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ELEMENTS

OF

GENERAL AND PATHOLOGICAL

ANATOMY.

Printed by John Stark,
Old Assembly Close, Edinburgh.

ELEMENTS

OF

GENERAL AND PATHOLOGICAL

ANATOMY,

ADAPTED TO THE PRESENT STATE OF KNOWLEDGE IN THAT SCIENCE.

By DAVID CRAIGIE, M.D.

EDINBURGH:
PRINTED FOR ADAM BLACK, EDINBURGH; AND
LONGMAN, REES, ORME, BROWN, AND GREEN, LONDON.

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PREFACE.

THE value of Morbid Anatomy as the basis of rational pathology was early recognized by physicians; and the works of Wepfer, Gerard Blasius, Schenke, Pechlin, Harder, Plater, Vander-Wyl, and Fantoni, demonstrate the diligence with which the pathologists of the 17th century laboured to investigate the nature and effects of morbid action. The elaborate but somewhat confused collection of Bonetus was the first attempt to classify the facts observed by these and previous authors. To Morgagni, however, was reserved the merit of publishing a work, distinguished equally by critical knowledge of the labours of his predecessors and contemporaries, and by accurate personal observation. From the days, indeed, of Fantoni, Valsalva, and Morgagni, to those of Sandifort, Baillie, Meckel, and Laen-

nec, the study of Morbid Anatomy has been assiduously cultivated by all who were interested in the progress of accurate knowledge.

At no period, however, has this department of science been pursued with greater zeal than during the last twenty years, in the course of which the observation and collection of pathological facts has engrossed the attention of numerous observers, both in this country and in France and Germany. Of this the result has been, more accurate distinction of diseases formerly confounded, fuller and more precise information regarding those which were imperfectly known, and an extraordinary accumulation of matter on all topics. In some instances the boundaries of the science have been extended; in others, departments already known have been more diligently explored; and if the result has not at all times been absolute discovery, some advantage has accrued from the correction or the modification of former statements.

The advantage to the science at large has nevertheless been accompanied with great and increasing inconvenience to the student. The recorded information is scattered through so many volumes, that the usual period allotted to the acquisition of knowledge is quite inadequate to consult

them in the most cursory manner. Many of the most valuable papers also are contained in periodical works, in which it is not always easy to peruse them. In short, so great is the accumulation of materials, yet so dispersed and multiplied, that the most intrepid diligence is disconcerted, and the most indefatigable perseverance is exhausted.

To alleviate, if not to remove, some of these difficulties, the most obvious plan is to classify the principal facts which it is important for the student to know; to reduce to general heads the numerous, isolated, and not unfrequently unarranged facts, recorded by different observers; to reconcile what is discordant; to explain what is anomalous; to distinguish the essential from the accidental,—the important from the trivial; and to exhibit in a connected and systematic shape those deductions and inferences which are justified by accurate analytic comparison of the best authenticated facts. Though these are the objects which have been held in view in the composition of the present volume, it can only be determined by others with what success they have been attained.

In the arrangement of the materials of which it consists, I found it impossible to adopt the me-

thods in ordinary use. Without pretending to determine the comparative merits of the methods of Baillie, Conradi, Meckel, and Cruveilhier, each of which has peculiar advantages, I may be permitted to observe, that the first object in tracing the progress and effects of pathological processes is to fix the boundary between what is sound and what is morbid, and that every morbid process always bears some relation to the proper characters of the texture in a sound state. For these reasons I have chosen as the basis of arrangement the distinctions of the component tissues of the animal body, as derived from the similitude and difference of their anatomical characters; and though the advantages of this method have been recognized by John Hunter, Carmichael Smyth, Bichat, Dr Thomson, and Beclard, I am not aware that any complete system of pathological anatomy has been hitherto constructed according to its principles. The present attempt is, I believe, the first instance in which it has been carried to the length of a full though elementary treatise.

It is almost superfluous to enter into any detailed account of the principles on which this work is composed. In describing both the sound and morbid states of the different organic tissues, I have in general indicated the sources of my infor-

mation. On the subject of the normal or healthy states, without neglecting the labours of previous authors, it has been my study to give accurate descriptions of the objects from frequent and careful personal dissection. Whatever I have stated on my own authority has been from repeated and rather elaborate examination ; and if I have erred or misrepresented, it is not from carelessness or indifference in the endeavour to insure accuracy.

In describing the pathological changes incident to each tissue, it has been my study not so much to speak from personal observation, as to generalize with fidelity the results of the researches of others. In a subject so extensive and so complicated as Morbid Anatomy, individual observation and research are of little avail, unless as they tend to confirm, to correct, or to modify the results obtained by other inquirers. The duty of the author of an elementary treatise in such circumstances is chiefly to compare and generalize these results. For these reasons, I have seldom spoken of what I have seen myself, unless where that tended either to confirm some uncertain inference ; to settle some controverted or ambiguous point ; or to verify views in favour of which information was either scanty, deficient, or contradictory. I must, however,

say, that, in adducing the testimony of other observers, I have in no instance spoken on subjects which I have not taken care to verify myself. Of every morbid change described, the description is derived in some instances from repeated inspection,—in all from more or less personal examination of its physical and anatomical characters. Of my own observation, however, I say nothing, but leave the reader to judge both of its extent and its accuracy.

Though I have been thus studious to avoid intentional errors, it is possible that many have been committed in the course of the volume, both from ignorance and from oversight. These I will not extenuate by any apology derived either from the difficulty and complicated nature of the subject, or from the calls of other professional engagements. When such apology is admissible, its first interpretation is,—that the author should have left the undertaking to some one better qualified by opportunities and attainments to execute it creditably. On some points I have gone less into detail than the nature of the subject may seem to require ; on others unnecessary diffuseness may be perceived ; and in some, perhaps, omissions may be detected.

In the section on the Diseases of the Nerves,

though I refer to the cases of Mojon and Covercelli, I confess that I had at the time some doubts regarding the connection between existence of the tumour and the epileptic motions. Since that sheet was printed I met with the remarkable case of Dr Short,* which has tended to remove these doubts; and I have elsewhere offered a conjecture on the connection between these tumours and the sensation called *epileptic aura*. This it was unnecessary to notice, had not my friend, Mr William Wood, attaching to the conjecture more value than it really merited, resumed with his usual acuteness the investigation of a subject, on which he was the first to communicate exact information. The monograph of Mr Wood, published in the third volume of the Edinburgh Medico-Chirurgical Transactions, is now not only the fullest, but the best account of the neuromatic tubercle; and had it been composed previous to the sheet in which the account in the present volume is contained, would have enabled me to give a much better description of that disease.

To the peculiar disease of the intestinal mucous membrane in children described by Dr Crampton, I have not assigned a separate place in the text, from difficulty of understanding its exact nature.

* Medical Essays and Observations, Vol. iv. p. 416.

In some of the cases recorded by that physician, the *villi* seemed converted into tubercles. In others the presence of pustular ulcers not unlike small-pox seems to indicate the usual follicular disease of that membrane. And in others the granular appearance of the villous membrane appears to correspond with the usual effects of dysenteric inflammation. These appearances the ingenious author of the account ascribes to inflammation operating on the strumous habit. *

The work of Dr Abercrombie on the Pathology of the Intestinal Canal, I did not receive till the sheets on the diseases of the Mucous and Serous Membranes were printed. It was therefore impossible for me to avail myself of the researches of that acute observer.

On one department of Pathological Anatomy the reader will find little or no information in the present volume. I allude to local diseases, and to those varieties of malformation which consist in misapplications of the component parts of organs. These, it is almost superfluous to remark, cannot, without violation of the principles of arrangement, be introduced in a work on General Anatomy; and I have therefore, however reluctantly, excluded

* Dublin Reports, Vol. ii. p. 286.

them almost entirely, unless so far as their general characters could be stated.

Farther, it was my intention to conclude the work with an account of the healthy structure and the morbid changes of the Glandular system. I found it, however, difficult to give such a general sketch of the healthy anatomy of these organs as would be applicable to all without being untrue of any,—and by no means easy, without swelling a volume already too large, to exhibit such a view of the anormal deviations as would be either just or useful. This, therefore, I am obliged to defer for the present.

Lastly, the limits within which it is requisite to confine this work, principally intended for the student of pathology, have compelled me to touch very cursorily on many points, which, from their importance, would have required fuller details. Though I have throughout been solicitous to present the unbroken chain of evidence on which the inferences and deductions are made to rest, I have often been obliged to state the latter only, and in a form perhaps too dogmatic, with the view of saving the time of the reader. In no instance, however, has this been done without deliberate examination of the authorities for every fact, and of the evidences for each con-

clusion. On ordinary points, on which pathological opinion is unanimous, I have been sparing of reference, or omitted it entirely. On subjects, on the contrary, on which information is doubtful and scanty, or on which there is room for diversity of sentiment, I have, by referring the reader to the best sources, enabled him to appreciate the validity of the conclusions stated. Without attempting, however, to refer to all the authorities extant, which must have uselessly enlarged the work, I have directed him chiefly to those which are at once most useful and most accessible.

Edinburgh, 4th November 1828.

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ELEMENTS

OF

GENERAL ANATOMY AND PATHOLOGY.

CHAPTER I.

DIVISION OF THE TEXTURES.

THE Human Body has been said to consist of solid and fluid parts, the former of which are organized, and determine the shape of the body and its parts. In the same manner the solid parts were distinguished into simple and vital; the first of which were believed to possess only the general properties of matter, as weight, cohesion, elasticity, flexibility, &c. but to be destitute of sensibility and mobility, the great characteristics of the vital solids. Under the head of vital solids it is evident that the brain, *cerebellum*, spinal chord, and nervous branches on the one hand, and the whole of the muscles on the other, were comprehended. Of the simple solids, on the contrary, bone, tooth, cartilage, tendon, and ligament were conceived to

be examples. This division, which was made at a time when the attention of physicians was more attracted by physical and mathematical, than by physiological and vital properties, may now be safely set aside, while we adopt another which, though less scholastic, is more suited to the nature of living bodies.

In the living body, it may be observed, there is no solid which is not alive, and which does not possess vital properties; and there is no vital solid which does not possess all the properties ascribed to the simple solid, or the usual attributes of inanimate matter. The great characteristic of living or organic bodies is, that every substance which enters into their composition possesses not only the usual properties of matter, as weight, cohesion, flexibility, elasticity, &c. but also peculiar properties not found in inorganic bodies, and which have therefore been termed indiscriminately *animal or living properties.*

Every animal body consists of several kinds of organic substance, which differ from each other in various modes, and each of which is characterized by peculiar properties. In the human body, and in those of all mammiferous animals, these various kinds of organic substance are believed to be presented in their most perfect state; and it is to these more especially that the attention of the pathologist is directed, and from their examination that his knowlege is derived.

At an early period of the study of anatomy, the

human body was distinguished into various kinds of animal substance; and we find even in the writings of JACOPO BERENGER of Carpi, but more distinctly in the great work of VESALIUS, an enumeration and general description of the different kinds of substance found to constitute the human body. The example given by these founders of the science was imitated to a greater or less extent, and in different degrees of perfection by succeeding systematists; and we find in the works of ADRIAN SPIGEL,* CASPAR and THOMAS BARTHOLIN,† DIONIS,‡ MARCHETTIS,‖ and WINSLOW,§ but especially in the bulky compilation of SAMUEL COLLINS,¶ various attempts to communicate a 1521.

* Adriani Spigelii de Corporis Humani Fabricâ, libri x. 4to, 1632.

† Thomæ Bartholini, Anatomica Reformata, ex Casparis Bartholini Parentis Institutionibus omniumque Recentiorum et propriis observationibus. 8vo, Hagæ Comitum, 1660.

‡ The Anatomy of Human Bodies improved, &c, publicly demonstrated in the Royal Garden at Paris, by Monsieur Dionis, Chief Surgeon to the late Dauphiness, and to the present Duchess of Burgundy. Translated from the third edition. London, 1703.

‖ Dominici de Marchettis Anatomia. Batav. 1652. 4to.

§ Exposition Anatomique de la Structure du Corps Humain. Par Jacques-Benigne Winslow, de l'Academie Royale, &c. &c. A Paris, 1732. 4to.

¶ A System of Anatomy treating of the Body of Man, Beasts, Birds, Fish, Insects and Plants, illustrated with many Schemes, consisting of a variety of elegant Figures drawn from the Life, and engraven in Twenty-four folio Copper Plates. By Samuel Collins, Doctor of Physic, Physician-in-Ordinary to

just idea of the intimate structure and properties of the several animal textures. In general, however, these notices are meagre and scanty. Sometimes they are too generalizing, and hastily refer every variety of texture to one or two hypothetical elements; too often they consist of fanciful conjectures substituted for accurate observation; and they are never so clear and satisfactory as to afford useful instruction to the pathological inquirer.

1628. MARCELLO MALPIGHI, professor of medicine successively in the universities of Bologna, of Pisa, and of Messina, and finally invited to Rome as physician to Innocent XII., was the first anatomist in whose hands the knowledge of intimate structure became a science of accurate obser-
1660. vation. In this manner he investigated assiduously the minute structure of the lungs and the disposition of their vessels; he examined the
1661. omentum, and inquired into the manner in which fat and marrow are secreted; he studiously en-
1665. deavoured to unfold by dissection and microscopical observation the minute structure of the brain; he demonstrated the organization of the skin, and considered its constituents as the organ of touch; he studied the structure of bone, and exposed the

his late Majesty of Blessed Memory, and Fellow of the King's most famous College of Physicians in London, and formerly a Fellow of the Royal Foundation of Trinity College, in the most flourishing University of Cambridge. In the Savoy, printed by Thomas Newcomb, 1685. Two volumes folio.

errors of Gagliardi ; he traced the formation, and explained the structure of the teeth ; and he finally carried his researches into the substance of the liver, the spleen, the kidneys, and the conglobate 1666.
glands. In these delicate and difficult inquiries, the observations of Malpighi are in general faithful to nature, and his descriptions accurate. The information which he collected was new and curious, and it is communicated in perspicuous language, and in an interesting manner. He may be justly regarded as the founder of that part of anatomical science which treats of structure and organization ; and even in the present day his writings on this subject are by no means destitute either of interest or instruction.

About the same time the researches of De 1641.
Graaf and Ruysch tended to throw some light on the intimate structure of several organs. De Graaf, who was young, while Malpighi was declining in years, studied particularly the structure 1664.
of the pancreas, and of the organs of generation 1668.
in both sexes, and at once removed many popular errors, and communicated a large proportion of accurate information. Had he not been cut off at the early age of thirty-two, it cannot be doubted 1673.
that his zeal in prosecuting the true knowledge of minute structure would have greatly advanced this department of anatomy.

Frederic Ruysch, professor of anatomy and 1638.
surgery at Amsterdam, was more fortunate. Assiduously devoted, during a long life, to the cul-

tivation of anatomy, and eminent for the perfection to which he carried the art of injecting, he was enabled to obtain more correct views than his predecessors of the arrangement of minute vessels in the interior of organs, and to demonstrate peculiarities of organization, which had escaped the scrutiny of previous anatomists. Scarcely a part or texture of the human body eluded the pene-
1665. tration of his syringe; and his discoveries were proportionally great. His researches on the lungs, on the vascular structure of the skin, of the bones and their epiphyses, of the spleen, of the glans pe-
1691. nis, the clitoris, and the womb, impregnated and unimpregnated, were sufficient to give him the repu-
1701. tation of a most able and accurate anatomist. These, however, were but a limited part of his anatomical labours. He studied the minute structure of
1715. the brain; he demonstrated the organization of the choroid plexus; he described the state of the hair when affected with Polish plait; he proved the vascular structure of the teeth; he injected the dura mater, the pleura, the pericardium, and peritoneum; he investigated the structure of the synovial apparatus placed in the interior of the joints, and he discovered many curious particulars relating to the lacteals, the lymphatics, and the lymphatic glands. So assiduously, indeed, did Ruysch study by injection the tissues and organs of the animal body, that it is less easy to say what he did than what he neglected. We are indebted

to him for many of the facts of which anatomy at the present day consists. 1731.

The labours of these ingenious and indefatigable inquirers added considerably to the stock of accurate knowledge, and tended to diffuse a taste for correct observation in the study of the minute structure of the parts of the animal body. Not much, however, had been done for the arrangement of the materials thus collected. Though many isolated facts had been established, and several curious discoveries had been made, they were not yet digested in that systematic order which renders them useful to the purposes of pathology.

It is in the great work of HALLER that we recognize the first traces of a better spirit and more philosophical views. This accomplished scholar and indefatigable observer was the first who attempted to present, in a collected form, the most correct information on the intimate structure of the animal tissues. Assiduous in his cultivation of anatomy, and deeply impressed with the necessity of accuracy in research, Haller scrutinized with the eye of rigorous observation every point in anatomical structure advanced by his predecessors and contemporaries. In his description of the cellular web, of the adipose membrane, of arterial texture, of the veins, of the structure of the heart, of that of the brain and nerves, of the lungs, of the minute structure of the muscles, of the membranes, and of the organs in general, the reader perceives, that, while Haller did not disdain to 1757.

avail himself of the results of previous and coeval inquiry, he scrupulously avoided adopting what he had not verified by personal observation. The work which he modestly styled Elements of Physiology shows, that, in extent of information and soundness of judgment, he had no rival in the day in which he lived ; and though something has been added to science since his death, it is more by the combined efforts of many than by the labours of any individual.

Amidst so much excellence it was unfortunate that the vain search after an elementary fibre or rudiment, into which every variety of animal substance was supposed to be resolved, led him to indulge in some fanciful conjecture and gratuitous generalization. *

* It will scarcely be credited that Haller could speak of this hypothetical fibre in the following terms. " *Fibra* quo communi nomine multiplex genus elementorum comprehendimus, et cujus discrimina continuo exponemus, communis toti humano corpori materies est, etiam, ut alibi ostendemus, cerebro et medullæ spinali. Fragilis aut mollis, elastica, aut penitus pultacea, longa absque fere latitudine, vel lata ut longitudini par fere latitudo sit, ossa, cartilagines, membranas, vasa, ligamenta, tendines, musculos, nervos, cellulosum textum, viscerum parenchymata, pilos et ungues sola constituit." Here it is represented as constituting the most opposite animal substances, and entering into the composition of every texture. The composition of this ideal fibre is not less wonderful. " Invisibilis ea fibra, quam sola mentis acie attingimus, ex solis elementis terreis et glutine, non ex minoribus fibris composita, cum sui similibus abit in duo conspicua elementa solida corporis animalis."

The distinction of the animal body into separate kinds of texture thus introduced and recognized was confined principally to anatomy and physiology. The merit of applying them to pathology is divided between William Hunter, William Cullen, and John Hunter. The first, in a Paper on Emphysema, in the second volume of the Medical Observations and Inquiries, gave in 1757 an ingenious account of the difference between the cellular texture and the adipose membrane, with some observations on the serous membranes, and showed in what manner the respective properties of each tend to modify their different morbid states. In the Nosology, Physiology, and First Lines of Dr Cullen, we find the author making frequent allusion to the organic properties of the various substances which enter into the composition of the animal body, and employing these distinctions as the foundation of his Pathology. In the hands of John Hunter this system was carried to still greater perfection; and his work on Inflammation contains the rudiment of many of the improvements which Pathology has derived from this source.

1757. 1762. 1765. 1769. 1777.

General anatomy was thus beginning to attain insensibly the form of a science, and to be cultivated with assiduity as the surest basis of pathological knowledge. I must not omit to mention, that in the time of the elder Hunter and Cullen it underwent a valuable improvement in the hands of an ingenious foreigner. This consisted in the

systematic and connected view which ANDREW BONN of Amsterdam delineated of the mutual connections of the membranes of the human body. In his Inaugural Dissertation, *De Continuationibus Membranarum*, published at Leyden in 1763, this author, after some preliminary observations on membranes in general, and on their structure and organization, unfolds the structure of the skin and its component parts, as ascertained by the best anatomists. He then proceeds to trace its continuation or transition into the mucous membranes, which he regards as productions of the skin; 1*st*, By the eye-lids into the lacrymal passages; 2*d*, Into the external ear-hole; 3*d*, Into the nasal passages in the form of the Schneiderian, or pituitary membrane; 4*th*, Into the mouth, throat, and Eustachian tube and tympanal cavity; 5*th*, By the larynx and windpipe into the bronchial tubes and lungs; 6*th*, By the pharynx and œsophagus into the stomach and bowels, where, at the lower extremity of the rectum, its continuity with the skin may again be traced. He concludes this part of his essay with a short view of the transition of the skin into the mucous membrane of the urinary and genital organs, or what has since been named the genito-urinary surface. This may be regarded as the first division of his subject.

In the second, in which he treats of the membranes beneath the skin, he considers, 1*st*, Those of the muscles, as the cellular membrane and apo-

neurotic expansions; 2*d*, The periosteum and perichondrium, with their modifications and uses; and shows that one or other of these membranes invests and connects every bone of the skeleton.

In the third division he places the internal membranes of cavities, or those which are now denominated serous and fibro-serous membranes. He first traces at great length the course and divisions of the *dura mater* and *pia mater*, and contends that they accompany each nerve and nervous branch; then examines the course of the pleura and pericardium, and the relations of the mediastinum; and, lastly, he describes the extent of the peritoneum and its several divisions in connection with the organs contained in the abdominal cavity.*

The quantity of accurate information which Bonn has here collected, and the new and interesting views which he communicates are truly wonderful. This essay is one of the best specimens of correct and useful generalization which can be imagined; and it is an example of the capricious nature of scientific reputation, that while the work of Bichat, which was published forty years after, though little more than the thesis of

* Specimen Anatomico-Medicum Inaugurale de Continuationibus Membranarum, quod publicæ ac solemni disquisitioni submisit Andreas Bonn, Amstelædamo-Batavus ad die 14 Octobris 1763. Extat in Thesauro Dissertationum, Programmatum, aliorumque Opusculorum Selectorum, Eduardi Sandifort, M.D. &c. Vol. II. Rotterodami, 1769, xii. p. 265.

Bonn expanded, has given its author an imperishable name, the small treatise of Bonn is equally unknown and unregarded, and has scarcely served to rescue his name from utter oblivion.

1790. I have already alluded to the application of the distinctions of general anatomy to pathology in the writings of Cullen and John Hunter. A more complete specimen of this was given in 1790 by Dr Carmichael Smith. In a paper published in the second volume of the Medical Communications of London,* this physician took a view of the phenomena and peculiarities of inflammation as they are observed in the different sorts of organic substance found in the animal body. This may be regarded as the first systematic attempt in this country to trace the influence which different peculiarities of structure exercise on the phenomena and progress of morbid action.

After this time various attempts were made to enumerate and classify the several animal substances of which the human body consists, and to describe in general terms their obvious and distinctive characters and properties. M. Pinel,

1798. in his *Nosographie Philosophique*, first published in 1798, made the distinctions of the membranes and other animal tissues the foundation of his arrangement and pathology. Soon after Xa-

1800. vier Bichat, in his Treatise on the Membranes, gave a neat and comprehensive view of the general structure of these tissues, and of their connection

* Transactions of a Society for Promoting Medical Knowledge, Vol. II. London, 1790.

with the vital and morbid processes carried on at their respective surfaces. This, however, was merely the introduction to a work still more extensive and elaborate. In his Treatise on the Membranes he confined himself to the examination of the structure and properties of the mucous, serous, and fibrous membranes, and a short view of the fibro-mucous and fibro-serous tissues. In his General Anatomy, which appeared in 1801, he delineated the first, and perhaps the most perfect arrangement of the different organic textures of the human body that has yet appeared.

This author considers the human body as an assemblage of many different organs, each of which consists of a greater or smaller number of animal substances, which, though thus combined in the formation, or entering into the composition of the same part or organ, are very different in structure and properties from each other Each of these distinct forms of animal matter he calls a *tissue* or texture, *(textus, tela ;)* and he refers the whole of those which anatomists have enumerated, or which accurate discrimination can distinguish in the human body, to twenty-one general heads. 1801.

1. CELLULAR. Subdivided into
- Subcutaneous, connecting the skin to the subjacent parts.
- Subserous, connecting the serous or transparent membranes to the contiguous parts.
- Submucous, connecting the mucous membranes to the subjacent parts.
- Arterial, surrounding and enclosing arteries.
- Venous, veins.
- Excretory, excretory ducts.
- Enveloping, surrounding and enclosing organs.
- Penetrating, entering into the substance of organs.

2. and 3. NERVOUS.
- *a* Animal life.
- *b* Organic life.

4. ARTERIAL.

5. VENOUS.

6. EXHALANT.

7. ABSORBENT. { Absorbent vessels. / Absorbent glands.

8. OSSEOUS. { Bones proper, long, flat, and short. / Teeth.

9. MEDULLARY. { Marrow of short and flat bones, or the ends of long bones. / Marrow of the shafts, or bodies of long bones.

10. CARTILAGINOUS. { Articular ends of moveable bones. / Articular surfaces of immoveable bones. / Ribs, Larynx, Nasal Partition, &c.

11. FIBROUS.
- Membranous or Expanded.
  - Proper Fibrous Membranes. { Periosteum. / Dura Mater. / Sclerotic. / Albuginea. / Membrane of Kidneys, Spleen, &c.
  - Fibrous Capsules. { Scapulo-humeral articulation. / Ilio-femoral articulation.
  - Fibrous Sheaths. { Partial. { Palms of hand and foot. / Flexor tendons. / General. Annular ligaments.
  - Aponeuroses. { Enveloping. / Inserted. { α By broad surface. / β Arched. / γ By isolated fibres.
- Fasciculated or Collected.
  - Tendons. { Simple. / Compound.
  - Ligaments. { Regularly fasciculated. / Irregularly fasciculated.

12. FIBRO-CARTILAGINOUS.
- Membranous. Fibro-cartilages of the { Ears, / Nose, / Trachea, / Eyelids,
- Articular. { Interarticular, those of the knee-joint, lower jaw. / Intervertebral fibrocartilages.
- Tendinous.

13 and 14. MUSCULAR. { *a* Animal life, all the voluntary muscles. / *b* Organic life, *c. g.* heart, stomach, and intestines.

15. MUCOUS, comprehending the gastro-pulmonary mucous surface and genito-urinary mucous surface.

16. SEROUS, comprehending the arachnoid membrane, pleura, pericardium, peritonæum, and vaginal coat.

17. SYNOVIAL.

18. GLANDULAR, comprehending the secreting glands only.

19. DERMOID or CUTANEOUS.

20. EPIDERMOID or CUTICULAR.

21. PILOUS or HAIRY.

These different forms of animal substance he considers as the organic elements, or proximate principles, to use the language of chemistry, into which animal bodies may be resolved. These elementary tissues he again refers to two great orders,—one generally distributed and everywhere present, so as to form an integrant part of every other animal substance. To this order, which he termed *general or generating systems*, he referred cellular membrane, arterial and venous tissue, the nerves, and the exhalants and absorbents. The substances of the second kind, which are placed in determinate situations, and confined to particular regions, consist of the bones, cartilages, fibrous substances, muscles, and muscular parts, the mucous, serous, and synovial membranes, glandular organs, the skin and its appendages, the nails, hair, &c. All the substances of this latter order consist of a peculiar matter, by which they are distinguished, and more or fewer of the general tissues.

As the structure and properties of the same elementary tissue are nearly the same in whatever region of the body it is found, or undergo only such modifications as its peculiar use or local connections render requisite, a just idea of the structure of the human body suggests the propriety of considering the extent, disposition, structure, and most obvious properties, mechanical and vital, of each tissue by itself. The examination of these circumstances constitutes the subject

of his General Anatomy, a work which, in originality of plan and general excellence of performance, notwithstanding occasional defects and errors, has not yet been surpassed.

The arrangement, however, of Bichat has been found incorrect or inconvenient; and various alterations or modifications of it have been proposed by subsequent authors. The first which we shall notice is that proposed by Dupuytren and Richerand, which has been generally esteemed in France as more correct and comprehensive. It may be exhibited in the following tabular form.

1. Cellular.	
2. Vascular, - -	Arterial, Venous, Lymphatic.
3. Nervous, - -	Cerebral, Gangliar.
4. Osseous.	
5. Fibrous, - -	Fibrous, Fibro-cartilaginous, Dermoid.
6. Muscular, - -	Voluntary, Involuntary.
7. Erectile.	
8. Mucous.	
9. Serous.	
10. Horny or Epidermal.	Pilous, Epidermal.
11. Parenchymatous.	Parenchymatous, Glandular.

In this enumeration several important differences from that of Bichat will be recognized. It presents altogether nineteen separate tissues, of which five are so decidedly peculiar, that they do not admit of being associated with any similar, and consequently form distinct systems by themselves; while the other fourteen are referred to the

general heads of vascular, nervous, fibrous, muscular, horny, or parenchymatous systems. The result of this arrangement is to diminish the number of organic systems from twenty-one to eleven, one of which, the *erectile*, comprehending the peculiar structure of the cavernous body, the clitoris, the nipple, and the spleen, is not found in the original arrangement of Bichat, but has been added by MM. Dupuytren and Richerand.

A less neat and elegant arrangement is that given by Hippolytus Cloquet, who admits in the human body the following fifteen tissues: 1. The cellular; 2. The membranous; 3. The vascular, including blood-vessels, and lymphatics; 4. Bone; 5. Cartilage; 6. Fibro-cartilage; 7. Ligament; 8. Muscle; 9. Tendon; 10. Aponeurosis, or fascia; 11. Nerve; 12. Glandular structure; 13. Follicle; 14. Lymphatic ganglion, or gland; 15. The *Viscera*. It is evident that the last mentioned term is greatly too vague, and that the structure which it is intended to denote may be either united with several of those already noticed, or is so different or opposite in different situations, that admitting it as a separate tissue becomes of no use whatever in a correct classification.

Not unlike to the arrangement of MM. Richerand and Dupuytren is that proposed by John Frederic Meckel, who looked on the arrangement of Bichat as too detailed, and embarrassed with too many and minute distinctions. According to this anatomist, the medullary system should be united

with the cellular; the synovial should be viewed as a modification of the serous system; the pilous and epidermal systems ought not to be separated from the cutaneous or dermal; and even this last, along with the glandular and mucous, ought to be referred to the same general head. According to these principles all the organized substances composing the human body are referred by Meckel to the following ten heads:—

1. Mucous, or cellular.
2. Vascular.
3. Nervous.
4. Osseous.
5. Cartilaginous.
6. Fibro-cartilaginous.
7. Fibrous.
8. Muscular.
9. Serous.
10. Cutaneous.

Against this arrangement Mayer, professor of anatomy at Bonn, has urged the following objections:—That it is impossible to consider the scarf-skin, or cuticle, and the hairs, as of the same or similar structure with the cutaneous tissue in general; that glandular structure cannot be regarded as pertaining to the same order with the mucous membranes; that the fibro-cartilages ought neither in this arrangement nor in that of Bichat to be considered as distinct from cartilage; and that in both several parts of the animal body are omitted, or can have no convenient place of reference. Mayer therefore reduces the twenty-one tissues of Bichat to seven, and adds an eighth, comprehending the crystalline lens, the cornea, epidermis, hair, nails, &c. to which he gives the general name of *lamellar* tissue. The classification of organic tissues

given by this anatomist would stand in the following order :—*

I. LAMELLAR.
- Crystalline lens, Cornea.
- Cuticle.
- Hair, nails in whatever form, as claws, bill, hoof.
- Horns, scales, &c.
- Teeth.

II. FILAMENTOUS CELLULAR.
1. Cellular system, S. Cellulosum.
2. Adipose system, S. Adiposum.
3. Medullary system, Medullare.
4. Serous system, Serosum.
5. Synovial, Synoviale.
6. Vascular, Vasculosum.
7. Dermoid, Dermodeum.
8. Mucous, Mucosum.
9. Structure of the womb and reservoirs of secreted fluids, Uterus.

III. FIBROUS.
1. Hard membrane, Dura meninx, Dura mater.
2. Periosteum.
3. Cartilage.
4. Proper membrane of intestinal tube, T. Nervosa.
5. Membrane of synovial capsules.
6. Ligaments.
7. Sheaths, Vaginæ tendinum.
8. Aponeurosis, Fascia.
9. Tendon.
10. Neurilema,
11. Soft membrane, Meninx tenuis, Pia mater.

To these may be added a series of parts pertaining at once to the fibrous and the filamentous cellular system, since their structure presents a predomination of fibrous filaments. These are,

1. The Sclerotic.
2. The Tunica albuginea of the testicle.
3. The Proper tunic of spleen and kidneys.
4. The Cellulo-fibrous sheath of conglomerate and conglobate glands.
5. The Corpus cavernosum and C. spongiosum.

IV. CARTILAGINOUS.

V. OSSEOUS.

VI. GLANDULAR.
1. Lymphatic ganglion or glands.
2. α Granular glands, or those provided with excreting duct, the lacrymal gland, the salivary glands, the pancreas, liver, kidneys.
β Glandular organs without excreting duct, as the spleen, thymus, renal capsules.

These three forms of glandular organs are considered by Professor Mayer as combinations of minute lymphatics, or blood-vessels, or both united.

* Sur Histologie, avec une division nouvelle des tissus du corps humain. Par le Docteur Mayer, Prof. d'Anatomie et de Physiologie. Bonn, 1819.—Journal de Medecine, &c. Vol. XII. 193, XII. 99.

VII. Muscular. 1. Animal or voluntary.
2. Organic or involuntary.
VIII. Nervous.

This arrangement, which is undoubtedly very elaborate, and perhaps more comprehensive than either that of Bichat or any other author, is not, however, quite faultless. It may be doubted whether the lens is an organic body at all, and it is certainly much less an organic substance than the cornea, with which it is arranged. Cellular and cutaneous tissue are certainly not so similar as to admit of being referred to the same rank; and the organs destined to contain secreted fluids are so opposite and different in structure, that it appears rather violent to connect them in one group. The proper membrane of the intestinal tube, is, according to the result of my observations, nothing but the corion of the villous membrane; at least I cannot conceive any other part to which the description will apply; and surely the soft cerebral membrane (pia mater) cannot justly be associated with such substances as ligaments, tendons, or aponeurotic sheaths.

The system termed glandular by Professor Mayer is still more awkwardly situate. For not only is it doubtful with what justice the lymphatic glands are associated with the proper secreting glands, but the latter are themselves much varied in structure and anatomical characters; and as to the old notion of glandular structure being merely an expansion of vessels arranged in a peculiar manner, I fear that is not only too general to be true,

but that there is no tissue in the human body which might not be defined in the same manner.

In the formation of any arrangement of the organic tissues of which the human body consists, two extremes must be sedulously avoided. First, care should be taken not to diminish too much the number of individual or distinct tissues, and to avoid the useless and unnatural system of referring the several substances employed in the construction of the human body to a small number of general heads. This was the error of the ancient physiologists, who, from a wish to simplify more than nature admitted, referred the various animal substances to an elementary fibre or fibres, which they imagined formed the basis or ground-work of the whole animal organization.

The second extreme which ought to be avoided in this matter is the practice of dividing the substances of the animal body into a greater number of distinct kinds and species than is convenient or necessary. Very superficial inspection, indeed, shows that they are not the same either in anatomical or physical characters, or in chemical composition, and that the idea of considering one tissue as a modification of another, or one animal substance as forming or generating another, is, if not unnatural and impossible, at least much more remote from the truth, than to consider them as actually differing in kind, and possessing the properties of a separate form of organized matter. This, therefore, though an evil in its way, is one of much

less injurious consequence than the former, which by its generalizing spirit has a tendency to supersede investigation, and to consider the nature of the animal tissues as sufficiently established. This perhaps was the error of Bichat, if his arrangement is chargeable with fault. But with still greater justice it may be said, that the recent attempts at classification, like the imperfect ones of the ancient physiologists, are to be blamed in diminishing too much the number of separate tissues, and in delivering arrangements, the principles of which are more general and comprehensive than nature warrants.

It may indeed be assumed as a safe principle, that all the substances employed in the construction of the animal body, which are not very obviously alike, may be considered as separate or distinct proximate principles, till careful examination shall show that they ought to be associated with others. This indeed defeats the purpose of classification, which is useful in proportion as it discovers genuine analogies and general resemblances for the purpose of communicating knowledge with facility; but it also prevents the approach or insinuation of error, by the caution with which it examines, and the discrimination with which it adopts.

In the short view which I propose here to take of the organic tissues, I shall not adhere scrupulously to either of those arrangements which I have already noticed, but attempt to modify that

of Bichat, which is perhaps the least objectionable, by adopting as many of the suggestions of his commentators as the nature of the subject and personal observation may seem to authorize. In the course of this exposition I shall have frequent occasion to refer to the best and most complete commentary that has yet appeared,—that by Professor Beclard, who has availed himself of the researches of J. F. Meckel, and Dr J. Gordon of Edinburgh, the Prodromo of Mascagni, the Histologie of Mayer, and the View of Bock.

The different organized solids which enter into the composition of the human body may be referred to the following simple tissues. Filamentous or cellular tissue, including the ordinary cellular membrane and adipose membrane; artery, vein, with their minute communications, termed capillary vessels, and the erectile vessels; lymphatic vessel and gland; nerve, plexus, and ganglion; brain; muscle; white fibrous system, including ligament, periosteum and fascia; yellow fibrous system, including the yellow ligaments, &c.; bone and tooth; gristle or cartilage; fibro-cartilage; skin; mucous membrane; serous membrane; synovial membrane; compound membranes, for instance the fibro-mucous, and fibro-serous; and lastly, the peculiar matter which forms the liver, the kidneys, the female breast, the testicle, and other organs termed glands.

CHAPTER II.

FILAMENTOUS OR CELLULAR TISSUE. (*Tela cellulosa*,—*Tissu cellulaire*,—*Tissu muqueux* of Bordeu.—*Corpus cribrosum*, Hippocratis,—*Corps cribleux* of Fouquet,—Reticular Membrane of William Hunter.)

SECTION I.

THE general distribution of the filamentous or cellular tissue was first maintained by Haller and Charles Augustus de Bergen, and afterwards made the subject of more elaborate discussion by William Hunter and Bordeu. It may be described as a substance consisting of very minute thready lines, which follow no uniform or invariable direction, but which, when gently raised by the forceps, present the appearance of a confused and irregular net-work. As these minute lines cross each other, they form between them spaces of a figure not easily determined, and perhaps not uniform. By some authors these spaces or intervals have been named cells; but accurately speaking the term is not fortunately applied. The component lines, which do not exceed the size of the silk-worm threads, are so slender, that they do not form those distinct partitions which the term *cell* implies; and though by forcible distension, such as takes

place in insufflation or separation by forceps, cavities appear to be formed, these, it will be found, are artificial, and result from the separation of an infinity of the slender filaments of which the part is composed. These interlinear spaces necessarily communicate on every side with each other; and indeed the most distinct way of forming a true idea of the structure of the cellular tissue is to suppose a certain space of the animal body which is divided and intersected into an infinite multitude of minute spaces, (*areolæ*,) by slender thready lines crossing each other.

This description, originally derived from personal observation, led me to apply to this tissue the name of *filamentous* as more appropriate than that of *cellular*, by which it is generally known. I find, however, that in this I am anticipated by Charles Augustus de Bergen, the most accurate observer who has treated of its anatomical structure. His description is so faithful that it should be known to the student of general anatomy. "Alteram vero non adeo distincté saltem paucissimis, ut mihi videtur, observatam." He alludes here to the filamentous as distinct from the adipose tissue. "Ubi sic dicta cellulosa ex innumerâ atque intricatissimâ congerie *staminum aut filamentorum*, nullatenus cellulas pinguedinem continentes efformantium, componitur; quæ tenerrima mirificé obliqué disposita, inexplicabili adeo contentu viscerum omnium et musculorum substantiam internam perreptant, ut nihil certi vel mi-

crocospiis adjutus hic effari queas; quam proin *substantiam filamentosam* vocabo." *

The interstitial spaces resulting from the interlacement of these filaments do not exist as distinct cavities in the healthy state, so that they cannot be said to contain any substance solid or fluid. But when an incision is made into this tissue in the living body, it is found, that, if we except those fluids which issue from divided vessels, nothing is observed to escape, but a thin exhalation or vapour, which is evidently of an aqueous nature. This is what some authors have termed, from its resemblance to the serous part of the blood, the *cellular* serosity, (Bichat,) and the quantity of which has been greatly exaggerated. In the living body it appears not to exist as a distinct fluid, but merely as a thin vapour, which communicates to the tissue the moist appearance which it possesses.

This fluid is understood to be derived from the minute colourless capillaries named *exhalants;* and it is supposed to be no sooner poured forth in an insensible manner, than it is removed by the absorbing power either of lymphatics, according to the followers of the Hunterian hypothesis, or of minute veins, according to Magendie. It is of no great moment whether this process of absorption be ascribed to lymphatics or to veins, or be under-

* Caroli Augusti a Bergen, Programma de Membrana Cellulosa. Francofurti ad Viadrum, de 21 Aug. 1732. Apud Haller, Disputat. Anatomic. Select. Vol. III. p. 82.

stood, as is probably the truth, to be effected by both. It is sufficient to remark, that, whatever serous fluid is secreted into the interstitial spaces or cells of the filamentous tissue, makes no long abode in that situation, but in the healthy state is speedily removed; so that if we suppose exhalation, absorption must be also admitted; and the filamentous tissue is therefore represented as the seat of an incessant exhalation and absorption.

The serous fluid of the filamentous tissue varies in quantity in different regions. In the cellular tissue of those parts which are free from fat, as in the eyelids, the prepuce, the *nymphæ* and *labia*, and the scrotum, it is said to be somewhat more abundant than in others. The peculiar structure of those parts, which is cellular, may render any excess of serous fluid more conspicuous; for it is matter of observation, that in many persons otherwise healthy these parts are not unfrequently distended with serous fluid. On the other hand, it must be remarked that the submucous cellular tissue, and that which surrounds arteries, veins, and excreting ducts, which is delicate in substance and compact in structure, contains but a small proportion of serous fluid, and does not readily admit its presence.

This fluid has been generally said to be of an albuminous nature; and if it be identical with the serum of the blood, from which it is believed to be secreted, this character is not unjustly given it. Bichat, who maintained this opinion, injected al-

cohol into the filamentous tissue of an animal previously rendered emphysematous, and found in various parts *whitish flocculi*, which he regarded as coagulated albumen. He also obtained the same result by immersing a portion of the scrotum in weak nitric acid; and when a considerable quantity of this tissue was boiled, it furnished much whitish foam, which Bichat regarded as albuminous. * These experiments, however, are liable to this objection, that the effects in question may have arisen from coagulation of part of the filamentous tissue itself, which contains a considerable proportion of albuminous matter. The best mode of determining the point is to obtain the fluid apart, and to try the effects of the usual tests on it when isolated from the tissue in which it is lodged.

The description here given applies to the proper filamentous tissue. This substance was shown by Ruysch, and afterwards by William Hunter and Mascagni, to be penetrated by arteries and veins. Exhalants, absorbents, and nerves, it is also said to receive. The arteries certainly belong in the healthy state to the order of colourless capillaries, which is nearly the same with exhalants. It does not appear that the nervous twigs observed to pass through this tissue are lost in it, for in general they have been traced to some contiguous part.

Such are the general properties of this tissue considered as an elementary organic substance

* Anatomie General, Tome I. p. 50.

extensively diffused through the body. In particular regions it undergoes some modifications, which may be referred to the following heads. 1. Beneath the skin, or rather under the adipose membrane—the subcutaneous and intermuscular cellular tissue; 2. Beneath the villous or mucous membranes—the submucous cellular tissue; 3. Beneath the serous membranes—the subserous cellular tissue; 4. Round blood-vessels, excreting ducts, or other organs—the enclosing tissue, vascular sheaths, &c.; 5. In the substance of organs—the penetrating cellular tissue.

The situation of the subcutaneous filamentous tissue deserves particular notice. Though generally represented as below the skin, it is not immediately under this membranous covering. The skin rests on the adipose membrane, beneath which again is placed the filamentous tissue, extending like a web over the muscles and blood-vessels, penetrating between the fibres and bundles of the former, surrounding the tendons and ligaments, and connected by these productions with a deep-seated layer, on which the muscles move, where they do not adhere to the periosteum and to bones.

The extensive distribution of the subcutaneous filamentous tissue, the mutual connection of its parts, and its ready communication with the filamentous tissue of the mucous and serous membranes, were demonstrated by Haller, William Hunter, and Bordeu, and have been clearly ex-

plained by Portal and Bichat. The principal points worthy of attention may be stated in the following manner.

The filamentous tissue of the head and face communicate freely with each other, and with that of the brain by the cranial openings, and with the submucous tissue of the eyelids, nostrils, lips, and the inner surface of the mouth and cheeks. It communicates also with the subcutaneous tissue of the neck all round; and at the angle of the jaw in the vicinity of the parotid gland is the common point of re-union. To this anatomical fact is referred the frequency of swellings and purulent collections in the region of the parotid in the course of various diseases of the head, face, and neck.

The filamentous tissue of the neck may be viewed as the connecting medium between that of the head and trunk. From the former region it may be traced downwards along the back, loins, breast, sides, flanks, and belly. At the cervical region, and between the shoulders, it is dense and abundant; and, surrounding the dorsal part of the vertebral column it is connected with the mediastinal tissue, the submucous tissue of the lungs, and the subserous tissue of the costal pleura. At the fore part of the neck it is in like manner connected with the abundant tissue of the pectoral region, and by means of that surrounding the larynx and trachea, 1*st*, with the submucous tissue of the bronchi; and, 2*d*, with the anterior

mediastinum. Passing downwards, the same communication may be traced with the intermuscular tissue of the loins and belly, the tissue surrounding the lumbar and sacral portion of the vertebral column, that connecting the mesentery and large vessels to the vertebræ, and extending all round under the muscular peritonæum, and into the pelvis, where, by means of the tissue at the posterior surface of the abdominal muscles, at the anterior surface of the *iliacus internus*, and through the obturator hole and ischiatic notch, it communicates with the filamentous tissue of the lower extremities. From the rectum and branches of the ischium it is continued along the perinæum by the urethra, and into the scrotum.

In the whole of this course it is abundant in the space before the vertebræ round the *psoæ* and *iliacus internus* muscles, and round the bladder, rectum, prostate gland, and womb. The tissue surrounding the vertebral column communicates with that in the interior of the column by the intervertebral holes.

The arm-pit may be considered as the point of union between the filamentous tissue of the trunk and that of the upper extremities, while the groin is the corresponding spot for the lower extremities. These facts should be kept in mind in observing the phenomena of diseases of this tissue.

Notwithstanding this general connection, however, certain parts of the tissue are so dense and close as to diminish greatly the facility of com-

munication. Thus along the median line it is so firm, that air injected invariably stops, unless impelled by a force adequate to tear open its filaments, and water is rarely found effused in this situation. In the neighbourhood of some parts of the skeleton also, as at the crest of the ilium, over the great trochanter, and on the shin, the filamentous tissue is very dense and coherent.

In chemical composition it consists principally of gelatin, but contains some albuminous matter.

Section II.

The filamentous tissue is liable to inflammation, acute and chronic, circumscribed, and with exudation of lymph, or diffusive and spreading, generally without this exudation, and with the production of purulent matter; to induration; to hemorrhage; to serous infiltration; to aerial distension; and to new growths.

1. Inflammation of the subcutaneous tissue when circumscribed constitutes phlegmon, a name applied rather in reference to our observation of it near the surface of the body, than with a view to the natural relation between an organized texture and its pathological processes.

In other situations, as it is seldom recognized before it has passed to the stage of suppuration, inflammation of cellular tissue is generally implied in those abscesses or collections of purulent matter,

(apostemata, abscessus), acute or chronic, which frequently form in the human body. If inflammation of cellular tissue do not terminate in suppuration, nor is resolved, it terminates in effusion of lymph, with concretion or agglutination of its filaments through a space more or less extensive. This is known by slight swelling, hardness, and immobility of the part. The phenomena of inflammation in this tissue are best observed in deep wounds, which divide a considerable extent of it. If the wound be what is called *simply incised*, the constitution good, and the inflammation moderate, lymph is effused, and the cut edges are united by what was anciently named the *first intention*. This mode of union was termed by John Hunter adhesive inflammation, (p. 226,) and union by adhesion.

