ours, for breaking the coheſion of their food, which they ſwallow without ſufficient chewing. Hence it is evident the force of the ſtomach is not ſo great as ſome would have it, nor its contraction ſo violent: otherwiſe that of dogs would be undoubtedly wounded by the ſharp bones, &c. they always take down; for the contraction here is ſtill greater than in the human ſtomach, which is much thinner. The rugæ of the tunica villoſa are neither ſo large, nor ſituated tranſverſely, as in the human; but go from one orifice to the other: the reaſon of which difference is, perhaps, that they might be in leſs danger of being hurt by the hard ſubſtances this creature frequently feeds upon; and for the ſame reaſon there is not the like coarction at their pylorus.

The inteſtines of this animal are proportionally much ſhorter than ours: for the food which theſe creatures moſtly uſe, ſoon diſſolves, and then putrifies; on which account there was no occaſion for a long tract of inteſtines, but on the contrary that it ſhould be quickly thrown out of the body. The ſame is to be obſerved of all the carnivorous animals. The muſcular coat of the inteſtines is alſo ſtronger than the human, to protrude the contents quickly and accurately.

The valvulæ conniventes are leſs numerous, and in a longitudinal direction.

The *duodenum* differs conſiderably in its ſituation from the human. For in man it firſt mounts from the pylorus upwards, backwards, and

to

to the right-ſide; then paſſes down by the gall-bladder; and, marching over the right kidney and ſuperior part of the pſoas muſcles, makes a curvature upwards; and paſſes over the back-bone and vena cava inferior, to the left hypochondrium, where it gets through the omentum, meſentery, and meſocolon, to commence *jejunum*, being firmly tied down all the way, the biliary and pancreatic ducts entering at its moſt depending part: Whereas, in the dog, the duodenum is fixed at the pylorus to the concave ſurface of the liver, and hangs looſe and pendulous with the meſentery backwards into the cavity of the abdomen; then turning up again is fixed to the back-bone, where it ends in the jejunum; the bile and pancreatic juice are poured into it at the moſt depending part. Therefore the ſame intention ſeems to have been had in view in the formation of this part in both, *viz.* the giving the chyle, after the liquors of the liver and pancreas are poured into it, a diſadvantageous courſe, that ſo it might be the more intimately blended with the humours before its entry into the jejunum, where the lacteals are very numerous: And thus, by reaſon of their different poſture, the ſame deſign (though by a very different order of the parts) is brought about in both.

The other ſmall guts are much the ſame with ours, only ſhorter. The great guts are alſo ſhorter and leſs capacious than in the human body; and we take it for a general rule, that all animals that live on vegetable food, have not only their ſmall guts conſiderably longer, but alſo their great guts more capacious, than ſuch creatures as feed on other animals. Hence man, from this form of his inteſtines, and that of the teeth, ſeems to have been originally deſigned for feeding on vegetables chiefly; and ſtill the moſt of his food, and all his drink, is of that claſs.

The reaſon of this difference ſeems to be, that as animal-food is not only much more eaſily reduced into chyle, but alſo more prone to putrefaction, too long a remora of the juices might occaſion the worſt conſequences. So it was neceſſary that their receptacles ſhould not be too capacious; but on the contrary, being ſhort and narrow, might conduce to the ſeaſonable diſcharge of their contents. Whereas vegetable food being more difficultly diſſolved and converted into an animal nature, there was a neceſſity for ſuch creatures as fed on it to be provided with a long internal canal, that this food in its paſſage might be conſiderably

ably retarded, and have time to change its indoles into one more agreeable to our nature. Beſides which, there is another advantage which accrues to man in particular, from having his great guts very capacious: for as he is a rational being, and moſtly employed in the functions of ſocial life, it would have been very inconvenient as well as unbecoming for him to be too frequently employed in ſuch ignoble exerciſes; ſo that, having this large reſervoir for his fæces alvinæ, he can retain them for a conſiderable time without any trouble.

The *appendix vermiformis* juſtly enough deſerves the name of an *inteſtinum cæcum* in this ſubject, though in the human body it does not; and it has probably been from the largeneſs of this part in other animals, that the oldeſt anatomiſts came to reckon that ſmall appendicle in man as one of the great guts. On its internal ſurface we obſerve a great number of mucous glands.

The *colon* has no longitudinal ligaments; and conſequently this gut is not purſed up into different bags or cells, as the human: nor does this inteſtine make any circular turn round the abdomen; but paſſes directly acroſs it to the top of the os ſacrum, where it gets the name of *rectum*.

At the extremity of the *inteſtinum rectum*, or verge of the anus, there are found two bags or paunches, which contain a moſt abominable fetid mucus, for which I know no uſe, unleſs it ſerves to lubricate the ſtrained extremity of the rectum, and defend it againſt the aſperity of the fæces, or to ſeparate ſome liquor that might otherwiſe prove hurtful to their bodies. There is nothing analogous to thoſe ſacs in the human ſubject, unleſs we reckon the mucilaginous glands that are found moſt frequent and largeſt about the lower part of the rectum.

The *meſentery* is conſiderably longer than in the human body; as, in his horizontal ſituation, the inteſtines may reſt ſecurely on the ſoft cuſhion of the abdominal muſcles. The fat is here diſpoſed in the ſame way, and for the ſame reaſon, as in the omentum. The interſtices betwixt the fat are filled with a fine membrane. Inſtead of a great number of glandulæ vagæ to be found in the human meſentery, there is only one large gland to be obſerved in the middle of the meſentery of a dog, which, from its imagined reſemblance to the pancreas and the name of its diſcoverers, is called *pancreas Aſellii*. The reaſon why this in man is as it were

were ſubdivided into many ſmaller ones, may poſſibly be, that as the guts of a human body are proportionally much longer than thoſe of this creature, it would have been inconvenient to have gathered all the *lactea primi generis* into one place; whereas, by collecting a few of theſe veſſels into a neighbouring gland, the ſame effect is procured much more eaſily.

The *pancreas* in man lies croſs the abdomen, tied down by the peritoneum; but the capacity of this creature's abdomen not allowing of that ſituation, it is diſpoſed more longitudinally, being tied to the duodenum which it accompanies for ſome way. Its duct enters the duodenum about half an inch below the others.

The *ſpleen* of this animal differs from ours very much, both in figure and ſituation. It is much more oblong and thin, and lies more according to the length of the abdomen, like the pancreas. Though the ſpleen of this creature is not firmly tied to the diaphragm (which was neceſſary in our erect poſture to hinder it from falling downwards), yet by the animal's prone poſition, its poſterior parts being rather higher than the anterior, it comes to be always contiguous to this muſcle, and is as effectually ſubjected to an alternate preſſure from its action as the human ſpleen is.

The human *liver* has no fiſſures or diviſions, unleſs you pleaſe to reckon that ſmall one betwixt the two *pylæ*, where the large veſſels enter: Whereas in a dog, and all other creatures that have a large flexion in their ſpine, as lions, leopards, cats, &c. the liver and lungs are divided into a great many lobes by deep ſections, reaching the large blood-veſſels, which in great motions of the back-bone may eaſily ſhuffle over one another; and ſo are in much leſs danger of being torn or bruiſed, than if they were formed of one entire piece, as we really ſee it is in horſes, cows, and ſuch creatures as have their back-bone ſtiff and immoveable. There is here no *ligamentum latum* connecting the liver to the diaphragm, which in our ſituation was neceſſary to keep the viſcus in its place: whereas, in this creature, it naturally gravitates forwards, and by the horizontal poſition of the animal is in no danger of preſſing againſt the vena cava; the preventing of which is one uſe generally aſſigned to this ligament in man. Had the liver of the dog been thus connected to the diaphragm, the re-

ſpiration muſt neceſſarily have ſuffered; for, as we ſhall ſee afterwards, this muſcle is here moveable at the centre, as well as at the ſides: But in man the liver is fixed to the diaphragm, moſtly at its tendinous part; that is, where the pericardium is fixed to it on the other ſide; ſo that it is in no danger of impeding the reſpiration, being ſuſpended by the mediaſtinum and bones of the thorax. In conſequence of this viſcus being divided into ſo many lobes, it follows that the hepatic ducts cannot poſſibly join into one common trunk till they are quite out of the ſubſtance of the liver.

We come next, after having examined the chylopoietic viſcera, to diſcourſe of thoſe organs that ſerve for the ſecretion and excretion of urine. And firſt of the kidneys; which in this animal are ſituated much in the ſame way as in the human ſubject, but have no fat on their inferior ſurface, where they face the abdomen, and are of a more globular form than the human. The reaſon of theſe differences will eaſily appear, if you compare their ſituation and poſture in this animal with thoſe in a man who walks erect. They are placed in this ſubject in the inferior part of the body, ſo are not ſubject to the preſſure of the viſcera, which ſeems to be the principal cauſe of the fatneſs of thoſe organs in us, and perhaps may likewiſe be the cauſe of our being more ſubject to the ſtone than other animals. Hence there is no need of any cellular ſubſtance to ward off this preſſure where there would neceſſarily be fat collected; but the ſuperior part of their kidneys is pretty well covered with fat, leſt they ſhould ſuffer any compreſſion from the action of the ribs and ſpine.

In the internal ſtructure there is ſtill a more conſiderable difference, for the *papillæ* do not here ſend out ſingle the ſeveral *tubuli uriniferi*; but being all united they hang down in form of a looſe pendulous flap in the middle of the pelvis, and form a kind of ſeptum medium, ſo that a dog has a pelvis formed within the ſubſtance of the kidney. The only thing that is properly analogous to a pelvis in man is that ſac or dilatation of the ureters formed at the union of the *ductus uriniferi*. The reaſon of theſe particularities may probably be, that the liquors of this animal, as of all thoſe of the carnivorous kind, being much more acrid than thoſe that live on vegetable food, its urine muſt incline much to an alkaleſcency, as indeed the ſmell and taſte of that liquor in dogs, cats, leopards, &c.

&c. evidently ſhew, being fetid and pungent, and therefore not convenient to be long retained in the body. For this end it was proper, that the ſecerning organs ſhould have as little impediment as poſſible by preſſure, &c. in the performing their functions; and for that deſign, the mechaniſm of their kidneys ſeems to be excellently adapted: We have moſt elegant pictures in Euſtachius of the kidneys of brutes, delineated as ſuch, with a view to ſhew Veſalius's error in painting and deſcribing them for the human.

The *glandulæ* or *capſulæ atrabiliariæ* are thicker and rounder than the human, for the ſame reaſon as the kidneys.

The *ureters* are more muſcular than the human, becauſe of the favourable paſſage the urine has through them; they enter the bladder near its fundus.

The bladder of urine differs conſiderably from the human; and firſt in its form, which is pretty much pyramidal or pyriform. This ſhape of the dog's bladder is likewiſe common to all quadrupeds, except the ape and thoſe of an erect poſture. In men it is by no means pyriform, but has a large ſac at its poſterior and inferior part: this form depends entirely on the urine gravitating in our erect poſture to its bottom, which it will endeavour to protrude; but as it cannot yield before, being contiguous to the os pubis, it will naturally ſtretch out where there is the leaſt reſiſtance, that is, at the poſterior and lateral parts; and were it not for this ſac, we could not ſo readily come at the bladder to extract the ſtone either by the leſſer or lateral operation of lithotomy. Moſt anatomiſts have delineated this wrong; ſo much, that I know of none who have juſtly painted it, excepting Mr Cowper in his *Myotomia*, and Mr Rutty. It has certainly been from obſerving it in brutes and young children, that they have been led into this miſtake. The ſame cauſe, *viz.* the gravity of the urine, makes the bladder of a different form in brutes: in their horizontal poſition the cervix, from which the urethra is continued, is higher than its fundus; the urine muſt therefore diſtend and dilate the moſt depending part by its weight.

As to its *connection*, it is faſtened to the abdominal muſcles by a proceſs of the peritoneum, and that membrane is extended quite over it; whereas in us its ſuperior and poſterior parts are only covered by it: hence in

man alone the high operation of lithotomy can be performed without hazard of opening the cavity of the abdomen. Had the peritoneum been ſpread over the bladder in its whole extent, the weight of the viſcera in our erect poſture would have ſo bore upon it, that they would not have allowed any conſiderable quantity of urine to be collected there; but we muſt have been obliged to diſcharge its contents too frequently to be conſiſtent with the functions of a ſocial life: Whereas by means of the peritoneum the urine is now collected in ſufficient quantity, the viſcera not gravitating this way.