It is not always, however, that the process is so simple. When the wound is extensive or complicated, and involves the cellular web of several different tissues, the lymph effused is inadequate to effect reunion at once; and another process termed granulation takes place. The basis of this indeed consists in exudation of lymph, which is effused in minute masses of no definite form, and which are soon penetrated by blood-vessels, and thereby become organized, (Hunter, p. 477.) Their surface becomes covered with more or less lymph, which, as they increase in size, causes them mutually to cohere; and by the successive production, growth, and union of these granular bodies,

the divided surfaces are made eventually to unite. The process of granulation in the filamentous tissue is accompanied with more or less suppuration; but as the granulations coalesce, this is gradually diminished.

2. The second form of inflammation occurring in filamentous tissue is when it spreads, or is diffused along the membrane, or through its substance. John Hunter was aware of the tendency which the inflammatory process in certain circumstances manifests to spread; and referring it to a sympathetic disposition in the surrounding parts, suggests an illustration in the opposite qualities of dry and damp paper. "If dry," says he, "then it will not spread; it will be confined to its point; but if damp, it will spread, being attracted by the surrounding damp to which it has an affinity," (p. 262.) Though this is a mere illustration, and is a statement of a physical, not a physiological phenomenon, it affords no imperfect idea of the distinction between the limited or circumscribed, and the spreading or diffuse inflammation.

Two circumstances, however, appear to have perplexed the principles both of this author and of his successors. The first of these was the sense in which the terms *erysipelas* and *erysipelatous* inflammation were to be understood; the second the constant search for final causes, or ultimate intentions. By most physicians and surgeons, previous to the time of Carmichael Smyth and Wil-

lan, and even later, every spreading inflammation was termed *erysipelatous*, whether it existed in skin, mucous membrane, serous membrane, or cellular tissue; and the character of nomenclature was derived, not from the texture, but from the supposed nature of the morbid process. This practice, if not positively wrong, was attended with confusion in arrangement and description; and it is well that the general usage of correct pathologists has now restricted the term to inflammation of a particular tissue. The second source of confusion in the views of Hunter consisted in his regarding the exudation of lymph as an invariable barrier against the diffusion of the morbid process. This exudation doubtless constitutes the character of the limited form of inflammation; but Hunter appears to have forgotten that, in certain circumstances, as in the sort of inflammation now considered, this barrier does not exist, and the morbid process therefore spreads, or is diffused over the membrane. It is further evident from what he says, (p. 271, 272, and 367,) that he regarded the spreading inflammation of the cellular membrane as erysipelas attacking that tissue, and that he considered its pathological peculiarity to consist in the absence of lymphy effusion, and the consequent want of limitation. Though it may be disputing about a name only, to question this, it is perhaps better to regard this form of inflammation as entirely different from erysipelas, which must be referred to the outer surface of the co-

rion; and to represent it as a process tending to spread without adequate effusion of coagulable lymph.

Another point in the pathology of this disorder may be here noticed. Certain facts would favour the notion, that it consists in affection of the adipose membrane, as distinct from the filamentous tissue. Thus, diffuse inflammation occurs mostly in those parts in which the adipose membrane is abundant, *e. g.* in the neck, on the chest between the two pectoral muscles, in the armpits, in the extremities immediately beneath the skin, and on the buttock at the verge of the anus. In the following passage Hunter seems to have this in view, "The cellular membrane, free from the adipose, appears to be more susceptible of the adhesive inflammation than the adipose membrane, and much more readily passes into the suppurative. Thus we see that the cellular membrane connecting parts together as muscles, and the cellular membrane connecting the adipose to muscles, easily inflames, and runs readily into suppuration, and, as it were, separates the muscles from their lateral connections, and even separates the adipose from the muscles, while the skin and adipose membrane shall only be highly inflamed." (P. 234.)

Diffuse inflammation of the filamentous tissue has been described by Kirkland, (p. 282, Vol. II.) Willan, Thomson, and Copland Hutchinson, under the name of *phlegmonoid erysipelas*, noticed

by various authors as inflammation of the *fascia*, (Abernethy, Kirkland, 268,) and recently has been fully investigated by Dr Duncan Junior under its proper denomination.

Its general characters are diffuse swelling spreading over the limb or affected region, compressible, but not elastic, often doughy; deep-seated pain, with an oppressive sensation of weight; and tension of the skin, sometimes with a dull red tinge, not unfrequently without change of colour. At a period, varying from the fifth to the tenth day, the swelling presents in sundry parts a peculiar, compressible, but not very elastic character, as if the subjacent tissues were floating in a fluid or semi-fluid matter.

If the affected part or limb be examined after death, the whole cellular tissue, subcutaneous and intermuscular, is found enlarged, gray, or ash-coloured, and distended with blood-coloured fluid or serum, sero-purulent or purulent matter. It is detached extensively from the several tissues which it connects in the healthy state. Between the muscles are long sinuous caverns filled with dirty ash-coloured fluid; sloughs or mortified shreds are seen here and there hanging from aponeurotic sheaths, tendons, or even blood-vessels; and, while in most cases shreds or filaments of the subcutaneous or subfascial cellular tissue are the only traces of its existence, in not a few instances the muscles are detached from the periosteum, and the periosteum from the bone. These shreds are

mortified pieces or sloughs of filamentous tissue; and correspond to the pieces of wet tow mentioned by Hunter and Sir E. Home, and the wads of wet chamois leather noticed by Mr James.

This process is attended with much disturbance of the circulation, loss of appetite, heat, thirst, dry skin, and more or less derangement of the intellectual functions. Towards the close of the disease, the pulse becomes quick, small, and sometimes intermitting; the strength of the muscular system is greatly impaired; the raving is accompanied with muttering, and starting of the tendons, and alternates with stupor; and the breathing becomes quick, panting, and laborious, or slow, languid, and interrupted, and terminates in death.

This may be regarded as the most severe form of the disease. In such circumstances its duration varies. It appears from the result of Dr Duncan's observations that death does not take place before the sixth day, but may occur in any subsequent one to the twelfth or fifteenth. Perhaps in the average number of cases, the seventh, eighth, or ninth may be stated as the day on which the termination occurs. In milder cases it may terminate in resolution or in abscess. When the latter result takes place, the inflammatory action changes its character, and instead of spreading, shows a tendency to stop. Lymph is effused, healthy purulent matter is formed, and adhesion taking place in one or more points, the disease ter-

minates in phlegmonic suppuration and granulation.

When recovery takes place after suppuration and sloughing of the cellular tissue, it is affected partly by direct adhesion taking place between the muscles, or their cellular substance, partly by the formation of new cellular tissue, similar to the new membranes formed on the serous surfaces. The former is the cause of the stiffness, immobility, and condensation of parts after this inflammation has taken place.

In some instances the circumscribed, or limited, and the spreading forms of inflammation may be combined. The latter proceeds at one part of the affected tissue; while the limited, with lymphy exudation and adhesion takes place at another. This appears to be the variety of those tedious cases in which the disease is prolonged for weeks, and the patient either recovers, or ultimately dies hectic.

Diffuse inflammation may occur in any part of the filamentous tissue of the whole body, and may affect either the subcutaneous and superficial, or the intermuscular and deep-seated layer. But the regions in which it is most commonly observed, may be enumerated in the following order:—

a. The neck and throat. (Case by Wells in Transactions of a Society, Vol. III. p. 360, and by Wilson, p. 367.) *Angina interna* of Kirkland, Vol. II. p. 158, and James, p. 187, &c.)

In persons, generally females, of full gross habit

and bloated appearance, swelling diffuse, deep-seated, on the side of the neck towards the angle of the jaw, causing much pain in the side of the head; attended with much fever, general disorder, loss of appetite, raving, stupor, or coma. It terminates in sloughs of the tissue, foul, ill-conditioned purulent matter; does not point, but may burst internally, and cause suffocation. In some cases death takes place from the constitutional disorder with the affection of the brain.

b. The breast, or outer surface of the chest and arm-pit, and the side; *abscess in the axilla* of Kirkland. Several cases in Dr Duncan's Essay. Diffuse painful swelling of the side occurring in middle-aged subjects, male or female, terminating in suppuration all over the side, or between the pectoral muscles, or in the arm-pit.

c. An upper extremity, and passing to the arm-pit and side of the chest. This is the form which takes place after venesection, after punctured wounds in dissecting, or the application of animal matter or fluid to a wounded surface.

d. An inferior extremity. The swelled leg of puerperal women is to be referred to this head, (See Hunter, p. 204.) Certain injuries of the foot and toes, more especially when the fibrous tissues have been much lacerated, appear also to be of the same kind. The phlegmonoid erysipelas of the lower extremities of seamen, as described by Mr Copland Hutchinson, comes under this head.

e. The buttock and the perinæum. (*Proctia,*

phyma of the ancients. *Proctitis, Proctalgia* and *Clunesia* of the nosologists. *Suppuration gangreneuse* of the French. Described by Pott in his 2d section on *Fistula ani*, p. 49. Case given by Hunter in his 3d chapter, section xiv., on the use of the adhesive inflammation. Abscess *juxta anum* of Mr James, p. 189.) In persons of gross habit, either naturally or rendered so by intemperance, hard diffuse swelling of the verge of the anus on each side, skin doughy and unresisting, sometimes colourless, generally of a dusky red or purplish colour, with shivering, sickness, vomiting, great restlessness, heat, and thirst; pulse at first hard, quick, full, and jarring, afterwards weak, fluttering, and irregular; brown tongue and mental disorder. After three, four, or five days, a small quantity of ill-conditioned matter, and sloughs of the cellular and adipose membrane are formed. This inflammation may spread along the urethral and scrotal filamentous tissue, and form the urethral abscess (*abscessus juxta urethram*) of Mr James. Of this an instructive example is related by John Hunter at the passage above referred to. The disease is distinguished according to him by the combination of the suppurative with the erysipelatous spreading inflammation. "It is not so circumscribed as the former; nor does it spread along the skin like the latter. But the skin is shining and œdematous; and the inflammation goes deep into the filamentous tissue, and forms dusky, fetid, purulent fluid, sometimes with air in

a bag or abscess, without previous adhesion." The inflammation may pass downward and forward into the scrotum and beside the urethra, and upwards by the dense filamentous tissue of the belly and loins; and when openings are made, either artificially or by the process of ulceration, matter is discharged, and the mortified membrane hangs out like wet dirty tow. (Hunter, p. 368.) Yet notwithstanding this extensive destruction both of filamentous tissue and even of skin, it is remarkable that the rectum generally escapes.

f. When this disease appears in other parts of the body after wounds with foul instruments, bites of poisonous animals, as the rattlesnake or the cobra di capello, morbid animal secretions, or the juice of the acrid plants, applied in any manner to the exposed corion, its characters and phenomena may be easily understood from the description already given.

g. I am uncertain whether to this head should be referred the peculiar fatal inflammation which succeeds punctured and lacerated wounds of the extremities, compound fractures with much contusion, compound luxations and severe gun-shot wounds. This is commonly regarded as gangrene, and is familiarly termed traumatic gangrene. It consists, however, in a peculiar form of inflammation, spreading rapidly along the subcutaneous and intermuscular cellular tissue, accompanied with emphysematous distension, and causing great constitutional disturbance, in which disorder of the

brain and its functions are conspicuous characters. Death generally takes place before any of the tissues are mortified, in consequence of the violence of the constitutional symptoms, chiefly the affection of the brain.

3. *Inflammation of a chronic nature* is not uncommon in the filamentous tissue. In the ordinary acute form, the process is attended with more or less pain and swelling, and proceeds quickly to suppuration. In other circumstances, however, little or no pain is felt; swelling is not perceived till late; and the first intimation of the existence of the disease is a collection of purulent matter, which, when discharged, is not homogeneous, but consists of flaky or curd-like shreds floating in a thinnish watery fluid. This constitutes the cold abscess (*apostema frigidum*) of the surgeons of the Saracen school, and is the chronic abscess of modern surgeons. (Boyer.)

The cold abscess may be formed in any part of filamentous tissue; but it is most frequent where this tissue is loose and abundant. Seldom seen in the head, it is frequent in the neck, in the chest, in the back, especially in the lumbar region, and in the extremities. I have seen this tumour most generally in the loins, where it is liable to be confounded with lumbar abscess; in the cellular tissue of the *glutæi* muscles; and in the thigh and leg, especially the posterior and internal region. In these situations it is not unfrequently the cause of sinuous cavities, which are difficult to be healed.

Several of the forms of lumbar abscess, in which there is no affection of the vertebræ or of their ligaments, are examples of this abscess occurring in the abundant loose filamentous tissue, which connects the mesentery, the large vessels, and the psoæ muscles to the spine. Boyer also states that they are sometimes seen in the filamentous tissue which connects the serous membranes of the chest and belly to the walls of these cavities. Of the latter I have seen one instance simulating hernia, and by the destruction which it caused of the fibres of the *recti* muscles, actually leaving a space through which the intestines were protruded.

4. *Hemorrhage.* Effusion of blood into the filamentous tissue independent of external violence is not common. Of spontaneous and idiopathic hemorrhage no authentic example has been recorded. It occurs, however, in a secondary manner in land and sea scurvy, (Purpura and Scorbutus.) In the former disease it is rarely to any great extent, save when the complaint has terminated fatally with large and repeated hemorrhage from the mucous membranes. In sea scurvy it is at once frequent and considerable. Scarcely a case of this disorder attains any height, without much effusion of blood into the subcutaneous and intermuscular filamentous tissue. On this effusion in general depend the hard, livid tumours, deep in the limbs, with which sea scurvy is attended. The cause of this hemorrhage, or rather the state of the vessels which gives rise to it, is not well known. The

blood is probably altered, but the capillaries of the tissue are much affected, certainly overloaded, probably disorganized.

Similar effusion is occasionally found in the filamentous tissue in malignant agues, remittents, especially those of tropical countries, and sometimes in the fever of temperate regions.

5. *Induration. L'Endurcissement du Tissu Cellulaire* of Andry, Auvity, &c. *Scleroma* of Chaussier, (σκληρωμα σκληρος.) Skin-bound of Underwood and Burns. Compact œdema of M. Leger and other French authors. First observed by John Andrew Uzembezius in 1718, this affection was not accurately described till 1780, when Denman and Underwood in England, and Doublet in France, published the result of their observations. In 1787 it was fully investigated by Andry, in a memoir crowned by the prize of the Royal Society of Medicine of Paris; and afterwards, in 1789, in those of Auvity and Hulme. Since this it has undergone the successive researches of Naudeau and Bard in France, Went, Henke, Golis, &c. in Germany, Liberali and Palletta in Italy, and again of Trocon, Leger, Denis, and Breschet in France. Notwithstanding the research of these several inquirers, however, the nature of this change in the filamentous tissue is still imperfectly understood.

It has hitherto been observed only in infants, and very often immediately after birth. According to Leger, it appears most frequently eight, twelve, or twenty-four hours after, and very seldom takes place later than the seventh day. Ge-

nerally in the legs, not so often in the arms; the soft parts become unusually firm, dense, and diffusely swelled either continuously or in patches. The skin over these parts assumes a red, purple, or violet colour, which when pressed gives place to a yellow tint, with more or less depression. The same change is very generally remarked in the cheeks, the skin of which becomes quite immoveable; and it appears successively in the belly and chest, the integuments of which feel as stiff as a board. At the same time the surface, especially the extremities, are unusually cold; the pulse is quick and very small; the breathing is much constrained and panting; the infant ceases to cry, becomes blue in the face, and seems to expire suffocated.

The duration of the disease varies. The greatest number of infants die on the first, second or third day from the date of attack. In less rapid cases death takes place about the tenth or twelfth day, and in some so late as the twenty-first day.

After death the surface of the body appears in general hard, firm, and leathery, and presents a violet or brownish colour, interspersed with yellow patches. The cheeks, the extremities, and other parts affected during life are firm, rigid, and immoveable. The subjacent filamentous tissue is very dense and granular, and when cut communicates the sensation as if it were like collared brawn. From the sections slowly oozes a reddish serous fluid, which coagulates quickly; and in the tissue itself may be observed grayish or yellowish gra-

nules, which give the brawny aspect and sensation already mentioned. (Leger.) The greatest firmness and induration are generally remarked in the outer region of the legs, and in the dorsal region of the foot and hand; and this gives the members the air of a peculiar twist or distortion. The adipose membrane appears to be not much less the seat of this disease than the filamentous tissue.

The bodies of infants cut off by this disease are small, being of the medium height of seventeen inches; and all the organs are imperfectly developed. Thus the lungs are hard, marbled, uncrepitating, and sink in water; the windpipe is small, and the alimentary canal is shorter than usual in healthy infants of the same age. The heart, however, is large, and generally contains blood in clots. The *foramen ovale* is often open, and the arterial duct is never closed. The pericardium, and frequently the cavities of the serous membranes, contain more or less serous fluid.

The nature of this morbid change is unknown. The old notion of Uzembezius revived by Andry and Auvity, that it was occasioned by coagulation of the fluids frozen by extreme cold, is completely contradicted by the fact recorded by Leger, that among forty-four infants dead during the month of June 1823 in the Foundling Hospital of Paris, twenty-one were cut off by induration of the cellular tissue. The notion of Alard, that it is allied with the glandular disease of Barbadoes, scarcely deserves mention. On the contrary, its early occurrence after birth, the imperfect deve-

lopement of the several organs, especially of the lungs, its occasional appearance previous to birth, and its frequency among infants born before the full time, (Palletta,) show that it bears some relation to the fœtal mode of existence. The peculiar nature of the filamentous tissue in the fœtus and in the new-born infant may have some influence in the production of this malady.

6. Serous infiltration, (*œdema, anasarca.*) Under the operation of various causes, as cold, mercury, &c. the quantity of serous fluid in the filamentous tissue may be considerably increased; and this increase gives rise to a pale, white, or wan-coloured and cold swelling of the skin, which is distinguished by receiving the impression of the finger or any other substance forcibly applied. The swelling may be local, or confined to one arm, to one leg, to a hand, to part of a limb, to the scrotum, to the face, or so forth; or it may extend in different degrees to the greater part or the whole of the person. In the former case it is termed *Œdema,* (οιδημα) or swelling; in the latter it receives the name of *Anasarca,* (ὑδρωψ ανα σαρκα, dropsy in the flesh,) and is the *aqua intercus* of the Romans. It was the white or pale and blanched colour of this sort of swelling which procured for it the name of *Leucophlegmatia* (Λευκοφλεγματια) or white inflammation among the ancient physicians.

The fluid of the filamentous tissue may coagulate spontaneously, (Blackall, 263;) but it always undergoes coagulation on the application of heat or the addition of re-agents.

The preternatural increase of the cellular serosity now mentioned is supposed to arise either from diminished absorption or increased exhalation. This point will be considered afterwards when speaking of the exhalants.

7. *Emphysema. Pneumatosis spontanea et traumatica,* Cullen.

The filamentous tissue may be distended with air, which causes a uniform swelling, crepitating or emitting a crackling sound when pressed. The situations in which this aerial swelling may take place vary according to the cause by which it is produced. It may take place spontaneously (Baillie,) when it is commonly general, and is supposed to depend on a process of secretion from the blood-vessels. It may arise from rupture or laceration of the mucous membrane of the larynx or windpipe, (De Villars, Cheselden, Holyoke, O'Brien,) when the swelling appears chiefly over the face, neck, and upper part of the chest. It may succeed a broken rib, or any injury of the lungs, (Littre, Berger, William Hunter, Cheston, Leake, Gooch, Halliday,) when it appears sometimes over the neck, face, and chest, sometimes over the chest and side only. It may arise from rupture of the bronchial membrane during violent efforts, (Blagden, Hicks, Simmons;) and in this manner emphysema happens in puerperal women. Lastly, it may appear as an effect of gangrenous inflammation and mortification when it is confined solely to the affected limb. In the latter case the

air is produced by the decomposition of the serum of the blood in the morbid parts.

8. *Vascular Sarcoma.* (Abernethy.) The tumour known under this name is, of all the new growths incident to the animal tissues, the most simple in structure. I refer it to this head for two reasons. 1*st*, It appears to occur chiefly where filamentous or cellular tissue is found; and when it occurs among muscles, or in the substance of organs, it appears still to be referable to the filamentous tissue which enters into the composition of the texture in which it appears. 2*d*, The structure of this tumour is principally filamentous tissue condensed or modified by the local morbid action. Every instance of vascular sarcoma may be viewed as a new developement and hypertrophic augmentation of its proper substance in a particular point of the filamentous tissue. The tumour is always liberally supplied with blood from vessels which, if not more numerous, are greatly larger and more capacious than in the natural state; and if this be not the cause of the unusual deposition of substance, it must be regarded as the channel by which the additional matter is conveyed. It is also possible that the irritation resulting from the first effusion of blood, or other coagulable matter, which, according to Mr Abernethy, is the usual cause of tumours, may excite the vessels of the neighbouring parts so much as to cause their capacity to be enlarged, and to convey a more copious supply of blood.

This cause of the great vascularity, and its influence in increasing the size of the tumour, are particularly insisted on by Mr John Bell, and afterwards by Mr Abernethy.

The vascular sarcoma is enclosed in a thin capsule, which is formed of filamentous tissue much condensed by the pressure of the enclosed tumour. It may occur in any part or organ of the human body where filamentous tissue penetrates; but it is also found in the female breast, in the testicle of the male, and in the absorbent glands of both sexes. When it occurs in the testicle the vessels are said to be numerous and small. When it affects the female breast the vessels seem to be rather large than numerous, and the organization appears less complete. (Abernethy.)

9. *Melanosis.* The black deposite named *Melanosis* is often found in this tissue; and perhaps when it is said to occur in the interior of muscles, glands, and other tissues, it is in their filamentous substance that it is deposited. As it is, however, still more frequent in the adipose membrane, the points of its history deserving notice shall be introduced under that head.

10. *Tubercle.* I am uncertain whether to this tissue should be referred the small painful bodies situate beneath the skin, so well described by Mr Wood.* Though situate, as described by Mr Wood, in the subcutaneous cellular tissue, some

* Edinburgh Medical and Surgical Journal, Vol. VIII. p. 283 and 429.

facts would lead to the notion originally entertained by Camper,* that it is a morbid growth seated in one of the subcutaneous nerves, or probably in its neurilema. †

11. *Cysts.* Bichat has taken considerable pains to show the influence of this tissue on the formation of cysts. These, it is well known, are shut sacs containing fluids of different sorts. But however these fluids may differ, the containing cyst, which is a secreting membrane, has been regarded as formed of condensed and modified filamentous tissue. Against this doctrine Bichat urges the following objections. 1. Cysts are analogous in all respects to serous membranes, and should therefore have the same origin. 2. This mechanical hypothesis of their origin, in which all the vessels ought to be obliterated, does not accord with the exhaling and absorbing function of cysts, nor with their mode of inflammation. 3. If these sacs are formed by the mutual application and agglutination or adhesion of cells, (that is, of the filaments,) the contiguous tissue ought to be diminished, or to disappear when they are bulky, which is not observed to take place. 4. If cysts are formed by condensation of the filamentous tissue, and if their fluid is effused by exhalation, this fluid ought to exist in the organ which separates them from the blood.

* Demonstrationum Anatomico-Pathologicarum, Lib. i. p. 11.

† Ed. Journal, Vol. XI. p. 468.

For these reasons he infers that cysts begin at first to be developed, and to grow in the midst of the filamentous tissue, according to laws analogous to those of the growth of parts in general, and which appear to be unknown aberrations, or unnatural applications of these laws. When the cyst is once formed, the process of exhalation commences, and though scanty at first, it increases as the cyst enlarges. In short, the formation and growth of the organ precedes the accumulation of the fluid.

12. *Degeneration.* This term is obviously vague and indefinite. Under it, however, Sandifort has described in the body of a female infant a preternatural state of the cellular tissue of the breast, back, and axillary regions.* In some respects this change resembles the disease described above as induration. In others, however, it was different.

* Observationes Anatomico-Pathologicæ Eduardi Sandifort, Lib. iv. Cap. ii. p. 24. Lugduni Batavorum, 1777. 4to.

CHAPTER III.

ADIPOSE TISSUE, *(Tela adiposa,—Tissu adipeux,—Tissu graisseux.)*

Section I.

THE separate existence of an adipose membrane was suspected by Malpighi, distinctly taught by De Bergen and Morgagni, and demonstrated by William Hunter. It was, however, confounded with the filamentous tissue, under the general name of cellular membrane, adipose membrane, and cellular fat, by Winslow, by Portal, by Bichat, and most of the continental anatomists, till distinguished and positively described by M. Beclard himself.

According to the dissections of De Bergen and Morgagni, the demonstrations of Hunter, and the observations of M. Beclard, its structure consists of rounded packets or parcels *(pelotons)* separated from each other by furrows of various depth, of a figure irregularly oval, or rather spheroidal, varying in diameter from a line to half an inch, according to the degree of corpulence and the part submitted to examination. Each *peloton* or packet is composed of small spheroidal particles, which may be easily separated by dissection, and

which are said to consist again of an assemblage of vesicles still more minute, and agglomerated together by very fine and delicate cellular tissue. The appearance of these ultimate vesicles is minutely described by Wolff in the subcutaneous fat, and by Monro and Clopton Havers in the marrow of bones, in which the two last authors compared them to strings of minute pearls. If the fat with which these vesicles are generally distended should disappear, as happens in dropsy, the vesicles collapse, their cavity is obliterated, and they are confounded with the contiguous cellular tissue, without leaving any trace of their existence.

Hunter, however, asserts, that in such circumstances the cellular tissue differs from the tissue of adipose vesicles, in containing no similar cavities; and justly remarks that the latter is much more fleshy and ligamentous than the filamentous tissue, and contends, that though the adipose receptacles are empty and collapsed, they still exist. When the skin is dissected from the adipose membrane it is always possible to distinguish the latter from the filamentous tissue, even if it contain no fat, by the toughness of its fibres, and the coarseness of the web which they make.

The distinguishing characters between the cellular or filamentous and the adipose tissue may be stated in the following manner. 1*st*, The vesicles of the adipose membrane are closed all round, and, unlike the cellular tissue, they cannot be generally penetrated by fluids which are made to enter

them. If the temperature of a portion of adipose membrane be raised by means of warm water to the liquefying point of the contents, they will remain unmoved so long as the structure of the vesicles is not injured by the heat. If, again, an adipose *peloton* be exposed to a solar heat of + 40 centigr. though the fat be completely liquefied, not a drop will escape, until the vesicles are divided or otherwise opened, when it appears in abundance. The adipose matter, therefore, though fluid or semifluid in the living body, does not, like dropsical infiltration, obey the impulse of gravity. 2*d*, The adipose vesicles do not form, like cellular tissue, a continuous whole, but are simply in mutual contiguity. This arrangement is demonstrated by actual inspection, but becomes more conspicuous in the case of dropsical effusions, when the filamentous tissue interposed between the adipose molecules is completely infiltrated, while the latter are entirely unaffected. 3*d*, The anatomical situation of the adipose tissue is different from that of the filamentous tissue. The former is found, 1*st*, In a considerable layer immediately beneath the skin; 2*d*, Between the peritoneal folds which form the omentum and mesentery; 3*d*, Between the serous and muscular tissues of the heart; and, 4*th*, Round each kidney.

In each of these situations it varies in quantity and in physical properties. In the least corpulent persons a portion of fat is deposited in the adipose membrane of the cheeks, orbits, palms of the

hand, soles of the feet, pulp of the fingers and toes, flexures of the joints, round the kidney, beneath the cardiac serous membrane, and between the layers of the mesentery and omentum. In the more corpulent, and chiefly in females, it is found not merely in these situations, but extended in a layer of some thickness almost uniformly over the whole person; but is very abundant in the neck, breasts, belly, *mons veneris*, and flexures of the joints.

Besides the delicate cellular tissue by which the packets and vesicles are united, the adipose tissue receives arterial and venous branches, the arrangement of which has been described by various authors from Malpighi, who gave the first accurate account, * to Mascagni, to whom we are indebted for the most recent. According to the latter, who

* Malpighi's description is not much less accurate than that of Mascagni. "Vasa sanguinea expanduntur in ramos arborum adinstar, quorum extremitatibus appenduntur membranosi sacculi, seu lobuli, pinguedinosis globulis referti, qui veluti folia ramis adnata arboris exactam figuram complent."—"Per has membranas excurrunt minima vasa in modum retis expansa, quæ tenue omentum representant. Hæc a venis et arteriis, ut videre potui, ortum ducunt, et non tantum leviter exterius pinguedinis lobulos, sed etiam intime penetrant, et pinguedinosis globulis nectuntur."—"Quandoque autem cooperiuntur levi superextensa membrana ita ut in conspectum non erumpant; emergunt autem quotiescunque vetustate et carie membranosæ portiones corrumpuntur. Per hanc eandem membranam diramificantur adiposa vasa in omento reperta, quæ pinguedine turgent, si præcipue in de recenti mactato animali inspiciantur."—De Omento, Pinguedine et Adiposis Ductibus, p. 41.

has also delineated these vessels, the furrow or space between each packet contains an artery and vein, which being subdivided penetrates between the minute grains or particles of which the packet is composed, and furnishes each with a small artery and vein. The effect of this arrangement is, that each individual grain or adipose particle is supported by its artery and vein as by a foot-stalk or peduncle, and that those of the same packet are kept together not only by contact, but by the community of ramifications from the same vessel. These grains are so closely attached, that Mascagni, who examined them with a good lens, compares them to a cluster of fish-spawn, (*un aggruppimento di uova.*) Grutzmacher found much the same arrangement in the grains and vesicles of the marrow of bones. *

It has been supposed that the adipose tissue receives nervous filaments; and Mascagni conceives he has demonstrated its lymphatics. Both points, however, are so problematical, that of neither of these tissues is the distribution known.

The substance contained in these vesicles is entirely inorganic. Always solid in the dead body, it has been represented as fluid during life by Winslow, †

* De Ossium Medulla. 1748. Extat in Haller, Vol. VI. p. 390.

† "La graisse ou matiere graisseuse est plus coulante dans les vivans que dans les morts."—Winslow, Traité des Tegumens, sect. 73.

Haller, * Portal, † Bichat, ‡ and most authors on anatomy. The last writer indeed states, that under the skin it is more consistent, and that in various living animals he never found it so fluid as is represented. The truth is, that in the human body, and in most mammiferous animals during life, the fat is neither fluid nor semifluid. It is simply soft, yielding, and compressible, with a slight degree of transparency or rather translucence. This is easily established by observing it during incisions through the adipose membrane, either in the human body or in the lower animals.

The properties and composition of fat form a subject for chemical rather than anatomical inquiry; and in this respect its nature has been particularly investigated by M. Chevreul. According to the researches of this chemist, fat consists essentially of two proximate principles, *stearine*, (στεαρ *sebum, sapo*), and *elaine*, (ελαιον *oleum*.) The former is a solid substance, colourless, tasteless, and almost inodorous, soluble in alcohol, and preserving its solidity at a temperature of 138° cen-

* Elementa Physiologiæ, Lib. i. sect. 4.

† "La chaleur de la vie maintient la graisse dans une espece de fluidité; elle se fige par le froid de la mort; ce qui fait qu'elle est compacte dans les cadavres."—Portal, Tome II. p. 17.

‡ "La graisse est presque toujours solide et figée dans les cadavres, mais sur le vivant elle s'approche plus de l'etat liquide, au moins dans certains parties, comme aux environs du cœur, des gros vaisseaux, &c. Sous la peau elle est constamment plus consistante." Anatomie General, Tome I. p. 59.

tigrade. Elaine, on the contrary, though colourless, or at most of a yellow tint, and lighter than water, is fluid at a temperature of from 17° to 18° centigrade, and is greatly more soluble in alcohol. Of this substance marrow appears to be merely a modification; and the membranous cavities or medullary membrane in which it is contained may be viewed as an intra-osseous adipose tissue.

Little doubt can be entertained that animal fat is the result of a process of secretion. But it is no easy matter to determine the mode in which this is effected. Malpighi, departing, however, from strict observation, imagined a set of ducts issuing from glands, in which he conceived the fat to be elaborated and prepared. To this he appears to have been led by his study of the lymphatic glands, and inability to comprehend how the process of secretion could be performed by arteries only. This doctrine, however, was overthrown by the strong arguments which Ruysch derived from his injections; and Malpighi himself afterwards acknowledged its weakness and renounced it. In short, neither the glands nor the ducts of the adipose membrane have ever been seen.

Winslow, though willing to adopt the notion of Malpighi, admits, however, that the particular organ by which the fat is separated from the blood was unknown. Haller, on the contrary, aware of the permeability of the arteries, and their direct communication with the cells of the adipose tissue, and trusting to the testimony of Malpighi, Ruysch,

Glisson, and Morgagni, that it existed in the arterial blood, saw no difficulty in the notion of secretion, or rather of a process of separation; and upon much the same grounds the opinion is adopted by Portal and others. Bichat, again, contends, that no fat can be recognized in the arterial blood, and justly adduces the fact, that none can be distinguished in blood drawn from the temporal artery. To the accuracy of this fact I can bear positive testimony, having repeatedly examined, with the view of recognizing the buffy coat, and detecting oily particles, blood which I had drawn from this vessel,—the latter invariably without success. This result is not at variance with the fact observed by Dr Traill, who found oily matter in venous blood in two instances. In wounds in the human body during life, and in living animals, oily particles may be seen floating on the surface of the blood; but these proceed from division of the adipose vesicles.

That fat does not exist in the arterial blood may be therefore admitted as an established point. The idea that it is separated, or strained from this fluid, therefore, must also be gratuitous; and as such it is viewed by Bichat, who considers the deposition of fat as the effect of exhalation. This, it must be confessed, is little more than a different name for the process termed by Haller *secretion*. Lastly, an opinion has been delivered by Mascagni, that, while the arteries deposit or pour forth an imperfect or crude oily fluid, the lymphatics absorb the thin parts, and leave the residue in a more solid

and perfect form. (A.) In conclusion, all that can be affirmed regarding the formation of this substance is, that it is deposited by the blood-vessels, but by what particular process, or in what form, is entirely unknown. The process by which the arteries of the adipose membrane secrete fat appears to be equally mysterious as that by which the vessels of muscle deposit fibrine, those of bone deposit osseous matter, and those of cartilage form that animal substance.

Section II.

The pathological relations of the adipose tissue have not been distinctly indicated.

1. Is it subject to inflammation? I have already said that certain facts would lead to the inference, that the peculiar phenomena of diffuse inflammation may depend on the influence of the adipose membrane. At present, however, this is little more than conjectural. Meanwhile, it may be remarked, that the adipose cushion with which the blood-vessels are surrounded is sometimes the seat of a bad inflammatory action, terminating in fetid and sloughy suppuration. I have seen also an example of inflammation of the adipose cushion of the kidney, in which the whole of this substance was converted into an ash-coloured, fetid, semifluid pulp, mixed with shreddy filaments, and in which the sloughing process had opened a passage from the fat of the left kidney into the interior of the arch of the colon. An instance of a similar disease of

the renal fat is described in the fourth volume of the Transactions of the College of Physicians, by Dr Thomas Turner.

2. *Hemorrhage.*—Effusion of blood into the adipose tissue is not very common. It is observed in the same circumstances nearly in which it occurs in the filamentous tissue. Thus it has been seen in land and sea scurvy. Huxham observed it in fevers with petechial eruptions. And Cleghorn states that one of the appearances after death in the continuous and malignant tertians of Minorca was extravasation of blood in the form of black patches in the adipose layer of the mesentery, omentum, and colon.

3. *Excessive Deposition.*—In certain subjects, and in peculiar circumstances, the quantity deposited is enormous. The average weight of the human subject at a medium size is about 160 pounds, or between eleven and twelve stones. Yet instances are on record of its attaining by deposition of fat in the adipose membrane the extraordinary weight of 510, and 600 pounds, or from thirty-five to forty stones. Cheyne mentions a case in which the weight was 448 pounds, equal to thirty-two stones. In the Philosophical Transactions are recorded two cases of persons so corpulent, that one weighed 480 pounds, and another 500 pounds. And the Breslau Collections contain cases in which the human body weighed 580 and 600 pounds.

In females and in eunuchs it is more abundant than in males; in females deprived of the ovaries it is more abundant than in those possess-

ed of these organs ; and it is well known that sterility is frequent among the corpulent of both sexes. In some circumstances this accumulation may be so great as to constitute disease, (*Polysarcia adiposa,* Cyrilli, Sauvages, Cullen, and Good ;) and in other circumstances the deposition of fat is a means which the secreting system seems to employ to relieve fulness and tension of the vessels, and if not to cure, at least to obviate morbid states of the circulation. (Parry.) Accumulations of fat are said to take place in some animals in a few hours in certain states of the atmosphere. During a fog of twenty-four hours continuance, thrushes, wheat-ears, ortolans, and red-breasts are reported to become so fat that they are unable to fly from the sportsman. (Bichat.)

4. *Extreme Diminution.*—The diminution or disappearance of fat is much more frequent than its extraordinary abundance. This diminution is said to depend on one or other of the following causes. 1*st,* Long abstinence, as in fasting, and the periodical sleep of dormant animals ; 2*d,* Organic diseases, as consumption, cancer, disease of the liver, of the heart, ulceration of the intestines, &c. ; 3*d,* Purulent collections or secretions ; 4*th,* Leucophlegmatic and dropsical states ; 5*th,* Gloomy and melancholy thoughts or passions ; 6*th,* Long and uninterrupted effort of the intellectual powers ; 7*th,* Preternatural increase of the natural evacuations, as in cholera, diarrhœa, diabetes, &c. mucous discharges, especially from the pulmonary and intestinal membranes, as in chronic catarrh,

inflammation of the intestines and dysentery ; 8*th*, Long and intense heat, whether natural, as during hot summers, or artificial, as in furnaces, hot-houses, &c. ; 9*th*, Running, riding, and every species of fatiguing exercise long continued, as is exemplified in the case of grooms at Newmarket, Doncaster, &c. ; 10*th*, States of long disease not organic; 11*th*, Night-watching and want of sleep in general; 12*th*, Immoderate use of spirituous liquors ; 13*th*, Habit of eating bitter and spiced or acid aliments.

Yet even in these states the fat of the animal body is seldom entirely wasted. In several organic diseases, in which great emaciation takes place, a considerable quantity of fat is always found in the orbits behind the eyeball, round the substance of the heart, around the kidneys, in the colon, and in the mesentery and omentum. * According to the observation of William Hunter, anasarcous dropsy is the only disease in which the fat of the adipose membrane is entirely consumed. "This disorder, when inveterate, has that effect in such

* An instance of this, which occurred within the last few days, may be now mentioned. I had occasion to examine the body of a young gentleman, (3d October 1827,) who had laboured under symptoms of pulmonary disease during the three months previous to his death. Though the left lung was completely occupied with small whitish amorphous masses of tubercular matter of different degrees of consistence, and the right lung in addition to this was in the second stage of pulmonic inflammation, yet a considerable layer of fat was found between the skin and muscles on the chest and belly.

a degree, that we find the heart or mesentery of such subjects as free from fat as in the youngest children." This, however, is in some degree denied by Bichat, who contends that it is not uncommon to find much subcutaneous fat in subjects greatly infiltrated, (Vol. I. p. 57.) It is obvious that much will depend on the stage of the disease. It cannot be expected, that the moment serous infiltration appears in the filamentous tissue, all the fat should be at once removed from the adipose. The process of absorption is gradual as that of deposition ; and the inference of Hunter may be regarded as nearly exact in reference to long-continued, or what he terms inveterate dropsy. It is certain, that, while it is very difficult to deprive the bones of ordinary subjects of oil, those of dropsical subjects are the only ones which it is possible to obtain free from this substance.

The removal of the fat from its containing membrane is effected by the process of absorption, the agents of which are supposed by William Hunter, Portal, Bichat, and Mascagni, to be the lymphatics. According to the results of the experiments of Magendie, Mayer, Tiedemann and Gmelin, Segalas, &c. it must, in some measure at least, be ascribed to the influence of minute veins. It is a point of some interest to know in what form it is absorbed, whether as oily matter, or after undergoing a process of decomposition. The observation of Dr Traill, above quoted, would lead to the former view ; but it is not easy to conceive

that this should be uniform. We want, in short, correct facts on the point at issue.

5. *Adipose Sarcoma.* This consists in an unusual deposition of firm fatty matter in cells, the component fibres of which are sufficiently firm to give it consistence. The tumour, which is generally globular, is always surrounded by a thin capsule formed by the condensation of the contiguous filamentous tissue. The tumour is supplied by a few blood-vessels, which proceed from the capsule, but which form so slender an attachment that they are readily broken, and the tumour is easily scooped from its seat. This sort of tumour occurs almost invariably in the adipose membrane, and seems to consist in a local hypertrophy of the part in which it is found. It may have a broad basis, but is often pendulous, or attached by a narrow neck or stalk. It is the most common form of sarcomatous tumour, and may occur in any part of the body in which there is adipose membrane, but is chiefly found on the front and back of the trunk, and not unfrequently on two places at the same time.

6. *Steatoma.* In adipose sarcoma the adipose matter is deposited in cells, and the tumour derives a degree of firmness from the fibres with which it is thus traversed in every direction. In other instances, however, the adipose matter is deposited in a mass in the cavity of a spherical or spheroidal cyst, formed in the filamentous or the adipose tissue; and the tumour is soft and compressible, and

seems to contain fluid or semifluid matter. When cut open it is found to contain a soft semifluid matter of the consistence of honey, but of oily or adipose properties. In such circumstances the inner surface of the cyst, or at least the vessels of this surface, are the agents which secrete the fatty matter. This tumour may occur either in the filamentous or the adipose tissue ; but is to be regarded as an example of local deposition of adipose matter. It may appear in any region of the filamentous tissue, but is most frequent about that of the head and face. Small steatoms are not unfrequent in the eyelids and in the scalp. Larger ones are more frequent about the neck.

The other forms of encysted tumours, distinguished by the names of *atheroma*, (*αθηρωμα pulticula* ab *αθαρα pultis genus*), and *meliceris* (*μελιχηρις mel* and *cera*, honey wax,) are to be viewed rather as varieties of the steatom than as generically different. The substance contained may differ in consistence, but is nearly the same in essential qualities.

7. *Melanosis.* I have already spoken of the melanotic deposition taking place in the filamentous tissue. The adipose membrane is also a frequent seat of this singular change. The black or melanose matter is found in the subcutaneous adipose membrane and the subjacent cellular tissue of the chest and belly ; it is not uncommon in the fat of the orbit ; it is very commonly seen in the adipose cushion on the fore-part of the vertebral column,

that surrounding the kidneys, and in the fat of the anus and rectum; it is found in the anterior and posterior mediastinum; and it is found between the folds of the mesentery, of the mesocolon, and of the omentum. It is also found in the substance of the marrow of bones; and perhaps in most cases in which the osseous system appears to be stained with the melanose deposite, the dark matter may be traced to the medullary particles, the situation of which it is found accurately to occupy.

In all these situations it appears in various degrees of perfection, and in different forms. It may be disseminated in black or inky spots through the adipose membrane; it may be accumulated in spherical or spheroidal masses of various size and shape; or it may be found in the form of brown or ebon-coloured fluid or semifluid, enclosed in a cyst formed of the contiguous tissue more or less condensed.

The melanose matter is entirely destitute of organization, and is to be regarded as the result of a peculiar secretion. No vessels have been traced into it; and when bodies affected with this deposite are minutely injected, the vessels can be traced no farther than the enveloping cyst. (Breschet.) It is also to be noticed that it is never deposited exactly in the site of organic fibres, but always between them, and very generally in the precise situation of the adipose particles. These several

circumstances show that the melanose disease consists not in a degeneration or conversion into another substance, but in the deposition of a new form of matter in the manner of a secretion.

In what form the melanose substance is first deposited we have few accurate facts to enable us to form a judgment. Laennec is of opinion that it is first deposited in a solid form, and afterwards becomes fluid. The former he considers the stage of crudity, the latter that of softening, (*ramollissement.*) Several facts, however, would lead to the conclusion, that when first deposited it was fluid, and afterwards acquired consistency. Thus, in several dissections performed by Dr Cullen and Mr Carsewell, the matter of the small tumours, which are supposed to be of short duration, were found to be softest, and sometimes as fluid as cream. * In like manner, in a case recorded by M. Chomel, in which the disease was found in the liver in the shape of large cysts, the melanose matter was more fluid in the centre than in the circumference of the cysts. † Upon the whole, if the melanose deposite be as is supposed an inorganic secretion, the idea of its being poured forth from the vessels at first in a fluid or semifluid state is most probable, and most consistent with the usual phenomena and laws of animal processes.

* Transactions of the Medico-Chirurgical Society of Edinburgh, Vol. I. p. 264.

† Nouveau Journal de Medecine, Tome III. p. 41.

CHAPTER IV.

ARTERY, ARTERIAL TISSUE, (*Arteria,—Tissu arteriel.*)

SECTION I.

THE structure of the arteries has been so much the subject of examination at all periods of the history of anatomy, that to mention the authors by whom it has been described would be much the same as to enumerate all the anatomists who have ever written. To omit Galen, and some of those who wrote shortly after the revival of literature, descriptions of the structure of arteries have been given with different degrees of minuteness and accuracy by Willis, Vieussens, Verheyen, Lancisi, Bidloo, the first Monro, Morgagni, Ludwig, Haller, De La Sône, Bichat, Gordon, Magendie, and by Mondini. Yet the descriptions given by these observers are so discordant, that Ludwig complains of the difficulty of reconciling them, and Haller evidently felt it; and with the exception of those given by the four last authors, they do not accord with the characters which this substance actually presents.

The following account is derived principally

from repeated examination of the arteries of the human subject, occasionally compared with those of the more familiar domestic animals.

Every arterial tube greater than one line in diameter is visibly composed of one adventitious and two essential substances. The first, the sheath, reputed to consist of condensed filamentous tissue; the two last, the proper arterial and internal tissues. *(Tunica propria et membrana intima.)*

1. The inner surface of the arterial tube is formed by a very thin semitransparent polished membrane, which is said to extend not only in the one direction over the inner surface of the left ventricle, auricle, and pulmonary veins, but in the other to form the minute vascular terminations which are distributed through the substance of the different organs. This membrane is particularly described by Bichat under the name of *common membrane of the system of red blood*, because he believed it to exist wherever red blood was moving,—in the pulmonary veins, in the left side of the heart, and over the entire arterial system.

The inner membrane may be demonstrated by cutting open or inverting any artery of moderate size, when it may be peeled off in the form of thin slips by the forceps. Or, if the tube be fitted on a glass rod, by removing the layers of the proper membrane in successive portions, the inner one at length comes into view in the form of a thin translucent pellicle, of uniform, homogeneous aspect,

without fibres or other obvious traces of organization. This membrane is supposed to be prolonged to form those minute vessels in which the proper coat cannot be traced. It is very brittle, and is distinguished during life by a remarkable activity in forming the morbid states to which arteries are liable. In other respects it is deemed by Bichat peculiar, and, though similar to the proper membrane, is to be considered as unlike any other tissue. Its chemical composition is not known.

2. Exterior to this *common or inner* membrane is placed a dense strong tissue of considerable thickness, of a dun yellowish colour, which is found to consist of fibres disposed in concentric circles placed contiguous to each other round the axis of the artery. If this substance be examined either from without or in the opposite direction, it will be found that, by proper use of forceps, its fibres can be separated to an indefinite degree of minuteness, even to that of a hair, and that they uniformly separate in the same direction. Longitudinal fibres are visible neither in this nor in any other tissue of the arterial tube. This is the proper arterial tissue, *(tunica propria.)* Its uniform dun yellow colour is perceived through the semitransparent inner membrane, and is most conspicuous either when this is removed, or when the outer cellular envelope is detached and the component threads separated from each other; and if it be less distinct in the smaller branches, it is because the tissue on which the colour depends is

here considerably thinner. In this respect it varies in different regions. Though in general less dense and abundant as the arteries recede from the heart, it is thicker *cæteris paribus* in those of the lower than in those of the upper extremities. In the vertebral and internal carotid arteries, and in those distributed in the substance of the liver, spleen, &c., it is thinner than in vessels of the same size in the muscular interstices.

The nature of this tissue has been the subject of much controversy. It was long believed to be muscular, and to possess the properties of muscular fibre. Bichat showed that the arguments by which this opinion was supported are inconclusive, and that the arterial tissue has very few qualities in common with the muscular. The circumstances from which he derived his proofs were its physical and physiological properties.

The arguments derived from the physical properties of this tissue are chiefly the following. The arterial tissue is close, elastic, fragile, and easily divided by ligature; muscular fibre is more loose in structure, by no means elastic, and, instead of being divided or cut by ligature as artery is, undergoes a sort of strangulation. The action of alcohol, diluted acids, and caloric, by means of hot fluids, which are not corrosive, affords a proof of the chemical difference of these animal substances. All of them produce in the arterial tunic a species of shrivelling or crispation, which seems to depend on more complete coagulation of one of the che-

mical principles; but no similar effect takes place in muscular fibres. According to Berzelius the proper arterial tunic contains no fibrine.* Beclard, however, asserts, that he has ascertained that it contains a portion of this principle; but nevertheless hesitates to consider it as a muscular or fibrinous tissue, and expresses his opinion, that it would be with greater propriety referred to that order of substances which he has named yellow or tawny fibrous system.

The consideration of the physiological or organic properties leads to similar results. Neither mechanical nor chemical agents applied as stimulants produce any change or motion in the living arterial membrane. 1. The arteries of an amputated limb, exposed the moment after amputation, while the muscles are in active motion, do not contract or move when punctured by the scalpel. 2. The experiments of Bikker and Van-den-Bos with the electric spark, and those of Vassalli-Eandi, Giulio, and Rossi, with the galvanic pile, may be considered as disproved by the experiments of Nysten,† who found no contraction in the human aorta after violent death, while the heart and other muscles could still be excited. In performing the same experiment with the artery of the living dog this physiologist was equally disappointed.

* A View of the Progress of Animal Chemistry. By J. J. Berzelius, M. D. &c. &c. London, 1813. Pp. 24. 25.

† Nouvelles Experiences Galvaniques, &c. Par P. H. Nysten, &c. A Paris, An. XI. pp. 235 and 236.

3. The circular contraction of the calibre of an artery, either partially or wholly divided, depends not on irritability, but either on its elasticity, or on that property which it possesses of contracting strongly the instant the distending agent is removed. This power, which was rather happily named by Bichat *contractilité par defaut d'extension*, is quite different from muscular contraction or irritability, and must not be confounded with them; but it depends in a degree not much less on the living state of the body and the individual arterial tube. 4. The contraction said to take place in living arteries after the application of alcohol, acids, or alkalis, is to be ascribed to the chemical *crispation*, and not to stimulant power. It does not relax. 5. These inferences are not inconsistent with the experiments of Thomson, Philips, Hastings, and others, on minute arterial tubes, which may be admitted to possess something like irritability, or rather susceptibility of contraction, without the necessity of supposing the same property in the large branches and trunks. 6. This is so much more probable, as in these minute arteries the proper arterial tunic is either wanting, or is so much thinner and so modified, that it is impossible to conceive its presence capable of affecting the result of experiments made to determine the degree or kind of arterial contraction.

3. The outer surface of the proper arterial tissue is enveloped, as above noticed, in a layer of

dense filamentous or cellular membrane, which is very firmly attached to it, and which was formerly considered as part of the arterial tissue. It is adventitious; a modification of filamentous or cellular texture which establishes a communication between the artery and the contiguous parts, and is necessary to the nutrition and healthy state of the vessel. It incloses and transmits the minute vessels anciently denominated *vasa vasorum, (arteriolæ arteriarum*, Haller;) and if detached even through a trifling extent, the arterial portion thus divided is sure to become dead; to be affected with inflammatory and sloughing action; and ultimately to give way and discharge the contents of the vessel. M. Beclard considers it a fibro-cellular membrane, which may in the larger arteries be divided into two layers, one exterior, similar to the general filamentous tissue; the other inside between the outer layer and the proper tissue, yellowish and firm, but still sufficiently distinct from the proper tunic. In the cerebral arteries it is wanting, and in most parts of the chest and belly its absence is supplied by a portion of pericardium, pleura, or peritonæum. Yet even there a thin layer of fine cellular tissue appears to connect these membranes to the proper tunic. In the extremities the cellular sheath is removed in dissecting arterial preparations.

At different periods several anatomists have maintained the existence of longitudinal fibres in arterial tissue; and even at the present day this

notion is not entirely abandoned. Morgagni was the first who, trusting to mere observation, the only sure guide in anatomical science, doubted the existence of these fibres, and was not ashamed to say he was unable to perceive them. * Upon the same ground Haller would not admit their existence; † and Bichat and Meckel positively deny them. I have repeatedly examined almost every considerable artery of the human body, and I have never been able to recognize any longitudinal fibres either in the middle or proper coat, or in the thin internal membrane, as taught by Willis, Douglas, and De La Sône.

Though arterial tissue does not appear to be very vascular, it is furnished with arteries and veins *(vasa vasorum, arteriolæ arteriarum,)* which do not come from the artery or vein itself, but from the neighbouring vessels. ‡ Thus the aorta at its origin is supplied with minute arteries from the right and left coronary, and in some instances with a proper vessel adjoining to the orifice of the right coronary artery, which Haller regards as a third coronary. The rest of the thoracic aorta derives its vessels from the upper bronchials, from twigs of the internal mammary arteries, from the bronchials, from the œsophageals, and from the

* Adversaria Anatomica, II. p. 78.

† "Verum anatome et microscopium omnino fibros longitudinem sequentes numquam demonstravit, aut mihi, aut aliis, ante me, scriptoribus, quorum auctoritate meam tueor." —Elementa, Lib. ii. sect. 1. sect. 7.

‡ Hunter, IV. p. 131.

phrenics. The abdominal portion is supplied from the spermatics, the lumbar, and in some instances the mesocolic artery. The same arrangement nearly is observed with regard to the veins.

Few textures are more liberally supplied with nerves than arteries are. Almost every considerable trunk or vessel is surrounded with numerous plexiform filaments of nerves, many of which may be traced into the tissue of the artery. The anterior part of the arch of the aorta is abundantly supplied with branches from the superficial cardiac nerves, which Haller was unable to trace beyond the artery. The cœliac, the mesenteric, and the mesocolic arteries are invested with numerous plexiform nervous filaments derived from the large semilunar ganglion of the splanchnic nerve. The renal arteries in like manner are surrounded with numerous twigs of the renal plexus. And each of the intercostal arteries at its origin receives nervous threads from the intercostal nerves. This arrangement, which is observed chiefly in the blood-vessels going to the internal organs, led Bichat to announce it as a general fact, that the arteries derived their nerves almost exclusively from the ganglions, and the gangliar nerves.* The inference does not rest upon strict observation, and evidently owes its birth to the hypothetical opinions of this ingenious physiologist. All the ar-

* "Le grand arbre à sang rouge ou l'arteriel, est presque exclusivement embrassé par la premiere classe des nerves." —Anatomie Generale, Tom. I. p. 302.

teries going to the extremities, the axillary, and iliac, and their branches, receive nerves from the neighbouring nervous trunks, which are formed chiefly from cerebral or spinal nerves, and have no immediate connection with the system of the ganglions. In the internal carotid and the vertebral arteries, and their branches, nerves cannot be distinctly traced.*

Organized in the manner now described, it is requisite to take a short view of the anatomical connections of the arterial system, or to consider it in its origin, its course, and its termination.

The arterial system of the animal body may be viewed as one large trunk divided into several branches, which again are subdivided and ramified to a degree of minuteness which exceeds all calculation. It is requisite therefore to consider the origin, 1*st*, Of the aorta, the large trunk; 2*d*, Of the branches which arise from it; and, 3*dly*, Of the small vessels into which these are divided.

Every one knows that the aorta is connected at its origin with the upper and anterior part of the left ventricle. The manner of this connection has been well examined by Lancisi, by Ludwig, and particularly by Bichat. It may be demonstrated by dissection, but is much more distinctly shown by boiling the heart with the blood-vessels attached. In a heart so treated the thin internal membrane may be traced passing from the interior of

* H. A. Wrisberg De Nervis Arterias Venasque comitantibus, Tome III.

the ventricle along the margin of its orifice to the inside of the arterial tube. Exactly at the point of union it is doubled into three semicircular folds, forming semilunar valves, and thence is continued along the whole course of the artery. This membrane is entirely distinct from the proper or fibrous coat. Of the latter, the cardiac extremity or beginning is notched into three semicircular sections, each of which corresponds to the base or attached margin of a semilunar valve. These sections are attached to the aortic orifice of the ventricle by delicate filamentous tissue, but are not connected with the fleshy fibres of the heart; and at the angle or point of attachment, the thin inner membrane is folded in so as to fill up a space or interval which is left between the margin of the orifice and the circumference of the proper arterial tissue, where it is notched or trisected.

The aorta is soon divided into branches, which again are subdivided into small vessels. With the mathematical physiologists it was a favourite problem to ascertain the number of branches into which any vessel might be subdivided. Keill made them from forty to fifty. Haller states, that, counting the minutest ramifications, he has found scarcely twenty. The inquiry is vain and useless, and cannot be subjected to accurate calculation. In no two subjects is the same artery found to be subdivided the same number of times; and in no two subjects are the very same branches found to arise from the same trunk.

A branch issuing from a trunk generally forms with it a particular angle. Most generally, perhaps, these angles are acute ; but in particular situations they approach nearly to a right angle. Thus the *innominata*, left carotid and left subclavian issue from the arch of the aorta nearly at a right angle, at least to the tangent of the arch. The intercostals form a right angle with the thoracic aorta ; the renal and lumbar arteries form a large acute angle, approaching to right with the abdominal ; and the cœliac comes off nearly in the same manner from the anterior part of the vessel. The internal and external carotids, again, the external and internal iliacs, the branches of the humeral, and those of the femoral, form angles more or less acute with each other. The angle which the spermatics make is, generally speaking, the most acute in the arterial system.

I have already alluded to the structure of the arterial tissue at the divarications. These changes relate both to the inner and to the proper membrane. In the inside of the vessel the inner membrane is folded somewhat so as to form a prominent or elevated point, the disposition of which varies according to the angle of divarication. 1*st*, When this is rectangular, the prominence of the inner membrane is circular, and is equally distinct all round. 2*d*, When the angle is obtuse, as in the mesenteric artery, the prominence is distinct, and resembles a semicircular ridge, between the continuation of the trunk and the branch given off,

but indistinct on the opposite side where the angle is obtuse. *3d*, If the angle is acute, and that formed by the branch with the continuation of the trunk is obtuse, the beginning of the artery presents an oblique circle, the elevated half of which is near the heart, the other more remote.

The arrangement of the fibres of the proper tissue is described by Ludwig from the divarication of the iliac arteries, and may be seen in any part of the arterial system where the vessels are large. The circular fibres separating form on each side a half ring, from which is produced a complete ring which incloses the smaller rings formed by the circular fibres of the vessel given off. These circular fibres proceed to the prominence of the internal membrane already described, and are arranged round it much in the same manner in which those of the large vessel surround its inner membrane. In this, however, no continuity between the rings of the large vessel and those of the small one can be recognized. The latter are inserted as it were into the former, and they are connected by the continuity of the inner membrane only.

In observing the course or transit of arterial tubes, the principal point deserving notice is the sheltered situation which they generally occupy, their tortuous course, and their mutual communications. In the extremities they are always found towards the interior or least exposed part of the limb, generally deep between muscles, and sometimes lying along bones. When they are minute-

ly subdivided, they enter into the interior of organs, without, however, sinking at once into their intimate substance. In the muscles they are lodged between the fibres; in the brain in the convolutions; in glands between their component lobes. In such situations they are generally observed to be more or less tortuous in the course which they follow. On the reasons of this much difference of opinion still prevails. (Bichat and Magendie.)

In the course of the arteries, no circumstance is of greater moment than their mutual communications or inosculations, (*anastomoses.*) Of this there may be two forms, the first when two equal trunks unite, the second when a large vessel unites with a smaller one. Of the first, three varieties have been mentioned. 1*st*, Two equal trunks may unite at an acute angle to form one vessel. Thus, in the fœtus, the *ductus arteriosus* and the aorta are conjoined; and the two vertebral arteries unite to form the basilar trunk. 2*d*, Two trunks may communicate by a transverse branch, as the two anterior cerebral arteries do in forming the anterior segment of the circle of Willis. 3*d*, Two trunks may, by mutual union, form an arch, from the convexity of which the minute vessels arise, as is seen in the branches of the mesenteric arteries.

The second mode of inosculation is frequent in the extremities, especially round the joints. The multiplied communications of the arterial system in these regions, though well known to anatomists, and enumerated by Haller, were first clearly and

systematically explained by Scarpa, and afterwards by Cooper and Hodgson. The importance of this arrangement in facilitating the motions of the circulation, in obviating the effects of local impediment in any vessel or set of vessels, and in enabling the surgeon to tie an arterial trunk when wounded, affected with aneurism or any other disease, has been clearly established by these authors. Their researches have shown that there is not a single vessel which may not be tied with full confidence in the powers of the collateral circulation. Even the aorta has been found obstructed in the human subject; (Graham,) and a ligature has been put on its abdominal portion. (Cooper.)

To ascertain the several modes in which arteries terminate has been a problem of much interest to the physiologist, and of no small difficulty to the anatomist. The alleged terminations as believed to be established, are minutely and elaborately enumerated by Haller, who, however, multiplied them too much according to the modern acceptation of the term.

1. The first undoubted termination of arteries is immediately in veins. It is unnecessary to adduce in support of this fact the long list of observers enumerated by Haller. It is sufficient to say that it was clearly established by the microscopical observations of Leuwenhoeck, Cowper, and Baker, by Haller himself, and by Spallanzani in his beautiful experiments on the circulation of the blood.

2. The second termination which may be mentioned here is that into the colourless artery, *(arteria non rubra.)* This is sufficiently well established by the phenomena of injections.

3. A third termination which is supposed to exist, but of which no sensible proofs can be given, is that into colourless vessels supposed to open by minute orifices on various membranous surfaces, and therefore termed exhalants. The nature of these vessels shall be considered afterwards.

Haller admits a termination in, or communication with lymphatic vessels, but allows that it is highly problematical. Partial communications have been traced between arteries and lymphatics by several anatomists; but the point requires to be again submitted to accurate researches.

Another mode of termination, that namely into excreting ducts, admitted by Haller, scarcely requires particular mention. So far as an artery can be said to terminate in such a manner, it would come under the head of that into exhalant vessels. Many of the proofs mentioned by Haller, however, may be shown to be examples of a morbid state of the mucous membranes of these ducts, in which their capillary vessels are disorganized.

In considering the several terminations of arteries, it is not unimportant to advert to the distribution of these vessels. Injections show that they penetrate into every texture and organ of the animal body, excepting one or two substances in

which they have never yet been traced. But in different textures they are found in different degrees; and they may vary in extent even in the same texture in two different conditions. The parts which receive the largest and most numerous vascular ramifications are the brain and spinal chord, the glandular organs, the muscles, voluntary and involuntary, the mucous membranes, and the skin. In bones, on the contrary, in the fibrous membranes, and their modifications, tendons, and ligaments, and in the serous membranes few arteries are seen to penetrate; and these are generally minute, sometimes only colourless capillaries. There are some textures in which arteries cannot be traced, though their properties indicate that they must receive vessels of some kind. Such are cartilage, and the arachnoid membrane. (Ruysch and Haller.) Lastly, arteries are not found in the scarf-skin, in nails, the enamel of the teeth, the hair, nor in the membranes of the umbilical chord. In early life bones are much more vascular than in adult age; and in the bones of young subjects arteries may be traced going out through the epiphyses into the cartilages, in which they cannot at a later period of life be demonstrated. *

Section II.

The morbid states of arteries belong either to

* Hunter in Philosophical Transactions, No. 470.

the inner membrane, or to the proper arterial tissue, or to both.

1. *Adhesive Inflammation.* The inner membrane is liable to inflammation, terminating generally in effusion of lymph, adhesion of the sides, and obliteration of the canal of the tube. This process takes place in all circumstances in which the corresponding surfaces of the vessel are mutually applied, while the current of blood through the vessel is interrupted. The pressure of a tourniquet, or any mechanical object moderately firm; the pressure of a tumour, or of an aneurism in some instances; the application of a ligature not so tight as to divide the coats; and in the case of small vessels, the spontaneous retraction and collapse of its sides after complete division by a cutting instrument, are conditions which have been followed by adhesion and obliteration of the canal. On the knowledge of this property depends the practice of tying arterial tubes in wounds, and in the cure of aneurism.

Inflammation of the internal arterial membrane may also take place spontaneously, or independent of mechanical causes. Thus the inner membrane of the aorta may be inflamed in persons labouring under general or severe inflammation of the thoracic viscera. (Portal, Hodgson.) The anatomical characters are deep red colour of the membrane, and more or less effusion of lymph in the cavity of the vessel.

If the individual survives such a disease, the

lymph thus effused becomes penetrated with blood-vessels, and forms a new body adhering to the inner surface of the vessel. This is the origin of several of the granulated bodies, fungous growths, or vegetations, which have been described by Senac, Morgagni, Portal, Baillie, Corvisart, Burns, and Bertin, as often found at the origin of the aorta, attached to the semilunar valves, or even in the mitral valve, the structure of which is not dissimilar.

A red or crimson staining of the inner membrane, especially in the aorta, has been mentioned by Corvisart, Frank, Hodgson, and Laennec, and may be often seen in persons who have died without symptoms of pectoral or arterial disorder. Its nature is not well known. It seems to be the effect of a dying or tinging property of the blood, either during the last moments of life, or after the heart has ceased to beat. It must not be confounded with inflammation or its effects.

2. *Chronic Inflammation.* In persons who have long laboured under the constitutional effects of the syphilitic poison, or who have been repeatedly and permanently under the influence of mercury, especially in cold and variable climates, the arterial tissue is not unfrequently affected by a slow insidious process of inflammation. It is not easy to determine to what extent this may affect the inner membrane exclusively; for probably both suffer at the same time, and from the same causes; but the effects of the process differ in the

two tissues. In the inner membrane chronic inflammation may cause partial effusion of lymph, which becoming organized gives rise, as already mentioned, to the fungous growths and vegetations. It may render the membrane opaque and thick, and give it a shrivelled puckered appearance. It may cause a tubercular thickening either of the membrane or of the semilunar valves. It may induce gristly induration especially in these and in the mitral valve. (C.) Or, lastly, there is reason to believe it is often the agent of the process next to be considered,—calcareous deposition.

3. *Ossification, Earthy Degeneration of* Scarpa; *Calcareous Deposition.* It has been long known that arteries are liable to deposition of calcareous matter. By De La Sone it was first remarked that this process takes place in the inner membrane only;* and Bichat afterwards referred it to the outer or attached surface of the membrane, an opinion in which he is supported by the testimony of Meckel, Scarpa, Hodgson, and others. Scarpa only admits as a possible alternative its deposition in the interval between the inner and proper coat in the delicate tissue termed *second cellular* by Haller.† By Jourdan and Breschet, however, the translators of the work of Meckel, who contend that the internal membrane is never ossified, it is positively stated that the calcareous matter is accu-

* Memoires de l'Academie Royale, 1756. p. 199, 12mo.

† Sull Aneurisma, Capitolo v. § 22.

mulated in the cellular tissue connecting the inner to the proper coat. It is perhaps of no great moment to dispute this point; but I shall mention three facts, which show that the statement of MM. Jourdan and Breschet must be admitted with caution. 1*st*, There is no cellular tissue between the two membranes,* and the inner adheres simply to the proper coat. This is established, notwithstanding the authority of Haller, by dissection, and by observing the effects of maceration and boiling. 2*dly*, Calcareous deposition is observed to take place at the semilunar valves, which consist of two folds of inner membrane, when it is found in no other part of the aorta. 3*dly*, Admitting, for the sake of argument, that cellular tissue is placed between the inner coat and the proper arterial tissue, if calcareous matter be deposited in it, it is not analogous to what is observed in this tissue elsewhere. Without relying much, however, on these facts, I shall state the ordinary mode in which the deposition appears, independent of any opinion as to its precise source.

The calcareous incrustation commences invariably at the outer surface of the inner membrane in the form of minute gritty points, or of small isolated patches. In the former state they appear to be hard and crystalline, and render the inside of

* "La surface externe, foiblement unie à l'autre membrane, comme nous l'avons vu, n'a point un intermediare cellulaire."—Bichat, Tome I. p. 291.

the vessel rough; in the latter they are simply firm, and are less earthy or gritty, and without forming asperities in the inside of the vessel, may make it merely firm and unyielding, and deprive it of its elasticity. In either case, these calcareous deposites, confined more or less to one side, may spread along the tube for a considerable extent. They seldom affect the whole circumference of an artery unless in the lower extremities, in which they have been observed to form distinct rings, connected by intermediate portions of sound artery. (Hodgson.)

When the deposition is partial and limited, and of short duration, it is still covered by the inner membrane; and the inside of the vessel, though irregular, is comparatively smooth. When the patches multiply and enlarge so as to coalesce, the inner membrane gives way at one or more points of the margin of the calcareous deposite, which now adheres only to the surface of the proper membrane; and an irregular ragged circumference is exposed. If the artery contains many patches, its entire inner surface presents a series of asperities resulting from the rupture of the thin pellicle of inner membrane with which they were at first covered. Yet these calcareous patches are not known to be detached entirely.

Scarpa represents this morbid change as taking place something differently. But I shall afterwards show that this arises from confounding the calcareous with the steatomatous deposition, a

change different in several respects. This deposition may take place in any part of the arterial system; and it is said to be equally common in branches as in trunks. It may occur in the radial artery, in the temporal, or in the tibial. By Cowper and Naish it was found in the arteries of the leg in the course of amputation. * I have seen it in the radial and ulnar in tying the vessels of an amputated fore-arm; and in the femoral and several of the perforating branches of the thigh under the same circumstances. It is, however, most commonly found in the arch of the aorta, or in some of the branches which issue from it. Many cases of its occurrence in the coronary arteries have been recorded. (Crell, Erdmann, Frank, and Parry.) Nor is it confined to the arterial tubes only; for it is seen in that part of the pellucid arterial membrane which forms the valves, and lines the inside of the left ventricle, and is frequently found to take place in the semilunar and mitral valves. (D.)

The nature of this deposition has given rise to various speculations. But this variance has partly arisen from the practice of confounding it with the steatomatous deposition. It is said to differ from osseous matter in two circumstances. *First*, The deposition is earthy from the first, without any previous matrix of animal matter. *Secondly*, It is destitute of the usual fibrous struc-

* Philosophical Transactions, No. 285, p. 1391, and No. 369, p. 226.

ture, and presents an irregular but homogeneous crust without any obvious arrangement. It consists, however, of the usual combination of animal matter and bone-earth. A specimen analyzed by Mr Brande gave 65.5 parts of phosphate of lime, and 34.5 of animal matter in the 100 parts. The latter was chiefly albumen, with traces of gelatine.

Calcareous deposition may take place at any period of life, but is supposed to be most common in advanced age. Portal, Scarpa, and Hodgson, mention instances of its occurrence in young subjects. According to Stevens, it is more common to find the arteries ossified than healthy after the 30th year. * But this statement is probably delivered in too general terms, and from too limited a collection of cases. Baillie restricts its occurrence as a general phenomenon to the period after the 60th year; † and this corresponds with the inference of Bichat, who states, that in ten subjects seven at least present these incrustations after the 60th year. ‡ Its influence on the circulation varies at different periods of life, and according to its extent and situation. In the aged it is said to produce much less inconvenience than in the young and adult. (Bichat.) It is certain that in the latter it almost invariably causes fatal disease of the heart or arteries, or of both.

* Medico-Chirurgical Transactions, Vol. V. p. 433.

† Transactions of a Society for the Improvement, &c. Vol. I. p. 133.

‡ Anatomie Generale, Vol. II. p. 292.

The most ordinary effect of calcareous incrustation, when extensive, is to induce chronic inflammation and ulceration of the arterial tissue. The earthy matter operates as a foreign body, and by constant irritation destroys the vitality of the inner membrane, which exfoliates, and inflames the proper tissue, which is then eroded. In this state the occasional application of a slight force may be followed by more or less laceration of the proper coat. In arteries covered by a filamentous sheath, the blood thus discharged is injected into the sheath, which is then distended into a spherical sac situate more or less on one side of the vessel. This forms the disease described as true aneurism by Scarpa. In arteries not supplied with filamentous sheath, as in the brain, the blood escapes freely, and may by its quantity induce fatal compression of that organ. (Blane, Hodgson, Bouillaud, and Serres.)

The calcareous deposition renders the arterial tube so brittle, that the application of a ligature invariably cracks it, prevents the usual process of adhesion, and is generally succeeded by ulceration and hemorrhage. In persons advanced in life calcareous deposition in the arteries of the lower extremities is a cause not unfrequent of mortification of the toes, feet, and legs, generally terminating fatally. (Cowper, Naish, and Pott.)

4. *Atheromatous Deposition.* This term has been applied to a semifluid or cheesy opaque substance, which is not unfrequently found between the in-

ner and proper tunics of arteries. Its consistence may vary from that of purulent matter to the tenacity of curd, or the granular firmness of cheese. Observed by the first Monro, by Haller, and others, it appears to be considered by Scarpa as a variety of the same change which I am afterwards to mention as steatomatous deposition. From this certain circumstances show that it ought to be distinguished. 1*st* Atheromatous deposition appears to arise from a sort of suppuration; for, in general, it is possible to trace the transition from purulent fluid to the concrete matter of atheroma. 2*d*, This account of its origin derives strong confirmation from the fact, that it almost always contains a patch or patches of calcareous matter in its centre. 3*dly*, It is associated much more frequently with the calcareous than with the steatomatous deposite. It is for these reasons not unlikely that the atheromatous deposition is to be viewed as one of the effects of chronic inflammation, either in the inner or the proper tunic, or in both.

5. *Steatomatous Deposition*, either alone, or with calcareous patches, is often found between the inner surface of the proper membrane, and the outer surface of the internal one. Whether these deposites invariably derive their origin from the former or from the latter of these tissues, is not easy to say. In many instances they appear to be produced rather by the proper arterial tunic.

They occur in various forms; but two may be particularly mentioned.

In the first, small irregular patches of yellowish or fawn-coloured matter like wax appear on the inner surface of the proper coat. As the process of deposition advances, these become thicker and broader. They coalesce, and sensibly raise the outer filamentous coat; while, by their prominence interiorly, they diminish the capacity of the arterial tube. At the same time the inner membrane becomes irregular, opaque, and shrivelled; and the connection with the proper tunic being destroyed, it is detached with great facility. *

This deposition constitutes the *steatomatous degeneration* of Professor Scarpa and other authors. The name is not well chosen, for the substance deposited is not adipose, but rather like crude bees-wax. It was applied, however, by Stentzel, † the original writer on this subject, and it is unnecessary to change it, when its exact import is understood. Though it may occur probably in any part of the arterial tubes, it takes place most frequently at the bifurcations of the arteries. It invariably commences in this particular spot of the vessel; and when it occupies any extent of the tube, it will be found to

* Morgagni Epist. XXIII. Art. iv. vi. XLV. Art. xxiii. &c.

† Christiani God. Stentzel de Steatomatibus Aortæ. Haller Disput. ad Morborum Historiam, &c. Tomo II. p. 527. Art. lxv.

have begun at the bifurcation, and spread thence along the vessel. Thus I have seen this deposition confined to the point common to the common carotid, and its external and internal branches, and this in both sides in the same subject. I have seen it in another person at the same part of the carotids, and at the point common to the internal carotid and the sylvian artery. Lastly, in another instance I have found it affecting at once in the same subject the arch of the aorta, where it gives off the *innominata* and left subclavian artery; the descending aorta, where it gives off the cœliac and superior mesenteric, including the beginning of these vessels; and the cœliac, when it divides into its gastric, hepatic, and splenic branches.

In describing this morbid state of arteries, Professor Scarpa, I conceive, confounds it with ossification. After noticing the loss of fine polish *(l'intima tonaca dell' arteria perde per certo tratto suo bel liscio,)* which the inner arterial membrane sustains, he represents it as becoming irregular and wrinkled, and successively occupied with yellow spots, which are converted into so many earthy grains or scales, or into steatomatous and caseous concretions. I think they may be justly distinguished, because the calcareous deposite very often exists without the steatomatous; and conversely, the steatomatous may be found without the calcareous deposition. I must not omit to mention, nevertheless, that the circum-

stance which seems to have led Scarpa to consider these depositions as the same, is, that sometimes in the centre of a steatomatous patch is found a broad scale of hard substance, not so firm as bone, and not so crystalline or gritty as the genuine calcareous deposition. It is generally so soft as to be flexible, and resembles rather a firm piece of cartilage than true bone.

Scarpa represents the steatomatous state as proceeding invariably to ulceration. This, however, is not a uniform result. A large portion of an artery may be affected with it without suffering the smallest breach of continuity or destruction of tissue. It simply distends the vessel mechanically; and if unaccompanied with calcareous deposition, this distension may be considerable without any ulceration or laceration. In this manner probably are produced those simple dilatations of arteries which by many of the French authors are regarded as aneurism. In other instances, more especially when the steatomatous is combined with the calcareous deposition, or when the arterial tunics have been long and much distended, ulceration may take place and terminate in partial or entire destruction and rupture of the arterial tunics. In general, this destruction takes place in the transverse direction, (Hodgson,) and the laceration or fissure is therefore across the tube.

In such circumstances, if the aperture is not large enough to cause fatal hemorrhage, aneurism first by dilatation, and ultimately by rupture, is the consequence.

Aneurism. On the nature of the aneurismal tumour some difference of opinion has prevailed. Since it has been the custom to settle points of pathology by reference to dissection, three opinions have been successively entertained. *First*, It was maintained by Elsner, Severinus, Hildanus, Sennert, and others, that aneurism was produced by rupture of the proper coats of the artery. The second opinion, which is that of Fernel, Forestus, Diemerbroek, &c. is that it consists in uniform dilatation of the arterial tunics. *Thirdly*, From the cases recorded by Lancisi, Friend, Guattani, Morgagni, and especially those described by Donald Monro,* it results that aneurism may arise either from rupture or from dilatation of the arterial tissues, or from both causes jointly.

The first doctrine has been revived and strenuously and ingeniously defended by Scarpa, who infers that aneurism never consists in dilatation, but invariably arises from erosion and laceration of the proper coats, and injection of arterial blood into the filamentous or membranous sheath with which the vessel is invested. By Hodgson, again, this doctrine has been successfully combated, and the third opinion shown to be most consonant with the process of aneurismal disease. The result of his inquiries may be stated in the following manner. 1*st*, In many aneurisms the first step is destruction and partial laceration of the internal and proper coats of the artery; and when the blood escapes from its cavity it dis-

* Essays and Observations Phys. and Lit. Vol. III. Art. xii.

tends the filamentous or membranous sheath into a cyst or sac, between which and the tunics it is found in successive layers. *2dly*, In several aneurisms the first step of the process is mere dilatation of the arterial tunics, either partial or general. When this has proceeded to a certain extent, varying in different cases, the arterial tissues give way, and the same process of hemorrhage and coagulation in successive layers results.

It appears, therefore, that in every case of aneurism there is eventually laceration. The only difference is in the mode of origin, which in some is rupture, and in others mere dilatation. * In its final result an aneurismal sac bursts in one of two modes. 1*st*, When it bursts into the cavity of any of the serous membranes, as the pleura, pericardium, or peritonæum, the breach is formed by laceration. 2*d*, When it bursts through the skin or into cavities lined by a mucous membrane the breach is the effect of sloughing and ulceration.

Certain divisions of the arterial system are evidently more liable than others to aneurism; and in general the comparative liability may be traced to the greater or less susceptibility of disease of the tunics, and the situation of the vessel in being exposed to frequent or extensive motion. Hence aneurisms are *cæteris paribus* more frequently observed at the flexures of joints than elsewhere. Aneurisms are also more frequent in men than in women. The following table by Mr Hodgson ex-

* Hodgson on the Diseases of Arteries and Veins, p. 74.

hibits the comparative frequency of true aneurisms in different arteries, and in the two sexes, in sixty-three cases in which that gentleman either saw the patients during life, or examined the parts after death.

	Males.	Females.	Total.
Of the ascending aorta, the arteria innominata, and the arch of the aorta, - -	16	5	21
descending aorta, -	7	1	8
carotid artery, - -	2		2
subclavian and axillary arteries,	5		5
inguinal artery, - -	12		12
femoral and popliteal artery,	14	1	15
	56	7	63

Wounds and their consequences. An artery may be punctured, perforated, cut longitudinally, divided partially or entirely across, or torn completely asunder.

In the first three cases the blood which escapes is injected into the filamentous sheath, and coagulating, prevents further effusion from the vessel. In a few hours the edges of the wound inflame, and, pouring out lymph, are united by adhesion. In the case of small wounds, especially longitudinal, this union may be effected without obliteration of the canal. But when the wound is large or oblique, if the inflammation is sufficient to effect union and prevent further hemorrhage, so much lymph is effused, that in general, with the pressure and rest requisite, the opposite sides of the vessel adhere, and its canal is for some space obliterated. (Jones, Hodgson.)

In most cases, however, of longitudinal or oblique wounds, and in all cases of partial transverse wounds, the process is different. Supposing the external opening to be closed, which it sooner or later is, the blood from the wounded artery is extensively injected into the sheath, where its coagulation prevents as before further effusion. Though inflammation takes place, however, and lymph is effused, it is insufficient to unite permanently the divided edges. Either the wound is never thoroughly united, or at a period after its infliction, varying according to its extent and direction, and according to the size of the artery and its distance from the heart, its edges are rent asunder by the incessant impulse. (Jones, Hodgson, Guthrie.) Blood continues from time to time to escape into the sheath, which it distends into a sac, and in which it is deposited in successive layers. In this manner is formed a pulsating tumour, which has been termed false, spurious, or *bastard aneurism.* (Monro *Primus.*) If the injection is extensive, so as to cause a diffuse swelling, spreading to some distance along the limb, the disease is termed *diffuse aneurism.* If it is more limited, distends the sheath into a globular sac, and assumes the appearance of the usual aneurismal tumour, then it is termed *circumscribed aneurism.* This is the sort of aneurism which takes place when the brachial artery is opened, instead of the vein at the bend of the arm; (William Cowper, Macgill, Monro *Primus*, &c.) and it is not uncom-

mon in the temporal artery when that vessel has been opened to discharge blood for affections of the head. It may, however, succeed punctured wounds, especially sword-thrusts in any part of the body. In short, every cause which partially wounds or injures the side of an artery, as a sharp *spicula* of bone, may be followed by false aneurism. At the bend of the arm it is to be distinguished from aneurismal varix and varicose aneurism.

When an artery is entirely divided across, the result varies according to the size of the vessel. The moment the division is completed, a copious gush of blood issues from the vessel, the divided portions mutually recede with more or less force, and the walls of the vessel collapse so as to contract its area uniformly from the circumference to the centre. Of the two latter actions the former is limited by the attachment of the proper arterial tissue to the filamentous sheath. But notwithstanding this limitation, so forcible is the retraction, as it is termed, that the connecting fibres of the filamentous sheath are always rent for some small space from the cut ends of the tube. The annular contraction, or central diminution of the area, is also counteracted by the longitudinal impulse of the blood; and in large vessels this resistance to the central contraction is so great, that the latter has little or no sensible influence in suppressing hemorrhage. In such circumstances the chief agents of this process are the pressure of coagu-

lated blood effused into the sheath, *(coagulum externum,)* and a conical or cylindrical plug of the same material *(coagulum internum,)* within the mouth of the divided vessel. * When by the formation of this double clot a temporary check to the transit of blood is given, inflammation and lymphy exudation from the divided edges tend to supply the means of permanent suppression. When this fails false aneurism is the consequence.

In the case of small vessels the annular contraction bears a larger proportion *cæteris paribus* to the size of the vessel; and it exercises a greater influence in arresting the current of blood through the divided orifice. With the pressure of the external and internal clots, and the recession of the divided portions, this annular contraction is in general amply sufficient to stop permanently the effusion of blood from small vessels. Hence in partial wounds of such vessels as the radial, the ulnar, and the temporal arteries, the entire division of the vessel is often the most effectual means of checking the flow of blood from them. In amputation also, in which the arteries are divided transversely, the smaller vessels may be left untied without danger.

* "The mouth of the artery being no longer pervious, nor a collateral branch very near it, the blood just within it is at rest, coagulates, and forms in general a slender conical coagulum, which neither fills up the canal of the artery, nor adheres to its sides, except by a small portion of the circumference of its base, which lies near the extremity of the vessel."—Jones on Hemorrhage, Chap. I. sect. iii. p. 53.

The principle now laid down Dr L. Koch of Munich has attempted to carry to a much greater length. Denying that hemorrhage, from arteries entirely divided, is suppressed in the manner now mentioned, denying especially the formation of the double clot as a uniform result of transverse division, he has recourse to the supposition of a peculiar force and action to account for the cessation of hemorrhage. He denies the necessity of ligature in any case, and proposes to leave large as well as small vessels untied. His arguments are manifestly derived from the phenomena of the division of small arteries only, and cannot therefore be justly applied to large ones. I have already shown, that in the case of the former the annular contraction is the main agent of the cessation of hemorrhage; and to this, I conceive, corresponds the peculiar force to which Dr Koch ascribes that process. *

When an artery is lacerated or forcibly rent asunder, the same process of injection, coagulation, retraction, and annular constriction take place, but more powerfully and more speedily than in the case of the same artery divided transversely by a cutting instrument. The external clot especially is formed very rapidly; the internal one is large and extensive; and the annular contraction of the lacerated vessel is much more considerable. (Guthrie and others.) These circumstances afford an ex-

* Journal für Chirurgie und Augenheilkunde von Graefe und Walther, P. 9, t. 560.

planation of the well established fact, that any artery, when forcibly rent asunder, bleeds infinitely less than the same vessel completely divided by a transverse incision. So uniform is this fact, that arteries of moderate size have been torn by a transverse laceration without effusing more than a few drops of blood.

Aneurismal Varix. It sometimes happens that an artery subjacent to, and in immediate contact with a vein is punctured by the same instrument with which the vein has been perforated, and the wound thus inflicted establishes between the two vessels a communication through which the blood passes from the one to the other. Thus, from want of caution on the part of the operator, it may happen that in venesection at the bend of the arm the lancet may not only transfix the vein, but wound the subjacent artery. The blood flows from the latter into the former with a peculiar hissing noise, and dilates it into a sac which disappears on pressure, but returns when the pressure is removed. The tumour thus formed, which depends on the wound of the arterial and venous tunic remaining open while their sides are in contact, was first distinguished as a peculiar affection by William Hunter,* and is known under the name of *aneurismal varix.* It may occur in any part of the vascular system in which a vein lies immediately over an arterial trunk. In most of the cases hitherto re-

* Medical Observations and Inquiries, Vol. II. p. 396, 400.

corded it has continued for years (five, Hunter, Cleghorn; fourteen, Hunter, Scarpa, Bell; twenty-five, thirty-five, Bell, Hunter;) without serious inconvenience.

Varicose Aneurism. In the case of an artery lying beneath, but not in immediate contact with a vein, or in the case of the wound being oblique and the puncture of the vein not corresponding to that of the artery, the same accident is followed with another variety of tumour. The blood from the arterial tube flows partly into the sheath, which is distended into a sac, and partly into the vein, which is morbidly dilated. The tumour thus resulting, the anatomical characters of which are a circumscribed aneurism between the artery and vein, and a varicose state of the latter, has been distinguished as *varicose aneurism.**

The filamentous sheath, though not proper to the arterial tissue, performs, nevertheless, an important part in the morbid states of arteries, whether spontaneous or resulting from injuries. It has been already shown what is its influence in the production of genuine aneurism, in the suppression of hemorrhage, and in the formation of the several varieties of false or spurious aneurismal tumours. It is liable further to the same forms of inflammatory action as attack this tissue in other parts of the animal frame. But inflammation here is often attended with the bad effect

* Park in Medical Facts and Observations, Vol. IV. p. 111. Physick in Medical Museum Philadelphia, Vol. I. p. 65.

of producing ulceration of the middle coat, and laceration succeeded by hemorrhage more or less violent, according to the size of the vessel. This process, which depends on the destruction of the nutrient vessels *(vasa vasorum)* transmitted in the filamentous coat, may succeed any injury inflicted on the neighbouring parts, as contused wounds, burns, phagedenic sores, especially those in lymphatic glands, the application of improper ligatures, especially broad tapes, and the use of foreign bodies as pads, *presse-arteres* and *serre-arteres* in the neighbourhood of an artery. Removal of the filamentous sheath, partly or entirely, is not unfrequently followed with the same effect. This, however, must be understood to apply chiefly to the human subject. In the lower animals the filamentous sheath may be removed without injuring the proper and inner membrane. (Hunter and Home.)* This shows that in these circumstances its inflammation is not attended with the bad effects which result in the human subject.

Arteries may be involved in the diseases of muscles, bones, and other parts, and in the progressive invasion of foreign or new productions.

* Transactions of a Society for improving Medical and Chirurgical Knowledge, Vol. I. p. 144.

CHAPTER V.

VEIN, VENOUS TISSUE, Φλεψ. *(Vena—Tissu veneux.)*

SECTION I.

THE structure of the tubular canals, termed veins, has been much less examined by anatomists than that of the arteries. Some incidental observations in the writings of Willis, Glass, and Clifton Wintringham, comprise all that was published regarding them previous to the short account of Haller. Since that time they have been described with various degrees of minuteness and accuracy by John Hunter, Bichat, Magendie, Gordon, Marx,* and Meckel. In the following account the facts collected by these observers have been compared with the appearance and visible organization presented by veins in different parts of the human body.

The veins are membranous tubes extending between the right side or pulmonary division of the heart and the different organs in which their minute branches are ramified.

Every venous tube greater than one line in diameter consists of three kinds of distinct substance.

* Diatribe Anatomico-physiologica de structurâ atque vita venarum. Caroliruhæ, 1819.

The outermost is a modification of the filamentous tissue, *(membrana cellulosa,)* and though less compact, and less thick than the arterial filamentous envelope, is in every other respect quite similar, and is in general intimately connected with it. The innermost *(membrana intima)* is a smooth, very thin membrane. Between these is found a tunic somewhat thicker, which is termed the *proper venous tissue, (tunica propria venæ.)* The structure and aspect of this proper membrane shall be first considered.

1*st*, When the loose filamentous tissue in which the blood-vessels are inclosed, and the more delicate and firm layer immediately contiguous to the veins, are removed, the observer recognizes a red or brown-coloured membrane, not thick or strong, but somewhat tough, which is the outer surface of the proper venous tunic. If dissected clean, it is tolerably smooth ; but however much so it can be made, a glass of moderate powers, or even a good eye, will perceive numerous filaments adhering to it, which appear to be the residue of the cellular envelope.

According to Bichat parallel longitudinal fibres, forming a very thin layer, may be distinguished in the larger veins ; but he admits, although they are quite real, that they are always difficult to be seen at the first glance. In the trunk of the inferior great vein, *(vena cava inferior,)* they are always seen, he observes, more distinctly than in that of the superior ; and they are always more

obvious in the divisions of the former than in those of the latter vessel, and also in the superficial than in the deep-seated veins. These longitudinal fibres, he asserts, are more distinct in the saphena than in the crural vein, which accompanies the artery. Lastly, he remarks, these fibres are proportionally more conspicuous in branches than in trunks. *

Notwithstanding the apparent correctness of this description, Magendie informs us, he has sought in vain for the fibres of the proper venous membrane; and he remarks, that, though he has observed very numerous filaments interlacing in all directions, yet these assume the longitudinal and parallel appearance only when the tube is folded longitudinally,—a disposition often seen in the larger veins.

By Meckel, on the contrary, the accuracy of the observation of Bichat is maintained. This anatomist states that he has, by the most minute dissections, assured himself that these fibres are longitudinal; but he admits that they are not uniformly present in all parts of the venous system, and that in degree and abundance they are liable to great variation. He follows Bichat also in representing these fibres as thicker and more distinct in the system of the inferior than in that of the superior *cava*, and in the superficial than in the deep veins.

In the inferior cava of the human subject, cer-

* Anatomie Generale, Tom. I. p. 399.

tainly filaments or fibres may be recognized. But, instead of being longitudinal, they may be made to assume any direction, according to the manner in which the filamentous tissue is removed. For this reason probably these fibres are to be viewed as part of the filamentous sheath. In the saphena vein of the leg oblique fibres may be seen decussating each other; but it is doubtful whether these belong to the proper venous tissue, or to the filamentous covering.

The nature of this proper membrane or venous fibre, as it is sometimes named, (Bichat,) is not at all known. Its great extensibility, its softness, its want of elasticity in the circular direction, or fragility, its colour and general aspect, distinguish it from the arterial tunic. It possesses some elasticity in the longitudinal direction, and is retracted vigorously when stretched. It possesses considerable resistance, or in common language is tough. The experiments of Clifton Wintringham show that it sustains a considerable weight without breaking, and that this toughness is greater in early life, or in the veins of the young subject, than at a later period. * In short, it may be stated as a general fact, that venous tissue, though thinner, possesses greater elasticity and tenacity than arterial tissue. According to the experiments of the same inquirer this property depends on that of the superior density of the venous tissue, the

* Experimental Inquiry on some parts of the Animal Structure. London, 1740.

specific gravity of the matter of the *vena cava* being invariably greater than that of the aorta in the same subject, both in man and in brute animals.

From some experiments Magendie is disposed to consider it of a *fibrinous* character. But it exhibits in the living body no proof of muscular structure or irritable power. When punctured by a sharp instrument, or exposed to the electric or galvanic action, it undergoes no change or sensible motion.

This tunic is wanting in those divisions of the venous system termed *sinuses,* in which its place is supplied by portions of the hard membrane; (*dura meninx.*)

2. The inner surface of any vein which has been laid open and well washed is found to be smooth, highly polished, and of a bluish or blue-white colour. This is the inner or free surface of the inner venous membrane, (*membrana intima.*) It is exceedingly thin, much more so than the corresponding arterial membrane, much more distensible and less fragile. It bears a very tight ligature without giving way as the arterial does; but it also sustains considerable weight, which shows that it is tough and resisting. This is the membrane termed by Bichat *common membrane of dark or modena blood.* According to the views of this anatomist it forms the inner or free surface not only of all the venous twigs, branches, and trunks composing this system of vessels, but it is extend-

ed from the superior and inferior great veins over the inner surface of the right auricle and ventricle, and thence over that of the pulmonary artery and its divisions; and through this whole tract it is the same in structure and properties.

This doctrine has not yet been controverted. But perhaps it may be doubted, both with regard to the inner arterial membrane, that the inner tunic of the aorta and of the pulmonary veins is quite the same; and in regard to this inner venous membrane, whether that of the veins in general is quite the same with that of the pulmonary artery. The subject demands further research. Meanwhile strong confirmation is found in the interesting remark of Bichat, that the osseous or calcareous depositions which are common in various spots of the inner arterial membrane, and especially at the mitral and aortic valves, are never found in the inner venous membrane, or at the tricuspid valve, or in the semilunar valves of the pulmonary artery. Have these depositions been found inside the pulmonary veins, and not inside the pulmonary artery? This fact is still wanting to complete even their pathological similarity.