You may take it for a general rule, that thoſe creatures that feed upon animal-food have their bladder more muſcular and conſiderably ſtronger, and leſs capacious, than thoſe that live on vegetables, ſuch as horſes, cows, ſwine, &c. whoſe bladder of urine is perfectly membranous, and very large. This is wiſely adapted to the nature of their food: for in theſe firſt, as all their juices are more acrid, ſo in a particular manner their urine becomes exalted; which, as its remora might be of very ill conſequence, muſt neceſſarily be quickly expelled. This is chiefly effected by its ſtimulating this viſcus more ſtrongly to contract, and ſo to diſcharge its contents. That a ſtimulus is one of the principal cauſes of the excretion of urine, we learn from the common ſaline diuretic medicines that are given, which are diſſolved into the ſerum of the blood, and carried down by the kidneys to the bladder: the ſame appears likewiſe from the application of cantharides; or without any of theſe, when the parts are made more ſenſible, as in an excoriation of the bladder, there is a frequent deſire to make water. Accordingly we find theſe animals evacuate their urine much more frequently than man, or any other creature that lives on vegetable food. And if theſe creatures, whoſe fluids have already a tendency to putrefaction, are expoſed to heat or hunger, the liquids muſt for a conſiderable time undergo the actions of the containing veſſels, and frequently perform the courſe of the circulation, without any new ſupplies of food; by which the fluids becoming more and more acrid, the creature is apt to fall into feveriſh and putrid diſeaſes: and in fact we find that fatal and melancholy diſtemper the *rabies canina*, *vulpina*, &c. frequent in theſe animals; whereas thoſe that feed

on

on vegetable food ſeldom or never contract theſe diſeaſes but by infection.

Their *ſpermatic veſſels* are within the peritoneum, which is ſpread over them, and from which they have a membrane like a meſentery, ſo hang looſe and pendulous in the abdomen: whereas, in us, they are contained in the cellular part of the peritoneum, which is tenſely ſtretched over them. At their paſſage out of the lower belly, there appears a plain perforation, or holes; and from obſerving this in quadrupeds, has ariſen the falſe notion of *hernia* or *rupture* among authors. This opening is of no diſadvantage to them, but evidently would have been to us; for from the weight of our viſcera, and our continually gravitating upon theſe holes, we muſt have perpetually laboured under enteroceles. This they are in no hazard of, ſince in them this paſſage is at the higheſt part of their belly, and, in their horizontal poſture, the viſcera cannot bear upon it: and, to prevent even the ſmalleſt hazard, there is a looſe pendulous ſemilunar flap of fat, which ſerves two uſes, as it both hinders the inteſtines from getting into the paſſage, and alſo the courſe of the fluids from being ſtopped in the veſſels, which is ſecured in us by the cellular ſubſtance and tenſe peritoneum.

There is next a paſſage quite down into the cavity, where the teſticles lie. Had the ſame ſtructure obtained in man, by the conſtant drilling down of the liquor which is ſecerned for the lubricating of the guts, we ſhould always have laboured under an hydrocele; but their poſture ſecures them from any hazard of this kind: indeed your very fat lap-dogs, who conſequently have an overgrown omentum, are ſometimes troubled with an epiplocele.

The *ſcrotum* is ſhorter and not ſo pendulous as the human in all the dog kind that want the *veſiculæ ſeminales*, that the ſeed at each copulation might the ſooner be brought from the teſtes, thus in ſome meaſure ſupplying the place of the *veſiculæ ſeminales*; for the courſe of the ſeed through the *vaſa deferentia* is thus ſhortened, by placing the ſecerning veſſels nearer the excretory organs. The want of *veſiculæ ſeminales* at the ſame time explains the reaſon why this creature is ſo tedious in copulation.

The ſtructure of the *teſticles* is much the ſame with the human; as are likewiſe

likewiſe the *corpus pyramidale*, *varicoſum*, or *pampiniforme*, and the *epidydimis* or excretory veſſel of the teſticle. The *vaſa deferentia* enter the abdomen where the blood-veſſels come out; and, paſſing along the upper part of the bladder, are inſerted a little below the bulbous part of the urethra.

The præputium has two muſcles fixed to it: one that ariſes from the ſphincter ani, and is inſerted all along the *penis*; and this is called *retractor præputi*: but the other, whoſe office is directly contrary to this, is cutaneous, and ſeems to take its origin from the muſcles of the abdomen, or rather to be a production of their tunica carnoſa. The *corpora cavernoſa* riſe much in the ſame way as the human: but theſe ſoon terminate; and the reſt is ſupplied by a triangular bone, in the inferior part of which there is a groove excavated for lodging the urethra. There are upon the penis two protuberant bulbous fleſhy ſubſtances, at the back of which are two veins, which by the *erectores penis* and other parts are compreſſed in the time of coition; and the circulation being ſtopped, the blood diſtends the large cavernous bodies: after the penis is thus ſwelled, the vagina, by its contraction and ſwelling of its corpus cavernoſum, gripes it cloſely; and ſo the male is kept in action ſome time contrary to his will, till time be given for bringing a quantity of ſeed ſufficient to impregnate the female: and thus, by that *orgaſmus veneris* of the female organs, the want of the *veſiculæ ſeminales* are in ſome meaſure ſupplied. But as it would be a very uneaſy poſture for the dog to ſupport himſelf ſolely upon his hinder feet, and for the bitch to ſupport the weight of the dog for ſo long a time; therefore, as ſoon as the bulbous bodies are ſufficiently filled, he gets off and turns averſe to her: had then the penis been pliable as in other animals, the urethra muſt of neceſſity have been compreſſed by this twiſting, and conſequently the courſe of the ſeed intercepted; but this is wiſely provided againſt by the urethra's being formed in the hollow of the bone. After the emiſſion of the ſeed, the parts turn flaccid, the circulation is reſtored, and the bulbous parts can be eaſily extended.

The *proſtata* ſeems here divided into two, which are proportionably larger than the human, and afford a greater quantity of that liquid.

The *uterus* of multiparous animals is little elſe but a continuation of their

their vagina, only ſeparated from it by a ſmall ring or valve. From the *uterus* two long canals mount upon the loins, in which the fœtuſes are lodged: theſe are divided into different ſacs, which are ſtrongly conſtricted betwixt each fœtus; yet theſe coarctions give way in the time of birth. From theſe go out the *tubæ Fallopianæ*, ſo that the ovaria come to lodge pretty near the kidneys.

We ought next to examine the ſtructure of the thorax and its contents. But firſt it may not be amiſs to remark of the *diaphragm* in its natural ſituation, that it is in general more looſe and free than the human; which is owing to its connection with the neighbouring parts in a different manner from ours. The human *diaphragm* is connected to the pericardium; which again, by the intervention of the mediaſtinum, is tied to the ſternum, ſpine, &c. but here there is ſome diſtance between the diaphragm and pericardium. We obſerve further, that its middle part is much more moveable, and the tendinous parts not ſo large. And indeed it was neceſſary their *diaphragm* ſhould be ſomewhat looſe, they making more uſe of it in difficult reſpiration than man. This we may obſerve by the ſtrong heaving of the flanks of an horſe or dog when out of breath; which correſponds to the riſing of the ribs in us.

The diſpoſition and ſituation of the *mammæ* vary as they bear one or more young. Thoſe of the uniparous kind have them placed between the poſterior extremities, which in them is the higheſt part of their bodies, whereby their young get at them without the inconvenience of kneeling: nevertheleſs, when the creatures are of no great ſize, and their breaſt large, as in ſheep, the young ones are obliged to take this poſture. In multiparous animals, they muſt have a great number of nipples, that their ſeveral young ones may have room at the ſame time, and theſe diſpoſed over both thorax and abdomen; and the creatures generally lie down when the young are to be ſuckled, that they may give them the moſt favourable ſituation. From this it does not appear to be from any particular fitneſs of the veſſels at certain places for giving a proper nouriſhment to the child, that the breaſts are ſo placed in women as we find them, but really from that ſituation being the moſt convenient both for mother and infant.

The *ſternum* is very narrow, and conſiſts of a great number of ſmall bones,

bones, moveable every way; which always happens in creatures that have a great mobility in their ſpine. The ribs are ſtraighter, and by no means ſo convex as the human; whereby in reſpiration the motion forward will very little enlarge their thorax, which is compenſated by the greater mobility of their diaphragm: ſo our thorax is principally enlarged according to its breadth and depth, and theirs according to its length. The want of clavicles, and the conſequent falling in of the anterior extremities upon the cheſt, may contribute ſomewhat to the ſtraitneſs of the ribs.

The *mediaſtinum* in this creature is pretty broad. The pericardium is not here contiguous to the diaphragm, but there is an inch of diſtance betwixt them, in which place the ſmall lobe of the lungs lodges; and by this means the liver, &c. of this animal, though continually preſſing upon the diaphragm, yet cannot diſturb the heart's motion.

The heart is ſituated with its point almoſt directly downwards, according to the creature's poſture, and is but very little inclined to the left ſide. Its point is much ſharper, and its ſhape more conoidal, than the human. Here the names of *right* and *left* ventricles are proper enough, though not ſo in the human; which ought rather to be called *anterior* and *poſterior*, or *ſuperior* and *inferior*. The animal has the *vena cava* of a conſiderable length within the thorax, having near the whole length of the heart to run over ere it gets at the *ſinus Lowerianus dexter*. In men, as ſoon as it pierces the diaphragm, ſo ſoon it enters the pericardium, which is firmly attached to it, and immediately gets into the *ſinus Lowerianus*; which ſinus, in the human ſubject, by the oblique ſituation of the heart is almoſt contiguous to the diaphragm: and by this we diſcover that ſeveral authors have taken their delineations of the human heart from brutes; which is eaſily detected by the ſhape and ſituation of the heart, and long vena cava within the thorax. This was one of the faults of the curious wax-works that were ſhown at London and Paris, which were plainly taken from a cow.

This ſituation of the heart of the creature agrees beſt with the ſhape of its thorax, which is lower than the abdomen.

The egreſs of the large blood-veſſels from the heart is ſomewhat different from the human: for here the right ſubclavian comes off firſt;

and

and as a large trunk runs ſome way upwards before it gives off the left carotid, and ſplits into the carotid and ſubclavian of the right ſide, then the left ſubclavian is ſent off: So that neither here, properly ſpeaking, is there an *aorta aſcendens* more than in the human; but this name has probably been impoſed upon it from obſerving this in a cow, where indeed there is an aſcending and deſcending aorta.

From this ſpeciality of the diſtribution of the veſſels of the right ſide, which happens, though not in ſo great a degree, in the human ſubject, we may perhaps in ſome meaſure account for the general greater ſtrength, readineſs or faculty of motion, which is obſervable in the right arm. I believe, upon meaſuring the ſides of the veſſels, the ſurface of the united trunk of the right ſubclavian and carotid is leſs than that of the left ſubclavian and carotid, as they are ſeparated. If ſo, the reſiſtance to the blood muſt be leſs in that common trunk than in the left ſubclavian and carotid: but if the reſiſtance be ſmaller, the abſolute force with which the blood is ſent from the heart being equal, there muſt neceſſarily be a greater quantity of blood ſent through them in a given time; and as the ſtrength of the muſcles is, *cæteris paribus*, as the quantity of blood ſent into them in a given time, thoſe of the right arm will be ſtronger than thoſe of the left. Now children, being conſcious of this ſuperior ſtrength, uſe the right upon all occaſions; and thus from uſe comes that great difference which is ſo obſervable. That this is a ſufficient cauſe, ſeems evident from fact; for what a difference is there betwixt the right and the left arm of one who has played much at tennis? View but the arms of a blackſmith, and legs of a footman, and you will ſoon be convinced of this effect ariſing from uſing them. But if by any accident the right arm is kept from action for ſome time, the other from being uſed gets the better; and thoſe people are left-handed: for it is not to be imagined, that the ſmall odds in the original formation of the veſſels ſhould be ſufficient to reſiſt the effect of uſe and habit, (inſtances of the contrary occur every day); it is enough for our preſent argument, that where no means are uſed to oppoſe it, the odds are ſufficient to determine the choice in favour of the right. Now becauſe it is natural to begin with the leg correſponding to the hand we have moſt power of, this is what gives alſo a ſuperiority to the right leg.