The inner or common venous membrane is, however, the most extensive and the most uniform of all the venous tissues. It is the only one which is found in the substance of organs, and is present where the cellular and proper membrane are wanting. This is the case not only with venous branches and minute canals as they issue from the substance of muscles, bones, and such organs as the

liver, kidneys, spleen, &c. but is also very remarkably observed with regard to the venous canals of the brain. I have already noticed the absence of the cellular and proper tissues in these tubes; and I have now to remark, that the cerebral veins consist solely of the inner membrane, while in the brain or membranes, and when in the sinuses of this inner membrane, placed between folds of the *dura mater*. When the jugular vein reaches the temporo-occipital sinuosity, it loses its proper membrane, while its common or inner membrane passes into the hollow of the *dura mater*, called *sinus*, and thus forms the venous canal. This fact is readily demonstrated by slitting open either the lateral or the superior longitudinal sinus, when a thin delicate membrane, quite distinct from the fibrous appearance of the *dura mater*, will be found to line the interior of these canals.

The inner surface of many veins presents membranous folds projecting obliquely into the cavity of the vessel. These folds, which, from their mechanical office, have been named *valves*, (*valvulæ*,) are parabolic in shape, have two margins,—an attached and free, and two surfaces, a concave turned to the cardiac end of the vein, and a convex turned in the opposite direction. The attached margin is not straight, as may be imagined, but circular, and adheres to the inner surface of the vessel. The free margin resembles in shape an oblong parabola; and the direction of the valve is such, that a force applied to its convex surface would urge it more closely to the vein, whereas

a force applied to the concave surface would either obliterate the circular area of the vessel, tear the valve from the vein, or otherwise meet with resistance.

The size of the valves is variable. In some instances they are sufficiently large to fill the canal of the vessel, and in others they are too small to produce this effect. The obliteration of the circular area of the vessel is most perfect when there are two or three at the same point. Bichat ascribed the variable state of this quality to the dilated or contracted condition of the veins at the moment of death. This, however, is denied by Magendie.

In structure these valvular or parabolic folds are said to consist of a doubling, or two-fold layer of the inner membrane; and with this statement no fact of which we are aware is at variance. A hard prominent line, which generally marks their attachment of the fixed margin to the vein, is asserted by Bichat to consist of the proper venous tissue, the fibres of which, he says, alter their direction for this purpose; and when the common or inner membrane reaches this line, it doubles or folds itself *(elle se replie)* to form the valve, which thus consists of two layers of the inner or common membrane. This, however, is denied by Hunter,* who considers them of a tendinous nature, and by Gordon, who made several unsuccessful attempts to split these two layers. †

* x. Of Veins, p. 182. † Anatomy, pp. 66, 67.

Valves are not uniformly present in all veins. They are found, 1*st*, In the following branches of the superior great vein ;—the internal jugular, the azygos, the facial veins, those of the arms, &c. 2*d*, In the following branches of the inferior great vein ; the divisions of the posterior iliac, of the femoral, tibial, internal and external saphena, and in the spermatic veins of the male.

They are wanting in the trunk of the inferior great vein (*cava inferior*,) in the renal, mesenteric, and other abdominal veins, in the portal vein, in the cerebral sinuses, in the veins of the brain and spinal chord, in the veins of the heart, of the womb generally, and of the ovaries, and perhaps in all other veins less than a line in diameter. * In the cerebral sinuses the transverse chords are supposed to supply their place.

In situation the valves vary considerably. In general they are found in those parts of venous canals at which a small vein opens into a larger. But even from this arrangement there are deviations. The only valve which is definite and invariable in its situation is the Eustachian, (*valvula Eustachiana, valvula nobilis*), which is always placed at the cardiac end or beginning of the inferior *cava*, where that vessel is attached to the sinus of the right auricle. Shaped in general like a crescent, the attached margin of which is the arch of a large circle, and the free that of a small one, it proceeds from the left extremity of the si-

* Haller, Lib. ii. sect. ii.

nus downwards, forwards, and towards the left side, where it is insensibly lost on the membrane of the auricular *septum*. At its lower end it generally covers the orifice of the large coronary vein. This membranous production is always larger, more perfect, and more distinct in the fœtus, and in the infant, than in the adult. In the latter it is almost always reticulated; and sometimes the only vestige of its existence is a thin chord or two representing its anterior margin. I have seen it reticulated even at the age of sixteen or seventeen, and almost destroyed beyond thirty. Haller was much perplexed to account for the use of this membranous fold. * The conjecture of Bichat, that it is connected with some purpose in the fœtal circulation, is entitled to regard.

Dr Gordon has mentioned a third partial substance, which is occasionally found in local patches at various parts of veins. I have never met with this, and believe it to be accidental, or not connected with healthy structure.

Besides the cellular or filamentous envelope, veins receive capillary arteries, to which there are corresponding veins. The arteries rise from the nearest small ramifying arteries; and the corresponding veins do not terminate in the cavity of the vein to which they belong, but pass off from its body, and join some others from different parts; and at last terminate in the common trunk some

* Haller de Valvula Eustachii. Extat in Disput. Anatomic. Selec. Vol. II. p. 189.

way higher.* Nervous branches, or rather filaments, are observed in the pulmonary artery and great veins only. Are they derived from the great sympathetic, as is generally said?

In the veins, as in the arteries, the anatomist recognizes two extremities, the cardiac or collected, and the organic or the ramified. Examined physiologically, however, the terms origin and termination are not of the same import as when applied to the arteries. In reference to the veins, they become convertible terms; and it is the usage even of writers on anatomy to represent the veins as arising where the arteries terminate, and terminating at the organ from which the latter arise. This distinction must be kept in view in the following observations.

The cardiac extremity or termination of the veins is so well known as to render any minute explanation unnecessary.

The organic extremity or origin of the venous system is more obscure and difficult to be understood. It is indeed impossible to trace the origin of the small venous vessels, unless in the manner in which Leuenhoek,† William Cowper,‡ Henry

* Hunter, x. Of Veins, p. 181.

† Arcana Naturæ Detect. Opera Omnia, Tom. II. p. 160, 168.

‡ Philosophical Transactions, No. 280, p. 1179. Cowper saw this communication of arteries and veins not only in cold-blooded animals, as the lizard, tadpole, and fishes, but in the omentum of a young cat and a dog.

Baker,* Haller and Spallanzani, † did in their observations on the transparent parts of animals in general cold-blooded. From the experiments of these observers, we know that a very small vessel, evidently tending and conveying blood *towards* a larger, connected with a venous branch, may be seen passing directly from a similar small vessel, as evidently conveying blood *from* a larger, which is connected with the arterial system. All that we know from this, however, is, that a vein containing red blood may rise from an artery conveying red blood. This is matter of pure observation, and all beyond is little more than conjectural.

Haller indeed admits origins of veins as manifold as the terminations of the arterial system, a view in which he has been followed by almost all subsequent authors; and Bichat states it as a leading proposition, that the veins arise from the general capillary system. Neither conclusion is founded on strict observation; and while that of the former physiologist is derived chiefly from uncertain facts and loose analogies, the statement of the latter is too hypothetical and general to be either entirely true or wholly false.

Of one fact only are we certain. The blood which is conveyed into the small vessels and the substance of the tissues and organs is brought back by the veins. We have seen that the only

* On Microscopes, and the discoveries made thereby. Two vols. 8vo. London, 1785.

† Experiments on the Circulation of the Blood. By Lazaro Spallanzani. Translated by W. Hall. London, 1801.

origin which is strictly susceptible of demonstration is that of the red vein from the red artery. The point then to be ascertained is, whether colourless veins and absorbent veins arise from the several textures, as colourless and exhalant arteries terminate in them? The proper place for the further examination of this question is the subsequent chapter.

I must not omit to mention, nevertheless, that the veins have been shown to be connected at their ramified extremities with the lymphatics.

When the veins become distinct vessels, branches, and trunks, they become once more objects of sensible examination. In their course or transit from their organic to their cardiac extremities they present various circumstances which merit attention.

1. In general every artery is accompanied by a venous tube, which is divided in the same manner, and furnishes or receives an equal number of branches. Thus the descending aorta is accompanied by the *vena cava inferior;* the common iliac arteries by common iliac veins; the anterior iliac, femoral, and popliteal, by anterior iliac, femoral and popliteal veins. These veins are deep-seated, and are generally named the concomitant veins, *(venæ comites vel venæ satellites.)* In some situations an artery may be accompanied either in its trunk or in its branches by two veins of equal size. Thus in general the brachial artery and its branches, the radial and ulnar, are each accompanied by two veins. The only situations in which the number

of veins can be said to be exactly equal to that of the arteries, are in the stomach, in the intestinal canal, in the spleen, in the kidneys, in the testicles, and in the ovaries.

2. In the extremities and in the external regions of the trunk we find, in addition to the concomitant veins, an external layer of venous tubes immediately beneath the skin, (*venæ subter cutem dispersæ*, Pliny.) These subcutaneous or superficial veins do not correspond to any artery; but as they are chiefly destined to convey the blood from the skin and other superficial parts, they open into the deep-seated veins. Thus in the case of the basilic and cephalic, two superficial veins of the arm, the former, after passing the bicipital fascia, forms in the sheath the brachial vein; and becoming the axillary in the axilla receives the latter vessel. In the same manner, the saphena, (φλεψ σαφαινης, *vena manifesta,*) the superficial vein of the leg, passes through the falciform process of the *fascia lata* to join the femoral vein.

From this it results that the venous canals are on the whole more numerous than the arterial. In a few situations only a single vein corresponds to two arteries, as in the penis, the clitoris, the gall-bladder, and the umbilical chord. Often also in the renal capsules and the kidneys two or more arteries have only one corresponding vein. In such circumstances the vein is always large and capacious.

It has been generally stated that the calibre

and area of the venous tubes are much larger than those of the corresponding arteries, and consequently that the capacity of the venous system is much greater than that of the arterial. I acknowledge that I know not on what exact evidence the former of these propositions, the only one with which the anatomist is concerned, is made to rest. If it be mere inspection in the dead subject, or the effects of injection, little doubt can be entertained that the alleged greater calibre depends chiefly on the laxity and distensible nature of the venous fibre. The arterial tubes appear small in consequence of the tendency which they have to collapse, or annular contraction, when the distending force has ceased to operate. The venous canals appear large by reason of their distension and distensibility during life, from the tendency to accumulation in their branches in most kinds of death, except that by hemorrhage, and from a smaller degree of the physical property of shrinking and annular contraction when empty.

When a vascular sheath is exposed in the human subject, as in the operation for aneurism, or in the lower animals in the way of experiment, the vein, it must be admitted, generally appears larger than the corresponding artery. This, however, is never so considerable as it is represented by most authors, and certainly could by no means afford grounds for the high estimates which Keill, Jurin, and other mathematical physiologists have assigned to the relative capacity of the arteries and veins. It is also to be observed that something of

this greater size depends on the increase of dilatation resulting from removing the pressure of superincumbent parts. In young animals also the difference between the size of the veins and their corresponding arteries is so trifling as to be scarcely discernible. This would show that something is to be ascribed to the incessant operation of a dilating force increasing uniformly with the duration of life.

Upon the whole, it is chiefly on the ground of their larger numerical arrangement that the veins collectively can be said to be more capacious than the arteries. On this subject some observations of Bichat are entitled to attention. *

3. The veins in general accompany the arteries. The venous trunk placed contiguous to the arterial in the same sheath is divided into branches at the same points, and is distributed into the substance of organs much in the same manner. From this arrangement, however, certain deviations are observed in particular regions. Thus, in the brain, neither the internal carotid, nor the basilar artery, nor their large branches, are accompanied with veins. The small branches only have corresponding veins, which, as they unite to form large ones, pour their blood into the venous canals termed sinuses, the arrangement of which is unlike any other part of the venous system. In the chest also a different disposition of the venous from the arterial tubes is observed. The

* Anatomie Generale, Tome I. p. 378.

venæ cavæ, though conveying the blood to the pulmonic division of the heart, as the aorta conveys it from it, do not, however, correspond with the latter either in situation or in dependent branches. The *azygos* and the *demiazygos* veins in like manner, which receive the intercostal veins, have no concomitant artery, but open into the *superior cava*, to which it may be viewed as an appendage. *Lastly*, The portal vein which is formed of the united trunks of the splenic, superior mesenteric and inferior mesenteric veins, corresponds to no individual arterial trunk, and forms of itself a peculiar arrangement in the venous system.

Some anatomists have dwelt much on the more superficial and less sheltered situation of the veins than of the arteries. Upon this point no very positive inferences can be established. In the extremities the former are in general most superficial; but in the interior of the body, especially in the chest, the venous trunks are quite as deep-seated as the arterial.

The course of the venous canals is in general more rectilineal and less tortuous than that of the arteries. In no part of the venous system is such an inflection presented as that which the internal carotid makes in the carotic canal. The general result of this is, that a set of venous tubes is shorter than a corresponding set of arterial ones. The trunks also are less inflected than the branches.

4. The mutual communications of the venous

system, (*anastomoses, inosculationes,*) are more numerous and frequent than those of the arterial. 1. The minute veins communicate so freely as to form a perfect net-work. 2. In the twigs, though more rare, these communications are still frequent. 3. In the branches, though less numerous, they are nevertheless observed; and in this respect alone the venous must be greatly more numerous than the arterial inosculations, which are confined chiefly to the smaller and more remote parts of the system. These inosculations, indeed, between the venous branches constitute one of the most peculiar and important characters of their arrangement, in so far as by their means the communication is maintained between the superficial and deep-seated vessels of the system. Thus the emissary veins are the channel of communication between the cerebral sinuses and the temporal, occipital, and other external veins. The external and internal jugulars communicate by one or two considerable vessels. And the free communication between the basilic and cephalic by the median veins, that between them and the deep brachial vessel, and that between the saphena and its branches and the femoral vein, are sufficiently well known. The application of these anatomical facts to the ready motion of the venous blood is obvious.

But of all the communications between the branches or large vessels of the venous system the most important, both anatomically and physiologically, is that maintained by means of the *vena*

azygos between the superior and inferior *cavæ*. The azygos itself is connected at its upper or bronchial extremity with the superior *cava*, and at its lower extremity it is in some subjects connected directly with the inferior *cava*, in others by means of the right renal vein, and in most by the first lumbar veins. By means of the *demiazygos*, again, it is connected with the left renal vein, or the lumbars of the same side, and in some instances directly with the inferior *cava*. To the azygos and demiazygos, therefore, belongs the remarkable property of connecting not only the venous canals of the upper and lower divisions, but those of the right and left halves of the body.

Section II.

Venous tissue is liable to inflammation, adhesive or circumscribed, and spreading,—generally suppurative, to *varix*, to osseous deposition, and to the formation of concretions.

1. *Inflammation.* (*Phlebitis.*) Of *circumscribed* or *adhesive inflammation* of veins, a good example is found in the ordinary union after incised wounds as in venesection. In this case the lips of the wound, if accurately applied to each other, adhere sometimes directly by inosculation, in other instances by effusion of lymph, which becomes organized.

2. *Spreading inflammation* of venous tissue is a

much more serious disorder, and appears to belong essentially to the inner venous membrane. Rarely spontaneous, it takes place only after some violence offered to the vein; but the degrees of this may be so various, and even the kinds so different, that it is impossible to trace much analogy of action between them. Thus it may occur after a simple clean incision, as in blood-letting; after the application of a ligature, as occasionally happens in amputation, in the operation for varix, or in the umbilical chord after birth; or in consequence of pressure, as sometimes happens after the use of a tourniquet. In either case, the inflammatory action originating in a spot of the inner membrane spreads along its surface, generally towards the heart, more or less rapidly, and with much violence.

The pathological effects of this process vary according to its severity and extent. In general the tissue of the affected vein or veins is swelled, thickened, and indurated to such a degree as make the vessel resemble an artery. The interior is filled with purulent matter, or presents a series of abscesses along the tract of the canal; and the inner tunic is generally removed, the middle one not unfrequently injured by ulceration. This process is always attended with great commotion in the organs of circulation, much general fever, and more or less affection of the intellectual functions, and if considerable, generally proves fatal.

Inflammation of the inner venous membrane I

have represented generally to succeed violence offered to the vessel; but what sort of violence is requisite is not well known. I have in two or three instances thought I could trace it to wound, laceration, or pressure in the site of a valve; but in others this could not be established.

This process is known to take place spontaneously in the veins of the brain and in those of the womb. The latter Dr Clarke * and Mr Wilson † found filled with purulent matter or lymph in the persons of females cut off by puerperal fever; and in two fatal cases of the same disease I saw these veins containing purulent fluid. The venous tubes of the brain have been found presenting marks of inflammation by Dr Abercromby ‡ and M. Gendrin. §

It appears, therefore, that inflammation of the inner venous coat rarely terminates in albuminous exudation and adhesion; and it may be stated as a peculiar character of this tissue, as distinct from the inner arterial membrane, that, while the latter is almost sure to assume the adhesive, the former is exceedingly prone to the suppurative form of inflammation.

3. Instances, nevertheless, have occurred in which inflammation of this membrane was followed by

* Practical Essays on the Management of Pregnancy, p. 63, 72.

† Transactions of a Society, Vol. III. p. 63, and p. 80.

‡ Medical and Surgical Journal, Vol. XVIII.

§ Revue Medicale, Avril 1826.

deposition of lymph and union of its free surfaces producing obliteration of the canal of the vessel. Dr Baillie mentions an instance of obliteration of the lower *cava*, from the emulgent veins to the entrance of the *venæ cavæ hepaticæ*, which he ascribes to effusion of lymph and consequent adhesion; * and Mr Wilson records a similar case in which about four ounces of well-formed purulent fluid were found in the *vena cava* immediately below the liver, and a considerable quantity of coagulated lymph below the entrance of the three large hepatic veins, (*venæ cavæ hepaticæ*,) which at once united the opposite sides of the vessel, and prevented this fluid from proceeding to the heart. † Similar examples of obliteration are recorded by Haller, Morgagni, and by Hodgson, ‡ and Breschet. It is easy to perceive how the pressure of tumours may cause obliteration of these vessels. When any venous tube, under such circumstances, becomes impervious, the collateral communications afford channels for continuing the motion of the blood.

4. *Varix.* This consists in permanent dilatation of the venous coats beyond their natural capacity. It is in general, if excessive, confined to one spot; but sometimes a whole vein becomes more or less dilated through its entire course. At the same

* Transactions of a Society for the Improvement of Medical and Chirurgical Knowledge, Vol. I. Art. viii. p. 133.

† Transactions, &c. Vol. III. Art. vi. p. 63.

‡ Treatise, p. 10, sect. 3.

time it becomes so tortuous, that this may be received as one of the physical characters of varicose veins. We possess no very precise facts on the exact change which takes place in the venous tunics, whether it be mere dilatation or injury of some kind, and rupture of the proper venous coats. By Meckel it is regarded as simple dilatation without injury of texture. When one part of a vein is dilated into a distinct sac, I believe the inner coat is generally rent. In some cases of varix one or more valves are lacerated, or detached from the inner membrane. In others varix has followed a rent or lacerated wound of the outer venous tunic.

Varix occurs especially in the veins of the lower extremities, for instance in the trunk or branches of the saphena. It is common in those of the spermatic chord, in which it is distinguished by the name of *varico-cele*, and not unfrequent in the veins of the rectum, where it causes one variety of hemorrhoidal tumours. In the upper extremities it is rare, one case only by Petit being recorded. I have seen, nevertheless, a varicose tumour of the posterior ulnar vein on the back of the hand, which disappeared under the use of pressure, continued for six or seven months.

Of the internal veins the *vena azygos* and subclavian have been found varicose. (Morgagni, Portal, Baillie.) When a cluster of subcutaneous veins becomes varicose, they generally give rise to much pain, swelling and redness of the skin, and

if not opposed by suitable treatment, may produce cutaneous inflammation terminating in a bad ulcer. (*Ulcus varicosum.*) The same process nearly may result from the inflammation round a single varicose trunk. Varix sometimes terminates in laceration or rupture; and if the vein be large and not covered by the skin, the hemorrhage may be fatal. (Laurentius, Nebel, Bonet.) Varix of the *vena azygos* terminating in rupture and fatal hemorrhage was seen by Manfredi. *

Ossification. Calcareous or osseous matter is very rarely deposited in venous tissue. Instances of this, however, are recorded. (Morgagni, Baillie, Hodgson.) †

Loose stony concretions have been found in the cavity of veins, which in such circumstances are generally dilated. These concretions do not appear to be formed and deposited in the venous tissue, but, according to Hodgson, are more likely to have been produced outside by some contiguous tissue, and to have found their way into the venous tube by progressive absorption. Is it not possible that they are the result of temporary retardation or stagnation of a portion of blood around which, as a nucleus, calcareous matter had been deposited. They have not been chemically examined; but it is said that they have no appearance of any thing osseous. These concretions, which in other respects are very imperfectly known, have been termed *vein-stones.* (Phlebolites.)

* Morgagni, xxvi. 29. † Treatise, Part iv. sect. 2.

CHAPTER VI.

SYSTEM OF CAPILLARY VESSELS,—TERMINATIONS OF ARTERIES,—ORIGINS OF VEINS.

SECTION I.

THOUGH we can scarcely, with propriety, speak of the *capillary tissue*, or the tissue of capillary vessels, we find it requisite to introduce in this place the general facts of the anatomical peculiarities of this important part of the human body.

The term *capillary system*, though much spoken of in physiological and pathological writings, is perhaps not always precisely defined or distinctly understood. According to Bichat it is not only the common intermediate system between the arteries and veins, but the origin of all the exhalant and excreting vessels. * If we consider the modes in which arteries have been said to terminate, and veins to take their origin, we shall find, that in this view of the capillary system there are some things which are doubtful, and some which are inconsistent with the rest.

Haller, and most of the physiological authori-

* Anat. Gen. Vol. I. p. 471. *Systeme Capillaire*, Article 1.

ties since his time, concluded, chiefly from the phenomena of injections, sometimes from microscopical observation, and where these failed, from the obscure and uncertain evidence of analogy, that an artery traced to its last or minute divisions will be found to terminate in one or other of the following modes. 1*st*, Either directly in a red vein or veins; 2*d*, in excreting ducts, as in the lacrymal and salivary glands, the kidney, liver, and pancreas, the female breast, and the testicle of the male; 3*d*, in exhalants, as in the skin, in the membranes of cavities, (serous membranes,) the cavities of the brain, the chambers of the eye, the filamentous tissue, the adipose cells, the pulmonary vesicles, and mucous surfaces and their follicular glands; 4*th*, in smaller vessels, for instance lymphatics; and, 5*th*, in the colourless artery; (*arteria non rubra.*) *

A similar application of the same facts has assigned to the veins a mode of origin not unlike. If, therefore, we admit the definition given by Bichat, it follows that the capillary system consists, 1*st*, of minute arteries communicating with veins; 2*d*, of excreting ducts; 3*d*, of exhalants; and, 4*th*, of minute arteries or veins containing a colourless portion of the blood. It is obvious, however, that it is absurd to say that the system of capillary vessels at once comprehends and gives origin to the excretories and exhalants. In other respects the whole of this theory, for little of it is

* Elementa Physiologiæ, Lib. i. sect. 1. p. 22–29.

matter of strict observation, rests on very hypothetical grounds.

Of the different kinds of terminations assigned to arteries, and of origins assigned to veins, one only admits of sensible and satisfactory demonstration. Arteries, when they have so much diminished as to become *capillary*, are seen by the microscope, in some instances by the naked eye, to pass directly into corresponding capillary veins, or to end abruptly in some organ or membrane unconnected with any other vessel. * It is likewise certain that the microscope shows every capillary vein to arise from a capillary artery ; and if there be any other mode of origin, it has not yet been demonstrated or established. † Only one other circumstance requires to be taken into account in this inquiry. This is, that the capillary artery and vein may contain either red or colourless blood ; for, according to the size of the vessels, and the nature of the organs or tissues in which they are distributed, the blood which flows through them will be coloured or colourless. This view of the communication of minute arteries and veins, which is perfectly consistent with the known facts, will afford the only explanation which it is possible to give, of the singular division of the capillary system which Bichat has chosen.

This author has considered the capillary system under three general heads. 1*st*, In organs in which it contains blood only ; for instance, in the mus-

* Gordon, p. 56. † Ib. p. 62.

cles, the spleen, some parts of the mucous membranes. 2*d*, In organs in which it contains blood and other fluids, for example, in bone, cellular tissue, serous membrane, part of the fibrous system, the skin, the vascular *parietes*, glands, &c. And, 3*d*, In organs in which it contains no blood, the instances of which are, tendon, cartilage, ligament, hair, &c.

Now, it is of little consequence to say that the tissues of the two last divisions contain other fluids than blood, when we are also told that the phenomena of injections, which prove that their capillaries communicate directly with arteries conveying red blood, the effect of irritating applications mechanical or chemical, and the phenomena of acute or chronic inflammation, show that they may convey or receive red blood. The conclusion of this in common language is, that the capillary arteries and veins of the second order of tissues do not all contain red blood, but that many of them contain a colourless part of that fluid; and that all the capillary arteries and veins of the third order of tissues convey in the natural state colourless blood only. What then is the precise idea which ought to be formed of the intermediate system which Bichat conceived to exist between the minute arteries and veins, or what have been termed the venous *radiculæ*?

It appears that the present state of facts will admit of nothing more to constitute this capillary system than those minute vessels, whether con-

veying coloured or colourless blood, in which inspection, microscopic observation, and injections show that arterial branches at once terminate, and minute veins *(radiculæ venosæ)* have their origin. It is clear that, physiologically speaking, these vessels can neither be regarded as arteries nor as veins strictly; for the characters on which this distinction is founded are necessarily lost or obliterated in this system of vessels. There is no precise point at which the arterial tissue or structure can be said to terminate, and none at which the venous structure can be said to commence. Inspection or microscopic observation can afford little or no aid here, for the vessels are too small to allow us to examine their structure correctly. If, however, we adopt the doctrines of Bichat with regard to the inner arterial and venous tunics forming the ultimate tube of small arteries and small veins, we must conclude that the arterial membrane is lost in the venous, and that the common membrane of red blood is identified with the common membrane of dark or modena blood. In this conclusion there is nothing either absurd or improbable, and, though not founded on actual observation, it is greatly more natural than many similar ideas which have been formed on the nature of this system of vessels. It may be added that it is not at variance with what is observed in these vessels in the living body. It is found that the blood in a minute artery is not of the bright red colour which it possesses in the trunk and large

branch from which the minute artery derives its blood, but is gradually acquiring the dark hue which belongs to the blood of the venous branches and trunks.

By some, again, this direct communication of minute arteries and veins is denied. Thus, according to Doellinger, the arteries at their last ramifications are devoid of proper membranous walls; the blood moves in immediate contact with the solid matter of the body, which is in truth the fundamental or penetrating filamentous tissue; and from this it passes into the venous tubes and lymphatics, which also arise from this substance.

According to Wilbrand, again, who equally denies this direct communication of arteries and veins, all the blood is converted into organic fibres and secretions; and these organic fibres becoming gradually fluid are converted into blood and lymph, which continue the circulation.

These notions are too fanciful and too incapable of demonstration to become the object of serious attention to the anatomist. It is of little moment whether the vessels in the ultimate ramifications possess tunics or not. When they cease to possess tunics they cease to be vessels; and to carry observation beyond this point is either impracticable or useless. In other respects the investigation of this point belongs to the subject of the exhalant vessels.

Bichat has described two great capillary systems in the human body. 1*st*, The general one,

or that which consists of the minute terminations of the aortic divisions, and the origins of the superior and inferior great veins; and, 2*d*, The pulmonary capillary system, or that which consists of the minute terminations of the pulmonary artery, and the origins of the pulmonary veins. It is evident, that the manner in which the first of these systems is here represented, communicates a very incorrect idea of its true character; and that there is actually an individual capillary system, not only for every organ, but in some instances for every tissue. The brain possesses an individual capillary system; and that of the membranes is evidently distinct from that belonging to the organ itself. The heart and the kidneys possess each an individual capillary system; and the liver may be said to have two,—one formed by the communication of the hepatic artery and veins, and another consisting of the divisions of the portal vein, with the branches of the hepatic hollow vein. (*Vena cava hepatica.*)

The organic properties of the capillary vessels are as little known as their structure. Many physiological and pathological writers, especially experimentalists, have ascribed to them a power which has at different times been called muscular, tonic, irritable, contractile; and have asserted, that, because the larger arteries are provided with a fibrous membrane, which they have called muscular, and to which they have ascribed irritability, or the power of contraction when stimulated, their

minute or capillary terminations must have the same property. This conclusion is completely unfounded for two reasons. 1*st*, I have already shown that the proper arterial tunic is not muscular in structure, and, according to the best experiments, possesses no property of contraction when stimulated. 2*d*, Although it be admitted that the proper arterial tissue is muscular and irritable, it is quite certain that observation has not hitherto shown that this tunic can be recognized in arteries smaller than a line in diameter; and it is certain that in the capillaries, properly so called, that is, in vessels which partake of the nature of artery and vein, no such structure has yet been observed.

It is not improbable, however, that the capillaries possess certain organic or vital properties; but all that has been taught on this subject is either hypothetical, or derived from an insufficient and imperfect collection of facts. It is certain that the blood which moves through them is beyond the direct influence of the action of the heart, and can be affected by this only so far as it keeps the larger vessels constantly distended with a column of blood which cannot retrograde, and must therefore move forward in the only direction left to it. It has been therefore argued that the capillaries must have an inherent power of contraction by which this motion is favoured. Is it not sufficient to say that they act merely as resisting canals, to prevent their contents from escaping,

and to minister to the various tissues and organs those supplies of blood which the several processes of nutrition, secretion, &c. require ?

The effects which the application of mechanical irritants, or chemical substances, as alcohol, acids, and alkalis, produced in the experiments of Hunter, Wilson Philip, Thomson, and Hastings, have been supposed to demonstrate the irritable nature of the capillary vessels. The conclusion is illegitimate, in so far as the results of these experiments are open to several sources of fallacy. In some instances these effects are to be ascribed to incipient inflammation, in others to shrivelling of the capillary structure, or crispation by chemical action, in others to actual coagulation of the blood of the capillaries ; but none of them prove satisfactorily or precisely any peculiar properties in the vessels of which the capillary system is composed.

Section II.

The morbid deviations incident to the system of capillary vessels are of the utmost importance. As they are the main agents of most of the healthy processes of the animal body, so there are few morbid states in which their operation is not primary, or in which they do not more or less partake. To enumerate these would form a long nosological list, since the diseases of every tissue depend chiefly, if not entirely, on its capillary system. It will be

sufficient to consider the influence of the capillary vessels as an individual or isolated organic system in the production of morbid action.

1. *Inflammation.* The capillary vessels are believed to be the exclusive seat of the morbid process termed *inflammation.* No tissue, or no substance rather, destitute of capillaries, is believed susceptible of this process; and its frequency and violence are justly estimated in proportion to the number of capillaries with which the tissue is supplied. Hair, nail, enamel of the tooth, and cuticle, do not undergo inflammation; and their morbid states are to be ascribed to disorder of the textures on which their existence and nutrition depend. Filamentous tissue, on the other hand, mucous and serous membrane, and the substance of such organs as the lung, liver, &c. are very liable to various forms of inflammatory action, which is generally proportional to the predominance of red capillaries in the substance of each. Bichat has justly observed that inflammation is very frequent in the cutaneous, mucous, serous, and filamentous tissues, which injection and microscopic observation show to abound in capillary vessels, but rare in bone, cartilage, and the fibrous tissues in which there are few capillaries, or where the irritable or inflammatory susceptibility, *(la sensibilité organique,)* is more moderate. It is difficult to explain the infrequency of inflammation in muscular tissue without having recourse to this last property, which this author ascribes to the capillary vessels. Its

sensibility to the operation of a stimulus is great. Its susceptibility of inflammatory action is very small.

The change which takes place in the capillary vessels in the state of inflammation has given rise to much speculation, research, and experiment. But it may be doubted whether the questions which have been agitated on this subject can yet be regarded as decided. On one point only is there any thing like agreement in the various opinions delivered. It appears to be now the general belief, that during the process of inflammation the capillary vessels of the part are dilated, and contain more blood than in the healthy state. (Cullen, Hunter, Vacca, and many other authors.) On the cause of this dilatation, however, the sentiments of pathologists are as much at variance as ever; and not only are the results of experiments made to determine the circumstances on which this distended state of the capillaries depends, variable and sometimes contradictory, but the conclusions to which they have led are very opposite. One opinion is, that the dilatation depends on increased action; according to the other, it is the effect of a weakened state of the capillaries.

The first of these doctrines, which in some form or other has been adopted from Stahl, and De Gorter, by Dr Cullen, appears to have been suggested by the increased number of the arterial pulse in a given space, the hardness and tension of its beat, the throbbing of inflamed parts, and

the violent and sometimes rapid changes of structure which attend inflammation. This has led to the conclusion that the blood moves in the capillaries of such parts more rapidly, and with greater force, *(momentum,)* than in the healthy state. (Parry.) With superficial observers this opinion has passed current, as generally consonant with the phenomena and effects of the inflammatory process; and the pathologist has studied to render his notions palpable, by supposing, in the language of the mathematical physicians, an inordinate flow, *morbid afflux* or *increased determination* of blood to the inflamed parts. Had this opinion ever been subjected to rigid scrutiny its fallacy must have been manifest.

1*st*, The fact of increased determination is not established. In its present state it is a mere assumption. 2*d*, Increased determination is not necessary to the production of the effect. When the capillaries of any part are unusually loaded, this may take place from the blood not being removed with the same regularity, and in the same proportion in which it is conveyed, with the same facility as by supposing an increased current. 3*d*, Even admitting the current to be increased through any set of capillaries, it is impossible to discover the agents of such a process. It is clear it cannot be the heart. And to suppose the capillaries capable of this, is to ascribe to them a power which they have not been proved to possess.

Against the hypothesis of increased force and

increased velocity of circulation, various arguments may be urged ; and several of these depend on the circumstance, that this hypothesis also has been assumed on very insufficient grounds. 1*st*, The increased number of the arterial pulse does not demonstrate that the blood is moving more rapidly than in the ordinary circumstances of health. It merely shows that the heart contracts more frequently in a given time than usual. 2*d*, The increased number, or strength, or tension of the arterial pulse does not indicate that the blood is moving with greater force, or that the arteries through which it is moving are acting with greater power, but rather that the heart is contracting much more frequently, in order to overcome some obstacle. 3*d*, It does not appear that the increased number or force of the pulse, as manifested by the contractions of the heart, depends on any other cause than the vital irritation occasioned by a local stimulus of a morbid nature. 4*th*, The throbbing of inflamed parts proves nothing more, than that the shock communicated from the heart along the arterial tubes is rendered more sensible, first, by their dilated and distended condition ; and, secondly, by the greater quantity of matter deposited in and around these vessels. (Parry.)

The second doctrine, that the distended or dilated state of the capillaries is to be ascribed to weakness or debility in their coats, appears to be more consonant with the usual phenomena of the process, and with the effects which it produces in

the different tissues. But although much has been lately done by Wilson Philip, Hastings, and others, to determine this point, it is still beset with some difficulties and objections, and would perhaps require some variation in the experiments, in order to place the subject in the clearest light. This hypothesis first originated with Vacca Berlinghieri, and was supported in this country by Lubbock, Allen, Reeve, Wilson Philip, and recently by Hastings and Black.

Upon the whole, two facts may be considered to be established regarding the state of the capillary vessels of an inflamed part. The *first* is, that these vessels are unnaturally and unusually distended, and really contain more blood than in the state of health. This is proved not only by incisions into inflamed parts, but by dissections of every part and organ of the body. The *second* is, that the blood moves more slowly in these vessels than in the healthy state, and even after some time may remain entirely motionless. This is also established by observing the effects of inflammation in the human body, but especially by the phenomena of inflammation excited artificially in the bodies of the lower animals.

It is still a point to be ascertained, whether these two conditions constitute what may be termed the essence of inflammation; and it is still undetermined by what agency these states are induced in the capillary system of any tissue or organ. On this head it may be remarked, that, if by any

means the natural velocity with which the blood moves through any set of capillaries be diminished, and continue so, the quantity of blood in these vessels must be gradually and steadily increased, until it becomes very considerable. This appears to be one cause of the accumulation of blood in any part which is in the state of inflammation.

2. *Temporary dilatation of the capillaries not inflammatory.* The capillary vessels undergo a temporary dilatation during the progress of aneurism, whether allowed to go on naturally, or after the application of the ligature to the arterial trunk. When the collateral circulation has been fully established by the enlargement of the anastomosing branches, the capillary system shrinks to its ordinary size.

3. *Extravasation.* When the capillary vessels of any part have been injured, so as to burst or give way, the blood which they contained is effused round them, and into the cellular or other structure of the part, occasioning sometimes considerable swelling, and, if near the surface, a red, blue, or yellowish colour. In such circumstances the blood is said to be *extravasated*, and the change of colour is termed *ecchymosis*.

4. *Mode of repair; union by adhesion and granulation.* When they are divided by simple incision they pour out first blood, then serous or colourless fluids, lastly, a semifluid, which undergoes coagulation, and which forms the uniting medium of the divided surfaces. This is the *radical moisture* of the older physiologists; (Taliacotius, Ambrose

Paré, Phioravant, &c.); *the balsam of Nature*, or *agglutinative balsam* of Wiseman, * the *gluten* of Sauvages, Gaubius, and Cullen, the *coagulating or organizable lymph* of Hunter, and the *glutinous or albuminous exudation* of the French pathologists

According to the observations of Hunter, Baillie, and Home, this lymph is afterwards penetrated with minute arteries and veins, or acquires a capillary system of its own; and in this state it is properly *organized lymph.* This process of formation of new capillaries occurs in every situation in which lymph is deposited; 1*st*, In the exudation of inflamed serous membranes, which afterwards forms the membrane of adhesions; 2*d*, In wounds of skin, cellular membrane, mucous membrane, muscle, &c.; 3*d*, In inflammation of these tissues,

* "But in regard there is a certain *medium* which answers in proportion to a glue, required in this work, Nature taketh what is next in hand, even the nourishment of the part which is hurt to make it of. *Ubi morbus ibi remedium* is here as an oracle; where the disease is, there is the remedy. No sooner is the wound made but the balsam is discovered. Blood, at least the serous part of it, is the glue, which she useth both in curing by the first and second intention. The first being performed *per symphysin, i. e.* a reunion of the parts without any medium, by which word I here mean any *callus* or flesh, or other body interposed; for in another sense the balsam of Nature is the *medium*, the instrument of unity, and puts the parts together; the second *per syssarcosin, i. e.* with a medium or interposition of some flesh or callous substance, that fills up the space between the lips of the wound."—Chirurgical Treatises by Richard Wiseman, Sergeant-Surgeon, Book v. Chap. 1. Of Wounds.

whether occurring spontaneously, in consequence of bruise or laceration, or the introduction of foreign bodies. In each of these cases, though suppuration should also take place, still there is lymph effused, and this lymph is penetrated by newly formed capillaries. This formation of new capillaries is termed by the French pathologists *accidental developement of the capillary system.* Is it lymph of a peculiar kind that is effused from the capillaries of fractured bones in the first stage of the process of reunion? The substance named *callus* is certainly not cartilage, as was anciently supposed, and possesses qualities not unlike those of the lymph of soft tissues. Is lymph effused from the fragments of a broken cartilage, or a ruptured tendon? In each of these cases of injury a soft homogeneous fluid, pale red or bluish, is effused immediately or soon after the injury; and in each it seems to possess the same qualities, and only in the course of the process of reunion to be afterwards penetrated by the peculiar matter of the tissue injured. A preliminary step to this penetration of proper substance is uniformly the formation of new capillary arteries and veins.

In those examples of spontaneous disease or injury in which suppuration takes place, the capillaries in depositing lymph are concerned in another process, the formation of red eminences, hemispherical or hemispheroidal, of various size, and varying in firmness or consistence. This process has been termed *granulation*, a name which has

been also improperly given the individual bodies. The simplest, and perhaps the most correct view of this process, shows that it consists of three distinct stages, which it is important for the pathologist to know.

a. The first of these consists in effusion of lymph from capillary arteries in irregular globules or masses. The extent to which this exudation takes place will depend on the extent of the surface and the degree of inflammation; and the same principles will regulate the appearance of the globules or masses of lymph in the different points of the granulating surface.

b. After these globules have been effused and coagulated they are soon penetrated with vessels which, according to Hunter, may be justly esteemed mere prolongations of the capillaries which originally secreted the lymph. This penetration of vessels constitutes what may be considered the second stage of granulation. This process, which must have been observed by many practical surgeons, has been clearly and correctly described by Hunter. "I have often," says he, "been able to trace the growth and vascularity of this new substance. I have seen on a sore a white substance exactly similar to coagulating lymph. I have not attempted to wipe it off, and the next day of dressing I have found this very substance vascular; for by wiping or touching it with a probe it has bled freely." And, again, "The vessels of granulations pass from the original parts, whatever

these are, to the basis of the granulations, from thence toward their external surface, in pretty regular parallel lines, and would almost appear to terminate there." * At the same time the formation or secretion of purulent fluid goes on; and the surfaces of these bodies themselves acquire the same power of preparing this fluid which the surface from which the granulations were produced, possessed. In this instance we have an example of capillary vessels performing at the same time the effusion of lymph and the secretion of purulent fluid.

In this stage of the process of granulation Mr Hunter has remarked the disposition to union, cohesion, or adhesion, which granulating eminences possess, and described the mechanism by which this is accomplished. By many it might be deemed a distinct process. But in so far as the capillaries are concerned, the chief object of consideration at present, it is to be viewed as a part of the second stage. The vessels of the granulating eminences continue to secrete lymph, which unites the corresponding surfaces of their new bodies till their capillaries pass into each other, so as to inosculate, and the union is completed.

c. The third stage in the process of granulation consists in what he has termed *contraction.* In describing this important part I fear he has committed two errors,—one in looking at the whole granulating surface and contiguous parts,

* II. p. 477.

rather than at the individual bodies; the other in ascribing contraction to the elasticity and muscular action of the contiguous parts rather than to a change in the state of the granulations. These circumstances are certainly useful accessory means; but they must not be regarded as the primary and essential cause. Perhaps also some slight differences take place in the time in which contraction occurs, and the extent to which it proceeds, according to the nature of the granulating surface, and the relation which the production of the granulating eminences bears to the part to be restored. The general phenomena of the process appear to be the following.

After the granulating eminence or eminences have been formed, and have united with the contiguous ones, the uninterrupted action of their new capillaries continues to effuse lymph as a basis for fresh granulations, and to give out vascular or capillary prolongations, in order to organize them. Meanwhile the vessels of the granulating eminences near the edges of the surface begin to diminish in size; and as they diminish the eminences themselves become less red and smaller, but more firm. At length, as the eminences become covered with the membrane of cicatrization, they appear to have diminished so much that little inequality can be recognized, the redness is sensibly diminished, and the whole appears as if it were becoming quite as solid or firm as the contiguous parts. If in this part of the process a granulating surface be injected, the vessels which

go to the outer granulating eminences will be found to be, 1*st*, much less numerous; and, 2*d*, to be much diminished in size; and this change will be observed to be most remarkable at the edge, and less at the centre of the sore. It is this diminution in the number and size of the granulating capillaries which is the main agent of the process of contraction. As these vessels become less numerous and smaller, the bodies to which they are distributed diminish and become firmer; and if a wound or part which has been healed by granulation be injected some weeks or months after being healed, the vessels will be actually found less numerous and smaller than in the contiguous parts of the same tissue.

When union by granulation is accompanied with the formation of a thin membrane, which afterwards assumes the appearance and properties of skin, the last part of the process is called *skinning* or *cicatrization*,—the formation of a scar. The nature and mechanism of this process will be considered in its proper place.

Granulation may be viewed as the means which the several tissues of the human body possess of reproducing themselves, or repairing those losses of substance which result from direct injury, or take place in consequence of disease. Of this process the capillaries of the texture are the agents. But it is uncertain to what extent they possess the power of reproducing the same sort of substance as that of the texture destroyed. The kind of matter which is most generally reproduced

is filamentous or cellular tissue. It is certain also that bone is reproduced. But it is uncertain whether skin, that is true skin, muscle, tendon, or ligament, is reproduced, and almost certain that cartilage is not.

5. *Different effects of inflammation.* I have said that granulation is in general accompanied with the formation of more or less purulent matter. This process, which is termed suppuration, generally precedes that of granulation. It has been viewed at one time as a consequence or effect of inflammation, at another as a character of it, and at a third as a cause. The circumstances which justify these distinctions should be understood.

Inflammation is a progressive process, which tends through certain stages to a certain termination. Of the intermediate steps not much is known with certainty; and pathological writers have distinguished chiefly the different modes in which it may terminate. These are resolution, effusion, adhesion, suppuration, granulation, ulceration, cicatrization, induration, and gangrene. This division is more scholastic than natural. The first only can be justly denominated a termination. All the others are to be regarded as effects either immediate or remote of the process.

α. Resolution is that action in which the redness, pain, heat, and swelling of an inflamed part gradually disappear, either spontaneously or under the use of means, with or without sensible evacuation, and in which the part which had been

inflamed, resumes by degrees its natural state, without suffering derangement of structure or properties. This is exceedingly rare. The minute veins are doubtless the great agents of cure in such circumstances.

β. In most cases of inflammation more or less fluid is early effused or extravasated from the capillaries or the exhalants of the part. No sooner do the vessels become overloaded with blood than part of it either entire, or in the form of serous fluid, is separated from the vessels. Thus in inflammation of filamentous tissue blood or serum may be poured into its interstitial spaces; and the effusion of the latter is one cause of œdematous and anasarcous infiltration. In inflammation of the serous membranes also we shall find that effusion of serous fluid is an early and frequent result.

When this effusion is moderate it may be removed under suitable management by the action of the veins and lymphatics; and in such circumstances this termination would still come under the head of resolution.

γ. In general, however, the fluid effused is of a more complicated nature. The natural tendency of the process of inflammation is to cause the vessels to secrete or exhale, or effuse a fluid which at once contains coagulable lymph and a thinner serum, which, at a later period, at least in the filamentous tissue, corresponds to sero-purulent or purulent fluid. This serum is not converted, as

Cullen imagined, into purulent matter. But the same vessels which, at an early stage of the process, secrete serous fluid containing lymph, at a more advanced period secrete purulent matter. This is easily proved by tracing the progressive changes in a large wound; for instance an amputated stump, an incision made into an inflamed swelling, or an incision made on purpose into the soft parts of an animal. The same general conclusion results also from observing the progressive steps in the human body after a seton has been inserted, or an issue established. In the case of part of the surface being destroyed by caustic, actual or potential, the process may be less distinctly observed; but it is still nearly the same.

Upon the whole, the natural course of phenomena in inflammation may be stated in the following order. *First*, vessels dilated and distended with blood, which moves more slowly than natural. *Secondly*, the secretion or effusion from these vessels, or their exhalant terminations, of a fluid consisting of serum and coagulable matter, sometimes with extravasation of blood. *Thirdly*, the secretion of purulent fluid from the same vessels.

The intimate nature of the process by which purulent matter is formed is by no means well known. The notion of Grashuys, * that it arose from a liquefaction or melting of the adipose tissue, though adopted by Haller, † is too ridiculous to merit the slightest attention. It is sufficient to

* De Suppuratione. † Elementa, Lib. i. sect. 4.

remark, that purulent matter is prepared by many other tissues which contain no adipose matter; for instance the mucous and serous membranes, and several of the glandular organs, internal and external. The fallacy of the opinion of Cullen, which was derived from the experiments of Pringle and of Gaber, has been already noticed.