This difference is not peculiar to man, but is ſtill more obſervable in thoſe creatures in whom the ſame mechaniſm does obtain in a greater degree. Do but obſerve a dog at a trot, how he bears forwards with his right ſide; or look at him when a-ſcraping up any thing, and you will preſently ſee that he uſes his right much oftener than he does his left foot. Something analogous to this may be obſerved in horſes.

The *thymus* of this creature is proportionably much larger than ours; whereas the glandula thyroidea is much leſs: and it is generally remarked, that theſe two glands do thus always ſupply the place of each other; that is, in ſuch animals as have a large thymus, the glandula thyroidea is ſmaller, and *vice verſa*. Hence we are naturally led to aſcribe the ſame uſe to both, viz. the ſeparation of a thin lymph for diluting the chyle in the thoracic duct before it be poured into the blood; then if we conſider the different formation of the thorax in both, we ſhall readily account for the variety in the bulk of theſe two glands. Reſpiration being chiefly performed in man by the widening of the cheſt, the lungs at every inſpiration muſt preſs upon the thymus, and conſequently diminiſh it: but the diaphragm yielding more in the dog's inſpiration, this gland is not ſo much preſſed by the lungs, and ſo will be larger; and hence the glandula thyroidea will be proportionably leſs. Again, from the poſture of this creature, we ſhall ſee that it was much more convenient for a dog to have the moſt part of the diluting lymph ſupplied by the thymus, ſince the neck being frequently in a deſcending poſture, the lymph of the thyroid gland would have a very diſadvantageous courſe to get to the thoracic duct: whereas in the human body, the thymus is really below the lacteal canal, where it makes its curvature before it opens into the ſubclavian; and conſequently there is a neceſſity of a conſiderable ſhare of the diluting liquor being furniſhed by the thyroid gland, which is ſituated much higher; ſo that its lymph has the advantage of a perpendicular deſcent.

We may here obſerve, that the *thoracic duct* in a dog has no curvature before it enters the ſubclavian vein, the horizontal poſition of this animal allowing a favourable enough courſe to the chyle, ſo as not to need that turn to force its paſſage into the blood.

The lungs of this creature are divided into more numerous lobes, and deeper,

deeper, than they are in man, for the ſame reaſon as the liver. The left ſide of the thorax in this animal bears a greater proportion to the right than in man; the one being nearly as three to two, the other as four to three.

We look on it as a general rule, that all quadrupeds, as having occaſion to gather their food from the ground, are provided with longer necks than man: but as a long neck not only gives the advantage of too long a lever to the weight of the head, but alſo, when the animal is gathering his food, makes the brain in danger of being oppreſſed with too great a quantity of blood, by the liquor in theſe arteries having the advantage of a deſcent, while that in the veins muſt remount a conſiderable way contrary to its own gravity; it was therefore neceſſary that a part of the length of the neck ſhould be ſupplied by the length of the jaws. Thus we ſee horſes, cows, &c. who have no occaſion for opening their mouths very wide, yet have long jaws. Bull-dogs indeed, and ſuch animals as have occaſion for very ſtrong jaws, muſt of neceſſity have them ſhort; becauſe the longer they are, the reſiſtance to be overcome acts with a longer lever. Another exception to this general rule, is ſuch animals as are furniſhed with ſomething analogous to hands to convey their food to their mouths, as cats, apes, &c. The teeth of this creature plainly ſhew it to be of the carnivorous kind; for there are none of them made for grinding their food, but only for tearing and dividing it.

Even its poſterior teeth are not formed with rough broad ſurfaces as ours are; but are made conſiderably ſharper, and preſs over one another when the mouth is ſhut, that ſo they may take the firmer hold of whatever comes betwixt them.

The tongue, in conſequence of the length of the jaws, is much longer than ours; and as this creature feeds with his head in a depending poſture, the bolus would always be in danger of falling out of the mouth, were it not for ſeveral prominences placed moſtly at the root of the tongue, and crooked backwards in ſuch a manner, as to allow any thing to preſs eaſily down to the jaws, but to hinder its return. In ſome animals who feed on living creatures, theſe under-hooks are ſtill more conſpicuous, as in ſeveral large fiſhes, where they are almoſt as large as their teeth in the forepart of their mouth, and near as firm and ſtrong.

When we open the mouth, we ſee the *amygdalæ* very prominent in the poſterior part of it; ſo that it would appear at firſt view, that theſe were inconveniently placed, as being continually expoſed to injuries from the hard ſubſtances this creature ſwallows: but upon a more narrow ſcrutiny, we find this provided for by two membranous capſulæ, into which the *amygdalæ*, when preſſed, can eſcape, and remove themſelves from ſuch injuries.

The *velum pendulum palati* is in this creature conſiderably longer than in man, to prevent the food from getting into his noſe; which would happen more frequently in this animal than in man, becauſe of its ſituation while feeding.

In this ſubject there is no *uvula*; but then the *epiglottis*, when preſſed down, covers the whole rima entirely, and naturally continues ſo: there is therefore a ligament, or rather muſcle, that comes from the os hyoides and root of the tongue, that is inſerted into that part of the epiglottis where it is articulated with the cricoid cartilage, which ſerves to raiſe it from the rima, though not ſo ſtrongly but that it may with a ſmall force be clapped down again.

In the upper part of the pharynx, behind the cricoid cartilage, there is a pretty large gland to be found, which ſerves not only for the ſeparation of a mucous liquor to lubricate the bolus as it paſſes this way, but alſo ſupplies the place of a valve, to hinder the food from regurgitating into the mouth, which it would be apt to do by reaſon of the deſcending ſituation of the creature's head.

The *æſophagus* is formed pretty much in the ſame way as the human. Authors indeed generally allege, that quadrupeds have their gullet compoſed of a double row of ſpiral fibres decuſſating one another; but this is proper to ruminating animals, who have occaſion for ſuch a decuſſation of fibres. The action of theſe you may eaſily obſerve in a cow chewing her cud.

The *noſe* is generally longer than in man, and its external paſſage much narrower. The internal ſtructure is alſo better adapted for an acute ſmelling, having a larger convoluted ſurface on which the *membrana ſchneideriana* is ſpread; and this is to be obſerved in moſt quadrupeds, who have the oſſa ſpongioſa commonly large, and theſe too divi-

ded

ded into a great number of exceſſively fine thin lamellæ. The elephant, which has a head pretty large in proportion to its body, has the greateſt part of it taken up with the cavity of the noſe and frontal ſinuſes; which laſt extend almoſt over their whole head, and leave but a ſmall cavity for their brains. A very nice ſenſe of ſmelling was not ſo abſolutely neceſſary for man, who has judgment and experience to direct him in the choice of his food; whereas brutes, who have only their ſenſes, muſt have theſe of neceſſity acute, ſome having one ſenſe in greater perfection than others, according to their different way of life. We not only conclude *à priori* from the large expanded *membrana ſcheideriana*, that their ſenſe of ſmelling is very acute, but we find it ſo by cows and horſes diſtinguiſhing ſo readily betwixt noxious and wholeſome herbs, which they do principally by this ſenſe.

The external *ear* in different quadrupeds is differently framed, but always calculated to the creature's manner of life. In ſhape it commonly reſembles the oblique ſection of a cone from near the apex to the baſis. Hares, and ſuch other animals as are daily expoſed to inſults from beaſts of prey, have large ears directed backwards, their eyes warning them of any danger before; rapacious animals, on the other hand, have their ears placed directly forwards, as we ſee in the lion, cat, &c. The ſlow hounds, and other animals that are deſigned to hear moſt diſtinctly the ſounds coming from below, have their ears hanging downwards. Man again, who muſt equally hear ſounds coming from all quarters, but eſpecially ſuch as are ſent from about his own height, has his external ear placed in a vertical manner, ſomewhat turned forward. In ſhort, wherever we ſee a ſpeciality in the make of this organ in any creature, we ſhall, with very little reflection, diſcover this form to be more convenient for that creature than another. There are ſome differences to be obſerved in the ſtructure of the internal ear in different animals; but we know ſo very little of the uſe of the particular parts of that organ in the human ſubject, that it is altogether impoſſible to aſſign reaſons for theſe variations in other creatures.

All quadrupeds have at the internal canthus of the *eye* a ſtrong firm membrane with a cartilaginous edge, which may be made to cover ſome part of their eye; and this is greater or leſs in different animals as their

eyes

eyes are more or leſs expoſed to dangers in ſearching after their food. This *membrana nictitans*, as it is called, is not very large in this animal. Cows and horſes have it ſo large as to cover one half of the eye like a curtain, and at the ſame time is tranſparent enough to allow abundance of the rays of light to paſs through it. Fiſhes have a cuticle always over their eyes, as they are ever in danger in that inconſtant element. In this then we may alſo obſerve a ſort of gradation.

All quadrupeds have a ſeventh muſcle belonging to the eye, called *ſuſpenſorius*. It ſurrounds almoſt the whole optic nerve, and is fixed into the ſclerotic coat as the others are. Its uſe is to ſuſtain the weight of the globule of the eye, and prevent the optic nerve from being too much ſtretched, without obliging the four ſtraight muſcles to be in a continual contraction, which would be inconvenient: at the ſame time this muſcle may be brought to aſſiſt any of the other four, by cauſing one particular portion of it to act at a time.

The next thing to be remarked is the figure of the *pupil*, which is different in different animals, but always exactly accommodated to the creature's way of life. Man has it circular for obvious reaſons; an ox has it tranſverſe, to take in a larger view of his food: cats, again, have theirs ſomewhat perpendicular (but can alter it pretty much) for a ſimilar reaſon, and ſo of the reſt. The pupil of different animals varies in wideneſs, according as the internal organs of viſion are more or leſs acute: Thus cats and owls, who ſeek their prey in the night, or in dark places, (and conſequently muſt have their eyes ſo formed as that a few rays of light may make a lively impreſſion on the retina), have their pupils in the day-time contracted into a very narrow ſpace, as a great number of rays would oppreſs their nice organs, while in the night they dilate conſiderably. In the ſame way, when the retina is inflamed, a great number of rays of light would occaſion a painful ſenſation; therefore the pupil is contracted: on the contrary, in dying people, or in a beginning amauroſis, it is greatly dilated, as the eyes on ſuch occaſions are very difficultly affected, and as it were inſenſible.

The poſterior part of the choroid coat, which is called *tapetum*, is of different colours in different creatures. For oxen, feeding moſtly on graſs have this membrane of a green colour, that it may reflect upon the retina

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all the rays of light which come from objects of that colour, while other rays are obſcured: Thus the animal ſees its food better than it does other objects. Cats and owls have their tapetum of a whitiſh colour; and for the ſame reaſons have the pupil very dilatable, and their organs of viſion acute: and we ſhall find that all animals ſee more or leſs diſtinctly in the dark, according as their tapetum approaches nearer to a white or black colour. Thus dogs, who have it of a greyiſh colour, diſtinguiſh objects better in the night than man, whoſe tapetum is dark brown, and who I believe ſees worſt in the dark of any creature; it being originally deſigned that he ſhould reſt from all kinds of employment in the night-time. The difference then of the colour of the tapetum, as indeed the fabrick of any other part in different creatures, always depends on ſome particular advantage accruing to the animal in its peculiar manner of life from this ſingularity.

We ſhall now proceed to the *brain*, which we remark in the firſt place is proportionally much ſmaller in all quadrupeds than the human. There was no ſuch occaſion for ſo great a quantity of brains in thoſe animals as in man; ſeeing in them all its energy is employed in their progreſſion, while man has a great waſte of ſpirits in the exerciſe of his reaſon and intellectual faculties. And beſides all this, a great bulky brain would be inconvenient to theſe creatures, in ſo far as it would add conſiderably to the weight of the head; which having the advantage of a long lever to act with, would require a much greater force to ſupport it, than now it does; for the heads of the greateſt part of quadrupeds are not near ſo heavy as they would at ſight ſeem to be, from the *ſinus frontales* being produced a great way upwards to enlarge the organs of ſmelling.