The view of Hunter is, on the whole, more correct. In inflammation of the filamentous tissue, where the parts, or more accurately the vessels, lose the power of resolution, they begin to " alter their mode of action, and continue changing till they gradually form themselves to that state which fits them" to prepare purulent matter. This applies, however, only to the case in which lymph is exuded and purulent matter is secreted, simultaneously or successively, or, in other words, to the transition from the adhesive to the suppurative stage. In certain circumstances this transition does not take place, and purulent fluid may be secreted without the previous effusion of coagulable lymph. The first action of the vessels is then to pour forth serous fluid, and the next is the secretion of purulent matter in a more or less perfect form. This is well exemplified in diffuse inflammation of the filamentous tissue.

No doubt can be entertained, from the experiments of Brugmann,* Hunter, † and Home, ‡ and

* De Puogenia. 8vo. Groningæ, 1781.

† Treatise on the Blood, Inflammation, &c. Chap. v.

‡ On the Properties of Pus. 4to. London, 1788.

from the daily phenomena of purulent collections, that suppuration is a process analogous to, if not the same as secretion. *

This is demonstrated in the case of mucous and serous membranes, in which purulent matter is formed without breach of surface, and in which, therefore, its formation must be ascribed to a new action of the vessels. It does not, however, follow from this that these vessels perform, as Hunter imagined, the office of a gland. This notion appears to be adopted merely to render the conception of suppuration more distinct than it would be if simply ascribed to the action of vessels.

Suppuration is the direct and exclusive, or the concurrent effect of inflammation. It is generally the direct effect in inflammation of the mucous membranes, often in that of the serous membranes, and it is so in diffuse inflammation of the filamentous tissue. In circumscribed inflammation in the filamentous tissue, in inflammation of the skin, and occasionally in inflammation of the serous membranes, it is preceded by exudation of coagulable lymph, and is either concurrent or successive to it.

Suppuration is represented by Hunter as always preparatory to granulation. This, however, must be understood to apply to suppuration of cellular tissue, and those textures of which it makes part. In mucous and serous membranes suppuration may, and almost invariably does, take place without

* "This new structure or disposition of vessels I shall call glandular, and the effect or pus a secretion." Chap. v.

granulation. I shall afterwards have occasion to mention another sort of purulent collections, in which granulation never occurs.

Suppuration varies according to the nature of the inflammatory process which it succeeds, and according to the texture in which it takes place.

As inflammation varies according to the nature of the texture in which it takes place, so its effects are different in the different organic textures. The purulent matter formed on the skin differs from that which flows from an abscess of the cellular tissue. That secreted by mucous membranes is different from either; and even the purulent fluid of serous membranes possesses certain characters by which a careful observer may distinguish it from the same fluid in other situations.

The suppurating process may be varied according to the nature of the inflammation by which it is preceded. A sound principle laid down by John Hunter was to regard every form of suppuration as the result of inflammation. From this, however, he departed in his views of the nature of suppurations of lymphatic glands, of diseased joints, of lumbar abscesses, and of the cold or chronic abscess in general. * It is easy to show, that,

* Many indolent tumours, slow swellings in the joints, swellings of the lymphatic glands, tubercles in the lungs, and swellings in many parts of the body, are diseased thickenings, without visible inflammation. And the contents of some kinds of encysted tumour; the matter of many scrofulous suppurations, as in lymphatic glands; the suppuration

with the single exception of pulmonary tubercles, in every one of the instances which he has adduced the formation of fluid matter, is invariably preceded by inflammation, that is, by morbid enlargement of the capillaries of the affected texture.

In the case of lymphatic glands suppurating, these bodies invariably enlarge previously, and are always the seat of dull heavy pain. This enlargement depends either on the vessels undergoing a slow process of dilatation and distension, or on the formation of tubercles in the substance of the gland.

The affections of the knee-joint, hip-joint, and other articulations, have been satisfactorily traced to inflammation either of the synovial apparatus, or of the cartilages, or of both, passing on the one hand to the capsule, and on the other to the bones. During life they are painful, generally swelled or enlarged, and invariably hotter than natural. Dissection shows these parts to be more or less, sometimes highly, vascular.

of many joints, viz. those scrofulous suppurations in the joints of the foot and hand, in the knee, called white swellings; in the joint of the thigh, commonly called hip-cases; in the loins, called lumbar abscesses; the discharge of the above-mentioned tubercles in the lungs, as well as in many other parts of the body, are all matter formed without any previous visible inflammation, and are therefore in this one respect all very similar to one another. They come on insensibly, the first symptom being commonly the swellings, in consequence of the thickening, which is not the case with inflammation; for there the sensation is the first symptom." —Treatise, Chap. iv. IV. p. 391.

The collections denominated *lumbar abscess* depend either on disease of the vertebræ, generally of an inflammatory nature, or on slow inflammation of the lumbar cellular tissue and lymphatic glands.

The circumstance on which Mr Hunter went, in considering these collections to be independent of inflammation, was the absence of pain as the first symptom. In this, however, I believe that accurate observer was mistaken. In every one of the cases of disease to which he refers as examples, more or less pain is invariably felt in the course, if not from the first date of the complaints. Two circumstances, indeed, distinguish this sort of pain. It is neither severe nor uninterrupted, and may be so moderate as not to attract the attention of the patient, or form a serious subject of complaint. But even admitting the statement of Mr Hunter, that the sensation of pain is not the first, it is doubtless too limited a view of the inflammatory process to imagine, that this can never exist unless when the sensation is the first symptom. In some of the textures, especially mucous membrane, we know that inflammation may be established for some time without much attendant pain. In others, especially the serous membranes, inflammation approaches so slowly and imperceptibly, that both lymph and purulent matter may be effused before the existence of the disease is suspected.

For these and similar reasons it has become requisite to admit the existence of a slow insidious form of inflammation termed *chronic*, correspond-

ing to the inflammation *by congestion* of Paré, Hildanus, Wiseman, and the older surgeons, and causing the *cold abscess* to which I had occasion formerly to allude. But, with the exception of its being attended with little or no pain, and proceeding much more slowly than acute inflammation, little is known regarding the anatomical and pathological characters of this form of the process. From several circumstances it might be inferred that the capillaries begin to assume the suppurative action, at least in filamentous tissue, more readily than in the case of acute inflammation. In other parts chronic inflammation may exist without terminating in the suppurative process.

In cases in which the acute seems to be combined with the chronic, so as to form an intermediate or mixed variety of disease, it has been distinguished by the name of *subacute* inflammation.

Under certain circumstances chronic inflammation may terminate in the acute. Thus an abscess in the cavity of a joint, either by distension or by propagation of action, may induce inflammation in the subcutaneous cellular tissue and in the skin. When a chronic abscess is opened, its whole interior surface is attacked with acute inflammation; and when a lumbar abscess is opened, or is allowed to burst, the same effect results. By carefully excluding the air, indeed, and healing up the wound according to the manner of Mr Abernethy, the severity of this inflammation may be much mitigated; but it always takes place, and

sooner or later becomes general and severe. In this sense only can suppuration be said to cause inflammation. But the proper view of the relation of these two processes is, that chronic inflammation may cause the acute form by the capillaries assuming a new mode of action, or by propagating the irritation to those of a new texture. In circumstances of this description suppuration is in general without granulation or attempt at repair.

δ. Suppuration may be either without attempt at repair, or with absolute destruction of texture; and it is then distinguished as *ulceration*, or the formation of an ulcer. Since the time of Hunter, who gave the first clear idea of this process, ulceration has been generally understood to consist in *absorption with suppuration*. This notion is perhaps more hypothetical than the old one of breach of surface or loss of substance, which simply expressed the fact without reference to its supposed cause. But as loss of substance implies the absorption or resumption of part of the animal texture, and as this must be understood to be effected by the vessels of the part, the chief objection with which this opinion can be charged, is, that not only the lymphatics, but the minute veins must be concerned in the process of resumption.

I do not propose here to consider all the various forms of ulceration, or the circumstances under which it may take place. But I shall mention a few by way of example.

Ulceration occurs in the skin in consequence of

inflammation from injury, as wound, tear, burn, &c., death of a part occasioned either by mortification, or by the cautery, actual or potential, or the application of a morbid poison.

Ulceration occurs in the mucous membranes under the same circumstances as in the skin, and also after spontaneous inflammation, that is, inflammation coming on without manifest cause.

Ulceration occurs in the cellular tissue in consequence of the pressure and progressive advancement of a large abscess; in consequence of the presence of foreign bodies, as bullets, sword-points, pins, &c.; or the sharp end of a bone.

Ulceration is not common in serous membranes. In these, however, it takes place in consequence of the continued pressure of large collections of matter. This is seen in empyema and collections of purulent matter in the peritonæum.

Ulceration occurs in bone either spontaneously, or in consequence of the death of part of it. The former is seen in caries; the latter in necrosis and exfoliation.

Ulceration occurs in cartilage in consequence of inflammation. This is seen in diseases of the knee-joint and hip-joint.

In all cases of ulceration the capillaries of the parts are larger and more numerous than natural, and certainly contain more blood than in the state of health. This is seen very well in the case of ulcers of the cornea, which are invariably surrounded by an annular net-work of small vessels,

which in the sound state of that texture are invisible. In the skin it is very well established by incisions made in the treatment of boil and carbuncle. In both cases, if the incision be carried through either tumour, much more blood is discharged from the point where ulceration is established than at any other part. The same fact is demonstrated by the appearance of ulcerated patches of the intestinal mucous membrane.

In the process of ulceration it is generally possible to trace a final intention or definite purpose, after the accomplishment of which it ceases spontaneously. It takes place under circumstances in which it is requisite to remove some part of a texture which is either unsound, or has become foreign to the system, as in the case of dead bones, mortified sloughs; or to procure an outlet for some morbid fluid, as is seen in deep purulent collections; or to expel a foreign body from a situation in which its presence is injurious. Hence it has been justly remarked by Hunter, that every process of ulceration is preceded by adhesive inflammation at one or more points, sometimes round the whole line along which the ulcerating process takes place. The object of this is to prevent hemorrhage by the closure of vessels, and to prevent the diffusion of purulent fluid in situations where its presence would be injurious. In several situations, however, it fails to accomplish this purpose.

When the ulcerative process has effected the object for which it was commenced, a new mode

of action takes place. The vessels begin to deposit lymph in rounded masses, which become vascular; and all the phenomena of granulation succeed. In such circumstances, are we to suppose that the absorbing process has given way to that of deposition,—the action of veins and lymphatics to that of minute arteries?

In certain situations this process of deposition may be observed going on in one part of a sore, while that of removal, destruction, or absorption is proceeding in another. Thus in an eschar occasioned by a burn, or by cautery, actual or potential, while the process of ulceration is detaching the margin of the slough, a crop of granulations may be observed rising with equal rapidity and steadiness, and pushing off, as it were, the dead substance. The phenomena of these and similar processes present objections to the theory of Hunter.

ε. *Induration.* This, which by the older pathologists was thought to be *scirrhus*, (σκίῤῥος, *induratio*,) is occasioned by the effusion of lymph, which, as it coagulates, causes adhesion of the filamentous tissue either subcutaneous, or of any organ, *e. g.* a gland, the lungs, &c. It is not a termination so much as an effect of inflammation.

ζ. *Gangrene or Mortification.* This is much less frequent than has been supposed. It may occur in the skin, in mucous membranes, in fibrous structures, especially tendons, in bone, in cartilage, and in the substance of the lungs. In dry gan-

grene, *(necrosis, ustilago, mal des ardens,)* which is the most perfect specimen of the death of parts, it affects skin, cellular membrane, muscle, tendon, ligament, artery, vein, periosteum, bone, and cartilage indiscriminately and generally. Its anatomical character consists in coagulation of the blood in the vessels, always the capillary, sometimes the larger branches. But whether this be the cause or the effect of the death of the parts is uncertain. A fact formerly mentioned regarding the influence of ossification of the arteries in producing gangrene of the toes, feet, and legs in old persons would seem to show that it is the cause. The phenomena of the dry gangrene, or that produced by spurred rye and bad food, on the other hand, might favour the notion, that coagulation of blood is the effect. The gangrene produced by tight ligature, as in the case of tumours, may be referred to either head.

6. *Fever.* In this disease, whatever be its form, intermittent, remittent, or continued, the capillary vessels are the principal seat of disorder. Nor is the affection confined to the capillaries of one region, of one organ, or of one tissue. The seat of fever is to be sought neither in the capillaries of the brain and spinal chord, nor in those of the lungs, nor in those of the alimentary canal; but it is diffused over the minute ramifying communications of the aortic and venous branches in whatever part of the body these communications are found. To establish the truth of this statement

it is requisite merely to consider the phenomena of fever in the living body, and its traces and effects in the dead.

α. I presume that the affection of the capillary system of the brain, both cranial and vertebral, is too generally admitted to require being formally demonstrated. In point of fact, the pain of the head in the beginning of all fevers, the derangement of thought during their progress, and the tendency to stupor and absolute coma towards the conclusion, are sufficient alone to prove disorder of the cerebral capillaries. But when blood or serous fluid is found effused into the ventricles, when the vessels of the brain are found turgid, distended with blood, and more numerous than natural, it is impossible to resist the inference as to the overloaded state of the cerebral capillaries during life. I am aware that cases of fever are sometimes adduced in which neither pain of the head nor deranged thought are observed. I can only say, that among a very great number of cases which I have observed, though in a few the patient did not complain of headach, it was always possible to recognize more or less derangement of thought.

In all cases pain is felt when the patient coughs or stoops, or when the head is slightly shaken; and when no pain is said to be felt, it indicates that the stage of natural sensation is passed, and that he complains not, because he does not feel.

In ague the oppression of the cerebral capillaries may be so great as to constitute inflammation

(*Siriasis Ægyptiaca,*) or phrenitic ague, or in various degrees the sleepy quotidian, the sleepy, lethargic, hemiplegic, carotic, and apoplectic tertian, and the comatose quartan of practical authors; (Werlhof, Torti, Lautter, Morton, Sydenham, &c.); the same disease which has been named by Lancisi, Baglivi, and Morgagni, epidemic apoplexy. (*Apoplexia febricosa, Carus febricosus.*)

The disorder of the capillaries of the spinal chord is indicated by pain and weight in various parts of the column, by the derangement in the muscular motions, especially local palsy, *e. g.* of the arms, legs, &c. by the tetanic spasms and convulsions taking place in many fevers. After death much serous fluid flows from the *theca;* the vessels of the chord are distended and numerous; in all instances serous fluid is effused; and sometimes pure blood issues from its capillaries.

β. That the capillary system of the lungs is overloaded and oppressed in all fevers is one of the most certain points in pathology. During the ague fit the respiration is invariably quicker than natural, sometimes to the amount of thirty or thirty-six in the minute; the patient complains of a sense of weight in the breast, cannot breathe fully, pants, and has frequent cough. In continued fever the respiration is invariably quicker and more laborious than natural; a deep breath cannot be drawn easily; and more or less sense of oppression and weight is felt. I have found the respiration in continued fever so quick as thirty-six in

the minute, while in ordinary cases the application of the stethoscope indicates an embarrassed state of the circulation in the pulmonary capillaries. In persons predisposed, expectoration streaked with blood, (*hæmoptoe,*) is not unfrequent during continued fever.

The same conclusion is clearly established by examination of the lungs of persons cut off either by intermittent or by continued fever. In many instances of the former it induces bronchial inflammation, or proceeds to actual peripneumony or pleurisy, constituting the catarrhal, pneumonic, or pleuritic tertian respectively. (Werlhof, Torti, Lancisi, &c.) In the latter, the bronchial mucous membrane is always more or less red, sometimes crimson or purple, and much thickened ; the submucous tissue is brown and loaded with serous fluid ; and the minute vessels are much distended with dark-coloured blood. The serous surface of the organ is generally livid or marbled from this cause ; but the pleura itself is not much changed, save from bloody serum discharged into its cavity. The lungs in totality are generally dense, and firmer than in the natural state.

These changes arise from the minute ramifying vessels at the termination of the pulmonary artery, and the origins of the pulmonary veins being unusually loaded with blood. As they are more so than can be readily affected by the ordinary quantity of air admissible in such a state, imperfect respiration and undue change of venous blood

contributes powerfully to the bad symptoms and the unfavourable termination of the disease. In such a state of the organs of respiration the bronchial arteries are less able to counteract the bad effects of imperfectly respired blood, in so far as they receive from the aorta blood which has not been sufficiently arterialized.

γ. In the capillary system of the chylopoietic and assistant chylopoietic viscera traces of the same condition may be recognized, both from the symptoms during life and the appearances after death. In these organs two capillary systems may be distinguished, a primary and a secondary one. The primary is that which consists of the ultimate divisions of the splenic, gastric, and duodenal arteries, and of the superior and inferior mesenteric arteries, and their corresponding veins, which afterwards terminate in the splenic and superior and inferior mesenteric veins. The secondary capillary system is that which results from the union of the minute extremities of the portal vein, and of the hepatic artery with those of the *venæ cavæ hepaticæ*.

It is unnecessary to dwell on the proofs of the loaded state of the capillary system of the alimentary canal. It is sufficient to remind the student that the furred or brown tongue, the thirst, the sense of internal heat, the loathing, squeamishness, and sometimes sickness, with weight, oppression, and tenderness of the epigastric region, sufficiently demonstrate the morbid state of the capillaries of

the œsophagus, stomach, and duodenum; while the constipation of the bowels at the commencement, insensibility to cathartic medicine throughout, and occasional looseness at the conclusion, indicate the deranged condition of those of the intestines. After death the minute vessels of the whole of these parts are found much distended with blood, generally dark-coloured. (Hamilton, Mills, Bateman, Percival, &c.)

The portal vein constitutes, among the vessels of the digestive organs, a secondary capillary system, in which the blood is not less accumulated than in the primary one. It may be thought, that, as the blood is accumulated in the first, it ought not so readily to find its way into the trunk, branches, and ramifications of the second. But this objection will vanish, when it is remembered that at the same time both the primary and the secondary system of capillaries become overloaded. This state of the capillaries of the portal and hepatic system is established by the appearance of the liver in persons cut off by fever.

The spleen may suffer so much from this capillary distension as to resemble a mass of clotted blood without trace of organization.

This morbid and extraordinary distension of the primary and secondary capillary systems of the chylopoietic organs, though distinct enough in the fevers of temperate countries, is most conspicuously demonstrated in the agues and remittents of warm climates, and especially in the se-

vere and exquisite form termed *yellow fever*. In the former great sickness and epigastric tenderness, with more or less vomiting, are frequent, and in the latter constant symptoms. The vomiting, nevertheless, is not bilious, as has been too generally imagined. It is at the commencement always a watery fluid, evidently derived from the capillaries of the gastric, and perhaps the duodenal mucous membrane. (Dr John Hunter, Jackson, &c.) After some time it begins to be mixed with bile, expressed in all probability from the gall-bladder by the pressure of the stomach in the act of vomiting. A much more uniform occurrence, however, if the disease does not subside spontaneously, or is checked by art, is the gradual admixture of blood somewhat darkened with the watery fluid. This blood issues from the capillaries of the gastric and intestinal tissues by a process analogous to exhalation in the sound state, but differing in so far as in the capillaries, from which it proceeds, a degree of disorganization has taken place. As the blood escapes into the cavity of the canal originally not highly scarlet, it is rapidly blackened by the action of the carbonic acid and sulphuretted hydrogen gases, at all times present in greater or less quantity. This bloody exudation is at first scanty, but gradually increases as the disease goes on, until it constitutes the greater part of what is discharged both by vomiting and by stool. In the former case it forms the black vomit, *(vomito prieto,)* or coffee-ground

matter, so frequent in fatal cases of remittent or yellow fever. In the latter it forms the dark, tarry, or treacle-like stools mentioned by practical authors in the same disease. (Jackson, Hunter, Physic, Cathrall, Bancroft, &c.)

The description now given is general, and applies to this capillary disorganization, as it takes place both in bad agues and remittents, and in yellow fever. In the former it is less frequent, but nevertheless takes place sufficiently often. In the latter it is seen in its most exquisite form, and is almost invariable in fatal cases. Its origin and formation have been traced in the most satisfactory manner by repeated dissections.

The idea of black vomit being morbid or vitiated bile deserves no attention. In some instances of severe yellow fever a dark-coloured fluid of the same physical characters as those found in the intestinal tube, may be traced coming down the biliary and hepatic duct from the *pori biliarii.* This, however, instead of being bile, is blood which has oozed from the hepatic capillaries in the same manner as that from the intestinal ones.

δ. The capillaries of the urinary system are much affected during fever. Both in intermittents and in continued fevers bloody urine has been discharged.

ε. In the same manner the capillaries of the muscles, of the filamentous tissue, and of the skin are morbidly distended. One of the most common

symptoms of fever is pain, soreness, and a sense of bruising in the muscular parts and limbs in general. In fatal cases, when these parts are examined by incision, unusual vascular distension and extravasation of blood are frequently seen. The livid spots and patches, (*vibices, ecchymomata*) are proofs of the same state of the capillaries of the filamentous tissue, as petechial eruptions denote this in the skin.

In short, there is scarcely a texture or organ of the animal body, the capillaries of which are not disordered in the different forms of fever; and this disorder, instead of being confined to the capillaries of a single organ, is extended throughout the capillary system at large.

It is doubtless true that in individual cases this disorder may be greater and more distinct in one set of capillaries than in another. In one set of patients the capillaries of the brain may appear to be most disordered; in another those of the lungs; in a third those of the intestinal canal; and in a fourth those of the urinary organs. It is always found, however, in such cases, that the affection of one organ does not entirely exclude that of another; and while the capillaries of the one are very much affected, though those of the others are less so, they are by no means in the healthy state. In all cases of severe and exquisite fever, whether intermittent, remittent, or continued, the capillaries of the brain, of the lungs and heart, of the chylopoietic organs, of the urinary organs, of the

muscles, of the cellular tissue, and of the skin, are affected nearly in the same degree. (Macartney, Cooke, &c.)

An important question is to ascertain the precise nature of this affection. The dissections of Pringle, Home, Ploucquet, Mills, &c, as to the brain, those of Schenck, Morgagni, Lieutaud, Sarconi, and others, as to the thoracic organs, and those of Lieutaud, Petit and Serres, and Broussais, as to the intestinal canal, might favour the supposition that the morbid process of fever consists in inflammation. Against this conclusion, however, various facts and arguments may be adduced. *1st*, In fatal cases of fever unequivocal traces of inflammation are not uniformly or invariably found. The proportion in which these marks, as albuminous effusion, suppuration, ulceration, &c. are observed, is small compared with the number in which accumulation of blood in the capillaries, and more or less disorganization of these vessels are observed. *2d*, In cases of pure, genuine, and unmixed inflammation of the internal organs, whether spontaneous or from injury, the concomitant symptoms, though febrile, are totally different from those which distinguish either intermittent or continued fever. *3d*, The marks or effects of inflammation which are found in the bodies of persons cut off by fever are accidental complications, and may almost invariably be traced to inflammatory reaction supervening on the febrile process, in consequence either of the physical peculiarities of the individual, the local

weakness of the parts, or the influence of external morbific causes. *4th*, Inflammation is a local action confined to the capillaries of one tissue, or at most of one organ and contiguous tissues; and while the structure and functions of the organ may be completely impaired, those of others remain unaltered. In fever, on the contrary, the capillaries of all the tissues and of every organ are affected; and while no individual organ is much affected at the commencement, every organ suffers a little in the general disorder of the capillary system. *5th*, Inflammation gives rise to albuminous exudation, suppuration, ulceration, and in certain parts to serous, or sero-purulent effusion. In fever the morbid state of the capillaries terminates in complete destruction or disorganization of their organic extremities, and the consequent oozing of blood from the surface of the several membranes and organs.

In conclusion, though it may be regarded as established, that during the morbid process of fever the whole capillary system is unduly distended and loaded with an inordinate quantity of blood, which really moves more slowly and imperfectly than during health, we have no facts which enable us to determine what induces this peculiar and excessive accumulation. Much has been lately said of congestion, and especially venous congestion. The state of the capillary system which I have attempted to describe is that of congestion or accumulation; and so far the hypothesis of congestion is intelligible. Of the existence

of venous congestion, however, unless as an effect of that in the capillary vessels, there is neither proof nor probability. It is not a primary but a secondary, or rather remote consequence. (Marsh.)

7. *Hemorrhage.* In all cases of hemorrhage, whether by rupture or by exhalation, the capillaries are unusually loaded with blood. This is established by the appearance of the brain in apoplexy, of the lungs in *hemoptysis*, (pulmonary apoplexy of Laennec, *pneumonorrhagia* of Frank and Latour,) of the prostate gland in chronic enlargement, (Home,) and the state of the mucous surfaces in general. In the two first cases, especially in that of the lungs, the pulmonic capillaries are large, numerous, and distended with blood, the pulmonic tissue more or less injected and firm, and blood is found oozing from the surface of the bronchial membrane. (Stark and Laennec.)

8. *Excess of Nutrition. (Hypertrophia.)* Hypertrophic augmentation. That every unusual increase in the size of parts is to be ascribed to the agency of the capillaries is well established by the phenomena of morbid enlargements and preternatural growths. Every instance of unusual or anormal size is of three kinds.

α. A texture or organ becomes enlarged in consequence of a uniform increase of its proper organic substance. Thus the heart becomes thicker, firmer, and larger in all its dimensions. Its muscular substance, and perhaps the intermuscular filamentous tissue, are actually augmented. They are redder, firmer, and contain more blood than na-

tural; and their blood-vessels are increased in size and number. The bladder in like manner undergoes the same change; and in its thickened and indurated tissue also dissection shows a more copious supply of blood, and a more abundant distribution of vessels than in the natural state.

Of this preternatural increase of bulk and density the capillaries of the organs are the sole agents. In some instances this hypertrophy appears to be of the nature of a chronic process of inflammation. This is exemplified in the case of the liver, the testicle, the prostate gland, the female breast, and even the heart.

β. Any individual texture may undergo a preternatural or anormal enlargement by local deposition of matter similar to itself. Thus a bone may become enlarged, as in *exostosis;* a gland may become enlarged, as in various instances the testicle and the female breast do. That the skin is liable to a particular species of hypertrophic augmentation is well ascertained from cases given by many authors, but especially from one recorded by Mr John Bell.* In mucous membrane, lymphatic gland, and secreting glands, similar local augmentations take place.

γ. In any tissue or organ a deposition of new matter altogether foreign to that tissue may take place. This new matter may be either similar to that of some natural tissue of the animal body; for example, it may be serous membrane, or bone,

* Principles of Surgery, Vol. III. Discourse ii. Case of Eleanor Fitzgerald.

or cartilage; or of a nature entirely dissimilar, and never seen unless in the morbid state; for instance, the several varieties of tubercular deposition, of scirrhous deposition, of fungoid deposition, and several of the forms of *sarcoma* enumerated by Mr Abernethy.

In whatever mode these new productions vary in intimate structure, all agree in being connected with more or less augmented developement of the capillary system. In many the growth, if not the origin, can be traced to the increased number, or at least enlarged size, of the capillary arteries. In most of these tumours the vessels are large, numerous, and well filled with blood; and if divided in the living body they are the source of abundant hemorrhage. In some instances these vessels penetrate from the adjoining tissue all round the tumour in the form of numerous minute arteries, which afterwards are ramified in the tumour. In others, which are perhaps more numerous, they enter at one point in the shape of three or four large trunks, which are afterwards divided in the substance of the growth.

As these new or foreign growths, therefore, are known to abound in capillaries, it is inferred, that, if this abundance of vessels be not the direct cause, they furnish the materials of growth. The difficulty in the theory of their formation is to ascertain the circumstances which first determine this local developement of the capillary system. In some instances it can be distinctly traced to mechanical injury, (John Bell and Abernethy.) After

a bruise, for example, blood and lymph being poured forth, instead of being absorbed, become penetrated with vessels, which conversely are stimulated by the presence of this substance to convey more blood, and thus enlarge in size. In others this local capillary developement commences without obvious cause. Upon the whole, the growth of tumours is to be viewed as the result of an aberration or anormal action of the usual nutritive process to which the capillary vessels are subservient.*

The theory of tumours or morbid growths depending on inordinate local developement of the capillary system was understood by Valsalva, Morgagni, Pohl, and others, but has recently been much illustrated by John Bell and Mr Abernethy. †

* "As wounded parts are healed by adhesion, so are dilated or strained parts by increased nutrition."—"Tumour and various modifications of disease follow from the same law of vascular action and nutrition which maintained health. If each individual vessel, whether artery or vein, have its coats thickened by dilatation or partial laceration, the same must be presumed of each minuter vessel in the distended womb, of each lesser vein and petty artery in a piece of distended skin, or in a diseased gland. The enlargement, then, of each blood-vessel by deposition of nutritious matter along its sides makes not a mere distension of vessels, but a solid and permanent bulk. The more vessels are enlarged consistently with their healthy action, the more particles are they able to secrete; whence the increment of tumours is perpetually accelerating, unless when opposed by peculiar causes."—The Principles of Surgery, by John Bell, surgeon. Vol. III. Discourse ii.

† An Attempt to form a Classification of Tumours according to their Anatomical Structure, by John Abernethy. London, 1811.

CHAPTER VII.

ERECTILE TISSUE,—*Vasa Erigentia*,—*Vascula Erectilia*,—*Tissu Erectile*.

SECTION I.

THE system of capillary arteries and veins does not present the same arrangement in all situations or in all the tissues of the human body. Among the terminations of arteries enumerated by Haller, one which he referred to the head of exhalants was that of a red artery or arteries pouring their blood into the spongy or cellular structure of the cavernous bodies of the nipple, the clitoris, and the penis, that of the wattles of the turkey, and the comb of the cock. * His detailed examination of these parts shows, that, with a correct knowledge of their anatomical structure, he had not a very distinct conception of the manner in which their vessels are disposed.

Bichat remarked that the spleen and the cavernous body of the penis, instead of presenting, as the serous surfaces, a vascular or capillary network, *(reseau vasculaire,)* in which the blood oscillates in different directions according to the impulse which it receives, exhibit only spongy or la-

* Elementa, Lib. ii. sect. 1. sect. 24. III. p. 102.

mellar tissues, still little known in their structure, in which the blood appears often to stagnate instead of moving. As this peculiar structure was known in the cavernous body to be the seat of a motion long known by the name of *erection*, MM. Dupuytren and Richerand distinguished this arrangement of arteries and veins as a peculiar tissue, under the name of *erectile*,—a distinction which, though partly understood before, has only now been admitted as well-founded in the writings of anatomical authors. According to the recent arrangements of M. Beclard this tissue comprehends not only the structure of the cavernous body, but that of the spongy substance, *(corpus spongiosum,)* which encloses the urethra, and forms its two extremities, the bulb and gland, the *clitoris*, the *nymphæ*, and the nipple of the female, the structure of the spleen in both sexes, and even that of the lips. *

It is somewhat unfortunate that the researches of anatomists on this erectile tissue have been restricted chiefly to the spongy body of the urethra and the cavernous body of the penis ; and it is rather by analogy than very direct proof, that similarity of structure between them and the other parts referred to the same head is maintained. I shall state here what is most satisfactorily known on the subject.

* Additions à l'Anatomie Generale de Xav. Bichat, par P. A. Beclard, p. 118.

The cavernous body of the urethra, or what is now termed its *spongy body*,* is represented by Haller to consist of fibres and plates issuing from the inner surface of the containing membrane, and mutually interlacing, so as to form a series of communicating cells,† into which the proper urethral arteries pour their blood directly during the state of erection.‡

The cavernous body of the penis is in like manner represented to be a part of a spongy nature, or to consist of innumerable sacs or cells separated by plates and fibres, which at the moment of erection were distended with blood poured from the arteries, and which was afterwards removed by some absorbing power of the veins.

This opinion, which was that of many subsequent anatomists, even Bichat himself,§ was derived apparently from the facility with which the blood so deposited escapes, not, as it was believed, from divided vessels, but from *areolæ*, or interlaminar spaces. It appears, however, to have been at variance with what had been anciently

* Haller applies the name of *cavernous body* not only to the structure of the penis, but to that of the urethra.—Elem. Lib. xxvii. Sect. 1.

† Elementa Physiologiæ, Lib. xxvii. sect. 1. § 33.

‡ "Sed et in pene, et in clitoride, et in papilla mammæ, et in collo galli indici, nimis manifestum est, verum sanguinem effundi, neque unquam ejus color totus de iis partibus evanescit, quæ ab effuso sanguine turgere solent."—Elementa, Lib. xxvii. sect. 3. § 10.

§ Systême Absorbant, § 3. p 598.

taught by Vesalius, Ingrassias, and Malpighi, and more positively stated regarding these vessels by Hunter; and modern researches have shown it to be completely erroneous. Cuvier and Ribes in France, Mascagni, Paul Farnese, Moreschi in Italy, and Tiedemann in Germany, have shown that there are no cells or spongiform structure in the erectile tissue of the cavernous body.

The first correct view of the structure of parts of this description in the human subject was given by Mascagni in his account of the arterial and venous communications in the Spongy Body of the Urethra. In 1787 he announced in his work on the Lymphatics, that the parts called cavernous bodies, both in the *penis* and in the *clitoris*, were simply fasciculi, or accumulations of arterial and venous vessels without interruption of canal; but that between the arteries and veins of the spongy bodies a dilated cavity or minute cell was interposed. In 1795 repeated minute injections led him to doubt the existence of this sort of cell; and about the close of 1805 he publicly demonstrated the fact, that many veins of considerable calibre collected in the manner of a plexus, with corresponding arteries, but small and less numerous, really form the outer and inner membranes of the urethra, the whole of the *glans penis*, and the whole substance of the spongy body. In each of these parts, and also in the spongy structure inclosing the orifice of the vagina, he ascertained by repeated injections that there are no

cells, as was imagined, and that the arteries, reflected, as it were, give origin to numerous veins,* which, forming an intimate plexiform net-work, constitute the whole glans, and the entire vascular body which surrounds the urethra and the entrance of the vagina.

In the cavernous bodies of the penis and clitoris he had not sufficient facts to ascertain the existence of the same structure, as he had never succeeded in injecting these parts so completely as the *glans* and the spongy part of the urethra. Eventually, however, he succeeded, especially in children, in injecting fully these cavernous bodies of the penis and clitoris. He found in their interior nothing but *fasciculi* of veins, with corresponding arteries, but rather smaller. He inferred, therefore, that these vessels, collected and ramified in various directions, constitute a vascular texture capable of expanding and shrinking, according to the quantity of blood conveyed to it. †

The general accuracy of this description has been since confirmed by the researches of Paul Farnese and Moreschi. The latter especially has shown, 1*st*, That the glans consists of arteries and

* "Le arterie vi si ritorcono, et danno origine alle vene, e queste formano in seguito alcuni plessi, i quali accumulati in varia maniera, instituiscono tutto il glande, e tutta quella massa vascolare, che trovasi intorno al' canale dell' uretra, e all' ingresso della vagina." Prodromo della Grande Anotomia di Paolo Mascagni. Folio, Firenze 1819. Capitolo II. p. 61.

† Prodromo del Paolo Mascagni, *loco citato*, p. 61.

a very great number of minute veins, which pour their blood into the cutaneous dorsal vein; 2*d*, That the urethra, and especially its posterior part, may in like manner be shown to consist of numerous minute veins, which terminate in a posterior branch of the dorsal vein, and communicate with the veins of the bulbous portion of the urethra; and, 3*d*, That in the cavernous bodies, though also receiving blood-vessels, these are much less numerous, and are chiefly derived from the urethral vessels. *

The same arrangement was recognized by Cuvier in the penis of the elephant, and by Tiedemann in that of the horse.

Upon the whole, the facts collected by different anatomists on this subject furnish the following results.

If the arteries, on the one hand, be injected, they are found to terminate in very fine ramifications, the disposition of which is exactly the same as in other parts. If, on the other, the veins be injected, it is easy to perceive the two following circumstances. 1*st*, That they are much dilated at their origin, that is, that the venous *radiculæ* are really more dilated than might be anticipated from the other characters of these vessels. 2*d*, That the tubular dilatations to which they are accessory,

* Commentarium de Urethræ Corporis Glandisque Structurâ 6to Idus Decembris 1810 detectâ Alexandri Moreschi, Eq. Coron. Ferreæ in Ticinensi primum, tum Bononiensi Archigymnasio, Anatomes Professoris Mediolani, 1817.

form very numerous inosculations or anastomoses, precisely as the capillary system of which they constitute a part. The effect of this arrangement is to give these vessels the appearance of being penetrated with sieve-like openings, which makes them resemble *areolæ*, or interlaminar spaces mutually communicating. As the whole difference, therefore, between the capillary vessels of this and other parts of the human frame consists in the minute veins (*radiculæ venosæ*) being dilated or distended in a peculiar manner, M. Beclard concludes, that the erectile tissue of the cavernous body consists simply of minute arteries and dilatable veins interwoven in the manner of capillary nets. These distended venous cavities are indeed so remote from being cells, that they are truly continuous with veins, the inner membrane of which may be easily recognized among them. *

During erection the blood accumulates in this tissue; but the cause and mechanism of this accumulation are completely unknown.

The spleen, M. Beclard thinks, may be said to resemble the cavernous body both in structure and phenomena; and he considers it as at once consisting of erectile tissue, and to be the seat of a species of erection more or less similar to that of the cavernous body. This organ, he argues, becomes the occasional seat of a motion of expansion and contraction; and he adduces the three following conditions in which it takes place. 1*st*, In ex-

* Additions, p. 119.

periments; when in a living animal the course of the blood in the splenic vein is arrested, the spleen swells, but returns to its former dimensions as soon as the circulation is restored. *2d*, In diseases; the paroxysms of intermittent fever are accompanied with obvious enlargement of this organ, which subsides at the conclusion of the paroxysm. *3d*, It appears that the same phenomenon takes place during digestion.

Sir Everard Home, with the assistance of the microscopic inspection of M. Bauer, has made many observations on the structure of this organ. But his purpose appears to have been more particularly directed to ascertain the phenomena of its function and uses; and I cannot discover that his ideas on its intimate structure, and the arrangement of its capillary system, are very precise or distinct.

The most distinct examples, in short, of erectile tissue are to be found, according to Beclard, in the spongy texture which surrounds the *urethra*, in the cavernous body of the *clitoris*, the vascular structure of the *nymphæ*, and in the nipple of the female. The structure of the lips in both sexes is not unlike. The veins of these parts may be shown to be well-marked and largely dilated at their origin, so as to give the appearance of cellular net-work. The same disposition is observed in the pulp of the fingers. It has been attempted to explain the motions of the iris

by supposing it to be formed of this erectile tissue; but the justice of this conjecture seems doubtful.

The peculiar arrangement of vessels constituting the erectile tissue was very nearly anticipated by our countryman William Cowper, who states, that he demonstrated the direct communication of arterial and venous canals, not only in the lungs, but in the spleen and penis, " in which," says he, " I have found these communications more open than in other parts." *

In the tissue now described it is manifest that the physiologist ought to place the phenomena of the process distinguished by the name of vital turgescence *(turgor vitalis)* by Hebenstreit, † Reil, ‡ Ackermann, § and Schlosser. || Though these authors suppose vital turgescence in different degrees in almost all the textures of the animal body, their most distinct examples are taken from those parts which consist of erectile vessels. After the explanation of the anatomical structure above given, it is superfluous to seek for any other

* Philosophical Transactions, No. 285, p. 1386.

† Brevis Expositio Doctrinæ Physiologicæ de Turgore Vitali. 1795. Ab Ernesto Benjamino Gottlieb Hebenstreit, M. D. &c. extat in Brera Sylloge Opusculorum Select, Vol. II. Opusc. vi.

‡ Archiv. für die Physiologie, I. Band, 2. Heft, S. 172.

§ Ackermann Physische Darstellung der Lebenscraft, 1797. 1. Band, S. 11.

|| Georgii Eduardi Schlosser Dissertatio de Turgore Vitali ext. in Brera Sylloge, Vol. VII. Opusc. ii.

cause except the arrangement of the minute vessels, and especially that of the veins.

Section II.

Little is known regarding the peculiar pathological states of this tissue.

1. *Rupture* of its vessels occasionally occurs, but is not attended with peculiar phenomena, unless there is an external communication, when hemorrhage takes place.

2. It is liable to a peculiar species of enlargement or swelling, in which the parts are very tense, and resemble a swollen bladder. They have an œdematous appearance, yet it is not œdema. This is often seen in *phimosis* and *paraphimosis*, in enlargement of the *nymphæ* and *labia* in females, and in a swelling incident to the eyelids after the application of leeches in both sexes.

3. *Priapism* is a morbid state of the erectile tissue of the cavernous body. The painful and anomalous mode of erection termed *chordee* appears to depend on the erectile tissue of the *corpus spongiosum* being unduly irritated by the presence of the inflammatory stimulus in the urethral membrane and its submucous tissue. There is at the same time, however, a spasm of the erector muscle, *(ischio-cavernosus,)* which, Haller justly remarks, instead of erecting the penis, ought to depress it.

4. Is the erectile tissue more prone to hemor-

rhage than others? Is this hemorrhage more frequently venous than arterial? These are points on which we have almost no certain information. Urethral hemorrhage, when violent and copious, may depend on rupture of the erectile tissue of the spongy body, or those vessels of the urethra which have been well delineated by Mr Shaw.* When it is so copious as to be restrained with difficulty, there is reason to believe that a communication is opened between the urethra and the communicating veins of the spongy body.

5. The disease described by John Bell and Mr Freer† under the name of *aneurism by anastomosis*‡ (*aneurysma per anastomosin*), termed by Meckel *angiectasia*, (Αγγειον εκτασις, *vasorum dilatatio*,) and by some of the German pathologists, *telangiectasis*, (*vasorum ultimorum distensio*,) appears to be an accessory or morbid form of erectile tissue occurring in parts naturally provided with simple capillary tissue. In some circumstances it is a congenital disease, and appears at birth like a *nævus maternus*. In its early stage the tumour is a mere pimple, and appears to

* Medico-Chirurgical Transactions, Vol. X. p. 342 and 357.

† Observations on Aneurism and some Diseases of the Arterial System. By George Freer, Fellow of the Royal College of Surgeons, London, &c. Birmingham, 1807, p. 34.

‡ The Principles of Surgery, in Two Volumes, &c. by John Bell, Surgeon, Discourse XI. p. 456, Vol. I. 4to Edition. 1801.

consist of a congeries of arteries and veins.* In this state it is firm, and the throbbing is indistinct; but as the cellular net-work, which ultimately forms the bulk of the swelling, is developed, it becomes more compressible, and the pulsation becomes more evident. At last it appears to consist of a cluster of sacs of a purple or livid colour, which burst from time to time, and bleed profusely. Anastomotic aneurism may occur in any part of the body in which the capillary vessels are numerous. Mr Bell saw it in the face, near the angle of the eye. Mr Freer saw it with-

* "The tumour is a congeries of active vessels; and the cellular substance through which these vessels are expanded resembles the cellular part of the penis, the gills of a turkey cock, or the substances of the placenta, spleen, or womb. It is apparently a very simple structure that enables those parts, (the womb, the penis, the spleen,) to perform their functions; and it is a very slight change of organization that forms this disease. The tumour is a congeries of small and active arteries, absorbing veins, and intermediate cells. The irritated and incessant action of the arteries fills the cells with blood; from these cells it is reabsorbed by the veins; the extremities of the veins themselves perhaps dilate into this cellular form. There seems to be a perpetual circulation of blood; for there is incessant pulsation. The tumour is permanent, but its occasional variation of bulk is singular. It swells like the penis in erection, or the gills of a turkey-cock in a passion. It is puffed up by exercise, drinking, or emotions of the mind. It is filled and distended with blood upon any occasion which quickens the circulation, as by venery, menstruation, the pleasures of the table, heated rooms, or the warmth of the bed."—Principles of Surgery, p. 457.

in the mouth, between the gums and the cheek. I have seen it on the gum. When it occurs on the surface of the body, its covering is so thin as to appear destitute of the usual corion. The pulsation in the tumour is increased by all those causes which accelerate the action of the heart.

6. Not dissimilar to the anastomotic aneurism is a species of throbbing tumour observed by Pearson,* and fully described by Scarpa.† In the latter instance a pulsating tumour, which had gradually attained the size of the fist, was formed in the substance of the anterior part of the tibia, beneath the periosteum, which had become thick and fleshy, and formed a sort of containing membrane. Its inner surface was villous and irregularly spongy, like the uterine surface of the placenta; and wax injected into the popliteal artery escaped from it, and was deposited between layers of coagulated blood, which must have proceeded from vessels opening on this surface. The substance of the tibia at the bottom of the cavity was rough, corroded, and partly destroyed.

After the limb was removed the patient remained well for five years, when the stump, and eventually the whole thigh, was attacked with painful pulsation. At death, which soon took place, the substance of the thigh-bone was found

* Medical Communications, Vol. II. p. 95 and 100.

† A Treatise on the Anatomy, Pathology, and Surgical Treatment of Aneurism. By Antonio Scarpa. Edinburgh, 1808, Case x., p. 439.

to be removed by absorption from the cut end to near the neck; and the periosteum, which was much thickened, was interspersed with largely dilated vessels, and formed a sort of capsule or inclosing membrane to the diseased parts.

This disease differs from anastomotic aneurism in its pulsation and distension being at all times the same, and in not presenting the phenomena of erection. Though it is mentioned in this place from its general resemblance to that disease, it may be more justly regarded as genuine aneurism of the capillaries.

CHAPTER VIII.

System of Exhalants, *(Vasa exhalantia.)*—Exhalant System, *(Systeme Exhalant.)*

Section I.

Are there such vessels as the exhalants described by physiological authors? Is their existence proved by observation or inspection? If not, what are the proofs from which their existence has been inferred?

The existence of minute arteries, the open extremities of which are believed to pour out various fluids in different tissues of the human body, has long been a favourite speculation with physiological anatomists. The decreasing vessels *(vasculo-*

um continuo decrescentium multi sibique succeden-es ordines,) * and exhalant orifices of Boerhaave, ure, or should be known to almost all. Haller as-ribes to the skin, membranes of cavities, (*serous membranes,*) ventricles of the brain, the chambers of the eye, the cells of the adipose membrane, the vesicles of the lung, the cavity of the stomach and intestines, an abundant supply of these exhalant arteries or canals, which, according to him, pour out a thin, aqueous, jelly-like fluid, which in dis-ease, or after death, is converted into a watery fluid susceptible of coagulation. The existence of these vessels, he conceives, is established by the watery exudation which appears in these several parts after a good injection of the arteries. †

As these minute canals, however, through which this injected fluid is believed to percolate, have never been seen, or rendered capable of actual in-spection, their existence was denied by Mascagni, who ascribed the phenomena of exhalation to the presence of inorganic porosities in the arterial pa-rietes, through which he imagined the fluids tran-suded to the membranes or organs in which they were found. This mechanism, which was equally

* Haller, Elementa, Lib. ii. sect. i. and his Notes on Boerhaave, Prælectiones, Tom. II. p. 245.

† "Aqueum humorem de arteriis perinde exhalare, olei terebinthinæ, aliorumve pigmentorum et vivi argenti iter persuadet, quod anatomica manu impulsum, aut omnino vivo in homine a consuetis naturæ viribus eo deductum, in ejus humoris, quam vocant cameram depluit."—Elementa, Lib. vii. sectio 2. § 1.

invisible with the Hallerian, was, for obvious reasons, denied by Bichat, who resolved to reject every opinion not founded on anatomical observation, and to determine the existence of the exhalants by this evidence alone. Obliged, however, to avow the difficulty of forming a distinct idea of a system of vessels, the extreme tenuity of which prevented them from being seen, he undertook to attain his object by what he terms a rigorous train of reasoning.

This consists in nothing more than the effects observed to result from fine and successful injections of watery fluids, or of spirit of turpentine containing some finely levigated colouring matter, from the phenomena of active hemorrhage, which Bichat considers merely as exhalation of blood instead of serous fluid, and from a multitude of considerations which are to be unfolded in the course of further examination of the subject. In this manner he believes himself warranted to conclude, that the only things rigorously ascertained are, 1*st*, The existence of exhalants; 2*d*, Their origin in the capillary system of the part in which they are distributed; and, 3*d*, Their termination on the surfaces of serous and mucous membranes, and the outer surface of the corion or true skin.