The pits in the anterior part of their ſkulls are much more conſpicuous than in the human cranium; which may be occaſioned by the depending poſture of theſe creatures heads while they gather their food: the brain at this time gravitating much on the bones while they are as yet ſoft, will gradually make impreſſions upon them at theſe places where it riſes into eminencies. This is prevented in man moſtly by his erect poſture.

The *falx* is not near ſo large in quadrupeds as in man, as they have little occaſion to be on either ſide, and the two hemiſpheres of the brain

are in a great meaſure hindered from juſtling againſt one another in violent motions, by the brain's inſinuating itſelf into the abovementioned pits.

The ſecond proceſs of the *dura mater*, or *tentorium cerebello ſuper-expanſum*, is conſiderably thicker and ſtronger in moſt quadrupeds than in man; eſpecially in ſuch of them as are very ſwift of foot, as hares and rabbits, and that moſt when they are old. This membrane is generally oſſified, that it may the more effectually keep off the weight of the ſuperincumbent brain from the cerebellum in their rapid motions, which otherwiſe would be of bad conſequence.

The olfactory nerves are very large, and juſtly deſerve the name of *proceſſus mamillaris*. They are hollow, and conſiſt of a medullary and cineritious ſubſtance, and at firſt ſight appear to be the anterior ventricles of the brain produced; but in man they are ſmall, and without any diſcernible cavity. The reaſon of this is pretty evident, if we conſider how this animal's head is ſituated; for the lymph continually gravitating upon the inferior part of the ventricles may thus elongate and produce them: but from this very inferior part the olfactory nerves riſe, and are ſent immediately through the os ethmoides into the noſe. Hence the ancients, thinking they were continued hollow into the noſe, believed they were the emunctories of the brain: in the brain of ſheep, which by its firm texture is the beſt ſubject of any for ſearching into the ſtructure of this part, we evidently ſee, that the name of the *ſigmoid cavity*, was very properly applied by the ancients to the lateral ventricles of the brain; which are really of a greater extent than they are ordinarily painted by the anatomiſts, reaching farther backwards, and forwards again under the ſubſtance of the brain.

The *nates* and *teſtes* deſerve this name much better here than in the human body, with reſpect to each other. They are here alſo of different colours; the *nates* being of the colour of the cortical, and the *teſtes* of the medullary ſubſtance of the brain: whereas, in man they are both of one colour. The reaſon of theſe differences, and others of the like nature to be met with, I ſhall not pretend to determine; for we have hitherto ſuch an imperfect knowledge of the brain itſelf, that we are entirely ignorant of the various uſes of its different parts. We may in general conclude, that

that the varying in one animal, from what it is in another, is fitted to the creature's particular way of living.

The *rete mirabile Galeni*, ſituated on each ſide of the *ſella turcica*, about which there has been ſo much diſpute, is very remarkable in moſt quadrupeds. Galen ſeems with juſtice to ſuppoſe, that this plexus of veſſels ſerves for checking the impetuoſity of the blood deſtined for the brain.

The ſtructure of the brain differing but very little in all quadrupeds, it will be needleſs to examine it in any other.

The ANATOMY of a COW.

THE next ſpecies of quadrupeds we propoſed to conſider, was the ruminant kind, of which we have an example in a cow; and accordingly ſhall take the fœtus of the animal *in utero*, that we may firſt remark ſome things that are peculiar to it in that ſtate, and afterwards proceed to examine its viſcera as a ruminant animal. Firſt then as a fœtus.

The form of a cow's *uterus* differs from the human, in having two pretty large cornua. This is common to it with other brutes; for a bitch has two long *cornua uteri*: But theſe again differ (as being multiparous and uniparous) in this, that in the bitch's cornua the fœtuſes are contained; whereas here there is only part of the ſecundines, being moſtly the allantois with the included liquor. The muſcular fibres of the uterus are more eaſily diſcovered; its internal ſurface has a great number of ſpungy, oblong, protuberant, glandular bodies fixed to it. Theſe are compoſed of veſſels of the uterus terminating here. In an impregnated uterus, we can eaſily preſs out of them a chylous mucilaginous liquor; they are compoſed of a great many proceſſes or digituli, and deep caverns, anſwering to as many proceſſes and caverns of the placenta. Their reſemblance has occaſioned the name of *papillæ* to be given them; and hence it was that Hippocrates was induced to believe that the fœtus ſucked *in utero*. It is not eaſy to determine whether the uterus grows thicker or thinner in the time of geſtation. The membranes, it is plain, (by the ſtretching of the parts) muſt be made thinner; but then it is as evident, that the veſſels are at that time enlarged, upon which principally the thickneſs of any part depends; ſo there ſeems to be as much gained the one way, as loſt the other.

The *os uteri* is entirely ſhut up by a glutinous mucilaginous ſubſtance, that is common to the females of all creatures when with young: by this the external air is excluded, which would ſoon make the liquors corrupt; it alſo prevents the inflammation of the membranes, and the hazard of abortion. By this means alſo the lips of the womb are kept from growing together, which otherwiſe they would certainly at this time do. There are mucous glands placed here to ſecern this gluten, which on the breaking of the membranes with the contained waters make a ſapo that lubricates and waſhes the parts, and makes them eaſily yield. The firſt of the proper involucra of the fœtus is the chorion.

The *chorion* is a pretty ſtrong firm membrane, on whoſe external ſurface are diſperſed a great many red fleſhy bodies of the ſame number, ſize and ſtructure with the papillæ, with which they are mutually indented. They have been called *cotyledones*, from Κοτύλη, "cavity." This is greatly diſputed by ſome as a name very improper; but I think without reaſon, ſince the ſurface that is connected to the papillæ is concave, though when ſeparated it appears rather convex. To ſhun all diſpute, they may be called properly enough *placentulæ*, ſince they ſerve the ſame uſe as the placenta in women. The ſeparation of theſe from the papillæ without any laceration, and our not being able to inject coloured liquors from the veſſels of the glands of the uterus into the placentulæ, ſeem to prove beyond a reply, that there can be here no anaſtomoſes betwixt the veſſels; on their coats run a great number of veſſels that are ſent to the ſeveral placentulæ, on the external ſide next to the uterus; whereas in creatures that have but one placenta, as in the human ſubject, cats, dogs, &c. the adheſion is ſomewhat firmer: The placentæ are likewiſe joined to the papillæ in the cornua uteri. We ſhall next give the hiſtory of the *allantois*.

This is a fine tranſparent membrane contiguous to the former. It is not a general involucrum of the fœtus in the mother, for it covers only a ſmall part of the amnios. It is moſtly lodged in the cornua uteri. In mares, bitches, and cats, it ſurrounds the amnios, being every where interpoſed betwixt it and the chorion. In ſheep and goats it is the ſame as in this animal; and in ſwine and rabbits it covers ſtill leſs of the amnios. This ſac is probably formed by the dilatation of the urachus, which is connected at its other end to the fundus of the bladder, through

through which it receives its contents, and the membrane is doubled at the extremity of the canal to hinder the return of the urine back into the bladder. Its veſſels are ſo exceſſively fine and few, that we cannot force an injected liquor farther than the beginning of this coat. This membrane is ſo far analogous to the cuticula, as not to be liable to corruption, or eaſily irritated by acrid liquors. The exiſtence of this membrane in women has been very warmly diſputed on both ſides. Thoſe who are againſt its exiſtence deny they could ever find it; and, allowing it were ſo, allege, that ſince the urachus is impervious, as appears by our not being able to throw liquors from the bladder into it, or *vice verſa*, it cannot ſerve the uſe that is agreed by all it does ſerve in beaſts, and therefore in the human body there is no ſuch thing. But when I conſidered on the other hand, firſt, that there ſeems to be the ſame neceſſity for ſuch a reſervoir in man as in other animals: ſecondly, that we actually find urine contained in the bladder of the human fœtus: thirdly, that urine has been evacuated at the navel when the urethra was ſtopped, which urine without this conduit would have fallen into the cavity of the abdomen: fourthly, that midwives have pretended to remark two different ſorts of waters come away at the time of birth: and laſtly, that Dr Littre and Dr Hale have given in this membrane of an human ſubject with all the other ſecundines curiouſly prepared, the one to the royal academy at Paris, the other to the royal ſociety at London, by which ſocieties their reſpective accounts are atteſted; not to mention Verheyen, Heiſter, Keil, &c. who affirm their having ſeen it; and Mr Albinus, that famous anatomiſt, profeſſor at Leyden, ſhows, as I am told, to his college every year a preparation of it: On all theſe accounts I muſt own, that it ſeemed not improbable to me there was ſuch a membrane in the human body. But in four bodies I purpoſely diſſected, wherein I was aſſiſted by a very accurate anatomiſt, Dr Sinclair, I could not obſerve any ſuch thing. However, my want of ſkill will more probably be doubted, than the truth of relations ſupported by ſuch authentic vouchers called in queſtion.

The third proper integument of the fœtus is the *amnios*. It is thinner and firmer than the chorion; it has numerous ramifications of the umbilical veſſels ſpread upon it, the lateral branches of which ſeparate a liquor into its cavity. This is the proper liquor of the amnios, which at

firſt is in a ſmall quantity, afterwards increaſes for ſome months, then again decreaſes, and in a cow near her time the quantity of this liquor is not above a pound. This membrane does not enter the *cornua uteri* in this creature; but for what further relates to the ſtructure of the involucra, with the nature of the liquors contained in them, I muſt refer to the ſecond volume of Medical Eſſays, from page 121, where you have the ſum of all I know of this matter.

There are here two *venæ umbilicales*, and but one in the human ſubject; becauſe the extreme branches coming from the ſeveral placentulæ could not unite ſo ſoon as they would have done had they come all from one cake as in the human.

There is a ſmall round fleſhy body that ſwims in the urine of this creature, mares, &c. which is the *hippomanes* of the ancients. Several idle opinions and whims have been entertained as to its uſe; but that ſeems to be ſtill unknown, or how it is generated or nouriſhed, for it has no connection with the fœtus or placentulæ.

Having thus conſidered the ſeveral involucra of this animal in a fœtus ſtate, let us next obſerve the ſpecialities in its internal ſtructure peculiar to a fœtus.

The umbilical vein joins the *vena portarum* in the *capſula Gliſſoniana* without ſending off any branches as it does in the human ſubject. This vein ſoon after birth turns to a ligament; yet there are ſome inſtances where it has remained pervious for ſeveral years after birth, and occaſioned an hæmorrhage. We may next obſerve the duct called *canalis venoſus*, going ſtraight from the *capſula Gliſſoniana* to the *vena cava*; this turns alſo afterwards to a ligament. The umbilical arteries riſe at acute angles from the internal iliacs, whatever ſome may ſay to the contrary: theſe alſo become impervious.

The pulmonary artery coming from the right ventricle of the heart divides into two: the ſmalleſt, called *canalis arterioſus*, opens into the deſcending aorta; the other divides into two, to ſerve the lungs on each ſide. The *foramen ovale* is placed in the partition betwixt the right and left auricles. At the edge of this hole is fixed a membrane, which when much ſtretched will cover it all over, but more eaſily yields to a force that acts from the right auricle to the left than from the left to the right.

After

After what has been ſaid, we may eaſily underſtand how the circulation is performed in a fœtus. The blood, being brought from the placenta of the mother, is thrown into the *capſula Gliſſoniana*, where it is intimately blended with the blood in the *vena portarum:* then part of this blood goes directly into the *vena cava* by the *ductus venoſus;* the reſt paſſes through the liver. Firſt, then, the whole is ſent from the *vena cava* into the right auricle, from whence part of it is ſent by the *foramen ovale* into the left auricle; the reſt paſſes into the right ventricle, then into the pulmonary artery; then the greateſt ſhare it receives is ſent immediately into the deſcending aorta by the *canalis arterioſus*, and the remainder circulates through the lungs, and is ſent back by the pulmonary veins into the left auricle; which, with the blood brought there by the *foramen ovale*, is ſent into the left ventricle, from whence it is driven by the aorta through the body. The great deſign of this mechaniſm is, that the whole maſs of blood might not paſs through the collapſed lungs of the fœtus; but that part of it might paſs through the *foramen ovale* and *canalis arterioſus*, without circulating at all through the lungs.

This was the opinion that univerſally prevailed till the end of the laſt century, when it was violently oppoſed by Monſieur Mery, who is very ſingular in ſeveral of his opinions. He will not allow that the foramen ovale tranſmits blood from the right to the left auricle, but on the contrary from the left to the right; and that for no other reaſon but becauſe he obſerved the pulmonary artery in a fœtus longer than the aorta. Mr Winſlow endeavours to reconcile theſe two opinions, by ſaying the blood may paſs either way, and that it is here as it were blended; his reaſon is, that on putting the heart in water, the foramen ovale tranſmits it any way. Mr Rohault, profeſſor of anatomy at Turin, and formerly one of Mery's ſcholars, ſtrongly defends his maſter, and criticiſes Mr Winſlow. What he principally builds on, is the appearance this foramen has in ſome dried preparations: This Mr Winſlow will not allow as a proof. After all, I remain in the common opinion; and that for the following reaſons: Firſt, the pulmonary artery being larger ſignifies nothing, ſince its coats are not only thinner and will be more eaſily diſtended, but alſo the reſiſtance to the blood in the pulmonary artery from the collapſed lungs is greater than the reſiſtance to the blood in the aorta. Secondly,

if

if we ſhould allow any of theſe two uncommon opinions, we ſhould have the right ventricle vaſtly more capacious than the left: for if we ſuppoſe the *foramen ovale* to be capable of tranſmitting one third of the whole maſs of blood in any given time, and the *arterioſus* as much in the ſame time, then you will find, that, according to Mr Mery's opinion, the whole maſs of blood being driven from the right ventricle into the pulmonary artery, one third paſſes by the *canalis arterioſus* into the deſcending aorta, two thirds paſſing through the lungs and returning into the left auricle; one half of which portion, or one third of the whole maſs, paſſes by the *foramen ovale* into the right auricle; and the other, or the laſt third, will be ſent into the left ventricle, and thence expelled into the *aorta;* which third, with that from the pulmonary artery by the *canalis arterioſus*, circulating through the body, are returned unto the right auricle, where meeting with the other third from the *foramen ovale*, with it they are ſent into the right ventricle to undergo the ſame courſe. Thus the whole maſs is expelled by the right ventricle, and only one third by the left. If this was the caſe, why is not the right ventricle three times as large and ſtrong as the left?

Then, if according to Mr Winſlow's ſyſtem the *foramen ovale* tranſmits equal quantities from both auricles, this comes to the ſame as if there was no *foramen ovale* at all: that is to ſay, the whole maſs going from the right auricle into the right ventricle and pulmonary artery, one third of the whole maſs paſſes into the aorta through the *canalis arterioſus;* the other two thirds, paſſing through the lungs, return to the left auricle and ventricle. Thus the right ventricle expels the whole maſs; the left, only one third.

But if, according to the common opinion, we ſuppoſe the *foramen ovale* to convey the blood from the right to the left auricle, then one-third paſſes this way into the left ventricle; the other two-thirds are ſent by the right ventricle into the pulmonary artery: from whence one-third paſſes by the *canalis arterioſus* into the *aorta deſcendens;* the other third circulates through the lungs, and is returned into the left ventricle; where meeting with that from the *foramen ovale*, it is therewith expelled into the aorta, and with the one-third tranſmitted by the *canalis arterioſus* returns into the auricle to run the ſame race as before. Thus we conclude, that two

thirds

thirds are expelled by each ventricle, and the whole circulates through the body; and hence they come to be of pretty equal dimenſions. In all this calculation I have had no regard to the blood diſcharged from the umbilical veſſels; but the greater quantity returned by the vēins, than ſent out by the arteries, ſtill argues for the common opinion.

The *kidneys* in the fœtus are compoſed of different lobes, which ſerves to give us an idea of the kidneys being a congeries of different glands; theſe lobes being kept contiguous by the external membrane are preſſed by the other viſcera, till at length they unite.

We come now to conſider the creature as a ruminant animal. There are no *dentes inciſores* in the upper jaw; but the gums are pretty hard, and the tongue rough. The animals therefore ſupply the defect by wrapping their tongue round a tuft of graſs; and ſo, preſſing it againſt the upper jaw, keep it ſtretched, and cut it with the teeth of the under jaw; then, without chewing, throw it down into the œſophagus, which in theſe creatures conſiſts of a double row of ſpiral fibres decuſſating one another. All animals which ruminate muſt have more ventricles than one; ſome have two, ſome three; our preſent ſubject has no leſs than four. The food is carried directly down into the firſt, which lies upon the left ſide, and is the largeſt of all; it is called γάστηρ, *ventriculus*, and κοιλία, by way of eminence. It is what is called by the general name of *paunch* by the vulgar. There are no rugæ upon its internal ſurface: the food, by the force of its muſcular coat, and the liquors poured in here, is ſufficiently macerated; after which it is forced up hence by the œſophagus into the mouth, and there it is made very ſmall by maſtication; this is what is properly called *chewing the cud*, or *rumination*: after this it is ſent down by the gullet into the ſecond ſtomach, for the œſophagus opens indifferently into both; however, the creature has a power to direct it into which it will. Some tell us, that the drink goes into the ſecond; but that might be eaſily determined by making them drink before ſlaughter. The ſecond ſtomach, which is the anterior and ſmaller, is called κεκρύφαλος, *reticulum*, *honeycomb*, the *bonnet*, or *king's-hood*. It conſiſts of a great number of cells on its internal ſurface, of a regular pentagonal figure, like to a honeycomb. Here the food is farther macerated; from which it is protruded into the third,

called

called Ἐχῖνος or *omaſum*, *vulgo* the *manyplies*, becauſe the internal ſurface riſes up into a great many plicæ or folds, and *ſtratum ſuper ſtratum*, according to the length of this ſtomach. Some of theſe plicæ are farther produced into the ſtomach than others, *i. e.* firſt two long ones on each ſide, and within theſe two ſhorter in the middle, &c. There are numberleſs glandular grains like millet-ſeeds diſperſed on its plicæ, from which ſome authors call this ſtomach the *millet*. From this it paſſes into the fourth, whoſe names are νυστρον, *abomaſum*, *caillè*, or the *red*, which is the name it commonly has becauſe of its colour. *Caillè* ſignifies *curdled*; and hence the French have given that as a name to this fourth ſtomach, becauſe any milk that is taken down by young calves is there curdled. It is this fourth ſtomach, with the milk curdled in it, that is commonly taken for making runnet; but after the bile and pancreatic juice enter, this coagulation is not to be found, which ſhews the uſe of theſe liquors. There are other creatures which uſe the ſame food, that have not ſuch a mechaniſm in their digeſtive organs. Horſes, aſſes, &c. have but one ſtomach where graſs is macerated, and a liquor for their nouriſhment extracted, and the remainder ſent out by the anus very little altered. From this different ſtructure of the ſtomach in theſe creatures, a ruminant animal will be ſerved with one third leſs food than another of equal bulk: graſiers are ſufficiently acquainted with this. The reaſon is, that ruminating animals have many and ſtrong digeſtive organs; all their food is fully prepared, and almoſt wholly converted into chyle: but a horſe's ſtomach is not fitted for this; ſo that he requires a much greater quantity of food to extract the ſame nouriſhment.

The guts of theſe creatures are of a conſiderable length in proportion to the bulk of the body; and this confirms what we ſaid formerly on the ſubject of the inteſtines of a dog, viz. that the length and capacity of the guts were different in different animals according to the nature of their food.

The *duodenum* is formed here much the ſame way as in a dog, and the general intention kept in view with regard to the mixture of the bile and pancreatic lymph. The great guts here hardly deſerve that name, their diameter differing very little from that of the ſmall ones; but to compenſate this, they are much longer proportionally than a dog's are, being convoluted

convoluted in the ſame way as the ſmall guts are. The cæcum is very large and long.

The *ſpleen* differs not much either in figure or ſituation from that of a dog's; but it is a little more firmly fixed to the diaphragm, there not being here ſo much danger of this viſcus's being hurt in the flexions of the ſpine.

The *liver* is not ſplit into ſo many lobes in this creature as either in a man or dog; which depends on the ſmall motion this creature enjoys in its ſpine, which made ſuch a diviſion needleſs. This alſo confirms what I formerly advanced on this head.

Their *veſica urinaria* is of a pyramidal ſhape. It is very large, and more membranaceous; for the urine of theſe creatures not being ſo acrid as that of carnivorous animals, there was no ſuch occaſion for expelling it ſo ſoon.

This creature is provided with a looſe pendulous *ſcrotum*, and conſequently with *veſiculæ ſeminales*. The female organs differ from thoſe of a bitch, moſtly as to the form of the cornua uteri, which are here contorted in form of a ſnail. In this, and all uniparous animals, they contain only part of the ſecundines; but in bitches, and other multiparous animals, they run ſtreight up in the abdomen, and contain the fœtus themſelves.

The ſituation of the *heart* is pretty much the ſame with that of a dog, only its point is rather ſharper: in us, the heart beating continually againſt the ribs, and both ventricles going equally far down to the conſtitution of the apex, it is very obtuſe; but here the apex is made up only of the left ventricle, ſo is more acute.

The *aorta* in this creature is juſtly divided into aſcending and deſcending, though this diviſion is ill-founded either in a dog or man; and it has certainly been from this ſubject that the older anatomiſts took their deſcriptions when they made this diviſion; for here the aorta divides into two, the aſcending and deſcending.

Of FOWLS in general.

THE next claſs of animals we come to conſider are the feathered kind; which are divided into the *granivorous* and *carnivorous*. But before we go on to conſider the ſpecialties in the viſcera of each kind, we muſt obſerve what both ſpecies agree in.

Fowls have a particular covering of feathers different from all other creatures, but exactly well ſuited to their manner of life: for it not only protects them from the injuries of the weather, but ſerves them in their progreſſion through that thin aërial element they are for the moſt part employed in; and as ſome fowls live much in the water, their feathers being continually beſmeared with an oily liquor, keeps the water from ſoaking into their ſkins, and ſo prevents its bad effects, which it would infallibly otherwiſe produce.

Fowls have the ſtrongeſt muſcles of their whole body inſerted into their wings; whence by the way we may obſerve, that it is altogether impoſſible for man to buoy himſelf up into the air like birds, even though he had proper machines in place of wings, unleſs he were likewiſe provided with muſcles ſtrong enough for moving them, which he has not. In the next place, their wings are not placed in the middle of their bodies, but a good deal further forwards; whence it would at firſt view appear, that their heads would be erect, and their poſterior parts moſt depending when raiſed in the air: but by ſtretching out their heads, which act upon the lever of a long neck, they alter their centre of gravity pretty much; and alſo by filling the ſacs or bladders in the inſide of their abdomen with air, and expanding their tail, they come to make the poſterior part of their bodies conſiderably higher; and thus they fly with their bodies nearly in an horizontal ſituation. Hence we find, that if their necks are kept from being ſtretched out, or if you cut away their tails, they become incapable of flying any conſiderable way. The largeneſs of the wings in different fowls varies according to the occaſions of the creature. Thus birds of prey, who muſt fly a conſiderable way to provide their food, have large ſtrong wings; whereas domeſtic birds, who find their nouriſhment almoſt every where, have very ſhort and but ſmall wings. The beſt account of the manner of progreſſion of fowls is given by Alfonſus Borellus,

Borellus, in his treatiſe *De Motu Animalium;* and in the *Religious Philoſopher* we have Borelli's doctrine ſtripped pretty much of its mathematical form. The poſterior extremities are ſo ſituated, as to make us at firſt think they would be in continual hazard of falling down forwards when they walk; but this is prevented by their holding up their heads and necks; and when they have occaſion for climbing up a ſteep place, they ſteetch out their head and necks forwards. Thus we may obſerve a gooſe entering a barn-door, where generally there is an aſcending ſtep, to ſtretch out its neck, which before was raiſed, and incline its body forwards. This is laughed at by the common people, who aſcribe it to a piece of folly in the gooſe, as if afraid of knocking its head againſt the top of the door.