The exhalant vessels, the existence, origin, and termination of which he thus proved, he distinguished into three classes. The first contains those exhalants which are concerned in the production of the fluids, which are immediately removed from

the body,—the cutaneous and the mucous exhalants. The second contain those exhalants which are employed in the formation of fluids, which, continuing a given time on various membranous surfaces, are believed to be finally taken again into the circulation by means of absorption. And the third class consists of the exhalants concerned in the process of depositing nutritious matter in the different tissues and organs of the human frame. This arrangement is more distinctly seen in the following table.

Exhalants may be

1. Exterior, opening on natural surfaces or canals.	Cutaneous. Mucous.
2. Interior, opening on membranes, or within cellular textures.	Serous. Synovial. Cellular. Medullary.
3. Nutritious.	

Each organic tissue is in this system supposed to have its appropriate exhalant arteries, from which it derives the material requisite for its nutrition.

It is undeniable that this arrangement is at once clear, and possesses a sort of interesting regularity, which would prompt the wish that the existence of these vessels was actually demonstrated with certainty. It is evident, however, that the regularity of arrangement is the only advantage which it possesses over the views of those authors, whose method and opinions Bichat professed not to follow. The existence of exhalants is just as little proved in the rigorous reasoning of Bichat as in the fanciful theories of Boerhaave, the generalizing conclusions of Haller, or the

bold supposition of lateral porosities by Mascagni. This defect in his system has therefore been recognized recently both by Magendie and Beclard, the first of whom, though he admits the existence of exhalation as a process of the living body, allows that no explanation of its mechanism or material cause has been given, and asserts that Bichat has created the system of vessels termed exhalants ;—while the second thinks that anatomical observation furnishes no evidence of their existence.

The colourless capillaries, he observes, which are admitted by all, and the existence of which is satisfactorily established by the well-known experiment of Bleuland, proves nothing whatever concerning the existence of exhalant vessels ; for these colourless arteries are observed to terminate in colourless veins, and there is no proof hitherto adduced of their proceeding further, or terminating by open mouths. He admits that the fact of exhalations in the living body, of nutrition, of transudation by arterial extremities, shows that these extremities possess openings through which the fluids of exhalation, the materials of nutrition, and the matter of injection escape. But whether these openings are found at the point at which the capillary arteries are continuous with veins, or belong to a distinct order of vessels continued beyond these arteries, is a question which observation has not yet determined, and which it perhaps is unable to determine. Such is the present state of knowledge in relation to the existence of exhalant arte-

ries. While the process of exhalation is admitted and believed, we must avow, as Cruickshank did long ago, that we are unable to prove satisfactorily the existence of any set of vessels, or any mechanism by which it might be accomplished.

This difficulty, however, need not prevent us from observing, that this is the proper place for noticing those morbid changes which are referred to the process of exhalation.

Section II.

The exhalations, properly so called, may be morbidly augmented or diminished, or quite changed.

1. The best examples of morbid increase of exhalation is conceived to be found in those of the serous membranes, giving rise to the disease termed *dropsy. (Hydrops.)* It is most frequent in the peritoneum and in the general cellular membrane; less so in the pleura and pericardium, and in the arachnoid membrane or its divisions. In a local form it is very frequent in the vaginal coat of the testicle. Recent observations on this morbid change, and on the state of the system when under its influence, would lead to the conclusion, that it is rarely a primary process, but is generally to be considered as the effect of another,—as the symptom of a peculiar condition of the system of capillary arteries going to the tissue which is the immediate seat of exhalation.

The conditions of the capillary system in which exhalation is preternaturally augmented are referable to two general heads. The first of these is the state of distension which takes place during inflammation, fever, &c. The second is the distension which results from any mechanical impediment to the free motion of the blood in a venous trunk or trunks, or in the arteries.

α. That the distended or overloaded state of the capillaries which occurs during inflammation may cause a great and disproportionate increase in the fluid exhaled, is established by the phenomena of inflammation of the filamentous tissue, and especially of the serous membranes. In the former, œdema and anasarca are results by no means unfrequent. In the latter, one of the first effects of inflammation, under certain circumstances, is effusion of fluid more or less copious, and containing various proportions of coagulable matter. If the proportion of the latter be great, its coagulation forms organizable lymph, which is the medium of adhesion, while the serous part disappears, apparently by absorption. If it be small, its coagulation gives rise to mere loose flakes, which, with the constant increase of the quantity of fluid effused, are unable to maintain their attachment to any part of the membrane; while the thin serous part is so copious, that, as it is not removed by the veins and lymphatics, it remains in the form of a serous, a sero-sanguine, or a sero-purulent fluid, constituting genuine dropsy. The detailed examination

of this morbid accumulation belongs to the chapter on the serous membranes.

That the capillary distension which takes place in fever is a frequent cause of anormal exhalation, is shown by the collections of limpid serum often found in the brain and spinal chord, by that sometimes seen in the pericardium, and by the brownish watery fluid often found in the pleura in the bodies of persons cut off by any of the varieties of that disease.

β. The influence of impediment to the return of the venous blood in the production of extraordinary effusion has been known from the earliest periods of medicine. In proof of this I shall not adduce the experiment of Lower, who, by tying the *vena cava* in a dog, produced dropsy in a few hours; for the injury in such a case may produce inflammation of the peritoneum, and consequent effusion; and Hewson has justly objected to its competency, that the ligature might have included lymphatics along with the venous trunk. * Nor is it requisite to notice the experiments of Peyer, Bontekoe, and others. It is sufficient to say, that the fact is established by the effects of deranged circulation, as they take place, *first*, in veins; *secondly*, in arteries; and, *thirdly*, in both sets of vessels jointly, or in the capillary system.

To the first head are to be referred tumours in the vicinity, or affecting the substance of veins;

* Experimental Inquiries, Part ii. by William Hewson, F. R. S. London, 1774, p. 142.

various diseases of the right auricle and right ventricle of the heart; hard disorganization or tubercles of the liver; hepatization or tubercular disorganization of the lungs; hard disorganization or scirrhus of the pancreas and spleen; and compression of the ascending *cava* by the gravid womb during the latter stage of pregnancy. Of a more local character are the œdematous swellings which appear in the neighbourhood of tumours and abscesses. Thus in abscess, aneurism, or tumour of the arm-pit, and in scirrhus or cancer of the female breast, the whole arm becomes œdematous from the top of the shoulder to the tip of the fingers. One of the earliest symptoms of lumbar abscess is in some instances an œdematous enlargement of the leg of the side on which the abscess takes place; and almost all deep-seated collections of matter give rise to considerable œdema of the superior cellular membrane and skin.

The operation of the several circumstances now mentioned, though well understood by many pathologists, has been happily illustrated by M. Bouillaud, who has shown that in many instances tumours in the neighbourhood of venous trunks compress them so much as to produce obliteration of their canal. The interior of the vessel is then occupied with a clot of blood, solid, fibrinous, and more or less friable, manifestly produced by the blood being stopped in its course along the vein.*

* De l'obliteration des veines et de son influence sur la formation des hydropisies partielles, &c. Par M. Bouillaud

To obstruction of this description M. Bouillaud traced several instances of partial dropsy.

Of the influence of the second cause in producing dropsical effusion, we have examples in that which results from enlargement of the right side of the heart, ossification and contraction of the mitral or semilunar valves, ossification of the coronary arteries, aneurism of the aorta or innominata, or even of the cœliac artery, all of which give rise to more or less serous effusion in the pleura, or a symptomatic dropsy of the chest.

The third condition is perhaps the most common origin of the symptomatic or secondary dropsies. Whatever retards the free circulation of blood through the minute arteries and veins of any organ or texture will produce one or other of the following effects ; viz. inflammation, injection with effusion of red blood, or effusion of serous fluid from the exhalants, according to circumstances. In subjects where the structure of the parts is somewhat lax and yielding, the last will be the most likely result ; and it may be regarded as the mere consequence of the mechanical obstruction which the blood encounters in its transit from the capillary vessels to the larger trunks. " The compression of a vein," it is judiciously remarked by Hewson, " may, by stopping the return of the blood, not only distend the small veins, but the small arteries ; and the exhalants may be so dilat-

interne des hopitaux civils de Paris.—Archives Generales de Medecine, Tome II. p. 188.

ed, or so stimulated as to secrete more fluid than they did naturally." * It is in general, however, a remote consequence, and is observed to take place only after the cause of deranged circulation has subsisted for some time. Thus tumours, tubercles, and other foreign growths of the brain give rise to watery effusion within its ventricles. Hepatization and tubercles of the lungs, chronic inflammation of the bronchial membrane, ossification, cancer, tubercles, and other morbid changes in the pleura, produce a symptomatic water of the chest. And in dysentery, tubercular disease of the peritoneum, and enlargement of the mesenteric glands, (*tabes mesenterica*), symptomatic ascites is a very frequent occurrence.

2. Unusual increase of exhalation may take place in the synovial membranes, either articular or tendinous. In the former case it constitutes one form of disease of the joints, to which perhaps the name of *hydrarthrus* ought to be restricted. In the latter inordinate exhalation producing effusion forms the elastic hemispheroidal tumour known under the denomination of *ganglion*.

3. Diminution of exhalation is rare, unless in consequence of an unnatural augmentation of it elsewhere.

4. *Hemorrhage.* The only example of complete change of exhalation is that termed by Bichat *preternatural exhalations, (exhalations contre nature;)* and the most common of this is when the

* Experimental Inquiries, Part ii. &c. p. 142.

matter exhaled consists not of the usual watery fluid, but of pure blood, constituting several forms of the disease termed hemorrhage. This bloody exhalation may take place either in the exhalations termed excrementitial, or in those termed recrementitial.

α. To the first head are to be referred those hemorrhages from the skin which are sometimes observed, and those from mucous membranes, which are very frequent during congestion of their capillary system. In the lungs, for example, nothing is more common than exudation of blood from the bronchial membrane during catarrh or bronchial inflammation. In such circumstances it is generally small in quantity, (*hæmoptoe*,) and unlike the copious and irresistible discharge of pulmonary apoplexy.

It is still more distinct in *hæmoptysis*, in which considerable quantities of blood issue from the surface of the bronchial membrane without breach or laceration, and consequently from the orifices of vessels by a process analogous to exhalation. (Bichat.) Is it also by exhalation that the copious discharge of pulmonary apoplexy takes place? On this point facts are wanting.

In hemorrhage from any point of the gastro-intestinal membrane the blood is exhaled in the same manner. The researches of Portal, * and

* Mémoires sur la Nature et la Traitement de plusieurs Maladies. Par M. Antoine Portal. Tome II. Paris, 1800, p. 108.

Abernethy * especially, as well as those of Bichat, establish the point as to the stomach and small intestines in *hæmatemesis* and *melæna*. In dysentery the blood, however copious it may appear, oozes from a large extent of the surface of the lower end of the ileum, and from that of the colon, without ulceration or gangrene, and evidently from the vessels of the villous membrane, which during health secrete mucous and intestinal fluid. The same is to be understood of hemorrhages from the rectum, indiscriminately known under the name of *hæmorrhois* and hemorrhoidal discharges, and erroneously supposed to proceed in all cases from the hemorrhoidal veins. The true source of many of those bloody discharges is the vessels of the villous membrane of the bowel.

In the exhalants of the genito-urinary mucous system the same condition takes place. Hemorrhage from the kidney, unless caused by *calculus*, is the result of exhalation. Menstruation, both in the sound state and when excessive, is equally so. (William Hunter apud Cruickshank, † Bichat.)

* On the Constitutional Origin and Treatment of Local Diseases. By John Abernethy. London, 1811.

† "It happened that a woman died when her menses were flowing. Dr Hunter examined the internal surface of the uterus, found it exceedingly red and loaded with blood; that the principal redness was from the distended and convoluting arteries. He pressed forward the blood, which was fluid, and which, he asserted, never coagulated, and saw it appear on the surface near the extremities of these arteries.

In all these cases of hemorrhage two conditions of the capillary and exhalant system may be remarked. *First*, In the capillaries an unusual proportion of blood is accumulated, so that the small ones conveying red blood become large and distended, and those conveying the colourless part are injected with red blood. *Secondly*, After this state has continued for some time, red blood is observed to ooze in minute drops from the surface of the membrane, and progressively to increase in quantity and superficial extent. The cause of this accumulation and consequent exudation is not known. To assert, as Bichat has done, that a change in the organic sensibility of the exhalants opens a passage through them to red unchanged blood, is to describe the fact in a different mode without explaining its reason. The hemorrhagic effort of Stahl, and the *error loci* of Boerhaave, are equally true and not less intelligible.

β. In the recrementitial exhalants, and first in those of transparent or serous membranes, though less frequently, the same anormal condition may be often recognized. In the pleura or the peri-

As this discharge happened instantly, and from the gentlest pressure of the finger, it could not be transudation, which always requires time; it could not be rupture of vessel. I have had several opportunities of repeating this experiment, which always succeeded in the same manner."—The Anatomy of the Absorbing Vessels of the Human Body by William Cruickshank. London, 1786. Chapter xi. The same fact has been satisfactorily established by observation in cases of prolapsed or retroverted uterus, when the blood is seen oozing from the villous surface of the organ.

cardium, and in the peritoneum, it is not unusual to find bloody fluids of various tints, evidently the result of exhalation. The fluid effused may be simply bloody serum if little blood is exhaled, very red if more is poured forth, or even, as I shall show afterwards, it may be pure blood. In several of the cases in which blood is found in the ventricles of the brain it cannot be traced to any other source save the exhalants of the choroid plexus; and blood may be shown to be effused occasionally from the outer division of the arachnoid membrane, and also from that which covers the spinal chord.

In each of these cases, whether the fluid is merely sanguinolent or is pure blood, it issues from the same vessels which, in the healthy state of the membrane, prepare its proper secretions. No rupture or breach can be recognized by the most accurate scrutiny. Bichat is disposed to view the sanguinolent effusions as the effect of inflammation, acute or chronic, or like dropsy, as the consequence of organic disease. The few cases hitherto accurately recorded show, that, whatever be the remote cause, the state of the capillaries of the serous membranes is much the same as those of mucous surfaces under similar circumstances.

I formerly spoke of hemorrhage occurring in cellular membrane. The blood is in this case derived from the exhalants of that tissue exactly as it issues from those of the serous membranes. As an active hemorrhage, it is not unfrequent in severe *phlegmon*, and in the bloody abscess, as it is

named, with which the practical surgeon is familiar. As a passive hemorrhage, it occurs in land-scurvy and in sea-scurvy.

In some instances the synovial membranes, both in joints and in the tendinous sheaths, are found to contain blood or bloody fluid, which must have issued from their exhalant arteries.

5. *Elephantia.* Another example still of disease to be referred to the head of anormal exhalation, is presented in the unshapely enlargement of a member, which has been termed elephant-leg, (*Elephantiasis,*) the glandular disease of Barbadoes by Hendy, and which is known in the east under the name of the Cochin-leg. Though most frequently seen in the lower extremity, it is not peculiar to this part; and authentic instances of its occurrence in the upper extremity are not wanting. Thus, Fabricius Hildanus relates a case of enlargement of the arm, (*brachium monstrosum,*) in a poor woman of Champs d'Or.* Henseler records and delineates an example of the same in the arm of a woman at Ulm;† and mentions an instance in the arm and leg at once in a woman at Dresden. And an instance not dissimilar in the person of a Hindoo was given not long ago by Mr Kennedy of Madras.‡ According to Dr Graves, it is most frequent in the

* Joannis Henseler, Historia Brachii Prætumidi. Extat in Haller Disputat. Chirurgia, Vol. V. p. 445.

† Centuria IV. Observ. 69, with a good wooden cut.

‡ Case of diseased arm, by Alexander Kennedy, Esq. Edinburgh Medical and Surgical Journal, Vol. XIII. p. 54.

upper extremity in Ireland. * Cases of the same kind from Caithness, Ross-shire, and, if I remember right, from the Shetland Islands, are occasionally seen here. The instances in the lower extremity are doubtless most common in tropical countries.

Though it has been the general practice since the time of Hendy to regard this disease as resulting from obstruction of the lymphatic vessels and glands, the phenomena of its formation and progress, with those of its morbid anatomy, show clearly, I think, that the inordinate enlargement arises from a quantity of albuminous or sero-albuminous fluid, being effused from the exhalants into the cellular tissue of the limb, and which is not removed by adequate absorption. That the enlargement is effected in this manner, and that the effusion is the result of some form of the process of inflammation recurring periodically, may be inferred from the following considerations :—

1*st*, In all the cases of the disease which have been accurately observed, the first attack of enlargement is preceded by general inflammatory action affecting the whole limb, described as similar to rose (*erysipelas*,) and distinguished by heat, pain, general swelling, and more or less redness. Of these symptoms the effusion and enlargement are a sort of natural crisis.

2*d*, In most, if not all the cases, this inflammatory attack recurs after certain intervals, which

* Dublin Hospital Reports, Vol. IV. Clinical Observations, by Robert Graves, M. D.

are progressively shorter, and always with the effect of increasing the enlargement.

3*d*, In all the cases in which the enlarged limb has been examined by dissection, the subcutaneous and intermuscular filamentous tissue is hardened, thickened, and condensed, and contains a quantity of granular matter, viscid and gelatinous in consistence, but like fat in appearance. This has not been analyzed; but little doubt can be entertained that it contains a good proportion of albuminous matter. That this is the essential change, is established by the testimony of many observers. (Jaegerschmidt, Henseler, Kennedy, Graves, Hull.) The distension of the skin, the enlargement of its papillæ, the slender blanched appearance of the muscles, and the enlargement of the inguinal glands, are effects only of the state of the subcutaneous and intermuscular cellular tissue. In short, until new facts be adduced, the description given by Dr Graves, and the case of Mr Hull, establish the inference, that the elephantine enlargement of the extremities is the result of gelatinous or albuminous exudation from the arteries of the subcutaneous filamentous tissue.

6. *Accidental Developement or Morbid Formation of the Exhalant System.* In several instances a process of exhalation takes place in certain textures in which it did not originally exist, at least under the same form; or a process of exhalation may go on without a corresponding one of removal by absorption. Of this anormal de-

velopement of the exhalant system, which constitutes the tumours called encysted, (*tumores cystici, tunicati,* Salzmann, Heister,) several varieties have been noticed by practical authors, as Ingrassias, Severinus, Tagault, Paré, Schelhamer, Astruc, Meckren, Heister, &c.; and the division of Celsus into *meliceris, atheroma,* and *steatoma,* has been repeated by the generality of writers, from Hildanus, to Monteggia, Abernethy, and Boyer. This division, to which I have already adverted in speaking of encysted tumours in the cellular tissue, is nevertheless imperfect; and indeed no distinct and connected arrangement of all the varieties of encysted tumour has yet been given, unless the seventh genus of the system of Plenck be entitled to this character. * Without attempting to specify the individual defects of the classification of this surgeon, I conceive I am justified in asserting, that one more strictly pathological may be given.

Considered as examples of inordinate exhalation without corresponding absorption, the species of encysted tumour may be enumerated in the following order.

α. ***Hydatids*** are cysts secreting limpid watery fluid. They have been commonly believed to be living animals. Independent, however, of the ambiguous nature of the proofs of this opinion, and the difficulty of demonstrating any thing like

* Josephi Jac. Plenck, Novum Systema Tumorum quo hi morbi in sua genera et species rediguntur. Viennæ, 1767.

an isolated animal existence, their connection with increased exhalation of serous membranes, their structure and intimate arrangement, and their contents, are circumstances more in favour of the opinion that they are pellucid serous cysts newly developed. By Plenck the hydatid is regarded as a variety of the next species—the *hygroma*. Combined with atheromatous or steatomatous matter, hydatid-cysts are occasionally found in the subcutaneous cellular tissue. (Heunden *apud* Tyson, sixty hydatids in a cyst in the neck.)

β. ***Hygroma.*** Cysts secreting serous, sero-purulent, or even a sero-sanguine fluid. This epithet Plenck applies to a spherical tumour containing coagulable lymph, evidently meaning fluid; and regards it as differing from the hydatid in size only, and from lymphatic (serous) tumours, by the possession of a membranous covering, or proper cyst. 'It is more expedient to apply it to all encysted tumours not manifestly hydatoid, which contain serous, sero-purulent, or viscid glairy fluid, or even reddish serum, in whatever situation they are found. The best example of this tumour is the cyst or cysts often found in the female ovary, in which they vary in size, and in the colour and consistence of their contents, from mere serum, with more or less albumen, to reddish, bloody, or even tar-like fluid. They occur in the brain, *e. g.* its hemisphere, * and in the pineal gland. The

* The Morbid Anatomy of the Human Brain. By Robert Hooper, M. D. Plates XIII. XII. Fig. 8. and XIV.

cases delineated by Hooper as vesicles and encysted tumour, are evidently of this description. Plenck admits the serous hygroma in the cellular membrane.

γ. *Hæmatoma.* A cyst secreting, or containing a bloody fluid. Severinus, Ingrassias, and more recently Monteggia, John Peter Frank, Scarpa, and Montini, mention examples of globular or spheroidal tumours containing blood more or less fluid within a membranous sac or covering. Under the name of *bloody abscess*, indeed, Severinus * assembles aneurisms, as well as the blood-cyst. Frank, I believe, first (1786) distinguished one of these tumours on the chin of a girl of nine, of the size and shape of a goose-egg, as of the encysted kind, and first applied to it the denomination of *hæmatoma.* † About the same time (1789) Monteggia described the bloody tumour similar to that of Severinus, as occurring in the arm-pit, and attaining a great size, and when opened speedily proving fatal. ‡ An example of the disease was afterwards seen by Scarpa in the same situation in the person of a priest about fifty, in the thyroid gland and neck of other subjects, and in the

* Marci Aurelii Severini apud Neapolitanos Medici ac Philosophi Regii, de Abscessuum Recondita Natura, Libri viii. Lugduni Batavorum, 1724. Lib. iv. Cap. vii.

† Joannis Petri Frank, Med. Clinic. in Ticinensi Academia, Prof. Discursus Academic. mense Junii 1786, habitus, Observationem de Hæmatomate, &c. exhibens. Delectus, Vol. III. Ticini, 1787.

‡ Monteggia, Fasciculi Pathol. p. 88. Mediolani, 1789.

breast of a lady;* and Montini saw it in the thigh of a woman in childbed at Lodi. †

From the united testimony of these observers, it appears that the blood-cyst *(hæmatoma)*, is a tumour consisting of a membranous sac, the inner surface of which is liberally supplied with blood-vessels, from which blood, or a bloody fluid, is incessantly oozing or distilling by exhalation. In some instances this fluid contains a proportion of fibrin sufficient to effect coagulation; and the interior of the cyst then resembles the spleen or a mass of clotted blood. From aneurism it may be distinguished by the following marks; that it does not throb; that it contains a fluid; that it is surrounded by bluish tortuous veins; and that it is dark or purple-coloured, while the investing skin is transparent. When seated in the neck, however, near the carotid artery, it may derive from it, or from the subclavian, a pulsating motion, which may give it the appearance of aneurism.

Its ordinary locality is easily understood from what has been already said. It occurs most usually in the filamentous tissue of the arm-pit and neck, in the substance of the thyroid gland, and at the knee. (Monteggia.) Zeller describes it as it appears in the brain of infants, under the name of *cephalæmatoma*. Dr Hooper has represented

* Treatise on the Anatomy, &c. Appendix, p. 456. See also Richter *de raro tumore mammæ*. Works of Else, and J. E. Pohl de Varice, § xi.

† Montini, Saggio di Osservazioni et Riflessioni Chirurgico-pratiche. Lodi, 1808.

an example of what he refers to this head in his tenth engraving. But from the description the justice of this appears questionable.* It is also mentioned by Dr Monro. †

δ. *Meliceris.* An indolent tumour, generally small, with smooth uniform surface, communicating a sense of fluctuation, and containing viscid matter of the aspect and consistence of honey. Seated always in the skin or its attached surface, meliceris consists in the enlargement of one of the subcutaneous glands or follicles, arising from obstruction of its excretory duct. The mechanism of its formation from this source was understood by Plenck ‡ and Monteggia, § and has been recently brought under notice by Sir Astley Cooper. ‖ It must not be forgotten, however, that it is to this variety only of encysted tumour that this mode of explanation is applicable. Meliceris is in short the only example of the *folliculated* tumour.

Meliceris may occur in any part of the person where sebaceous follicles exist. When on the scalp, they are distinguished among the older surgeons by peculiar epithets (*talpa et testudo;*) and

* Morbid Anatomy of the Human Brain, p. 27.

† Morbid Anatomy of the Brain, p. 56.

‡ Josephi Jacobi Plenck, Novum Systema, Classis vii.

§ "Alcuni cisti si formano per la chiusura del orificio escretore dè follicoli sebacei e mucosi." Instituzioni Chirurgiche di G. B. Monteggia, edizione seconda. Milano, 1813. Vol. II. capo xiii.

‖ Surgical Essays, by Astley Cooper, F. R. S., and Benjamin Travers, F. R. S. Part ii. London, 1819. Essay iii. On Encysted Tumours, p. 220.

natta when on the face. In such situations they often contain hair. Those which Severinus mentions at the wrist appear to have been *ganglia*; a mistake which enables us to understand why he doubted whether the meliceris was an encysted tumour.

ε. *Atheroma.* A wen or cyst, indolent, uniform on the surface, firmer than the *meliceris*, of the same colour with the skin, and containing granular semifluid matter like boiled meal or saw-dust. It is always confined to the cellular tissue. The mechanism of its formation is unknown, unless that proposed by Monteggia be admitted. According to this pathologist, the tumour may originate in slight adhesive inflammation of any definite portion of cellular tissue, in consequence of which one cell, being obstructed and prevented from communicating with others, is progressively distended by deposition of matter, which, pressing on the surrounding tissue, gradually condenses it into a membrane as it extends. To this idea objections have been already stated from Bichat; and it must be admitted that facts are still wanting to explain this otherwise than by saying, that the cyst is formed, and secretes its proper contents.

ζ *Steatoma.* A wen or cyst, containing adipose matter like lard, or fat void of its natural yellow colour, and become white, firm, and granular like suet, (Boyer,) with more or less albumen, approaching to the nature of adipocire. In the first case it is soft, compressible, and generally

small, and is not unfrequent in the eyelids and on the scalp. In the second case it is more common on other parts of the body; and the size which it then attains is enormous. In all surgical works almost instances are given of the extraordinary size of steatomatous tumours.* In some instances osseous matter is deposited either in the cyst, or with the sebaceous matter; a circumstance which has procured it from Plenck a separate place with the title of *osteo-steatoma.* † (Scheuzer, Hundtermarc, and Haller.) It is merely a variety of the steatom. The appearance of steatomatous cysts in bones and bony tumours, as seen by Kulm and Weidmann ‡, belongs to another place.

* *Vide* Joannes Philip. Ingrassias de Tumoribus. Severini, de Abscessum Naturâ Reconditâ, Lib. iii. Cap. xxii. Gulielmi Fabricii Hildani, Opera omnia. Francof. 1646. Gabrielis Fallopii, Op. Lib. de Tumoribus, p. n. c. 24. Fabricii ab Aquapendente, Lib. i. Ambrose Paré, Book vi. c. xix. one of twenty-six pounds. J. Langius;—one said to weigh sixty pounds. Papers in Haller's Disputationes Chirurgicæ, Vol. V. by Elsholz, Kell, and Friesse. Fred. Ruysch, Epist. ad Boerhaave. J. Palfyn. Anatomie du Corps Humain, B. ii. chap. ii. Two of great weight, one by Schrock, from Morgagni in the Ephem. Nat. Curios. Cent. 5. Ob. 27. and others in the same work. In the Phil. Transactions, Mémoires de l'Academie Royale de Chirurgie, &c. Edinburgh Medical Essays, Vol. III. Medical Com. I. 190. Ed. Med. and Surg. Journal, Vol. IX. J. P. Weidmann de Steatomatibus, 4to, Moguntinæ, 1817.

† Breslau Sammlungen, 1722, p. 319. Tittmani Dissert. Osteo-steatomatis, cas. rar. Halleri Opuscula Pathologica, Obs. 6.

‡ Joan. Adami Kulm, Disputatio Medico-Chirurgica de Exostosi Steatomatode, &c. Haller, Vol. V. p. 653. Weidmann, p. 6, and Fig. 5.

η. Lipoma. This name was first applied by Littre to a wen or cyst filled with soft matter possessing the usual properties of animal fat. * The matter of steatom, according to this surgeon, is either not, or imperfectly inflammable, by reason of its degeneration or commixture with some other animal secretion. The propriety of this distinction has been denied by Louis and others, who maintain that these tumours differ in nothing, unless perhaps in degree. It has been favoured, nevertheless, by Morgagni, and adopted by Plenck, Desault, Bichat, and various foreign surgeons, and is defended by Boyer, who represents the steatom as differing from *lipoma*, in the matter being white, firm, and changed from its original character, and in possessing the tendency to degenerate into cancer. † Plenck had previously distinguished the lipoma, by being destitute of cyst, a circumstance not required by Littre.

Though thus admitted to differ, the anatomical character, as given by Morgagni, ‡ and confirmed by Boyer, is in both nearly the same. A cyst containing unchanged fat, or granular adipose matter, in cells formed by the original fibres of the adipose membrane, according to Morgagni, or those of the filamentous tissue, according to Boyer. At

* Histoire de l'Academie Royale des Sciences, Anno 1709. Observat. Anatom. 3.

† Traité des Maladies Chirurgicales, Tome II. Chap. i. Art. 12.

‡ De Sedibus et Causis Morborum, Lib. iv. Epist. 1. Art. 24 and 25, and Lib. v. Epist. lxviii. Art. 6 and 8.

the base or stalk in the case of pendulous steatoms, the cells are compressed, but loose in the body of the tumour.

This description, with the alleged cancerous tendency, accords more with the characters of the adipose *sarcoma* than those of the genuine wen. Personal examination enables me to say, that, in the case of small steatoms of the scalp, eyelids, face, &c. no fibres of this kind are recognized ; and to such, if any distinction be adopted, the name of *lipoma* should be confined. In the case of such larger steatoms as I have seen in other regions of the body, though the contents are firmly connected together, and some filamentous threads may be seen here and there, or the tumour may be even separable into masses, I have not been able to trace the distinct arrangement of cells mentioned by Morgagni and Boyer. Weidmann mentions, that in one case the matter of steatom was a sort of liquefied fat, and in another firm and dense, and not divided into lobes or cells. (H.)

θ. Lupia. This term, which has been often applied generally to wens, (*loupes*,) is used in a more limited sense by Plenck, to designate a cyst containing a spongy substance in the cellular tissue, of which it is conceived to be a degenerate form. It is convenient as a head to which certain rare and anomalous cystic tumours may be referred.

ι. Melanoma. In many instances the melanotic matter, already mentioned, is deposited in a cyst. In such circumstances, therefore, it is referable to this head.

CHAPTER IX.

LYMPHATIC SYSTEM, (*Vasa Lymphatica,—Vasa Lymphifera,—Lymphæ-Ductus* of GLISSON and JOLYFFE.—*Systeme Absorbant,*—Die Saugadern.)

SECTION I.

IN most situations of the human body, and especially in the vicinity of arterial and venous trunks, there are found long, slender, hollow tubes, pellucid or reddish, which present numerous knots, joints, or swellings in their course, and to which the name of lymphatics or absorbents has been given. It is most expedient to employ the former appellation only, as the latter implies the performance of a function, the reality of which has been much questioned of late years.

Though Eustachius had seen the thoracic duct in the horse, and some slight traces of a knowledge of vascular tubes, different either from arteries or veins, are found in the writings of Nicolaus Massa, Falloppius and Veslingius, the merit of establishing their existence is generally ascribed to Caspar Asellius, a physician of Pavia. This anatomist, who had, in 1622, seen the white-co-

loured tubes, then first named *lacteals*, issuing from the intestines of the dog, observed also a cluster of vessels less opaque near the portal eminences of the liver,—an observation which he afterwards repeated in the horse and other quadrupeds. The same vessels were also described and delineated by Highmore.

Passing over the uncertain and obscure hints given by Walaeus and Van Horne, the first exact information after Asellius is that which relates to Olaus Rudbeck, who, in 1650, is said to have seen them in a calf, and to have demonstrated the thoracic duct, and the dilated sac, afterwards termed *receptaculum chyli.*

Glisson informs us that Jolyffe had, in 1652, imparted to him the knowledge of a set of vessels different from arteries and veins; and it appears from the testimony of Wharton, that Jolyffe had demonstrated these vessels in 1650.* In short, the discovery of lymphatics, and the correction of some errors of Asellius, is ascribed to the English anatomist, not only by Wharton and Glisson, but by Charleton, Plott, Wotton, and Boyle.

The existence of these vessels, thus partially demonstrated, was afterwards more fully established by the researches of Bartholin, Pecquet, Bilsius, Nuck, the second Monro, and Haller. It is chiefly to the exertions of William Hunter, and

* Francisci Glissonii Anatomia Hepatis, Cap. xxxi. Thomæ Wharton, Adenographia, Cap. ii. p. 98.

his pupils, Hewson,* Sheldon,† and Cruickshank‡ in this country, and to those of Mascagni§ in Italy, that the anatomical world are indebted for the complete examination and history of this system of vessels.

The lymphatic vessels consist, in the members, of two layers, a superficial and a deep-seated one. The first is situate in the subcutaneous cellular tissue, between the skin and the aponeurotic sheaths, and accompanies the subcutaneous veins, or creeps in the intervals between them. A successful injection of these superficial lymphatics will show an extensive network of mercurial tubes surrounding the whole limb.

The deep-seated layer of lymphatics is found chiefly in the interspaces between the muscles, and along the course of the arterial and venous trunks. In tracing both layers of lymphatics to the upper, fixed, or attached end of the members, we find they increase in volume, and diminish in number. At the connection of the members with the trunk, they are observed to pass through certain spheroidal or spherical bodies, termed lymphatic glands

* Experimental Inquiries, Part the Second. By William Hewson, F. R. S. London, 1774, 8vo.

† The History of the Absorbent System, &c. by John Sheldon, Surgeon, F. R. S. &c. London, 1784. Folio.

‡ The Anatomy of the Absorbing Vessels of the Human Body. By William Cruickshank. London, 1786, 4to.

§ Pauli Mascagni Vasorum Lymphaticorum Corporis Humani Historia et Ichnographia, folio, Paris, 1787. See also Prodromo, &c. Capitolo i.

or ganglions. The lymphatics of the upper extremity, after passing through the glands of the arm-pit, terminate in trunks, which open into the subclavio-jugular veins, one on each side of the neck. Those of the lower extremity, after passing through the glands of the groin, proceed with the common iliac vein into the abdomen, where they unite with other lymphatics.

The lymphatics of the trunk consist in like manner of two layers, a subcutaneous and deeper seated one, distributed in the chest between the muscles and pleura, and in the abdomen between the muscles and peritoneum. In the chest and belly, each organ possesses a superficial layer of lymphatics distributed over its surface, and pertaining to its membranous envelope; the other ramifying through its substance, and pertaining to the peculiar tissue of the organ. This twofold arrangement is most easily seen in the lungs, the heart, the liver, spleen, and kidneys.

In a similar manner are arranged the lymphatics in the external parts of the scull, on the face, where they are very numerous, in the spaces between the muscles, and on the neck, in which they pass through numerous glands. No lymphatics, however, have been found in the brain, the spinal chord, their membranous envelopes, the eye, or the ear.

All the lymphatics hitherto known terminate in two principal trunks. One of these, termed from its site *thoracic duct, (ductus thoracicus,* die Milch-

bruströhre, *canal thoracique)* is situate on the left side of the dorsal vertebræ. It receives the lymphatics of the lower extremities, of the belly, and the parts contained in it; those of great part of the chest, and those of the left side of the head, neck, and trunk, and left upper extremity. The other lymphatic trunk, which is situate on the right side of the upper dorsal vertebræ, is formed by the union of the lymphatics of the right side of the head, neck, right upper extremity, and some of those of the chest. Both of these trunks, it is well known, open into the subclavio-jugular vein of each side.

That lymphatics terminate in branches of the venous system has been asserted on the authority of various observers. Steno, for instance, states that he traced the lymphatics from the right side of the head, the chest, and pectoral extremity in animals into the right axillary vein; and he gives delineations of anastomotic connections of several lymphatics with the axillary and jugular veins. Similar facts have been reported by Nuck, Richard Hale, Bartholin, and Hartmann. Ruysch traced the lymphatics of the lung into the subclavian and axillary veins; Drelincourt those of the thymus gland in animals into the subclavians; and Hebenstreit saw those of the loins pass into the *vena azygos.*

Haller, though unwilling to deny the testimony of these observers, regards it liable to various sources of fallacy, and doubts the direct com-

munication of the lymphatic and venous systems. John F. Meckel, the grandfather, maintained the communication, from the circumstance, that he injected the lymphatics from the veins. Hewson, though not doubting the fact, regards it as an exception to the general rule. Cruickshank again, states that he never saw a lymphatic vessel inserted into any other red veins than the subclavians and jugulars. The termination remarked by Steno and his successors constitutes in truth the common trunk or lymphatic vein admitted by Cruickshank,—a *thoracic duct* of the right side.

Recently this mode of termination has been revived by Tiedemann and Fohman,* who, in the seal, state that the lactiferous vessels communicate with veins arising from the mesenteric glands, and pass thence into the venous trunks without proceeding through the thoracic duct. This, however, has been shown by Dr Knox to be a mistake, resulting from the decomposed state of the animals examined by the German anatomists †. M. Lauth Junior of Strasbourg, again, conceives that he has demonstrated, that lymphatics communicate with veins within the substance of organs, and in the interior of the lymphatic glands ;‡ an inference

* Anatomische Untersuchungen uber die Verbindung der Saugadern mit den Venen. Heidelberg, 1821.

† On the Anatomy of the Lacteal System in the Seal. Edin. Med. and Surgical Journal, Vol. XXII. p. 25. &c.

‡ Essai sur les Vaisseaux Lymphatiques. Strasbourg, 1824.

which at present requires further verification. (I.) The statements of Lippi of Florence, that every lymphatic almost communicates freely with venous tubes, is still more improbable, and has been rendered exceedingly doubtful by the recent researches of Rossi. *

The connections of the ends of lymphatics with the organs and tissues from which they arise, termed their *origins*, are completely unknown. In some favourable instances the lymphatics of the intestinal canal are so filled with a reddish or whitish fluid after the process of digestion has continued for some time, that not only are their larger branches easily seen, but by the aid of the microscope some of the smaller may be traced to their commencement. This, which was ascertained by Cruickshank, (p. 55 and 58,) and confirmed by Hewson, Bleuland, and Hedwig, has been contradicted by the observations of Rudolphi and Albert Meckel. In all other parts, however, though a successful injection may show the course and distribution of many of the smallest lymphatics, yet no orifices are perceptible at the point at which they seem to stop, and we are uncertain whether these points are their origins. (Cruickshank.) Mere observation is here as unavailing as in regard to the termination of exhalants. The continuation of lymphatics with

* Cenni sulla comunicazione dei vasi linfatici colle vene; di Giovanni Rossi Doctore, &c. Annali Universali di Medecina, Anno 1826. Vol. XXXVII. p. 52.

arteries, unless in the case of those which arise from the interior of arterial tubes, (Lauth) is not satisfactorily established. It has been conjectured, however, that their ends or imperceptible origins are connected to the tissues to which they are traced, and that the lymphatics arise in this manner from these tissues.

The lymphatics are distinguished by being in general cylindrical in figure, and by varying in calibre at short spaces. In this respect they differ from the arteries and veins. It has been further justly remarked by Gordon, that the middle-sized lymphatics are remarkably distinguished from the corresponding parts of the arterial and venous system by three peculiarities. 1*st*, When two lymphatics unite to form a third, the trunk thus formed is seldom or never larger than either of them separately; 2*d*, their anastomoses with each other are continual; and, 3*d*, they seldom go a great space without first dividing into branches, and then reuniting into trunks. *

The outer surface of a lymphatic is filamentous and rough, the inner smooth and polished, like that of small veins. It is impossible to observe the structure of these tubes in the middle-sized, or even in the large lymphatics; and anatomists have generally been satisfied with supposing that the structure of all of them is similar to that of the thoracic duct, or some other large vessels equally susceptible of examination. According to

* System, p. 71.

the observations of Cruickshank, (Chap. xii.) which have been verified by Bichat, the thoracic duct presents, 1*st*, a layer of dense firm filamentous or cellular tissue, exactly similar to that found inclosing arterial and venous tubes, which the latter regards as foreign to the vessel, but giving it a great degree of support and protection; 2*d*, a proper membrane, delicate, transparent, and moistened inside by an unctuous fluid, which he seems inclined to ascribe to transudation. Muscular fibres, of which Sheldon speaks positively, Cruickshank represents, though seen in some instances, (Chap xii.) yet to be more generally not demonstrable. Their existence, though admitted by Schreger and Soemmering, is denied by Mascagni, Rudolphi, and J. F. Meckel, and, I may add, by Bichat and Beclard. This account differs not much from that of Dr Gordon, who could not recognize distinctly more than one coat, similar to the inner coat of veins. The filamentous layer noticed by Bichat, and considered by Mascagni as an external coat, is of course excluded.

The knotted or jointed appearance of lymphatics is occasioned chiefly by short membranous folds in their cavity called *valves*. These folds are thinner than the venous valves; but they are equally strong, and have the same shape and mode of attachment to the inside of the vessel. They are generally found in pairs, but never three at the same point. A single valve is sometimes found at the junction of a large branch with a trunk, or of a trunk with

a vein. According to Cruickshank there is considerable variety in the distribution of valves; but in general a pair of valves will be found at every one-twentieth of an inch in lymphatics of middling size. In the larger lymphatics they are less numerous than in the small. The structure of these valvular folds is as little known as that of the inner membrane, of which they appear to be prolongations. According to Mascagni they sometimes contain a small portion of fine adipose substance.

The tissue which forms the lymphatic tubes is strong, dense, and resisting; and from the weight of mercury which they bear without rupture, it has been generally concluded that they are stronger in proportion to their size than veins. This tissue also possesses considerable elasticity.

The opposite states of lymphatics during digestion and after long fasting, and the phenomena of mercurial injections, prove that the tissue of which they consist is distensible and contractile. Though it does not exhibit appearances of muscular structure, it has been long supposed to be endowed with a property analogous to irritability. Such is the inference which Hunter, Hewson, Cruickshank, and others have derived from various phenomena in the living and recently dead tissue.

Though Bichat doubted what he termed organic sensible contractility, yet he admitted the insensible contractility as necessary to the functions

ascribed to lymphatics. Previous to his time Schreger, in different experiments, observed the first of these qualities in consequence of the application not only of acids, butter of antimony, and alcohol, but even of hot water and cold air. Similar contractions and relaxations have been induced by mechanical irritation.* Such phenomena are observed not only during life, but even after death; and if we add to this, that the thoracic duct is often after death large and flaccid, though empty, but in the living body is almost always contracted and scarcely visible, and that a portion of it included between two ligatures and punctured, quickly expels its contents, it may be inferred, according to Tiedemann and Beclard, that the lymphatic tissue possesses a considerable degree of this vital or organic property.

Section II.

The lymphatic vessels have been supposed to perform an important part in the formation of the diseases incident to the animal body. In addition to the ordinary causes of disease which affect all organic substances, the several derangements of property or function to which they are liable have been supposed to exert a powerful influence on other tissues and organs, and on their functions. On this principle Hewson, Cruickshank, Thomas White, Nudow, Isen-

* Schreger de Irritabilitate Vas. Lymph. Lips. 1789.

flamm, Johnstone, and Maanen, have ascribed to different forms and degrees of disorder of the lymphatic system a very large proportion of the diseases incident to the human body. All of these authors, nevertheless, have been exceeded by Soemmering, and more recently by Alard, both of whom represent the lymphatics as mainly concerned in every morbid state of the human body. The former has delineated an extensive picture of diseases, in the production of which the lymphatics are believed to be more or less concerned. Besides immediate morbid states of the lymphatics themselves, he enumerates upwards of sixty diseases and morbid states of the human body, in which, according to one or another pathologist, the lymphatics have an influence, direct or indirect, immediate or remote. The latter reasons most strenuously for the universal influence of the lymphatic system in every disease almost of the animal frame.

Little doubt can be entertained, that by these authors the influence of the lymphatic vessels has been very much overrated. Notwithstanding the authority of their names, it is certain that neither anatomical inspection, nor the observation of the phenomena and effects of disease, justify the views advanced by these authors. It further requires little argument to show, that this mode of explaining the formation and nature of diseases does not tend to the advancement of accurate pathological knowledge.

All the diseases to be referred to this head come naturally under two divisions. The first consists of disordered states occurring in the lymphatic vessels themselves. In the second are included morbid states of other textures or systems, arising immediately from disease of the lymphatics.

1. *Inflammation.* The first morbid state to be mentioned as incident to the lymphatics is inflammation. As a spontaneous occurrence it is little known, and perhaps is exceedingly rare. Hendy, indeed, undertook to show, that inflammation of the lymphatics was the pathological cause of Barbadoes leg ; * and this view, which has been almost implicitly adopted by every subsequent observer, has been strenuously maintained and illustrated by M. Alard. † I have already adduced such facts and arguments as I conceive are sufficient to show, that this disease depends on a peculiar inflammation of the filamentous tissue of the limb, recurring periodically, and terminating in albuminous exudation ; and that the affection of the lymphatic glands, vessels, &c. on which the hypothesis of Dr Hendy is founded, is an effect of this diseased state. It is unnecessary, therefore, to give the subject more consideration.

* Treatise on the Glandular Disease of Barbadoes, proving it to be seated in the Lymphatic System. By John Hendy. London, 1784.

† Histoire d'une Maladie particulière au Systeme Lymphatique, &c. 1806 ; et Nouvelles Observations sur l'Elephantiasis des Arabes. Par M. Alard, 1811.

Not less objectionable is the notion advanced by Charles White,* that inflammation or obstruction of the lymphatics is the cause of the swelled leg, *(phlegmasia dolens,)* of puerperal women. Observation and dissection concur in showing that this malady also arises from inflammation terminating in albuminous or sero-albuminous exudation.

Inflammation of lymphatic vessels may almost invariably be traced to irritation, or an irritating cause at their organic extremities. Thus a sore in the finger or hand, whitloe, or other inflamed states of the fingers, are often attended with painful red streaks or lines, extending up the arm to the arm-pit. These red streaks indicate inflammation of the subcutaneous lymphatics. In like manner I have seen a blister applied to the surface of the belly cause inflammation of the lymphatics leading to the inguinal glands.

The inflammation when not violent terminates in resolution. In more severe cases it may cause effusion of lymph into the cavity of the vessel, so as to effect adhesion, and obliterate its canal. This was probably the cause of the obstruction which Mascagni states he found in the lymphatics of several subjects after the use of blisters. Suppuration, as a consequence of inflammation of lymphatics, is little known.

2. *Wounds* of lymphatics must occur frequently.

* Inquiry into the Nature and Cause of that Swelling in one or both of the lower extremities in Lying-in-Women. By Charles White, Surgeon. Warrington, 1784.

In truth, scarcely an incision dividing the skin and cellular membrane can fail to involve several lymphatics, and every deep incision divides many of them.* They appear to unite easily. Is the cavity obliterated? The frequent anastomoses render this event of no consequence. Hewson observed, that in several instances lymphy coagulable fluid continued to ooze from the wounded vessel for days.