Carnivorous animals are provided with ſtrong crooked claws for the catching their prey: water-fowls uſe them for ſwimming; and principally for this purpoſe have a ſtrong firm membrane interpoſed betwixt the toes. There is a beautiful mechaniſm to be obſerved in the toes of fowls, which is of conſiderable uſe to them. For their toes are naturally drawn together, or bended, when the foot is bended: this perhaps proceeds from the tendons of the toes paſſing over in them, which is analogous to our heels; and when the foot is bended muſt conſequently be much ſtretched; and ſince they are inſerted into the toes, muſt of neceſſity bend them when the foot is bended; and when the foot is extended, the flexors of the toes are again relaxed, and they therefore expanded. This is of great uſe to water fowls: for had there been no ſuch contrivance as this, they muſt have loſt as much time when they pulled their legs in as they had gained by the former ſtroke; but, as the parts are now framed, whenever the creature draws in its foot, the toes are at the ſame time bended and contracted into leſs ſpace, ſo that the reſiſtance made againſt the water is not near ſo great as before: on the contrary, when they ſtretch their foot, their toes are extended, the membrane betwixt them expanded, and conſequently a greater reſiſtance made to the water. Again, ſuch fowls as live moſtly in the air, or have occaſion to ſuſtain themſelves on branches of trees in windy weather, and even in the night-time when aſleep, while all their muſcles are ſuppoſed to be in a ſtate of

relaxation; ſuch, I ſay, have no more to do but lean down the weight of their bodies, and their toes continue bended without any muſcles being in action; and whenever they would diſentangle themſelves, they raiſe up their bodies, by which their foot, and conſequently their toes are extended.

Carnivorous fowls have their beaks long, ſharp, and crooked; the domeſtick fowls, ſuch as the hen kind, *&c.* have ſtrong ſhort beaks, commodiouſly fitted to dig up and break their food; the water-fowls again, have long or very broad ſcoop-like beaks, which is moſt convenient for them. The *ſternum* of fowls is much larger proportionally than the human, and has a ridge riſing in its middle for the more commodious origin of the muſcles that move the wings. It is alſo leſs moveable than ours: for had it been very moveable, a great deal of the force employed for moving the wings would at every contraction of the muſcles have been loſt, or elſe ſome other muſcles muſt have come in play to keep firm the ſternum; but this additional weight would have been inconvenient for their progreſſion.

What other things are moſt remarkable in the ſtructure of the ſeveral viſcera, we ſhall conſider in that common domeſtic animal the cock or hen, and afterwards obſerve the difference of their *viſcera chylopoietica* from a carnivorous fowl.

The ANATOMY of a COCK.

THE *œſophagus* of this creature runs down its neck, ſomewhat inclined to the right-ſide; and terminates in a pretty large membranous ſac, which is the ingluvies or crop, where the food is macerated and diſſolved by a liquor ſeparated by the glands, which are eaſily obſerved every where on the external ſurface of this bag. The effect of this maceration may be very well obſerved in pigeons, who are ſometimes in danger of being ſuffocated by the peaſe, *&c.* they feed upon, ſwelling to ſuch an immenſe bulk in their ingluvies, that they can neither get upwards nor downwards. If it be a favourite fowl, it might be preſerved by opening the ſac, taking out the peaſe, and ſewing up the wound.

The food getting out of this ſac, goes down by the remaining part of the œſophagus into the *ventriculus ſuccenturiatus*, or *infundibulum Peyeri*, which

which is a continuation of the gullet with more numerous glands, which ſeparate a liquor to dilute the food ſtill more, which at length gets into the true ſtomach or gizzard, which conſiſts of two very ſtrong muſcles covered externally with a tendinous aponeuroſis, and lined on the inſide by a very thick firm membrane, which we evidently diſcover to be a production of the cuticula. This might have been proved in ſome meaſure *à priori*, from taking notice, that this membrane, which in chicks is only a thin ſlight pellicle, by degrees turns thicker and ſtronger the more attrition it ſuffers: but there is no other animal ſubſtance, ſo far as we know, which grows more hard and thick by being ſubjected to attrition, excepting the cuticula. Hence may be drawn ſome kind of proof of what I have ſometimes affirmed concerning the tunica villoſa of the ſtomach and inteſtines in the human body, viz. that it was in part a continuation of the epidermis; nay, all the hollow parts of the body, even arteries, veins, &c. ſeem to be lined with a production of this membrane, or one analogous to it. The uſe of this internal coat of the ſtomach of fowls is to defend the more tender parts of that viſcus from the hard grains and little ſtones thoſe creatures take down.

The digeſtion of theſe animals is performed merely by attrition, as is evinced by many experiments. We ſee them daily take down conſiderable numbers of the moſt ſolid rugged little flints they find; and theſe can ſerve for no other purpoſe than to help the trituration of their aliments. After theſe pebbles, by becoming ſmooth, are unfit for this office, they are thrown up by the mouth. Hence fowls that are long confined, though ever ſo well fed, turn lean for want of theſe ſtones to help their digeſtion. But this was put beyond all diſpute by Mr Tauvry, who gave a ſpecies of metal to an oſtrich, convex on one ſide, and concave on the other, but carved on both; and opening the creature's body ſome time after, it was found, that the carving on the convex ſide was all obliterated, while the engraved character remained the ſame as before on the concave ſide, which was not ſubjected to the ſtomach's preſſure: which could not have happened had digeſtion been performed by a menſtruum, or any other way whatſoever; but may be eaſily ſolved by allowing a ſimple mechanical preſſure to take place. We are, however, by no means to conclude from this, as ſome have too raſhly done, that in the

the human body digeſtion is performed by a ſimple attrition; otherwiſe we may, with equal ſtrength of reaſon, by as good arguments drawn from what is obſerved in fiſhes, prove that the aliments are diſſolved in our ſtomachs by the action of a menſtruum. But this method of reaſoning is very faulty; nor can it ever bring us to the true ſolution of any philoſophical or medical problem. It is very plain, ſince the ſtructure of the parts of the human ſtomach are ſo very different from that of this creature, that it is fooliſh and unreaſonable to imagine both of them capable of producing the ſame effects. At each end of the ſtomach, there are as it were two particular ſacs of a different texture from the reſt of the ſtomach, not conſiſting of ſtrong muſcular fibres; they ſeem to be receptacles for the ſtones, (eſpecially at the end which is fartheſt from the orifice), while the digeſted aliment is protruded into the inteſtines.

The *duodenum* begins pretty near the ſame place at which the œſophagus enters: yet notwithſtanding the vicinity of theſe two tubes, the aliments are in no danger of getting out before they are perfectly digeſted, by reaſon of a protuberance or *ſeptum medium* betwixt the orifices; and in thoſe creatures who have ſuch a ſtrong muſcular ſtomach, it is a matter of great indifference, whether the entry of the œſophagus or pylorus be higheſt, provided that the entry from the œſophagus does not allow the food to regurgitate, ſince the force of the ſtomach can eaſily protrude it towards the duodenum. This gut is moſtly in the right-ſide, and hangs pendulous in their abdomen, having its two extremities fixed to the liver. The *ductus choledochus* enters near its termination, where it mounts up again to be fixed to the liver; and leſt, by the contraction of the inteſtines, the bile ſhould paſs over without being intimately blended with the chyle, that duct enters downwards, contrary to the courſe of the food, and contrary to what is obſerved in any of the animals we have yet mentioned. But ſtill the general intention is kept in view, in allowing theſe juices the faireſt chance of being intimately blended with the food.

The *ſmall guts* are proportionally larger than thoſe of carnivorous birds, for the general cauſe already aſſigned. At the end of the ilium they have two large *inteſtina cæca*, one on each ſide, which ſerve as reſervoirs to the fæces; which, after ſome remora, there regurgitate into what

what ſoon becomes the rectum: which, together with the excretories of urine, and organs of generation, empties itſelf into the common cloaca. The ſmall inteſtines are connected by a long looſe meſentery, which has little or no fat accompanying the blood-veſſels, there being no hazard of the blood's being ſtopped.

The *pancreas* in the creature lies betwixt the two folds of the duodenum, and ſends two or three ducts into this gut pretty near the biliary.

The *ſpleen* is here of a round globular figure, ſituated between the liver and ſtomach, and betwixt theſe and the back-bone it enjoys the ſame properties as in other animals, *viz.* large blood-veſſels, &c. All its blood is ſent into the *vena portarum*, and has a perpetual conquaſſation. It has no excretory, as far as we know. Their *liver* is divided into two equal lobes by a pellucid membrane, running according to the length of their body; and hence we may obſerve, that it is not proper to that bowel to lie on the right ſide; which is ſtill more confirmed by what we obſerve in fiſhes, where it almoſt lies in the left ſide.

The ſhape of their *gall-bladder* is not much different from that of quadrupeds; but is thought to be longer in proportion to the ſize of the animal, and is farther removed from the liver.

The principal difference to be remarked in their *heart*, is the want of the *valvulæ tricuſpides*, and their place being ſupplied by one fleſhy flap.

The *lungs* are not looſe within the cavity of the thorax, but fixed to the bone all the way; neither are they divided into lobes, as in thoſe animals that have a large motion in their ſpine. They are two red ſpongy bodies covered with a membrane that is pervious, and which communicates with the large veſicles or air-bags that are diſperſed over their whole abdomen; which veſicles ſerve two very conſiderable uſes. The one is to render their bodies ſpecifically light, when they have a mind to aſcend and buoy themſelves up when flying, by diſtending their lungs with air, and alſo ſtraiten their *trachea arteria* and ſo return the air. Secondly, they ſupply the place of a muſcular *diaphragm* and ſtrong abdominal muſcles; producing the ſame effects on the ſeveral contained viſcera, as theſe muſcles would have done, without the inconveniency of their additional weight; and conducing as much to the excluſion of the egg and fæces.

The

The *trachea arteria*, near where it divides, is very much contracted; and their voice is principally owing to this coarctation. If you liſten attentively to a cock crowing, you will be ſenſible that the noiſe does not proceed from the throat, but deeper; nay this very pipe, when taken out of the body and cut off a little after its diviſion, and blown into, will make a ſqueaking noiſe, ſomething like the voice of theſe creatures. On each ſide, a little higher than this contraction, there is a muſcle ariſing from their ſternum, which dilates the trachea. The cartilages, of which the pipe is compoſed in this animal, go quite round it; whereas in men and quadrupeds, they are diſcontinued for about one-fourth on the back part, and the intermediate ſpace is filled up by a membrane. Neither is the trachea ſo firmly attached to their vertebræ as in the other creatures we have examined. This ſtructure we ſhall find of great ſervice to them, if we conſider, that had the ſame ſtructure obtained in them as in us, their breath would have been in hazard of being ſtopped at every flexion or twiſting of their neck, which they are frequently obliged to. This we may be ſenſible of by bending our necks conſiderably on one ſide, upon which we ſhall find a great ſtraitneſs and difficulty of breathing; whereas their trachea is better fitted for following the flexions of the neck by its looſe connection to the vertebræ.

In place of a *muſcular diaphragm* this creature has nothing but a thin membrane connected to the pericardium, which ſeparates the thorax and abdomen. But beſides this, the whole abdomen and thorax are divided by a longitudinal membrane or *mediaſtinum* connected to the lungs, pericardium, liver, ſtomach, and to the fat lying over their ſtomach and guts, which is analogous to an *omentum*, and ſupplies its place.

The *kidneys* lie in the hollow excavated in the ſide of the back-bone, from which there is ſent out a bluiſh-coloured canal running along by the ſide of the *vas deferens*, and terminating directly into the common cloaca. This is the *ureter*, which opens by a peculiar aperture of its own, and not at the penis. This creature having no *veſica urinaria*, it was thought by ſome they never paſſed any urine, but that it went to the nouriſhment of the feathers: but this is falſe; for that whitiſh ſubſtance that you ſee their greeniſh fæces covered with, and which turns afterwards chalky, is their urine.

urine. Let us next conſider the organs of generation of both ſexes, and firſt thoſe of the male.

The *teſticles* are ſituated one on each ſide of the back-bone; and are proportionally very large, to the creature's bulk. From theſe run out the *vaſa ſeminifera*, at firſt ſtraight; but after they recede farther from the body of the teſticle, they acquire an undulated or convoluted form, as the epididymis in man. Theſe convolutions partly ſupply the want of *veſiculæ ſeminales*, their coition being at the ſame time very ſhort: Theſe terminate in the penis, of which this creature has two, one on each ſide of the common cloaca pointing directly outwards; and are very ſmall and ſhort, whence they have eſcaped the notice of anatomiſts, who have often denied their exiſtence. This is what is chiefly remarkable in the organs of the male.

The *racemus vitellorum*, being analogous to the ovaria in the human ſubject, are attached by a proper membrane to the back-bone. This is very fine and thin, and continued down to the uterus. Its orifice is averſe with reſpect to the ovaria; yet notwithſtanding, by the force of the *orgaſmus venereus*, it turns round and graſps the *vitellus*, which in its paſſage thro' this duct, called the *infundibulum*, receives a thick gelatinous liquor, ſecreted by certain glands. This with what it receives in the uterus, compoſe the white of the egg. By this tube then it is carried into the uterus.

The *uterus* is a large bag, placed at the end of the *infundibulum*, full of wrinkles on its inſide; here the egg is completed, receiving its laſt involucrum, and is at laſt puſhed out at an opening on the ſide of the common cloaca. From the teſtes in the male being ſo very large in proportion to the body of the creature, there muſt neceſſarily be a great quantity of ſemen ſecerned; hence the animal is ſalacious, and becomes capable of impregnating many females. The want of the *veſiculæ ſeminales* is in ſome meaſure ſupplied by the convolutions of the *vaſa deferentia*, and by the ſmall diſtance betwixt the ſecerning and excretory organs. The two *penes* contribute alſo very much to their ſhort coition, at which time the opening of the uterus into the cloaca is very much dilated, that the effect of the ſemen on the vitelli may be the greater.

A hen will of herſelf indeed lay eggs; but theſe are not impregnated, and yet appear entirely complete.

After having obſerved the contents of the abdomen and thorax, we next proceed to examine the parts about the neck and head.

Theſe creatures, as was obſerved of fowls in general, have no teeth; which would have been needleſs, as they ſwallow their food entire: but their *tongue* is made pretty firm, leſt it ſhould be hurt by the ſharp points of the grain they feed on. It is of a triangular figure, and pointed before; and as by their depending poſture their meat is in hazard of falling out of their mouths, to prevent this there are ſeveral ſmall pointed papillæ ſtanding out upon their tongue and palate, with their points inclined backwards, allowing an eaſy paſſage to the food, but hindering its return.

We have here no *velum palatinum*, *uvula*, or *epiglottis;* and in place of two large holes opening into the noſe, there is only a long narrow rima ſupplied with pretty ſtrong muſcles, and ſuch another ſupplies the place of a glottis. The creature has a power of ſhutting both at pleaſure; and the nature of their food ſeems not only to exempt them from the hazard of its getting into the noſe or trachea, but its ſharp points would hurt an uvula, or epiglottis, if they had any. Hence we ſee with what difficulty they ſwallow dough or other ſort of food that can be eaſily moulded into any form.

Their *cranium* is more cellular and cavernous than ours. By this means their heads are light, yet ſtrong enough to reſiſt external injuries; for the enlarging the diameter of bones contributes to their ſtrength. By this cavernous cranium the organ of ſmelling is ſuppoſed to be conſiderably enlarged; and further, ſinging birds, as is obſerved by Mr Ray and Mr Derham, have this cavernous ſtructure of the brain ſtill more obſervable: and we are told that the cavity of the tympanum communicates with the cells; but this I am apt to believe, ſo far as I could find from diſſection, is rather founded on theory than matter of fact. Their brain is covered with the common membranes, but its external ſurface is not formed into ſo many gyræ or convolutions as ours. Its anterior part is quite ſolid, of a cineritious colour, and ſo far has a reſemblance of the *corpora ſtriata* as to give riſe to the olefactory nerves. The whole of it appears to us as imperfect, and we can ſcarce determine whether there be any thing analogous to a third or fourth ventricle: neither the *corpus calloſum*, *fornix*, *nates* or *teſtes*, &c. can be obſerved here; which parts therefore cannot be imagined

imagined as abſolutely neceſſary for the functions of life, ſince we find theſe creatures perform them ſufficiently well. We may perhaps think theſe ſerve a particular uſe in man, who is a rational creature; but then quadrupeds enjoy them in common with man. Theſe protuberances, &c. ſeem rather to depend on the different diſpoſition of the ſeveral parts, being variouſly connected and meeting in different directions in different places, than their being abſolutely neceſſary for any particular uſe; and the uſes that have been aſſigned to different parts of the brain by authors, ſeem to me to have no foundation but in the author's fancy. I have already owned my ignorance of the uſes of the particular parts of the brain, ſo ſhall not pretend to give reaſons for their being different in different animals; but all ſeem to agree in this, that the cerebrum has always hollows and vacuities in it.

Their organ of *ſmelling* is very large, and well provided with nerves; hence they have this ſenſation very acute. Ravens and other birds of prey give a ſure proof of this, by their being able to find out their prey though concealed from their ſight and at a conſiderable diſtance.

Thoſe birds that grope for their food in the waters, mud, &c. have large nerves which run quite to the end of their bills, by which they find out and diſtinguiſh their food.

The anterior part of their *eyes* (inſtead of having the ſclerotic coat continued, ſo as to make near a ſphere as in us) turns all of a ſudden flat; ſo that here the ſclerotic makes but half a ſphere; and the cornea riſes up afterwards, being a portion of a very ſmall and diſtinct ſphere: ſo that in theſe creatures there is a much greater difference betwixt the ſclerotic and cornea than in us. Hence their eyes do not jut out of their heads, as in man and quadrupeds. As moſt of theſe creatures are continually employed in hedges and thickets, therefore, that their eyes might be ſecured from theſe injuries, as well as from too much light when flying in the face of the ſun, there is a very elegant mechaniſm in their eyes; which is a membrane riſing from the internal canthus of the eye, which at pleaſure, like a curtain, can be made to cover the whole eye; and this, by means of a proper muſcle that riſes from the ſclerotic coat, and, paſſing round the optic nerves, runs through the *muſculus oculi attollens* (by which however the optic nerves are not compreſſed), and palpebra, to be inſerted into the edge of this membrane. Whenever this muſcle

ceaſes to act, the membrane by its own elaſticity again diſcovers the eye. This covering is neither pellucid nor opaque, both which would have been equally inconvenient; but being ſomewhat tranſparent, allows as many rays to enter as to make any object juſt viſible, and is ſufficient to direct them in their progreſſion. By means of this membrane it is that the eagle is ſaid to look at the ſun. Quadrupeds alſo, as we mentioned before, have a ſmall *membrana nictitans*.

Beſides, all fowls have another particularity, the uſe of which I think is not ſo well underſtood; and that is, a pretty long black triangular purſe, riſing from the bottom of their eye juſt at the entry of the optic nerve, and ſtretched out into their vitreous humour, and one would imagine it gave ſome threads to the cryſtalline. This the French (who, as far as I know, were the firſt who took notice of it in their diſſections before the Royal Academy) give the name of *bourſe noire* to. This may poſſibly ſerve to ſuffocate ſome of the rays of light, that they may ſee objects more diſtinctly without hurting their eyes. It has a connection with the vitreous, and ſeems to be joined alſo to the cryſtalline humour. If we ſuppoſe it to have a power of contraction, (which may be as well allowed as that of the iris), it may ſo alter the poſition of the vitreous and cryſtalline humours, that the rays from any body may not fall perpendicularly upon the cryſtalline; and this ſeems to be neceſſary in them, ſince they cannot change the figure of the anterior part of their eye ſo much as we can do: and as this animal is expoſed often to too great a number of rays of light, ſo they have no tapetum, but have the bottom of their eye wholly black on the retina; and in conſequence of this, fowls ſee very ill in the dark.

They have no external ear; but in place thereof a tuft of very fine feathers covering the *meatus auditorius*, which eaſily allow the rays of ſound to paſs them, and likewiſe prevent duſt or any inſect from getting in. An external ear would have been inconvenient in their paſſing through thickets and in flying, &c. A liquor is ſeparated in the external part of the ear, or *meatus auditorius*, to lubricate the paſſage, and further prevent the entrance of any inſects, &c. The *membrana tympani* is convex externally; and no muſcles are fixed to the bones of their ear, which are rather of a cartilaginous conſiſtence: Any tremulous motions impreſſed on the air

air are communicated in theſe creatures merely by the ſpring and elaſticity of theſe bones; ſo probably the membrane is not ſo ſtretched as in the human ear by muſcles. The ſemicircular canals are very diſtinct, and eaſily prepared.

The ANATOMY of a CARNIVOROUS BIRD.

WE come next to the birds of prey, and for an example ſhall take a ſtenhil or ſmall hawk. The principal difference to be obſerved in them, is in their chylopoietic viſcera, which may be accounted for from their different way of life.

Immediately under their clavicles, you will obſerve the œſophagus expanded into their *ingluvies*, which is proportionally leſs than in the granivorous kind, ſince their food does not ſwell ſo much by maceration; and for the ſame reaſon, there is a leſs quantity of a menſtruum to be found here.

They have alſo a *ventriculus ſuccenturiatus* plentifully ſtored with glands, ſituated immediately above their ſtomach, which we ſee here is thin and muſculo-membranous, otherwiſe than in the granivorous kind: and this difference, which is almoſt the only one we ſhall find betwixt the two different ſpecies of fowls, is eaſily accounted for from the nature of their food, which requires leſs attrition, being eaſier of digeſtion than that of the other kind; nevertheleſs it ſeems requiſite it ſhould be ſtronger than the human, to compenſate the want of abdominal muſcles, which are here very thin.

The ſame mechaniſm obtains in this creature's *duodenum*, that we have hitherto obſerved. As being a carnivorous animal, its guts are proportionally ſhorter than thoſe of the granivorous kind; for the reaſon firſt given, *viz.* its food being more liable to corrupt, therefore not proper to be long detained in the body; and for that reaſon it has no *inteſtina cæca*, of which the other ſpecies of fowls have a pair. The difference in their wings, backs, and claws, are obvious; and have been already in ſome meaſure obſerved.

There is a full deſcription of the different parts of the egg, with the changes that happen in the time of incubation, in the ſecond volume of the Medical Eſſays.

The

The ANATOMY of FISHES.

AQUEOUS animals are generally divided into ſuch as have lungs, and ſuch as want them. The firſt ſpecies differ very inconſiderably from an ox or any other quadruped, and are not eaſily procured; ſo that all I have to ſay on fiſhes ſhall be taken from that ſpecies which is not provided with reſpiratory organs.

Of theſe we may firſt obſerve, that they have a very ſtrong thick *cuticle* covered with a great number of ſcales, laid one on another like the tiles of houſes; this among other arguments is ſuppoſed to prove the human epidermis to be of a ſquamous ſtructure: but the ſcales reſemble the hairs, wool, feathers, &c. of the creatures that live in air; and below theſe we obſerve their proper *cuticula* and *cutis*.

In the next place, theſe creatures have neither anterior nor poſterior extremities, as quadrupeds and fowls; for their progreſſion is performed in a different way from either of theſe ſpecies of animals: for this purpoſe they are provided with machines, properly conſiſting of a great number of elaſtic beams, connected to one another by firm membranes, and with a tail of the ſame texture; their ſpine is very moveable towards the poſterior part, and the ſtrongeſt muſcles of their bodies are inſerted there. Their tails are ſo framed as to contract to a narrow ſpace when drawn together to either ſide, and to expand again when drawn to a ſtraight line with their bodies; ſo, by the aſſiſtance of this broad tail, and the fins on their ſides, they make their progreſſion much in the ſame way as a boat with oars on its ſides and rudder at its ſtern. The perpendicular fins ſituated on the ſuperior part of their body keep them *in æquilibrio*, hindering the belly from turning uppermoſt: which it would readily do, becauſe of the air-bag in the abdomen rendering their belly ſpecifically lighter than their back; but by the reſiſtance theſe fins meet with when inclined to either ſide, they are kept with their backs always uppermoſt.