3. *Cirsus* (Κιρσος) *or Varicose Dilatation.* This name is applied by Meckel to denote a dilated state of lymphatics similar to varix in veins. Schreger and Tilesius delineate what they conceive to be varix in the lymphatics of the conjunctiva; Mascagni represents the same condition in those of the lungs; and Soemmering describes those of the intestines as varicose in hernia. The same condition was observed by Bichat in the lymphatics of serous membranes. In dropsical subjects they are always much distended with fluid; and hence the anatomist finds their demonstration much more easy in such circumstances.

4. ***Rupture*** of the lymphatics has been assumed as a probable cause of consumption by Morton, of scrofula in general by Ackerman, of Barbadoes leg by Hendy, of puerperal swelled leg by White, of dropsy by Van Swieten, Haase,† Assalini,‡

* Monro in Edin. Medical Essays, Vol. V. Art. xxvii.

† J. Gottl. Haasius de Vasis butis, &c. Absorbentibus, Leip. 1786.

‡ Essai Medical sur les Vaisseaux Lymphatiques, &c. p. 56.

Mezler,* and Soemmering, † and of white swelling of the joints by Brambilla. ‡ Yet in neither of these diseases has the existence of rupture of the lymphatics been demonstrated; nor has the accident been shown to be one of ordinary frequency. Baillie admits that the thoracic duct may have been ruptured. But Guiffart is the only person who is said to have seen this accident, in the person of a boy of fourteen. §

5. *Dilatation with Obstruction.* Soemmering repeatedly found the lacteals of the small intestines near the duodenum filled and distended with a thick curdy matter like soft cheese. Of the same deposition in the lacteals of the jejunum with much induration, Walter delineates an example in a man of about thirty. Edward Sandifort represents the lacteals in an infant of a few weeks much thickened, approaching to varicose, with swelled mesenteric glands. ‖ And Ludwig saw them in a similar state in a girl of seven, with induration of these glands.

6. *Osseous Deposition.* Callous hardness, with osseous matter, was seen in the coats of the lymphatics in the pelvis by Mascagni, Cruickshank, and Walter found them ossified, and of stony hard-

* Dissertio de Hydrope, &c. p. 23.

† De Morbis Vasorum Absorbentium, p. 132.

‡ Acta Acad. Medico-Chirurg. Militaris Viennaensis, Tom. I. p. 16.

§ Apud Bartholini Opuscula nova de vasis Lymphaticis, &c. Hafniæ, 1670.

‖ Observation. Pathologic. Anatom. Lib. ii. cap. 8.

ness. The thoracic duct was found filled with osseous matter by Poncy, and with earthy or osseous matter by Assalini. * Cheston found it obstructed with a solid substance resembling calcareous matter ;† Bayford found it much obstructed by the pressure of an aneurismal tumour ; ‡ and Scherl is said to have met with an actual concretion. §

The lymphatics have been long supposed to be the agents concerned in the formation of king's evil, (*struma, scrofula,*) and in the developement of the disease when latent. What are the proofs of this opinion ? Have the lymphatics been actually found disorganized in cases of strumous disease, and does scrofula never take place without traces of this disorganization ? Do they act as the cause, or do they partake in the effects of another morbific agent more general in operation ? In answering these questions much will depend upon the meaning attached to the term scrofula. If this be a disease appearing in the lymphatic glands only, there may be some ground for the opinion. But to assemble the numerous disorders termed *strumous*, under the head of the lymphatics, implies conclusions which are not supported by anatomical facts.

* Essai Medical sur les Vaisseaux Lymphatiques, &c. Par Paolo Assalini. Turin, 1787-8.

† Philosophical Transactions, Vol. LXX. 1780, and Pathological Inquiries.

‡ Medical Observations and Inquiries, Vol. III. p. 18.

§ Apud Haller, Dissertation. Patholog.

Since the arguments which have been adduced against the absorbent power of the lymphatic vessels by Mayer, Magendie, and others, their influence either in the production of dropsy, or in removing it, seems to be very doubtful.

How far can they be admitted to explain the process of ulcerative absorption so ingeniously contrived and ably maintained by John Hunter? and what share can they be supposed to possess in the removal of other matters, either proper or foreign to the system, as that pathologist believed? Upon these questions accurate facts are still wanting.

CHAPTER X.

Lymphatic Gland or Ganglion, Kernel,—(*Glandulæ Lymphaticæ,—Glandulæ Conglobatæ.*—Die Saugader-Dreusen.)

Section I.

This is the proper place to consider the structure of those bodies which are in common language termed *kernels*, to which anatomists have applied the name of *lymphatic glands*, and the French anatomists have more recently given that of lymphatic ganglions. The general appearance, figure,

and usual situation of these bodies, are well known and described in the common treatises on anatomy. In general they are spheroidal, seldom quite globular, and most commonly their shape is that of a flattened spheroid. In different subjects, and in subjects at different ages, they vary from two or three lines to an inch in diameter. The medium rate is about half an inch. Their surface is smooth; their colour grayish-pink, sometimes pale red, bluish, or of a peach-blossom tinge,—varieties which seem to depend on degrees of bloody transudation; for when washed and slightly macerated, they assume the gray or whitish-blue colour. In a few instances they are jet black,—a peculiarity which seems to depend on a degree of black infiltration, or on the incipient stage of that change which has been termed *melanosis*, or melanotic deposition. The idea that it may be derived from the carbonaceous matter suspended in the atmosphere of great cities, has been shown by Cruickshank to be absurd. Its anatomical possibility may be justly questioned.

They are always situate in the celluloso-adipose tissue found in the flexures of the joints. They are found in small number at the bend of the ham, and that of the elbow; they are more numerous in the arm-pit and groin; in considerable number in the cellular tissue of the lumbar region, before the *psoas* and *iliacus* muscles; and they are most abundant round the neck. The posterior mediastinum, and the cellular tissue between the mesentery and vertebral column,

abounds with lymphatic glands mutually connected in clusters.

Each gland may be said to consist of a peculiar substance, inclosed in a thin membrane like a capsule. The capsule is a thin pellucid colourless substance, which is resolved by maceration into fine whitish fibres. It is very vascular; and Mascagni appears to have detected absorbents in it. It is connected to the proper substance by fine filamentous or cellular tissue. The capsule is considered by Beclard as a fibro-cellular membrane. The proper substance of lymphatic glands consists of a homogeneous pulp, in which injections have shown numerous ramifications of minute vessels. As these vessels are injected from the lymphatics which are seen to enter the body of the gland, they are believed to be continuous with them, and to be lymphatics arranged in a peculiar manner. These vessels are of two kinds, one entering the gland called *vasa afferentia or inferentia*, entrant lymphatics; the other quitting is called *vasa efferentia*, egredient lymphatics. This distinction is founded on the direction of the valves. In the *vasa inferentia* the free margins of the valves are turned toward the gland; in the *vasa efferentia* they are turned from it.

The number of entrant lymphatics varies from one to thirty, and, what is more remarkable, almost never corresponds with that of the egredient lymphatics, which are in general much fewer. Cruickshank says he has injected fourteen entrant lymphatics to one gland, to which only one egre-

dient vessel corresponded. When the entrant lymphatic reaches the gland it splits into many radiated branches, which immediately sink into its substance. The egredient lymphatics are generally larger than the entrants.

The arrangement of these vessels in the interior of the glands is best described by Mascagni, whose observations are confirmed by Gordon. To see this well, it is requisite to inject the entrant lymphatics of two glands in two different modes; one with mercury, the other with wax, glue, or gypsum. After a successful mercurial injection, the entrants are seen, before sinking in the gland, to divide into two orders of branches. One of them, which belongs chiefly to the surface or circumference of the gland, consists of large vessels, bent, convoluted, and interwoven in every direction, communicating with each other, and swelling out into dilated cells at certain parts, and of smaller vessels, which form a minute network on the surface, and which seem to terminate in the cells or distended parts of the larger vessels.

From these distended parts or cells, again, arise many minute vessels, which, after winding about on the surface of the gland, unite gradually, and form the egredient vessels of the gland.

The wax, glue, or gypsum injection is employed to show the deep-seated or central vessels of the gland. The distribution of these is found to be quite the same as that of the superficial vessels.

The cells delineated by Cruickshank, I am disposed to regard as mere dilated parts of the lym-

phatic vessels which constitute the intimate structure of the gland.

These minute tubes are connected by delicate filamentous tissue, which is more abundant in early life than afterwards.

Injections show the existence of blood-vessels, which accompany the convolutions of the lymphatics in the glands. But no nerves have been found either in the glands or their capsules.

The white matter described by Haller and Bichat is not contained in the cellular substance, but in the cells of the lymphatic vessels themselves.

Section II.

1. *α.* The lymphatic glands as organized bodies may be supposed to be liable to ordinary inflammation. Yet on this subject no very precise facts are given. The swelling called *bubo*, (βουβων, Hippocrates) appears to be in most cases inflammation of the capsule and surrounding cellular substance.

β. Strumous Inflammation. The glands, however, appear to be liable to a slow chronic inflammation, which does not readily suppurate, and which, when it does suppurate, always forms a bad and tedious disease. They are believed to be often affected in scrofulous subjects; and the definition of the *evil* (*struma, scrofula, les ecrouelles,*) has been taken directly from this phenomenon. In such affections these bodies undoubtedly become the seat of a slow inflammatory action, which is attended with

gradual enlargement, without much pain or change of colour in the integuments. At length, the gland is found to become softer than it had been, and an opening takes place in the skin, through which a fluid is discharged, not homogeneous, but in general consisting of a thin serous water, in which thicker pieces like curd are mixed. This fluid, which is generally most completely formed in suppuration of the lymphatic glands, is what has been termed scrofulous, or strumous matter. Simple strumous enlargement in these glands may proceed to such an extent as to interfere with, and even impede the functions of important organs. In those of the neck they have, by compressing the windpipe, caused fatal suffocation. (Soemmering and others.) Bleuland saw them in an infant impede deglutition by pressing the œsophagus. *

γ. *Irritative Enlargement.* The lymphatic glands are liable to become painful and enlarged, in consequence of causes not originally resident in themselves. A sore or wound, especially if punctured or lacerated, on the hand or foot, may be succeeded in a few days by an enlarged painful swelling of one or more glands in the arm-pit or groin. A wound of the scalp may be followed by a glandular swelling of the neck; and a spoilt tooth, or a sore of the mouth, will often give rise to a painful enlargement of the glands under the jaw. I have repeatedly seen a whole chain of them enlarge, and continue so for months, in consequence

* Observationes de sana et morbosa Œsophagi Structura. Lugdun. Bat. 1785.

of the use of mercury carried to salivation. The tracheo-bronchial glands become enlarged in inflammation of the bronchial membrane, of the pulmonic tissue, and other diseases of the lungs; and those of the mesentery increase in consequence of disease of the intestinal canal. In such instances it is obvious that irritation at the organic end of the lymphatics is the cause of morbid action in the glands, at the glandular end of these vessels.

In other instances, for example, when a sore on the penis is followed by enlargement of the inguinal glands, or a cancerous breast is attended with swelling and pain of the axillary glands, it has been concluded, that, as the primary diseases depend on a peculiar or *specific action*, as it was termed, peculiar matter is absorbed, and conveyed to the gland, in which it gives rise to the morbid changes. We now know that it is unnecessary, in the majority of cases, to suppose absorption, which indeed is rendered very doubtful; and it is sufficient to ascribe the glandular enlargement in such instances to mere irritation at the organic ends of the lymphatics.

2. *Enlargement from the Operation of Poisonous Matter. Pestilential Bubo.* In plague the glands of the arm-pit and of the groin generally become enlarged as the disease advances. The period at which this takes place is uncertain, but seems to vary from the first twenty-four hours to the seventh or eighth day. (Russel, de Mertens, Orraeus, &c.) This enlargement, which soon proceeds to a bad open sore, accompanied with sloughing and

the discharge of foul, dirty-coloured fluid, has been generally ascribed to the absorption of the pestilential poison, and its direct operation on the glandular system. This is probably in general the true account of the pestilential bubo. As, however, they are almost invariably accompanied with carbuncles, it is not unlikely that in some instances the bubo may be the result of irritation from the presence of a carbuncle.

3. *Enlargement with Death of the Glandular Tissue.* *α. Strumous Mortified Bubo.* Of strumous bubo there are many varieties well known to the practical surgeon. To this head, however, I refer a peculiar disease which I have seen in the glands at the bend of the arm. The glands become enlarged, painful, and hard; and, notwithstanding all efforts to procure resolution, the skin first gives way, chiefly by sloughing, and matter with some membranous shreds is discharged. A sore of a peculiar character is formed. Its edges consist of skin cut very sharp, and notched or serrated, as it were, into angular slips. From these margins the sore descends deep and rather foul to an ash-coloured, solid, convexly-rounded body, which is evidently a diseased gland. Round this the process of suppuration and ulceration proceeds, with the occasional discharge of sloughs, till the gland is expelled either in fragments or in a mass; after which the hollow is filled with granulations, and cicatrization is easily effected.

This process is attended with pain at first in the skin chiefly, but afterwards it seems to cause no

more uneasiness than an ordinary abscess. Its duration varies according to the size and number of the glands to be ejected. In the most distinct cases which I have seen it occupied between three and four months. This disorder I regard as arising from a gland being suddenly smitten, as it were, with death in its intimate structure, from previous disease of its membranous capsule and proper vessels. I have seen it only in those at the bend of the arm; and to Cruickshank it appears to have occurred in the same situation.* It may occur, however, and probably has been seen by others elsewhere.

β. *Phagedenic Bubo.* Seen principally in the inguinal glands in persons labouring under the operation of the syphilitic poison, or who have been subjected to repeated courses of mercurial medicines. The skin first becomes hard, painful, hot, and dull red, with circumscribed edge, but diffusely swelled. The transition to a dirty grayish-brown indicates that the skin has become dead; and the process of ulceration, alternating with sloughing, is established. As the skin, and successively the cellular tissue, are thrown off in this manner, one, two, or more glands come into view, somewhat swelled, and of a brownish-red colour, but equally distinct as if they had been carefully dissected. The surface of the sore is generally a deep-red

* "I have known the last-mentioned glands (the brachial) die, and slough out in scrofula without any great inconvenience."—The Anatomy of the Absorbing Vessels, p. 132.

brown, covered with a foul blood-coloured serous fluid, without appearance of granulations, and with the sensation of burning or searing pain. The process of sloughing proceeds in the cellular tissue, while the gland or glands remain as so many brownish masses, with small marks of vitality, until they are detached entirely from the cellular substance, in which they are imbedded, and are thrown off dead. In effecting this object, the process of sloughing may proceed to such extremity as to affect first the superincumbent cellular coat, and next the sheath of the femoral artery, which, in such circumstances, inevitably gives way ; and the patient is suddenly destroyed by hemorrhage. An instance of this accident in a soldier of the guards used to be mentioned by Dr Hunter. * In a case which occurred some years ago in the military hospital of the Castle, it was deemed requisite to avert the impending danger by tying the femoral artery. Subsequent gangrene of the foot and leg, however, rendered amputation indispensable; and recovery at length took place.

In more favourable circumstances, after great destruction of parts, and the expulsion of one, two, or more mortified glands, the phagedenic action stops spontaneously, granulation takes place, and the sore is gradually healed.

I have described the progress and phenomena of this disease, as I have witnessed them in several instances which have fallen under my observation. It appears that the active symptoms mani-

* The Anatomy of the Absorbing Vessels. p. 122.

fest themselves first in the skin and cellular membrane; and it may therefore be thought that the disease belongs properly to these tissues. Their affection, nevertheless, is, so far as can be determined, the result of the previous state of the glands, which appear to be directly killed either by the syphilitic poison, or the mercurial action, and thus to give rise to the violent process of disorganization, which then takes place in the skin and cellular membrane.

Enlargement of the mesenteric glands has been supposed by most authors to be the anatomical characters of the disease termed mesenteric wasting—*Tabes mesenterica; Tabes glandularis.* (Wharton, Bastivi, Richard, Russell.) Without absolutely denying this, I shall afterwards show, that, in most instances of that disease, the enlargement of the glands is secondary to some morbid state either of the intestinal villous membrane, or of some of the intestinal tissues.

4. *Enlargement and Induration, (Vascular Sarcoma.)* Either after repeated attacks of inflammation, alternating with resolution, or with a slow and indistinct form of the disease, a gland, or a cluster of glands gradually enlarges, and, resisting all means of resolution, becomes unusually hard. This continues, or is liable to slight occasional aggravations, with dull pain in the substance or in the neighbourhood of the gland. Though such enlargement may be termed *strumous*, and may have originated in what is termed strumous action, the structure of the gland or glands is so

much changed as not to be distinguished from *vascular sarcoma.* A tumour of this kind, when divided, presents a firm homogeneous substance of a bluish-gray colour, somewhat elastic and compressible, traversed with more or fewer vessels, which may be injected from the neighbouring arteries, and consisting in its intimate structure of amorphous granular masses united by dense filamentous tissue. The great hardness, and the malignant tendency of this growth, have procured for it from most authors the ominous names of *scirrhus* and *cancer.* Though correct enough for all practical purposes, these epithets are not justified by the anatomical characters.

Sarcomatous enlargement may occur in any of the lymphatic glands. It is frequent in those of the neck, and may often be traced to strumous inflammation, or to the irritation of spoilt teeth. Cruickshank mentions an instance in which the tracheo-bronchial lymphatic glands were affected with this morbid change to such extent as to cause fatal suffocation.* In the internal iliac glands it is not uncommon, so as to form large indurated masses; and in the female may operate as a cause of difficult parturition equally fatal to the mother and the infant. (Hunter *apud* Cruickshank.)† The same disease occurs in the mesentery either primarily, or in consequence of ulceration of the intestines.

5. *Ossification, Calcareous Deposition.* The lymphatic glands are liable to become ossified, or to

* Anatomy of the Absorbing Vessels, p. 129. † Ibid, p. 123.

be penetrated with deposition of calcareous matter. The diseased action commences at one or more points, and is progressively extended, till the gland is converted into a bony mass. * This change was observed by Cruickshank in the tracheo-bronchial glands, which he represents as in that state producing ulceration through the trachea, and being coughed up as osseous concretions. † Baillie, adopting the same view, regards the calcareous deposition as more common in these bodies than in any other of the same texture. ‡ Lastly, Rayer has observed this change not only in the tracheo-bronchial glands in subjects which he terms phthisical, but in the cervical glands, in laryngeal consumption, and occasionally in persons cut off by mesenteric scrofula, (*carreau,*) and in the inguinal glands in persons who have had buboes. This change he considers the effect of inflammation. || To the same head are to be referred the earthy or calcareous depositions (*matiere platreuse, gypseuse*) observed by Dupuy in these glands.

The tubercular disorganization is represented by Laennec, Dupuy, and others, as exceedingly frequent in lymphatic glands. By some authors these bodies are regarded as constituting the ana-

* A Practical Essay on the Diseases of the Vessels and Glands of the Absorbent System, &c. By William Goodlad, Surgeon, &c. p. 74. London, 1814.

† Anatomy, &c. p. 129. ‡ Morbid Anatomy.

|| Memoire sur l'ossification morbide, considerée comme une terminaison des phlegmasies. Par P. Rayer. Archives Generales, Tome I. p. 439.

tomical character of the strumous or scrofulous gland. In many instances of scrofulous enlargement and induration, the glands are indeed found to be occupied with minute bodies, somewhat firm, which undergo a slow liquefaction or mollescence. But it is perhaps too limited a view to restrict to this only the characters of scrofula. In some instances these tubercles appear to consist of the original cells of the gland, filled with albuminous or albumino-calcareous matter.

6. *Melanotic Deposition* is common in the tracheo-bronchial lymphatic glands, and in those of the groin. Of the former, an example is at the present moment before me in the lungs of a woman much occupied by tubercular masses.

CHAPTER XI.

THE three orders of tubes or canals, the anatomical characters, and pathological relations of which have now been completed, constitute what has been termed the VASCULAR SYSTEM, (*Vasa; Systema Vasorum.* Das Gefass System. *Le Systeme Vasculaire.*) The great extent of its distribution, and the part which it performs in all the processes of the living body, both in health, and during disease, must be easily understood. In every texture and organ arteries and veins are found; and in all, except a few, the art of the anatomist has demonstrated those colourless valvular tubes denominated lymphatics. The arrangement

of the former, especially in the substance of the several textures, essentially constitutes what is termed the *organization* of these textures. Many anatomists have imagined that each texture has a proper matter, or *parenchyma*, by which it was supposed to be particularly distinguished, and which was conceived to consist of minute inorganic solid atoms. Whether this opinion be well founded or not, it is perhaps of little moment to inquire. At present it is certain that it is not susceptible of demonstration.

The phenomena of injections, in which he was eminently successful, led Ruysch to entertain the opinion, that every substance of the animal frame consisted of nothing but vessels. This idea, though opposed by Albinus * on the same grounds on which it was advanced, was nevertheless revived by William Hunter, who believed that the inorganic parts of animal bodies are too minute for sensible, or even microscopical examination. In every part, however minute, always excepting nails, hair, tooth enamel, &c. vessels could be traced ; and even a cicatrix he demonstrated is vascular to its centre.†

By the aid of the microscope the researches of Lieberkuhn tended still more powerfully to favour this opinion. ‡ But repeated observation of the effects of injection in every part and texture almost of the body by Barth and Prochaska has led the latter to conclude, that this opinion, understood in the ordinary mode, is not tenable.

* Annotationum Academicarum, Lib. iii.

† Medical Observations and Inquiries, Vol. II.

‡ De Villis Intestinorum.

Prochaska, who has investigated this subject with much attention, thinks he is justified in dividing all the substances of the animal frame into two,—those which may be injected, and those which cannot. In this manner he regards skin, especially its outer surface, muscle, various parts of the mucous membranes, the *pia mater*, the lungs, the muscular part of the heart, the spleen, the liver, kidneys, and other glands as very injectible; but tendon, ligament, cartilage, &c. as not injectible.* Without entering minutely into the merits of this distinction, or the inferences which Prochaska makes to flow from it, it is sufficient, so far as all useful knowledge is concerned, to infer, that blood-vessels are an essential constituent of every organic texture, however different; and if there be any other matter inherent in such textures, it must be derived from these as a secretion. Muscle, brain, nerve, osseous matter, and cartilage are depositions or the product of nutritious secretion from the respective arteries of these organized substances.

To apply these distinctions to pathological anatomy, therefore, two leading facts are presented as principles. The first of these is the arrangement of the vessels in the substance of the organic textures;—their organization. The second is the great result of organization, the principal duty performed by the vessels in each tissue;—the formation of each organic substance, or the process of nutrition. To changes in one or other of these

* Georgii Prochaska Disquisitio Anatomica-Physiologica Organismi Corporis Humani ejusque Processus Vitalis, 4to. Vienna, 1812.

two circumstances almost all morbid actions which become the subject of pathological anatomy may be referred; under the two general divisions, 1*st*, of *changes in organization*; and, 2*d*, *changes in nutritious deposition, or intimate structure.*

It is unnecessary to render this division more complex, by admitting, as has been done by several pathological writers, a third head in the changes which take place in the process of secretion. That process is to be viewed in general, nay, in almost all circumstances, as a complementary effect of nutrition; and the morbid changes which it occasionally undergoes may, without violence, be referred to one or other of the two foregoing heads.

It is different, however, with a third form or source of disease. I allude to those errors in the formation and relative situation of parts, especially the integrant parts of organs, which have been termed malformations. (Missbildungen.) These have been shown by Oken, Meckel, and others, to depend on the accidental interruption of the process of developement, and misapplication of the component parts of organs during the early stage of that process.

In the subsequent chapters of this work, though it is unnecessary to abandon the simple arrangement hitherto observed, the morbid changes incident to the several textures shall be enumerated in reference to the two first distinctions,—those in minute organization and its products, and those in nutrition and intimate structure. The various forms of malformation constitute a distinct family by themselves.

CHAPTER XII.

SECTION I.

NERVE, NERVOUS TISSUE,—(Νευρον,—*Nervus*, —*Tissu Nerveux*,—*Systeme Nerveux*.)

I AM unwilling to adopt here the denomination of *nervous system*, because it is not my intention, under this head, to treat of the brain or spinal chord. I deviate from this practice, 1*st*, Because I do not conceive it demonstrated that the brain is the same organic substance as the nerves; 2*d*, Because, although it were, this would not contribute to the knowledge of the minute structure of the nervous chords; 3*d*, Because the arrangement of these chords in the animal body is inconsistent with this, and will be best understood, when described separately.

The nervous system of the animal body includes, according to the most rational views, two general divisions. The first of these is collected in a single and indivisible mass, and contained in a peculiar cavity, formed by part of the osseous system of the animal. In the less perfect tribes this is limited to the vertebral column, or something analogous to it; but in man, and the more perfect animals, we find a large cavity at the su-

perior extremity of this column superadded. The second division of the nervous system, with which alone we are at present concerned, is found in the form of long chords or threads mutually connected, and running in various directions through the body in the mode of ramification. To these the name of nervous trunks or chords, or simply nerves, has been long applied.

The structure of the nerves has been examined with different degrees of accuracy and minuteness by a great number of anatomists. The more ancient authors, who wrote at a period when observation was much corrupted by fancy, and most of those who give descriptions in general systems, may be without much injustice passed over in silence. It is sufficient to say, that some good facts are given in the works of Willis,* Vieussens, † Morgagni, ‡ and Mayer; § that Prochaska, ‖ Pfeffinger, ¶ and the second Monro, ** are the first who professedly wrote on the struc-

* Thomæ Willis, Cerebri Anatome Nervorumque Descriptio et Usus. Amsterdam, 1682.

† Raymundi Vieussens Neurographia Universalis. Lyon, 1684.

‡ Adversaria Anatomica, 4to. Lugduni Bat. 1723.

§ J. C. Mayer Abhandlung vom Gehirn, Ruckenmark, und dem Ursprunge der Nerven. Berlin, 1779.

‖ Georgii Prochaska de Structura Nervorum Tractatus Anatomicus. Viennæ, 1779 and 1800, *apud* Op. Minora.

¶ Jo. Pfeffinger, de Structura Nervorum. In Ludwig, Scriptorum Neurolog. Select. Tom. I.

** Monro on the Structure and the Functions of the Nervous System. Edinburgh, 1783. Folio.

ture of the nerves; that the works of Reil,* Bichat, and Gordon, contain the most accurate information on the nervous chords in general; and that the treatises of Scarpa† and Wutzer‡ contain the most satisfactory information on the arrangement of those parts named ganglions and plexus.

Each nerve forms connections in three different ways; 1*st*, A nerve must be connected to some part of the central mass by one of its extremities, —the cerebral or spinal end; 2*d*, It must be connected to some texture or organ, or part of an organ by the other extremity,—the organic end; and, 3*d*, It may be connected to other nerves by a species of junction called anastomosis, *(ansa)*—anastomosing or uniting point. By means of the two first connections, it is supposed to maintain a communication between the central mass and the several organs; and by the latter it is understood to be subservient to a more general and extensive intercourse, which is believed to be necessary in various functions and actions of the animal system.

Every nerve consists essentially of two parts; one exterior, protecting, and containing; the

* J. C. Reil, Exercitationes Anatomicæ de Structura Nervorum. Haller, 1797.

† Anatomicarum Annotationum, Lib. Prim. de Nervorum Gangliis et Plexibus. Auctore Antonio Scarpa.

‡ De Corporis Humani Gangliorum Fabrica atque Usu, Monographia. Auctore Carolo Gulielmo Wutzer, Med. Chirurg. Doct. &c. Berolini, 1817.

other interior, contained, and functional, forming the indispensable part of the nervous structure.

The first of these, which has been known since the time at least of Reil by the name *neurilema*, (*νευρον, ειλεω, ειλημα, nervi involucrum,*) or nerve-coat, (Nervenhaut, Reil; Nervenhülle, Meckel;) has the form and nature of a dense membrane, not quite transparent, which is found on the outside of the nervous chord or filament, and invests the proper nervous substance. It must not, however, be imagined that the *neurilema* forms a cylindrical tube, in the interior of which the nervous matter is contained. This latter disposition, if it actually exists, applies to the smaller nerves only, and to some of those which go to the organs of sensation,—a peculiarity which we shall notice subsequently.

Any large nervous trunk, for example, the spiral or median of the arm, or the sciatic nerve of the thigh, is found to be composed of several small nervous chords placed in juxtaposition, and each of which, consisting of appropriate *neurilema* and nervous substance, is connected to the other by delicate filamentous tissue. These, however, do not, through their entire course, maintain the parallel disposition in respect to each other, but are observed to cross and penetrate each other, so as to form an intimate interlacement of nervous chords and filaments, each of which, however minute, is accompanied with its investing neurilema. The neurilema, in short, may be represented as a

cylindrical membranous tube, giving from its inner surface many productions forming smaller tubes (*Canaliculi*, Die Nervenröhre; primitive cylinders of Fontana;*) in which the proper nervous matter is contained.

Of this arrangement the consequence is, that each nerve or nervous trunk, enveloped in its general neurilema, is composed, nevertheless, of a number more or less considerable of smaller chord-like nervous threads (*funiculi nervei*, Prochaska; *chordæ*, *funes*, Nervenstraenge, Reil,) into which the nerve, by maceration and suitable preparation, may be resolved. Each chord, again, or *nerve-string*, as Reil terms it, though invested with a proper neurilem, may be further resolved into an infinite number of minute filiform or capillary filaments, (*Fila*, *fibrillæ*, Nervenfasern, Reil,) which, invested in a delicate covering, are understood to constitute the ultimate texture of the nerve.

This threefold division may be easily observed in the brachial and spiral nerves of the arm, and still more distinctly in the sciatic in the thigh. The utility of understanding the internal arrangement from which it results will appear forthwith, when the structure of those parts termed ganglions and plexuses comes under examination.

Of this arrangement in different nerves, and in different regions, this membrane undergoes great modification; and all opinions on its nature derived from thickness or transparency are liable to

* Observations sur la structure des Nerfs, &c. apud Traité sur le Venin, &c. par M. Felix Fontana.

considerable fallacy. Scarpa seems to view it as connected, in anatomical origin and character, with the hard membrane, (*meninx dura, dura mater.*) Reil, who devoted more care and time to the examination of its nature and structure than any other inquirer, represents it as consisting of cellular substance, many blood-vessels, and some lymphatics. * Bichat thought it resembled the soft membrane of the brain, (*pia meninx, pia mater,*) and was derived from it. † Gordon considers the neurilema of the cerebral nerves as consisting of soft membrane (*pia mater*) at their origin, but in all other situations as a species of cellular membrane.

By Mayer the neurilema is accounted a fibrous tissue, for the following reasons. 1*st*, It consists almost entirely of tendinous fibres, and is cellular only where it is very thin. 2*d*, The transverse folds presented by most of the nerves, and which give them a dentilated form, are derived from the neurilema, are of fibrous character, and are similar to those observed in tendinous sheaths. 3*d*, Several nervous productions are actually converted into tendinous or fibrous filaments; for example, the brain of the snail tribe, (*limaçons,*) and the spinal chord both in these and other animals at the *cauda equina.* 4*th*, The neurilema is either a continuation of the proper cerebral membrane, (*pia mater,*) or very similar to it; and this membrane is fibrous and aponeurotic at the spinal chord, and even at its upper end, and, accord-

* De Structura Nervorum, cap. i. p. 3.

† Anatomie Generale, p. 137, &c.

ing to Mayer, forms the denticulated ligament, which is a fibrous tissue. *

These views, which are the result, not of observation, but of hypothesis, it is impossible to adopt. Its connection with the *pia mater* was disproved by Reil; and though its analogy with the denticulated ligament were established, it would prove nothing regarding the neurilema. Upon the whole, the idea communicated by Reil is the most probable. According to the observations of this anatomist, who examined the neurilema after fine and successful injection, it is liberally supplied with blood-vessels. These derived from the neighbouring arteries penetrate the filamentous sheath of the nerve; and, immediately on reaching the neurilema, divaricating at right angles, generally run along the nervous threads, (*funes*) parallel to them, forming numerous anastomotic communications, and divide into innumerable minute vessels, which penetrate between them into the minute neurilematic canals. So manifold is the ramification, and so perfect the distribution, that in these canals not a particle of nervous substance is found which is not supplied with a vessel. † The arrangement of the veins is analogous.

It appears, therefore, that the neurilema is a

* Discours sur l'Histologie, par le Docteur Mayer. Bonn, 1819. Journal de Medecine, Vol. XIII. p. 99. 1822.

† Joannis Christiani Reil, Exercitationum Anatom. de Structura Nervorum, cap. 5. p. 19.

tissue of membranous form, with a multiplied mechanical surface, liberally supplied with blood-vessels, from which the nervous matter is secreted and nourished. It is impossible, indeed, to doubt, that, of the two parts which compose the nervous chord, it is the most perfectly organized; and that, though it may not be similar in structure to the *pia mater*, it is quite analogous in the use to which it is subservient. Like that membrane, it sustains the vessels of the nerve; it presents a multiplied surface, over which the vessels are distributed; and by penetrating deep into the body of the nerve, it conveys the nutritious vessels in the most capillary form to the inmost recesses of the nervous substance. *

The arrangement which has been above described is the only one which can be regarded as general. It varies in particular regions; and these varieties in the neurilematic disposition occur principally in the nerves which are distributed to the proper organs of sensation. † 1*st*, The olfactory nerve is soft, pulpy, and destitute of neurilema, from its origin in the sylvian fissure, to the gray bulbous enlargement which terminates its passage in the cranium; but as soon as it reaches the *canaliculi* or grooves of the ethmoid bone, and begins to be distributed through the nasal anfractuo-

* Reil, ibid, chap. i.

† By the term "proper organs of sensation" is understood those of sight, hearing, smell, and taste, which are confined to a fixed spot in the system.

sities, it is distinctly neurilematic. *2d*, The optic nerve is still more peculiar in this respect. The instant it quits the optic commissure, (*commissura tractuum*,) it begins to be invested by a firm general neurilema, which sends into the interior substance of the nerve various membranous *septa* or partitions, forming separate canals, in which the nervous matter is contained. These partitions, however, are so thin, that at first sight the optic nerve seems to consist merely of one exterior membranous cylinder inclosing the proper membranous substance. *3d*, *Lastly*, we may remark, that the auditory nerve, or the soft portion of the seventh pair of most anatomical writers, is the only nerve in which this covering cannot be traced.

The neurilema is much thinner and more delicate in the nerves which are distributed to the internal organs, as the lungs, heart, stomach, &c. (nerves of the organic life, great sympathetic and pneumogastric nerves, *par vagum*), than in those belonging to the muscular system.

The second component part of the nervous chord or filament is the proper nervous matter which occupies the cavity of the neurilematic canals. Little is known concerning the nature or organization of this substance. It is whitish, somewhat soft, and pulpy; but whether it consists of aggregated globules, as was attempted to be established by Della Torre and Sir Everard Home, or of linear tracts disposed in a situation parallel to each other, as appears to be the result of the inquiries of Monro, Reil, and others, or of

capillary cylinders containing a transparent gelatinous fluid as Fontana represents, seems quite uncertain. It has been presumed, rather than demonstrated, that it resembles cerebral substance. But this analogy, though admitted, would throw little light on the subject; for at present it is almost impossible to find two anatomical observers who have the same views of the intimate nature of cerebral substance itself. Whatever be its intimate arrangement, it appears to be a secretion from the neurilematic vessels. (Reil.)

The structure of the nervous chord may be demonstrated in the following manner. When a portion of nerve is placed in an alkaline solution, the whole, or nearly the whole, of the nervous matter is softened and dissolved, or may be washed out of the neurilematic canals, which are not affected by this agent, and the disposition of which may be then examined and demonstrated.* Aqueous maceration may likewise be advantageously employed to unfold this structure; for it separates and decomposes the cellular tissue by which the neurilematic canals are united, and subsequently occasions decomposition of the nervous substance, while it leaves, at least for some time, the neurilema not much affected. When, however, the maceration is too long continued, it is separated and detached like other macerated textures.

Lastly, If a large nerve be placed in diluted

* J. C. Reil de Structura Nervorum, cap. i. p. 3 and 5.

acid for the space of one or two weeks, the neurilema is gradually dissolved, and the nervous matter becomes so much indurated and consolidated that it may be separated from the contiguous chords in filaments with great facility.* In undergoing this change the portion of nerve becomes much shorter and considerably contracted, —is subjected, in short, to the process of crispation; so that unless a large nerve like the sciatic be employed for the experiment, it may be impossible to obtain the result in the most satisfactory form. These experiments, with many others of the same nature, were first performed by Professor Reil, and afterwards repeated and varied by Bichat and by Dr Gordon. Personal repetition of them enables me to assert, that, when correctly conducted, they never failed to give the results as described by these authors.

Nervous tissue, like all others, receives a proportion of what may be denominated the systems of distribution,—cellular tissue and blood-vessels. In the substance of the former, the disposition of which we have already remarked, we find the more conspicuous branches of the latter distributed. In a more minute and divided form they penetrate the neurilema and nervous substance.

* According to the experiments of Reil, nitrous acid diluted with water answers best. Muriatic acid, though equal or even superior in effecting solution of the neurilema, softens the nervous matter too much, and separates the component filaments too completely.—De Structura, cap. iii. p. 16.

Reil, who derived his conclusions from the result of delicate and successful injections, perhaps overrated the quantity of blood which in the sound state they convey; for it is quite certain, that, in the healthy state, hardly any red blood enters the nervous tissue, as may be easily shown by exposing the sciatic nerve of a dog or rabbit.

No good chemical analysis of nervous matter has yet been published. Every chemical examination of it has been conducted on the assumption that it is analogous to cerebral matter. Of this, however, there is no direct proof. In the analysis by Vauquelin the neurilematic covering appears not to have been detached,—a proceeding always necessary to obtain correct results in this inquiry. The effects of acids and alcohol show that it contains albuminous matter; but beyond this it is impossible at present to make any precise statements.

This description may communicate an idea of the structure of the nervous chord in general. In particular situations this structure is considerably modified. The modifications to which we allude occur under two forms—ganglions (Die knoten;) and plexuses (Die Nervengeflechte.)

Every ganglion consists essentially of three parts; 1*st*, an exterior covering; 2*d*, a collection of minute nervous filaments; and, 3*d*, a quantity of peculiar cellular or filamentous texture, by which these filaments are connected, and which constitutes the great mass of the ganglion.

The ganglions are of two kinds, the spinal or

simple, and the non-spinal or compound. These two kinds of bodies differ from each other, 1*st*, in the situation which they respectively occupy; 2*d*, in the kind of envelope with which they are invested; 3*d*, in the mode in which the nervous filaments pass through them and from them. By Wutzer, who considers the ganglion of Gasserius, the ciliary and the maxillary of Meckel, as cerebral ganglions, they are divided into three sets, those of the *cerebral* system, the *spinal* system, and the *vegetative*, or those connected with the organs of involuntary motion.*

Void of the dense strong coat with which the others are invested, the cerebral ganglions consist of soft secondary matter, connected to the filaments of one, or at most two branches, and are arranged with less complexity. (Wutzer.)

The spinal ganglions are said to possess two coverings, one of which resembles the hard cerebral membrane, *(meninx dura,)* the other the soft cerebral membrane, *(meninx tenuis, pia mater.)* The non-spinal, or compound ganglions, have also two coverings, which are merely different modifications of filamentous tissue less dense and compact than in the former. Both these sets of ganglions being by maceration stripped of their tunics, and deprived of the soft pulpy cellular matter, are resolved into an innumerable series of nervous threads, most of which are minute and

* De Corporis Humani Gangliorum Fabrica, &c. cap. i. ii. § 41, p. 52.

scarcely perceptible; all are continuous with the nerve or nerves above and below the ganglion. It appears that the nervous chord, when it enters the one apex of the ganglion, begins to be separated into its component threads, which diverge and form intervals, between which the delicate cellular tissue is interposed; and that these filaments are subsequently collected at the opposite extremity of the ganglion, where they are connected with the other nerve or nerves. Scarpa, to whom we are indebted for most of the knowledge we possess on this subject, * compares the arrangement to a rope, the component cords of which are untwisted and teased out at a certain part. *Lastly*, In the simple ganglions, the filaments of which they consist invariably follow the axis of the ganglion; but in the compound ones they are found to rise towards the sides and emerge from them; and upon this variety in the direction and course of these filaments depends the variety of figure for which these two orders of ganglions are remarkable. These nervous threads *(stamina s. fila nervea)* described by Scarpa, correspond to the medullary filaments *(fila medullaria)* of Wutzer. According to this anatomist these filaments, when about to enter the ganglion, lay aside their neurilem; yet they are sufficiently tough to resist a certain degree of tension.

Wutzer mentions a cluster of vesicles or cells *(cancelli)* in the filamentous tissue of the gan-

* Anatomicarum Annotationum Liber Primus de Nervorum Gangliis et Plexubus. Auct. Ant. Scarpa.

glion. But he was not enabled by any means, mechanical or chemical, to ascertain their exact nature.

The ganglions are well supplied with blood-vessels, derived in general from the neighbouring arteries. The intimate distribution is represented by Wutzer to be the following. The artery proceeding to a ganglion gives vessels to the filamentous tissue; and, perforating the proper coat, is immediately ramified into innumerable minute canals, the first order of which forms vascular nets on the inner surface of the tunic; while the residual twigs penetrate the flocculent texture, and the individual vesicles of the secondary or filamentous matter of the ganglion. *

This short exposition of the structure of the ganglions shows the mistaken notions of Johnstone, Unzer, Bichat, and others, on the structure and uses of these bodies. 1*st*, The idea first advanced by Johnstone, † and Unzer, ‡ adopted by Metzger, § Hufeland, || Prochaska, ¶

* De Corporis Humani Gangliorum Fabrica, &c. cap. ii. § 41.

† Philosophical Transactions, Vol. LIV. LVII. and LX. and Essay, &c.

‡ J. A. Unzer, Physiologie thierischer Körper. Leipzig, 1771, p. 66.

§ I. D. Metzger Opuscula Anatomica et Physiolog. Gothæ, &c. 1790.

|| C. W. Hufeland Ideenüber Pathogenie, &c. Jena, 1795.

¶ G. Prochaska Lehrsatze der Physiologie, &c. I.ter Band, Wien, 1797.

Sue, and Harless, * and afterwards applied with so much ingenuity by Bichat, that the ganglions are so many nervous centres or minute brains, is disproved by strict anatomical observation. 2*d*, That they are connected with the order of involuntary actions, and influence these actions, is a gratuitous hypothesis, and may be true or false, without being necessarily the case. 3*d*, Lastly, we remark, as a circumstance of some importance, that the only difference between a ganglion, and any other part of a nervous chord, is, that in the former the minute nervous filaments appear to be uncovered with neurilema, and lodged in a mass of cellular tissue, which is then inclosed in the neurilematic capsule; while in the latter each nervous filament has its appropriate neurilema, and the cellular tissue, instead of being within, is on its exterior, and connects it to the contiguous filaments.

In various situations two, three, or more nervous trunks or chords mutually unite by means of some of their component threads, and after proceeding in this manner for a short space, again separate, but not in the same number of original trunks, or preserving the same appearance. In general, the number of chords into which they finally separate is greater than that of which they consisted before union. Three or four nervous

* J. J. Sue, Recherches Physiologiques, &c. Paris, an. vi. German Translation by I. C. F. Harless, 1797, p. 2. Nurnberg, 1799, p. 3.

trunks, for example, after uniting in this manner, will form on their final separation five or six nerves or nervous chords; and it is quite impossible to determine which of the latter order was derived from any one or two of the former, or what number of individual chords it has received from each. Between the two points also, the first point of union, and the last of separation, many of the more minute component threads are detached from two or more of their trunks, and after first uniting with each other in an indistinct network, are again united to two or more of the nervous chords near the point at which they finally separate from the further end of union. This arrangement has been termed a *plexus, plait,* or *weaving,* in consequence of the manner in which the nervous chords are interlaced or plaited together. The arrangement which we have noticed as consisting of the more minute nervous threads has been called a *smaller plexus, (plexus minor.)* It is a subordinate plexus within a larger one.

The best and most distinct example of a plexus is that commonly named the brachial or axillary.*

* Imo nullibi fortasse clarior atque evidentior est hæc multarum conjugationum nervearum consociatio atque commixtio, quam in hac nervorum spinalium implicatione *plexum brachialem* appellata. Ibi enim quinque memorati nervi spinales cervicales una convenientes, qua primum cohaerent, aut tribuunt aut mutuo dant et accipiunt a sociis stamina, quæ demum in plures ramos consociata de plexu exeuntes brachiorum nervos faciunt ex omnibus illis quinque conju-

This, as is well known, is situate in the space contained between the broad dorsal muscle, *(latissimus dorsi)* behind, and the great pectoral muscle before, and is formed in the following manner. The fifth, sixth, seventh, and eighth cervical nerves, and the first dorsal, after forming the usual connections, *(ansae)* pass downwards from the vicinity of the vertebræ between the middle and anterior *scaleni* muscles, and nearly opposite the lower margin of the seventh cervical *vertebra*, or about the level of the first rib, begin to be united by the component threads of each nerve. Threads of the fifth and sixth cervical unite,—sometimes to form a single chord; in other instances to be connected a short space onward with threads of the seventh cervical in a similar manner. The seventh and eighth form two kinds of union. When the seventh is large, it divides almost equally into two chords or branches, one of which is connected first with the fifth and sixth, afterwards with the eighth, and with the first dorsal by interlacement of minute nervous threads. The other either passes downward to form one of the separate brachial nerves, or is also connected with the eighth cervical and first dorsal in a plexiform manner.

gationibus spinalibus, aut ex earum plerisque, compositos. Atque exinde sequitur, ut nervi brachiales dicti qui a plexu ad brachium, manum digitosque ejus omnes derivant, minime ad unam, sed ad plures spinalium conjugationes, nempe ad quatuor cervicales inferiores et dorsalium primam pertineant.—Anatom. Annotation. cap. iii. § 9. pp. 73, 74.

From this arrangement immediately arise the individual nervous branches which form the nerves of the arm, and which are named brachial nerves. The interlacement of minute nervous threads between the seventh and eighth cervical and the first dorsal, is what Scarpa has termed the *plexus minor*. He says it is peculiar, in being quite uniform, and in connecting those nervous branches which, from their subsequent destination, are called Median and Ulnar.

This description, though not generally applicable, will communicate some faint idea of the nervous unions and interlacements termed *plexus* or weavings. For more minute information on the distribution, arrangement, and configuration of this part of the nervous system, we must refer to the work of Scarpa already quoted. *

Plexiform arrangements are not confined to the exterior regions of the body. They are more numerous internally; and almost all the organs of the chest and belly have each a plexus, sometimes two, from which they derive their nervous chords.

Plexiform arrangements are generally situate in the neighbourhood of blood-vessels, and in some instances inclosing considerable arterial trunks more or less accurately. Thus the axillary plexus surrounds the axillary artery. The cœliac artery is surrounded with the solar plexus; and the coronary, hepatic, splenic, superior mesenteric, and

* Annotation. Anatom. § 9. cap. iii. pp. 94, 95.

renal, are also surrounded with plexiform nervous filaments. In some instances these nervous filaments are so intimately connected with the arterial tubes as to lead some anatomists to consider them as forming a peculiar net-work surrounding the vessel, and to exercise great influence on the circulation. (Wrisberg, Ludwig, and Haase.)

It is remarkable that the structure of the nervous chords which form a plexus has either appeared so simple as not to demand particular attention, or is so obscure as to be never noticed. Have the nervous chords and threads in such situations their usual envelope? Is the nervous matter in the chords quite the same as in other situations? Is there any other means of union, save the nervous substance itself? We believe there is no doubt that every chord in a plexus is provided with its neurilema as in other places; but this neurilema is generally thinner and more delicate; and the general neurilema seems to be wanting. Its mechanical properties of cohesion and resistance have not been examined.