The beſt account of this matter we have in the treatiſe beforementioned, viz. *Borelli de Motu Animalium*, *cap.* 23.

It may be next obſerved, that theſe creatures have nothing that can be called a *neck*, ſeeing they ſeek their food in an horizontal way, and can move

move their bodies either upwards or downwards as they have occaſion by the contraction or dilatation of their air-bag: a long neck, as it would hinder their progreſſion, would be very diſadvantageous in the element they live in.

The *abdomen* is covered on the inferior part with a black-coloured thin membrane reſembling our peritoneum. It is divided from the thorax by a thin membranous partition which has no muſcular appearance; ſo that we have now ſeen two different ſorts of animals that have no muſcular diaphragm.

Theſe creatures are not provided with *teeth* proper for breaking their aliment into ſmaller morſels, as the food they uſe is generally ſmall fiſhes or other animals that need no trituration in the mouth, but ſpontaneouſly and gradually diſſolve into a liquid chyle. Their teeth ſerve to graſp their prey, and hinder the creatures they have once catched from eſcaping again. For the ſame purpoſe, the internal cartilaginous baſis of the bronchi, and the two round bodies ſituated in the poſterior part of the jaws, have a great number of tenter-hooks fixed into them, in ſuch a manner, as that any thing can eaſily get down, but is hindered from getting backwards. The water that is neceſſarily taken in along with their food in too great quantities to be received into their jaws in deglutition, paſſes betwixt the interſtices of the bronchi and the flap that covers them. The compreſſion of the water on the bronchi is of conſiderable uſe to the creature, as we ſhall explain by and by.

The *œſophagus* in theſe creatures is very ſhort, and ſcarcely diſtinguiſhed from their ſtomach, ſeeing their food lies almoſt equally in both. The ſtomach is of an oblong figure. There are commonly found ſmall fiſhes in the ſtomach of large ones ſtill retaining their natural form; but when touched, they melt down into a jelly. From this, and the great quantity of liquors poured into their ſtomachs, we may conclude, that digeſtion is ſolely brought about in them by the diſſolving power of a menſtruum, and that no trituration happens here.

The *guts* in theſe animals are very ſhort, making only three turns; the laſt of which ends in the common cloaca for the fæces, urine, and ſemen, ſituated about the middle of the inferior part of their bodies.

What I call *pancreas*, ſome give the name of *inteſtinula cæca* to: it conſiſts

ſiſts of a very great number of ſmall threads, like ſo many little worms, which all terminate at laſt in two larger canals, that open into the firſt gut, and pour into it a viſcous liquor, much about the place where the biliary ducts enter. Their inteſtines are connected to the back-bone by a membrane analogous to a meſentery. No lacteals have been yet obſerved.

Their *liver* is very large, of a whitiſh colour, and lies almoſt in the left-ſide wholly, and contains a great deal of fat.

The *gall-bladder* is ſituated a conſiderable way from their liver; and ſends out a canal, the cyſtic duct, which joins with the hepatic duct juſt at the entry into the gut. Some fibres are ſtretched from the liver to the gall-bladder, but none that I know of have hitherto diſcovered any cavity in theſe cords: ſo in this animal it ſhould ſeem impoſſible that the bile can be carried into the gall-bladder in the ordinary way; and conſequently muſt either be ſecerned on the ſides of that ſac, or regurgitate into it from the canalis choledochus.

The *ſpleen* is placed near the back-bone, and at a place where it is ſubjected to an alternate preſſure from the conſtriction and dilatation of the air-bag, which is ſituated in the neighbourhood. Since in all the different animals we have diſſected we find the ſpleen attached to ſomewhat that may give it a conquaſſation, as in the human ſubject and quadrupeds it is contiguous to the diaphragm; in fowls, it is placed betwixt the back-bone, the liver, and ſtomach; in fiſhes, it lies on the ſaccus aërius: and ſince we find it ſo well ſerved with blood-veſſels, and all its blood returning into the liver; we muſt not conclude the ſpleen to be an *inutile pondus*, only to ſerve as a balance to the animal *pro æquilibrio*, but particularly deſigned for preparing the blood to the liver.

The only *organs* of *generation* in this animal are two bags ſituated in the abdomen uniting near the podex. Theſe in the male are filled with a whitiſh firm ſubſtance called the *milt*; and in the female with an infinite number of little ova cluſtered together, of a reddiſh yellow colour, called the *roe*. Both theſe at ſpawning-time we find very much diſtended; whereas at another time the male organs can ſcarce be diſtinguiſhed from the female; nor is there any proper inſtrument in the male for throwing the ſeed into the organs of the female as in other creatures. I

ſhall

ſhall not take upon me to determine the way whereby the female ſperm is impregnated; but we find that the ſpawn of frogs conſiſts in the ſmall ſpecks wrapped up in a whitiſh glutinous liquor; theſe ſpecks are the rudiments of the young frogs, which are nouriſhed in that liquor till they are able to go in ſearch of their food. In the ſame way, the ova of fiſhes are thrown out and depoſited in the ſand, the male being for the moſt part ready to impregnate them, and they are incubated by the heat of the ſun. It is curious enough to remark with what care they ſeek for a proper place to depoſit their ova, by ſwimming to the ſhallow, where they can better enjoy the ſun's rays, and ſhun the large jaws of other fiſhes. The river-fiſhes, again, ſpawn in ſome creek free from the hazard of the impetuous ſtream. But whether this mixture be brought about in fiſhes by a ſimple application of the genitals to each other, or if both of them throw out their liquors at the ſame time in one place, and thus bring about the deſired mixture, it is not eaſy to determine; the latter, I think, ſeems moſt probable. Theſe creatures are ſo ſhy, that we cannot eaſily get to obſerve their way of copulation; and are conſequently but little acquainted with their natural hiſtory.

After raiſing up the black peritoneum, there comes in view an oblong white membranous bag, in which there is nothing contained but air. This is the *ſwimming-bladder*: it lies cloſe to the back-bone, and has a pretty ſtrong muſcular coat, whereby it can contract itſelf. By contracting this bag, they can make the muſcles ſpecifically heavier than water, and ſo readily fall to the bottom; whereas the muſcular fibres ceaſing to act, they become ſpecifically lighter than water, and ſo ſwim above. According to the different degrees of contraction and dilatation of this bladder, they can keep higher or lower in the water at pleaſure. Hence flounders, ſoles, raia, and ſuch other fiſhes as want this ſac, are found always groveling at the bottom of the water: it is owing to this that dead fiſhes (unleſs this membrane has been previouſly broke) are found ſwimming a-top, the muſcular fibres then ceaſing to act, and that with their bellies uppermoſt; for the back-bone cannot yield, and the diſtended ſac is protruded into the abdomen, and the back is conſequently heavieſt at its upper part, according to their poſture. There is here placed a glandular ſubſtance, containing a good quantity of red blood. From the an-

terior part of the bag go out two *proceſſes* or *appendices*, which, according to the gentlemen of the French academy, terminate in their fauces: but in ſome fiſhes, as the cod and haddock, I never could find out this communication, either by tracing them, pouring in mercury or water, &c. I put, it is true, a probe through them; but then with the ſame ſtrength I could have put it through the ſides of the proceſſes.

At the ſuperior part of this bag there are other red-coloured bodies of a glandular nature, which are connected with the kidneys. From them the *ureters* go down to their inſertion in the *veſica urinaria*, which lies in the lower part of the abdomen, and the urethra is there produced which terminates in the podex.

Theſe laſt mentioned parts have not hitherto been obſerved in ſome ſpecies of fiſhes; whence authors too haſtily denied them in all. Theſe creatures have a *membranous diaphragm* which forms a ſac, in which the heart is contained. It is very tenſe, and almoſt perpendicular to the vertebræ.

The *heart* is of a triangular form, with its baſe downwards, and its apex uppermoſt; which ſituation it has becauſe of the *branchiæ*. It has but one *auricle* and one *ventricle*, becauſe they want lungs, and one great artery. The ſize of the auricle and that of the ventricle are much the ſame; the artery ſends out numberleſs branches to the branchiæ or gills.

The *branchiæ* lie in two large ſlits at each ſide of their heads, and ſeem to be all they have that bears any analogy to lungs. Their form is ſemicircular; they have a vaſt number of red fibrillæ ſtanding out on each ſide of them like a fringe, and very much reſemble the vane of a feather. Theſe branchiæ are perpetually ſubjected to an alternate motion and preſſure from the water; and we may here remark, that we have not found any red blood but in places ſubjected to this alternate preſſure. This obſervation will help us in explaining the action of the lungs upon the blood. Over theſe gills there is a large flap, allowing a communication externally by which the water they are obliged to take into their mouths with their food finds an exit without paſſing into their ſtomach: it is owing to theſe flaps coming ſo far down that the heart is ſaid commonly to be ſituated in their heads.

Their *brains* are formed pretty much in the ſame way as that of fowls; only

only we may obſerve, that the poſterior lobes bear a greater proportion to the anterior.

Their organ of *ſmelling* is large; and they have a power of contracting and dilating the entry into their noſe as they have occaſion. It ſeems to be moſtly by their acute ſmell that they diſcover their food: for their tongue ſeems not to have been deſigned for a very nice ſenſation, being of a pretty firm cartilaginous ſubſtance; and common experiment evinces, that their ſight is not of ſo much uſe to them as their ſmell in ſearching for their nouriſhment. If you throw a freſh worm into the water, a fiſh ſhall diſtinguiſh it at a conſiderable diſtance; and that this is not done by the eye, is plain from obſerving, that after the ſame worm has been a conſiderable time in the water and loſt its ſmell, no fiſhes will come near it: but if you take out the bait, and make ſeveral little inciſions into it, ſo as to let out more of the odoriferous effluvia, it ſhall have the ſame effect as formerly. Now it is certain, had the creatures diſcovered this bait with their eyes, they would have come equally to it in both caſes. In conſequence of their ſmell being the principal means they have of diſcovering their food, we may frequently obſerve their allowing themſelves to be carried down with the ſtream that they may aſcend again leiſurely againſt the current of the water; thus the odorous particles ſwimming in that medium, being applied more forcibly to their ſmelling organs, produce a ſtronger ſenſation.

The *optic nerves* in theſe animals are not confounded with one another in their middle progreſs betwixt their origin and the orbit, but the one paſſes over the other without any communication; ſo that the nerve that comes from the left ſide of the brain goes diſtinctly to the right eye, and *vice verſa*.

The *lens cryſtallina* is here a complete ſphere, and more denſe than in terreſtrial animals, that the rays of light coming from water might be ſufficiently refracted.

As fiſhes are continually expoſed to injuries in the uncertain element they live in, and as they are in perpetual danger of becoming a prey to the larger ones, it was neceſſary their eyes ſhould never be ſhut; and as the cornea is ſufficiently waſhed by the element they live in, they are not provided with palpebræ: but then, as in the current itſelf the eye muſt

be expoſed to ſeveral injuries, there was a neceſſity it ſhould be ſufficiently defended; which in effect it is by a firm pellucid membrane, that ſeems to be a continuation of the cuticula, being ſtretched over here. The epidermis is very proper for this purpoſe, as being inſenſible and deſtitute of veſſels, and conſequently not liable to obſtructions or by that means of becoming opake.

Whether fiſhes have a ſenſe of *hearing* or not, is very uncertain: all that have the appearance of an organ of hearing in theſe creatures, are two bones, or rather ſtones, each about the bulk of a ſmall horſe-bean; of a particular ſtructure, being very brittle, and compoſed of a great many different ſegments laid at one another's ſides, and ſituated in particular ſacs at each ſide of the brain. Is then the idea of ſound communicated to them by means of theſe ſtones? Or does their running away, at ſtamping hard on the ground, or crying loud, depend upon ſome other kind of ſenſation? This may poſſibly be produced in them, by a tremulous motion communicated to their bodies by the circumambient water, which is put in agitation from the like concuſſions happening in the air or neighbouring ground.

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P. 248. *l.* 10. After *written*, supply "concerning the use of the digastric muscles."

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