The view which has been given of the structure or arrangement of the nervous plexus has led Scarpa to consider them as nearly allied to ganglions. The same separation of the component threads or filaments of the nerve or nerves, the same interlacement, and the same or similar formation of new chords, appear to take place in both orders of structure. A ganglion, indeed, he conceives, is a condensed or contracted plexus;

and a plexus is an expanded or unfolded ganglion. The great anatomical purpose of both appears to be simply a new arrangement or disposition of nervous branches, previous to their ultimate distribution in the tissues or organs to which they are destined. This is nothing but the expression of a fact,—the interpretation in intelligible terms of an arrangement of organized parts without reference to any supposed uses.

I have already shown what is meant by the organic end or termination of a nerve. Although the nervous trunks are distributed in every direction through the animal body, they do not terminate in all the tissues or organs indiscriminately; and have been observed to be lost in the following only. 1*st*, the proper organs of sensation, the eye, ear, nose, palate, and tongue; 2*d*, the muscles, whether subservient to voluntary or to involuntary motion, as the heart, stomach, intestines, &c.; 3*d*, the mucous surfaces; 4*th*, the skin; 5*th*, glands, salivary, liver, kidneys, &c.; 6*th*, bones.

Nerves, therefore, are not organs of general distribution. According to Bichat, they have never been traced to the following tissues:—the cartilages, both articular and of the cavities; fibrous textures, viz. *periosteum*, *dura meninx*, capsular ligaments, aponeurotic sheaths, aponeurosis in general, tendon and ligament; fibro-cartilaginous textures; those of the external ear, nose, trachea, and eyelids, (cartilages of other authors); the se-

milunar cartilages of the knee-joint; those of the temporo-maxillary articulation; those of the intervertebral spaces; marrow; the lymphatic glands.

To this we may add the testimony of a professed anatomist of the nervous system, whose reputation for patient and industrious research cannot fail to sanction every thing which he has advanced. "In every subject," says Walter of Berlin, "in which I was desirous to trace the nerves, I injected the arteries with red-coloured wax, the veins with green, and even the lymphatics with quicksilver, so that I was able to distinguish the nervous filaments from each of these orders of vessels. By this contrivance, though it occupied much time and labour, yet I was satisfactorily convinced that the pleura, the pericardium, the thoracic duct, and the peritoneum, receive no nerves. Nay, that, contrary to the opinions of the most eminent recent anatomists, no nerves terminate in the lymphatic or conglobate glands. Sometimes, indeed, these organs are perforated by one or two twigs, as I have often had occasion to observe; but they instantly proceed to the next place assigned to them, and in which they are finally lost." * If after this conclusion of Walter personal testimony can be of any use, I may add, that I have examined the dura mater, the periosteum, and most of the synovial membranes repeatedly, to discover nervous filaments in them,

* Praefat. Tab. Nerv. Thoracis et Abdominis, J. G. Walter.

and always without success; and I may say the same regarding the absence or non-appearance of nerves in the peritoneum and pleura.

The nerves have different uses in the different organs and tissues to which they are distributed. 1. In the organs of sensation they receive the mechanical impressions made on the mechanical part of the organ. In the eye, the retina receives the last image formed by the transmitting powers of the transparent parts. In the ear, the terminations of the auditory nerve are affected by the oscillations or minute changes in the fluid of the labyrinth, occasioned by the motions of the tympanal bones. In the mucous membrane of the nasal passages, the filaments of the olfactory nerve are affected by aromatic particles, dissolved or suspended in the air. In the palate, tongue, and throat, the gustatory nerves are affected by sapid bodies dissolved in the mouth, or applied in a fluid state to the mucous membrane of that cavity. 2. In the system of voluntary muscles the nerves retain the action of the muscular fibres in a state of uniformity and equality, and keep them obedient to the will. In the involuntary muscles they appear merely to keep their action equable, regular, and uniform; and in both they maintain a communication, or consent, or harmony of action between different parts of the same system of organs, or even between different organs concurring to the same function. 3. In the glandular organs the nerves certainly exercise some influence over

the process of secretion; but what is the exact nature of this influence, or in what degree it takes place, is quite uncertain. This may be said to comprehend all that is accurately known regarding the uses of the nerves. Every other doctrine relating to sensibility, sympathy, irritability, &c. is either unfounded, not proved, or altogether imaginary and hypothetical.

In the fœtus the nerves are developed with remarkable perfection. I cannot speak from personal observation much earlier than the sixth month, when I have found the nerves of the extremities and voluntary muscles large and distinct. At the eighth month they are still more conspicuous. The anterior crural nerves are in the form of flat white cords one and a half line broad, and their branches like good sized threads. The sciatic is still more distinct. In the form of a thick cylindrical cord, fully a line in diameter, and not unlike a piece of whip-cord, it is tough, stringy, and resists tension; and its constituent threads are well-marked. I immersed a portion of this nerve three and a half inches long in *aqua potassæ*, when it first became much firmer and denser than before, assumed in two days the satin fibrous appearance first described by Fontana, and at length by solution of the nervous matter was separated into chords and neurilematic canals. In this state, preserved in spirit of turpentine, it conveys a tolerably correct idea of the arrangement of the neurilematic canals.

The nerves of the involuntary muscles are equally distinct in proportion. Those of the lung, heart, and splanchnic system are distinct and manifest at the eighth month.

The neurilem is much more vascular in the fœtus than in the adult. In the same fœtus of about eight months I found the neurilem of the sciatic nerve, from the ischiatic notch to its divarication in the ham, covered with a thick net-work of minute vessels, all injected with dark blood.

Section II

1. *Inflammation, spontaneous and from injury, —Nerve-ach, Neuralgia (Neurilemmia).* Nervous tissue is liable to inflammation. This may arise spontaneously, or in consequence of injury, as contusion, wound, laceration, ligature, &c. It is accompanied first with gnawing pain, which is oftener periodical than constant, spreading along the course of the nerve, sometimes its branches, with a sense of heat often very disagreeable, and a peculiar tenderness of the surface. After some time the pain is less violent, but more constant; and more or less derangement in the functions of the parts to which the nerve goes takes place. The skin becomes numb, cold, and insensible. Of muscular parts the motions are variously disordered, becoming irregular, spasmodic, and little under the influence of the will, so as to constitute convul-

sions, and finally being lost in different degrees, so as to cause palsy more or less complete. This constitutes one form of *neuralgia* or nerve-ach. It is most frequent in the sciatic, partly in consequence of its exposed situation, and sometimes in consequence of actual violence locally inflicted, as in falling. (*Ischias nervosa* of Cotunnius.) I have, however, seen this affection arising in other nerves; for example, the median or spiral, in the arm, and sometimes the posterior tibial, in the leg, in consequence of similar causes. In one instance it was confined with accuracy to the anterior branch of the radial nerve, which goes to the thumb and index finger. In such cases the inflammatory action is confined pretty accurately to a part of the neurilematic coat, which becomes firm, vascular, and more or less tender.

In neuralgia of the face (*tic douloureux*, Fothergill—*prosopalgia*, Frank, Weisse,) it is not easy to say what is the pathological cause. It is undoubted that it is seated in the nerve; and though some forms of this malady evidently depend on inflammation of the neurilema, yet others of them, which are of long continuance, and are attended by other peculiarities, are not perhaps to be ascribed to this cause. It is not requisite to suppose that the long continuance of this action, without producing suppuration or other changes, is an argument against its inflammatory character. The inflammation may be, like those in fibrous tissue, of long continuance, without inducing any other ef-

fect save that of thickening and stiffness by effusion of lymph.

An idea has been advanced by Reil, that general inflammation of the neurilema takes place in typhus fever, and is the pathological cause of that disease. * That the vessels of this tissue may be gorged in common with those of every other is exceedingly probable, and may be often the case. But it is manifest that this is one only of many simultaneous effects; and it is further evident, that neither observation nor anatomical inspection can justify the conclusion, that inflammation of the neurilema is the pathological cause of fever.

2. *Neurilemmia Chronica.* Inflammation of nervous tissue may terminate, 1*st*, in resolution; 2*d*, in effusion of lymph; 3*d*, in ulceration; or, 4*th*, it may induce a low chronic action, accompanied with enlargement of the nerve, or morbid growth by deposition of new matter. These phenomena are most distinctly seen in the changes which follow wounds of nerves. In this case effusion of lymph is common, and is not unfrequently succeeded either by local palsy, or by a train of symptoms similar to nerve-ache. *(Neuralgia.)*

Dr Denmark saw a contused wound of the radial nerve produce neuralgic symptoms requiring amputation. † Charles Bell saw the same result succeed contusion without wound in the popliteal

* Fieberlehre, Band. iv. p. 56.

† Medico-Chirurgical Transactions, Vol. IV. p. 48. London, 1813.

nerve, and the inflammation occasioned by the application of quicksilver to the same nerve.* Mr Wardrop saw neuralgic symptoms succeed a puncture of the finger, in which he thinks a nerve was injured;† and in another instance similar effects from wound of the thumb, in which a branch of the radial nerve close to the digital artery was punctured.‡ In venesection it sometimes happens when the cutaneous nerves are pierced, that numbness and tetanic stiffness, with spasmodic twitches, are felt in the arm or fore-arm for some time after. These symptoms it is justifiable to ascribe to chronic inflammation, with thickening and induration of the nerve.§ (Denmark.) This thickening depends partly on extreme and undue distension of the neurilematic vessels, partly on exudation of lymph, which proceeds from the same source.

In the remarkable case described by Mr Pearson, in which he ascribes severe and complicated neuralgic and paralytic symptoms to "a morbid condition of the nerves distributed to the extremity of the thumb,"‖ this morbid condition was

* Surgical Observations, &c. By Charles Bell. Lond. 1816, p. 440. Case of Baron Driesen.

† Medico-Chirurgical Transactions. Lond. Vol. VIII. p. 246.

‡ Medico-Chirurgical Transactions, Vol. XII. p. 205.

§ "The nerve was found thickened to twice its natural diameter, and contracted."—Transact. Vol. IV. p. 51.

‖ Account of Remarkable Symptoms, &c. By John Pearson, Esq. &c. Medico-Chirurg. Trans. Vol. VIII. p. 252.

probably chronic inflammation of some part of their neurilematic covering.

Patients who have undergone amputation sometimes complain of acute pain in a single point of the stump, liable to aggravation when touched, and spreading up the limb in the course of the nerves. It is usual to ascribe such complaints to implication of the nerve in the cicatrix; but it is more likely that a minute branch has been included in the ligature of some of the vessels. In such circumstances it is manifest that a cause is given for the most severe and obstinate form of neurilematic inflammation. *Lastly*, I may notice, that to the same head is to be referred a painful gnawing sensation of contraction ascending up the arm from the finger, which I have seen follow the communication of the inflammation of whitloe to one of the small branches of the radial nerve.

Ulceration of nervous tissue, though rare, may occur either after wound, laceration, or contusion of a nerve, as in the case of ligature, or in consequence of an ulcer of the contiguous parts spreading to the nerve. It does not appear to occur spontaneously after inflammation.

3. *Division and Re-union; Excision or Removal, and Reproduction.* When a nerve is cut across, no doubt can be entertained that it is again re-united. But it is questionable whether it is re-united by simple adhesion, by the growth of new nerve, or by the growth of new matter entirely different. The latter point has been a particular subject of inquiry to many anatomists and physi-

ologists in the case of excision, or removal of portions of a nervous trunk. Though the nerves have been divided by many, the first accurate experiments made with a view to ascertain their reproductive power were performed by Cruickshank. This anatomist found, that, when a portion of nerve is removed by incision, its place is supplied by blood and lymph, which first becomes vascular and organized, and is afterwards converted into a substance of the same colour as nerve; and which, though not fibrous, he regarded as nervous.* These experiments were repeated by Fontana, who, after much hesitation, came to the conclusion that nervous matter is reproduced †; by Arnemann, who denied that the new-formed matter is nerve ‡; by Haighton, who inferred that this substance is really and truly nerve §; by Baronio, || Michaelis, ¶ and Meyer, ** who have ar-

* Experiments on the Nerves, particularly on their Reproduction, &c. By William Cruickshank, F. R. S. &c. Phil. Transactions, 1795. Part I. p. 177.

† Experiences sur la Reproductions des Nerfs, apud Traité sur la Venin de la Vipere, &c. Par Felix Fontana. Tom. II. Florence, 1781, p. 177.

‡ Ueber die Reproduction der Nerven, Goettingen, 1786. Versuche Ueber die Regeneration der Nerven. Ibid, 1787.

§ An Experimental Inquiry on the Reproduction of Nerves. By John Haighton, M. D. Philosophical Transact. Lond. 1795. Part I. p. 190.

|| Memorie di Matematica e Fisica, Vol IV.

¶ Fr. Michaelis Ueber die Regeneration der Nerven. Cassel, 1785.

** Meyer apud Reil Archiv. für die Physiologie, II. Band. p. 449.

rived nearly at the same general result, and assert that nervous filaments may be traced through the new matter of the cicatrix.

According to Arnemann, who describes the process of reunion particularly, shortly after section, the end of the upper portion of cut nerve inflames and swells, forming a grayish, long, and hard knot; the end of the lower portion undergoes the same change, but in less degree; the knotty parts unite; and the substance which thus connects the cut portions of nerve, though it continues hard and large, is considered as either nervous matter, or as containing a considerable portion of that substance, for the sensations and motions of the parts are in most cases restored shortly after union.

This process, according to Bichat, therefore, consists of four stages. 1*st*, After incision the cut ends inflame, and its capillaries effuse coagulating or organizable lymph, which is penetrated with blood-vessels. 2*d*, This effusion, which takes place chiefly from the neurilema, forms a sort of cellular tissue, in which nervous matter is afterwards deposited. This cellular tissue, and the new matter in general, is in quantity according to the spaces to be filled up. If it be large, the new matter is augmented by successive effusion and granulation; and when small, the connection by deposition appears to be very speedily effected. 3*d*, The adhesion of the individual granulating bodies and consolidation of the part. 4*th*, The deposition

or exhalation of nervous substance in the new matter. * Is this, which is said to be the last stage of the process, not co-existent and simultaneous with the effusion of new matter in general? What are the proofs which show that the proper nervous matter is last deposited?

When a nerve has been divided under circumstances which prevent it from uniting in any manner with its detached segment, as in amputation, the extremity enlarges and becomes vascular, from the neurilematic vessels assuming the inflammatory action; blood and lymph are effused both from the cut extremity and into the interstices of the neurilematic canals; more or less adhesion is contracted with the contiguous textures; and when the active state of this process has subsided, a hard knotty tubercle is left in the site of the cut extremity. This tubercle is at first rendered vascular, afterwards grayish, solid, and so firm that the knife may be blunted in dividing it. (Arnemann.) The changes now mentioned I have often traced in the surface of stumps during healing. The size and shape of the tubercle vary according to circumstances not well ascertained. When situate not exactly at the extremity, as observed by Van Horne, † it merely shows that the inflammatory process had spread farther up the nerve than usual.

* Anat. Gen. Tom. I. Art. iii. sect. 3. p. 176.

† De iis quæ in partibus membri amputatione vulneratis notanda sunt. Lugduni Batav. 1803.

It was at one time supposed that the morbid growth called *blood-like fungus (fungus hæmatodes)* was peculiar to the nervous tissue. This idea is now known to be incorrect; and it appears that there is no process of disorganization peculiar to nerve, and not occurring in other textures.

Nervous texture is sometimes unnaturally soft; as in dropsy, fatal hemorrhages, and diseases of long wasting. (Autenrieth.) Is it ever unusually soft primarily, and without being the result of another disease? It undergoes mollescence (*ramollissement*) in consequence of mechanical injury; but it is exceedingly doubtful if this takes place spontaneously.

4. Local forms of palsy, that is, loss of mobility in an order of muscles, or in a limb, is a common result of injury done to a nerve or nerves. The effect of such injury is in general to produce inflammation or extravasation, and subsequent destruction of the proper nervous matter. It becomes soft, pulpy, and disorganized. In this state the nerve is no longer fit to perform its usual functions, and it loses the influence which it possessed over the muscles to which it is distributed. In the course of this process irregular motions, or what are termed spasms, not unfrequently occur.

Tetanus. Punctured or lacerated wounds of nervous tissue may be followed by tonic spasms, (*tetanus,*) or by convulsive motions in general. It is uncertain in this case whether the irregular mo-

tions depend on injury of the nerve, or its neurilematic sheath.

5. *Tumours*, (*Neuroma* of Odier.) Tumours of various size and structure have been found in nervous trunks. These may be either common to nerve with other tissues, or proper. * Of the former an example is given in the encysted tumour (*hygroma*) which Cheselden † found in the centre of the cubital (*ulnar*) nerve. Of that met with by Gooch in the axillary nerve, the account is not so distinct. ‡ Sir Everard Home mentions a tumour removed from the middle of the right arm by John Hunter, and in which the musculo-cutaneous nerve was found imbedded, divided into two portions, each much flattened. § This tu-

* It is singular to remark with how little precision pathological writers speak of these tumours. Odier compares the one mentioned by Cheselden to a firm one noticed by Gooch, and to the yellow-whitish tumour which he met in the radial nerve of a relative. Meckel also refers to Cheselden's case in speaking of tumours, considerably hard, roundish, yellow-whitish, of fibrous structure, and approaching to fibro-cartilage. The case of Cheselden should have been carefully distinguished from the tumours intended to exemplify this description. For that surgeon states specifically, that " it was of the cistic kind, but contained a transparent jelly." It was in truth an instance of *hygroma*, and, as I have stated in the text, it was common to the nervous and other tissues.

† The Anatomy of the Human Body, p. 256. London, 1778.

‡ Cases and Practical Remarks in Surgery, Vol. II.

§ Trans. of a Society, &c. Vol. II. p. 152. An Account, &c.

mour appears to have originated in the neurilem. In another instance Sir E. Home removed a tumour in which one of the large nerves of the axillary plexus was encased.

Lastly, Odier describes, under the name of *neuroma*, in the person of a member of his own family, an instance of tumour in the radial nerve, in which its component threads were separated from each other in the manner of a fan, or like the ribs of a melon, while the centre was filled with white and yellow matter, effused in the intervals of an infinite number of transparent vessels, mutually interlacing.* Examples of similar tumours are mentioned by Marandel, † Neumann, ‡ Von Siebold, § Spangenberg, || Alexander, ¶ Mojon and Covercelli. ** Some years ago I saw, in the arm of a woman about thirty, an oblong pyriform hard body, extending along the inner margin of the *biceps flexor*, in the site of the brachial vessels and nerves, to the anterior

* Manuel de Medecine Pratique, &c. Par Louis Odier, Doct. et Prof. a Paris et Geneve, 1811. Cl. IV. Ord. v. 17, p. 362.

† Bulletin apud Journal de Medecine continue, Vol. XI.

‡ In Von Siebold Sammlung Chirurg. Beobachtungen.

§ Von Siebold I. Band, p. 80, 82.

|| In Horn Archiv. V. Band, 2 Heft, St. 2. 306.

¶ F. S. Alexander, Dissertatio de Tumoribus Nervorum. Lugd. B. 1800. This work I have not seen, and I am therefore unable to say how far the tumours which he mentions belong to the present head, or that which is now to follow.

** Chiron, Band I. St. 3.; and Memorie, &c. di Genova.

tuberosity of the *humerus*. It was attended with prickling pain, and alternating with numbness of the arm, fore-arm, and fingers. From these symptoms (Home,) the absence of pulsation and its situation, no doubt could be entertained that it implicated the brachial nerve. The woman refused, however, to submit to have it removed; and I have not since heard of her. The evidence of dissection as to its precise nature is therefore still wanting.

It is not easy to determine which of these tumours are to be regarded as common, or proper to the nervous chord or the neurilematic tissue. It is manifest that the case of Cheselden, and perhaps that of Gooch, and the second one of Home, were common. That of Odier, and the first of Home, appear to have been seated either in the neurilema or its cellular tissue, and probably consisted in deposition of new matter in the interstices of the neurilematic canals. In the former case the filaments of the nerve are more or less expanded and separated. In the latter they pass through the body of the tumour in a mass.

6. *Neuromation*, (Νευρωμα τιον.) (Subcutaneous tubercle of Mr Wood.) By this name may be distinguished those pisiform tumours or hard tubercles which form beneath the skin, and of which I had already occasion to speak when enumerating the morbid states of the filamentous tissue. I then had occasion to remark, that there is strong reason for thinking that this painful disease con-

sists in the hard body being seated in some of the nervous twigs beneath the skin. I am now to advance such evidence as may show, that little doubt can be entertained that this is the true pathology of the subcutaneous tubercle.

Hard, painful, pisiform tumours beneath the skin are first mentioned by Cheselden, who met with three cases in which he employed excision, without being aware that they might be seated in the nerves or their coverings. * Camper is, so far as I am aware, the first anatomist who remarks the occasional occurrence of minute hard tubercles, not larger than a pea, in the cutaneous nerves; where he represents them as giving rise to excruciating darting pains night and day, admitting of no alleviation from external remedies. Of this kind he met with one in the musculo-cutaneous nerve of a woman at Franequer, and another in the knee of a woman at Amsterdam. Both he removed by excision, and found them white internally, of gristly hardness, elastic, and seated within the neurilema. †

The next notice of this disease is by Dr Bisset, who observed it in the form of an irregularly-oval tumour, the size of a filbert, on the outside of the left leg, six inches above the outer ancle, also in a

* Anatomy of the Human Body. By William Cheselden, p. 136.

† Petri Camper Demonstrationum Anatomico-Pathologicarum, Lib. i. Caput 2. § 5, p. 11. Lugduni Bat. Folio Imp.

woman of twenty-nine years.* Soon after it was observed by Mr Pearson in the subcutaneous nerve which accompanies the saphæna vein, in the leg of a woman of fifty-one; in the back of the leg, near the *tendo Achillis;* and at the bend of the arm, near the median vein,† in a young married woman. Since this time the disease was fully and accurately described by Mr William Wood of this city;‡ and occasional cases have been published by other authors.§

Mr Wood questions the justice of the opinion of Camper, that the tubercle is seated in the nerve-coat, or is a nervous tumour; and thinks that it is a distinct or peculiar species of tumour, situate in the subcutaneous cellular membrane. It may not perhaps be possible to prove that every little subcutaneous tubercle is of this description. But the observations of the authors above-mentioned, and those of A. Petit,‖ Tissot, Lassus, Jacopi,¶ Monteggia,** and Alexander, show manifestly that the nerves are liable to tubercles of this kind.

* Memoirs of the Medical Society of London, Vol. III. p. 58. Case of Irritable Tumour. By C. Bisset, M. D. &c. London, 1792.

† Medical Facts and Observations, Vol. VI. p. 96. Account, &c.

‡ Medical and Surgical Journal, Vol. VIII. p. 283, 429.

§ Ibid. Vol. XI. XVII. XVIII.

‖ Essai sur la Medecine, &c. A Lyon, 1806.

¶ Prospetto della Scuola di Chirurgia Pratica, &c. Vol. I. cap. 9. Milano, 1813.

** Istituz. Chirur. Vol. II. Capo xiv. p. 197. Milano, 1813.

The proofs, in short, which may be adduced in favour of this idea are the following. 1. In many instances of subcutaneous tubercle the lenticular body has been formed in the substance or coat of a nerve. (Camper, Bisset, A. Petit, Tissot, Lassus, Jacopi, &c.) 2. In the majority of cases the tubercle can be traced distinctly to the branch, twig, or filament of a subcutaneous nerve. 3. The painful sensation of which it is the seat, though severe and constant, is always aggravated by handling or pressing the tumour, and may be always traced along nervous branches.

In the cases in which the neuromatic tubercle has been dissected, it has been found hard, cartilaginous, and slightly vascular. It seems in general to consist in morbid change of the neurilema, by deposition of albuminous matter in the neurilematic interstices. (Jacopi.) It is much more frequent in women than in men, in the proportion nearly of from seven to one, and from ten to one. Monteggia states that he found the entire nervous system occupied with numerous *(centinaia)* neuromatic tubercles, which would indicate, as he observes, in some instances a neuromatic diathesis. * The cause of their formation is not known; but from the effects of ligature, division, and other injury, it may be in some manner conceived.

7. Considerable wasting and shrinking were seen in the optic nerves by Spigelius, Riolan, Rolfinck,

* Istituzione Chirurgiche, Vol. II. p. 197.

Morgagni, Santorini, and Benninger; and complete destruction in the olfacient nerves by Falkenburg. These changes, which take place generally at the cerebral end of the nerve, are accompanied with diminution or loss of function.

CHAPTER XIII.

Section I.

BRAIN, CEREBRAL SUBSTANCE, *Cerebrum*,—BRAIN, CRANIAL AND SPINAL. Μυελον εγκεφαλον και μυελον νωτιαιον,—*Marrow of the Head, and Marrow of the Back*, GALEN.

VARIOUS mysterious notions on the nervous system have much retarded the knowledge both of the structure and configuration of the brain; and imitation of the ancients, or adoption of their opinions without examination, has created and perpetuated various errors on the nature and physical, or physiological qualities which distinguish the peculiar animal substance of which this organ consists. It is not wonderful that the anatomists of the Greek and Alexandrian schools applied to this organ the name of an animal substance with which they were familiar, and endeavoured, by comparison with matter more easily understood,

to enlighten the obscurity of their notions on an organ not often seen even in animals, and believed to be the seat of the most mysterious and important processes of the animal frame. Nor is it wonderful that the revivers of medicine, and the creators of human anatomy, adopted the title of marrow from the writers who instructed them in all other things, and whom many would have deemed it sacrilege not to worship.

To the mind, however, which is unfettered by prejudices in favour of ancient opinions, it appears singular that the enlightened physiologists of the eighteenth century should talk of the medullary and cortical matter of an organ in which nothing like marrow or bark can be seen ;—and it is more extraordinary still, that the accurate distinctions which anatomy has introduced since the commencement of the nineteenth century, have not demonstrated the evil of retaining terms which are improper as mere nominal distinctions, but which are doubly erroneous as the relics of an unfounded and exploded theory. Is the error of likening the brain to marrow obviated by shrouding it under the learned denomination of *medulla* and *medullary* ? Or is the absurdity of supposing the gray matter of the convoluted surface a bark, or envelope to the white pith, diminished in the slightest degree by calling that gray matter *cortical* ? The common sense of the present day will not hesitate to answer these questions in the negative. Should it be said

by the antiquists, that now, when the absurdity of these names is known, it can do no harm to retain them as mere names? We answer, it may do no harm; but as it can communicate no information, and explain no difficulties, it is at least a superfluous labour to augment the confusion of a department of anatomy not very easy by useless and antiquated names, which live only to proclaim their absurdity, and the impropriety of finding them there. Knowledge in the present day, to be worth the labour of acquisition, ought to be accurate; and books which are to be the means of conveying this knowledge ought to contain no superfluous or erroneous information.

As little to be approved is the application of the term *nervous matter* to the substance of the brain, because it implies the identity of this substance with that of the nervous tissue. It is not improbable that this may be the case; but, in the meantime, as it requires yet to be proved, we conceive it more judicious to consider the substance of the brain as quite distinct from that of the nervous chords. For these reasons, the cogency of which I presume cannot be denied, I propose to abandon entirely the terms hitherto used by anatomists when speaking of the brain, and I shall on all occasions consider it as a peculiar substance under the name of brain, cerebral substance, or cerebral matter.

No organ has been examined by so many anatomists, with such frequency, and with so much

accuracy as the brain. Besides the descriptions in systematic works, the number of express treatises either on the whole organ or some of its parts is very great. The names of these it is superfluous to enumerate ; and to attempt to estimate their respective merits does not belong to the plan of the present treatise. It is sufficient to remark those circumstances only which bear directly on the subject of this chapter.

Of all the works which have been composed on the anatomy of the brain, the subjects may be referred to two general heads ;—those which treat of the configuration of the organ, and those which undertake to investigate its minute structure. The authors themselves, however, do not always distinguish accurately between these two departments of anatomical science. As it is chiefly the latter which is to occupy attention at present, I may mention, that after the epistle of Varoli on the base of the brain and the origin of the optic nerves, the writings of Willis, Malpighi, and Vieussens, are the first which claim much notice. The works of Ridley, * and of Glaserus, † contain some good observations ; and that of Santorini ‡ deserves to be mentioned for the first good description of the optic *thalami*. Father Della

* Anatomy of the Brain. By Henry Ridley, Lond. 1695.

† J. H. Glaserus de Cerebro. Basil, 1680.

‡ Jo. Dom. Santorini Observationes Anatomicæ. Lugdun. Bat. 1739.

Torre, * Prochaska, † and Monro, are the first after Lewenhoeck who treat of the structure of the brain after microscopical observation. The essay of Vicq-D'Azyr, and his elaborate engravings are sufficiently well known. ‡ About the same time, 1780, Vincenzo Malacarne described the component parts of the organ with more accuracy than had hitherto been attempted. § Reil followed, and communicated much new information on the minute structure of several parts of the organ. ‖ The work of Rolando, which appeared in 1809, ¶ has been little known till of late. Better fortune awaited the elaborate treatise of John and Charles Wenzel, ** which is highly appreciated by every anatomical inquirer in Europe. Lastly, the description of Gordon, †† and

* D. Giovanni Maria Della Torre, Nuove Osservazione Microscopiche. Napoli, 1776.

† Georgii Prochaska, De Structura Nervorum Tractatus Anatom. Viennæ, 1779, et apud Op. Min. 1800.

‡ Recherches sur la Structure du Cerveau. Mémoires de l'Academie des Sciences. Paris, 1781–83.

§ Encefalotomia Nuova Universale di Vincenzo Malacarne Saluzzese. Torino, 1780.

‖ Fragmente Ueber die Bildung des Gehirns im Menschen Vom Professor Reil. Archiv. fur die Physiologie. 8ter, Band, &c. et various papers in 9ter, Band.

¶ Saggio sulla vera Structura del cervello dell' uomo. Sassari, 1809.

** J. et C. Wenzel, De Penitiore Structura Cerebri Hominis et Brutorum. Tubingæ, 1812.

†† Observations, &c. and Outlines of Human Anatomy. By John Gordon, M. D. &c. Edinburgh.

the microscopical observations of Sir Everard Home,* who has confirmed many of the facts observed by Della Torre, are entitled to the utmost attention.

The brain may be considered as a continuous organ consisting of three divisions ;—the convoluted, the laminated, and the smooth or uniform portions. Of these divisions, which are framed according to the peculiar external configuration of each, the first part corresponds to what is called the brain proper, (*cerebrum ;*) the second to the small brain, (*cerebellum ;*) and the third to the oblong body contained in the vertebral column, and known under the name of *spinal chord.*

The convoluted portion presents two surfaces, an outer or convoluted, and an inner or figurate. The laminated portion in like manner presents two surfaces, an outer or laminated, and an inner or central. The third has only one exterior surface.

The exterior surface of the convoluted division of the organ is formed into eminences longitudinal and rounded, but directed in various ways, and separated from each other by deep hollows. These eminences have been named convolutions or circumvolutions, *(gyri,* Soemmering, Wenzel,) and the depressions *sulci* or furrows. This surface of the organ is most properly termed the *convoluted surface.* To see it distinctly, the vascular membrane termed *pia mater, (meninx tenuis,)* (Das

* Phil. Trans. 1821, p. 25, 1824, p. 1, and 1825, p. 436.

Gefasshaut,) must be cautiously removed by dissection.

The convoluted surface communicates with another interior surface at two parts; 1*st*, on the middle plane, under the posterior end of the middle band or meso-lobe, *(corpus callosum)*; 2*d*, on each side of the middle plane, at the outer margin of the fluted masses termed *limbs* of the brain, (*crura cerebri*) (Die Hirnschenkel); between these limbs and the posterior end of the optic chamber or couch, *(thalamus opticus)* (Der Sehhugel.) This surface of the organ may be termed the central or figurate.

The exterior surface of the cerebellum is differently disposed. Instead of presenting convoluted eminences, it consists of thin portions of cerebral substance, placed contiguously, and either parallel or concentric. These portions, which have been named plates (*laminæ*,) or leaves (*folia*,) are separated from each other by furrows of various depth. This surface, which may be named the *laminar* or *foliated* surface of the small brain, communicates also with the figurate surface, 1*st*, at its superior part on the middle plane, between the semilunar notch (Der halbmondformige Ausschnitt; Reil) behind, and the white cerebral plate termed Vieussenian valve, before. 2*d*, At its inferior surface between the parts termed almonds by Malacarne, or spinal lobules by Gordon, above; and the upper end (*medulla oblongata*) of the spinal chord, below.

The convoluted surface of each hemisphere may

be conveniently divided into the following five regions; 1. The commutual or dichotomous; 2. The lateral-superior, or convex; 3. The antero-inferior, or frontal; 4. The medio-inferior, or spheno-temporal; 5. The posterior or cerebellic region of the convoluted surface.

The first of these regions of the convoluted surface is easily understood. Plane in its surface, of a shape nearly semicircular, it forms the central boundary of each hemisphere, corresponds to the falciform or dichotomous portion of the hard membrane, (μηνιγξ σκληρη, *meninx dura*,) by which it is separated from the similar surface of the opposite hemisphere. Before and behind it extends from the superior to the inferior surface of the brain; but a considerable portion of its middle is terminated by the upper surface of the object named middle band, (*mesolobe, corpus callosum*,) which lies between the two hemispheres. It is contained between the semicircular and the rectilinear margins.

The second region of the convoluted surface is extensive, and occupies the whole of the anterior, upper, lateral, and posterior parts of the hemisphere, from their anterior to their posterior extremity, and from the semicircular margin to a line which extends between these extremities along the lateral borders of the organ.

The antero-inferior or frontal, is that region of the convoluted surface which rests on the horizontal part of the frontal and ethmoid bones, and

commencing before with a curved outline,—the anterior end of the hemisphere, is bounded behind by the curvilinear hollow, which has been named the pit or fissure of Sylvius. It is slightly uneven, and is bounded at its inner or mesial margin by the great fissure which separates the hemispheres. This inner margin always presents one convolution, which is quite uniform in direction, extent, and configuration. It consists of a longitudinal eminence, which extends in the adult brain about $1\frac{1}{2}$ inch from the beginning or posterior end of the notch, towards its anterior extremity. The inner margin of the eminence, which is about four lines broad, forms the side of the fissure; and its outer margin or border is separated from the contiguous part of the convoluted surface, by a furrow or hollow equally uniform in direction and figure with the eminence,—about the same average length (1 inch 5 lines.) This furrow contains the cerebral portion of the first pair or olfacient nerves.

The medio-inferior or spheno-temporal, is situate immediately behind this region, from which it is separated by the curvilinear hollow. *(Fossa Sylvii.)* In the ordinary descriptions, this forms what has been named the *middle lobe* of the brain; while the posterior part of the convoluted surface, or that which corresponds to the cerebellum, though distinguished by no evident mark or limit, has been with equal impropriety named the *posterior lobe.* If the whole region be examined

from the curvilinear hollow to the posterior tip of the hemisphere, it affords no mark, line, or boundary, on which to establish this popular and much used division; and the whole presents a uniform region of convolutions, which resemble in every respect those found on other parts of this surface. The whole region, therefore, ought in truth to be viewed as a single division of the convoluted surface; but as its posterior part rests not on the cranium, but on the horizontal portion of the hard membrane which covers the small brain, while the division of lobes must be discarded as artificial, it may be expedient to subdivide the surface into two, the medio-inferior and postero-inferior regions of the convoluted surface, according as they correspond to different containing parts.

The first, which near the curvilinear hollow is slightly convex or rounded, is lodged in a considerable cavity of the cranium, formed by the sphenoid and temporal bones, bounded before by the spheno-frontal arch, and behind by the pyramid or petrous portion of the temporal bone. This part of the convoluted surface, which may be also named the *spheno-temporal*, is one of considerable importance, and should be accurately known by the anatomical student.

The posterior division of this region, which is plane, corresponds to the horizontal or cerebellic part of the hard membrane, and, though not to be distinguished by any minute or organic limit, may,

however, for the sake of more precision, be marked by this adventitious character.* It may be named the *cerebellic region* of the convoluted surface.

The ordinary appearance of the convoluted surface is well known. It is formed of cerebral matter, of a gray or dirty wax colour, the surface of which is smooth and polished, where it has not been rent by the removal of the membranes and their attachments. The convolutions consist of longitudinal eminences, rounded transversely, running in various directions, and separated from each other by deep furrows. If these be examined when the membranous coverings are removed, they are observed to present may minute orifices, into which the soft membrane (λεπτη μηνιγξ, meninx tenuis, *pia mater*) transmits filamentous bodies, most of them minute blood-vessels. They are neither arteries nor veins exclusively, but seem to consist of both.

Neither the eminences, nor the hollows or depressions, are uniform in number or distribution;

* Lest the use of these terms be objectionable by their obscurity, I may observe, that in describing parts of the human body, it is not unfrequently requisite to have recourse not only to marks on the organ described, but also to certain characters belonging to the contiguous parts. The first of these may be named the *organic or innate*, as they belong to the organ; the second, which do not belong to it, should be named *adventitious or esoteric*. This is indispensable in relative anatomy.

and in no two brains is it possible to trace any similarity in the figure, presence, or direction of these objects. This must be understood of the whole upper, lateral, and posterior part of the convoluted surface, and, in short, all its divisions, unless where it approaches the central or figurate surface. In the latter situation, this want of uniformity disappears; and a number of important objects are presented to the attention of the observer. The points at which this approach of the two surfaces takes place, are, 1*st*, Along the rectilinear margin of the commutual region, where it is contiguous with the upper surface and the posterior end of the middle or central band; 2*d*, From the last of these situations, on each side over the protuberance and cerebral limbs; 3*d*, From this again by the outer margin of the cerebral limbs, to the curvilinear hollow, and along its course. In the last of these situations chiefly the convoluted surface becomes important, and exhibits objects which distinguish these regions from the others.

The outer surface of the cerebellum, or small brain, differs from that of the brain proper. It cannot be said to be convoluted; for it does not present the tortuous eminences and furrows which constitute the convolutions of this part of the organ. But the cerebral matter of which it consists is disposed in the manner of plates *(laminæ)* or leaves *(folia)* parallel to each other, or at least concentric, and separated by parallel or concentric

furrows. It is scarcely requisite to say, that this definition is not meant to imply, that the direction of all these objects is the same throughout the whole organ,—but merely that the cerebellic plates, of which certain groups consist, observe the same direction;—and that any one or two plates or leaves have several of the contiguous ones parallel or concentric with them, while those of the next group, though disposed differently, observe the same direction in relation to each other. By this peculiarity the various regions of the laminated or foliated surface of the small brain may be distinguished. The plates of the hemispheres are curvilinear and concentric, and pursue in various regions of the organ certain definite directions; those in the middle between the hemispheres are straight, transverse, and parallel; and at one spot they are oblique and parallel. By means of these invariable characters of the cerebellic plates, the surface of the organ may be conveniently distributed into several divisions.

To the cerebellic plates or their peculiarities, little attention was given before the time of Vincenzio Malacarne, professor of surgery in the city of Acqui, in the duchy of Montferrat. This learned person, the most diligent descriptive anatomist of his time, published in the year 1780 three Treatises on the Anatomy of the Brain;*

* Encefalotomia Nuova Universale di Vincenzo Malacarne, Saluzzese. Torino, 1780.

in the third of which he describes with much precision and minuteness, the anatomical characters of the outer or laminated surface of the cerebellum. Some knowledge of his distinctions, which were adopted by Reil, is requisite to comprehend distinctly the configuration and structure of this part of the organ.

Commencing with the well known division of the whole organ into two hemispheres, Malacarne remarks, that, if the whole upper surface of the organ be presented to the eye, the outline of each hemispherical surface is found to describe three-fourths of a circle; and as these circular segments mutually meet towards the mesial plane, where they are respectively adapted to different parts, the mode of union varies according to the figure of these adjoining objects. 1*st*, As the hemispherical border approaches the anterior part of the organ, it is found to be suddenly interrupted, where the cerebellic branches or peduncles *(crura cerebelli)* are connected with the protuberance; and, pursuing a retrograde direction on each side towards the mesial plane, forms a species of reentrant curvature. The hollow thus formed, which corresponds to the lower of the four eminences on the upper surface of the protuberance *(corpora quadrigemina,* Die Vierhugel,) is named by Malacarne the *semilunar curvature,* —(der halbmondförmige Ausschnitt; Reil.) 2*d*, Again, as the hemispherical borders approach the posterior part of the small brain, advan-

cing nearer to the mesial plane, they proceed, by an acute circular turn, almost straight backwards, so as to form, at the posterior edge of the organ, a deep rectangular notch,) (not unlike the figure of the ancient lyre. This posterior hollow, in which is lodged the cerebellic vertical portion of the hard membrane *(falx cerebelli,)* is named by Malacarne the *common perpendicular fissure (incavatura,)* and by Reil, to whose fancy this epithet seems to have been deficient in expression, *the purse-like fissure* (Der beutelförmige Ausschnitt.) Between these two well-marked boundaries the cerebellic plates, of which the hemispheres consist, are united in the middle by a confused interlacing junction (*un intreccio confuso ed irregolare di sostanza,*) to which the Italian anatomist gives the name of suture (*raffe,* raphe) of the cerebellum. I find that the careful removal of the soft membrane (*pia mater*) renders this more distinct, and shows the mesial termination of the hemispherical plates. On the surface, a large hollow between the hemispheres, and extending backwards from the semilunar to the purse-like fissure, previously called by Haller (*vallecula,*) the little valley, received from Malacarne the corresponding term (*valletta,*) in his own language.

The divisions of the cerebellic surface made by Malacarne, and adopted by Reil, are founded entirely on the groups of plates, and the comparative depth of the furrows by which these

groups are separated. Groups of plates, separated by the deepest furrows, are named lobes, (*lobi*, M. Lappen, R.); and those separated by furrows of less depth are named lobules, (*lobetti*, M. Läppchen, R.) In some situations the lobules present divisions formed by furrows of less depth, between which the groups of plates are of greater or less size. To such clusters Malacarne gives the name of laminar leaflets, (*foglietti laminosi.*)*

Each hemispherical surface consists of five lobes. 1. The anterior-upper. 2. The posterior-upper. 3. The posterior-lower. 4. The slender, rarely exceeding three lines in breadth. 5. The two-bellied or biventral. The two first belong to the upper or flat hemispherical surface; the three latter to the lower or convex hemispherical surface. Besides these, a sixth lobe may be mentioned as common to the two hemispheres. It is situate on the mesial plane of the upper surface, between the anterior end of the middle line (*raffe*,) and the middle or apex of the semilunar fissure. This situation is not an improper reason for the name by which Malacarne has distinguished it,—the central lobe.

In the bottom of the purse-like notch we find many bundles or clusters of plates, which unite the posterior lobes of the upper and lower surfaces to those of the opposite hemisphere. These Malacarne names *transverse laminar chords* (*cor-*

* Encefalotomia nuova, &c., Parte iii. Articolo i. No. 13.

doni laminosi traversali,) or commissures of the cerebellum.

The anterior-upper lobe, with four sides and four angles, named therefore by Malacarne the *quadrilateral* or *four-sided* lobe, (*vierseitige*, Reil,) approaches somewhat to the figure of the trapezoid. It is bounded by three curved margins and one straight one. Of the former, the most anterior forms one-half of the semilunar fissure; while the posterior, which is also the longest, and parallel to this, is a curvilinear or circular tract (the great furrow,) extending from the bottom of the purse-like fissure behind to the anterior outline of the hemisphere before, where it terminates about one inch from the end of the semilunar fissure. This last space between the anterior end of the great furrow forms the third curved margin of the four-sided lobe; while its straight margin is made by the middle line, which here is common to the two lobes. Malacarne further divides this lobe into five lobules, and describes the limits of each with minuteness and accuracy. For the details of these distinctions I refer to the original.

The posterior-upper lobe—the second division of the upper hemispherical surface—may be defined in the following manner. The circular tract or great furrow, which I have already said forms the posterior margin of the four-sided lobe, is its anterior boundary. The hemispherical outline of the upper surface, if traced from before backwards,

will be found to coincide about 1½ inch, sometimes more, from the purse-like notch, with a considerable furrow (the horizontal,) which turns round at the purse-like notch to meet the great furrow already mentioned. The curved outline thus continued is the outer boundary of the posterior lobe; and it is easy to perceive, that, in consequence of the direction which this line observes, and its meeting with the great furrow, the lobe is contained between the horizontal and great furrow, or between two curved lines. This lobe is subdivided by Malacarne more minutely than the former. It is found, however, that the number of lobules is not the same in both,—those of the left being most uniformly about eight, while those of the right are more numerous, but in general less distinctly marked.

These with the central lobe, the general situation of which has been already noticed, form the several divisions of the upper region of the cerebellic laminated surface. The inferior region presents divisions more numerous, more complicated, and more interesting.

The first of these, the posterior-lower, is contiguous, at its outer or greater boundary, with the posterior-upper lobe, where a small segment of it is seen when the cerebellum is examined from above. Its anterior or inner boundary is marked by a curvilinear furrow of moderate depth, by which it is separated from the slender lobe, and the posterior end of which terminates, not in the

purse-shaped notch, but, after a sigmoid turn towards the laminar pyramid, * is insensibly lost among a cluster of transverse plates, which I shall have occasion to notice afterwards.

Immediately anterior to this is found the slender lobe, (*il lobo sottile*, Malacarne; Der zarte Lappen, Reil;) which is not above three lines broad, and being contained between two concentric furrows, is not unlike the segment intercepted by the truncated arcs of two small circles of a sphere.

The space of the hemispheric surface within the slender lobe, or between this and the peduncle or arm, is inclosed by three circular lines, two of which, the exterior and interior, correspond to so many furrows; while the third, which is anterior, is formed by the horizontal or marginal furrow. The space thus inclosed is similar to a spherical triangle, and is occupied by a group of plates which Malacarne denominates the *biventral lobe*, (der Zwey-bauchige Lappen, Reil.) Its contiguity with the cerebral end of the pneumogastric nerve led Vicq-D'Azyr to give it the name of *the lobule of the eighth pair*, (*lobule du nerf vague*); and its situation at the posterior corner of the peduncle, and under that body, is the reason why it was called *sub-peduncular lobule* by Dr Gordon. Of these plates the arrangement is peculiar, since they are neither so exactly concentric as in the

* Encefalotomia, &c., Articolo i. No. 20, ed Articolo ix. No. 77. See p. 318.

other lobes; nor yet is their direction different from each other. The plates at its outer margin are the largest, as they extend the whole length from the marginal furrow to the end of the slender lobe, at which, however, they are contracted to a narrow point. The next set are shorter, and are more contracted or acuminated at their posterior end, where they are contiguous to the almonds or tonsils. The third and last set are the shortest, and are more twisted down, as it were, next the almonds. These contracted or acuminated ends of the cerebellic plates are named (*code*) tails by Malacarne.

The disposition now described renders the posterior corner of the biventral lobe very pointed, and its margin very concave; and between this margin and the parts which occupy the valley is placed a group of plates somewhat convex, rounded, and disposed also in a peculiar manner. This group Malacarne names the tonsil, or tonsils, (*tonsille,*)* a term which Reil, regarding it synonimous with *amygdalæ*, renders literally almonds, (Die Mandeln,) *the spinal lobule* of Dr Gordon. If the cerebellum be examined before the head of the spinal chord is cut from the protuberance, the inner margin of the almond will be found contiguous to the oval eminence (*corpus olivare,*) and even pressed by it. It is best, however, to examine the almonds after the chord (*medulla oblon-*

* Encefolotomia, Articolo ix.

gata) has been removed. It will then be perceived that each almond is bounded on the outside by a well-marked circular furrow, which separates it from the biventral lobe on the inside by a free surface directed to the corresponding surface of the opposite almond; and before, by a continuation of this directed outwards toward the biventral lobe. I have already said that the direction of the constituent plates of this body is peculiar. In general they observe a direction opposite to that of the biventral plates; so that, if produced, they would cross. Its apex or most pointed corner is contiguous to that of the biventral lobe; and altogether, each almond presents the appearance, on a cursory glance, of two similar bodies directed inversely to each other.

The last body which I shall notice here is the Flock or Flocks. The description of its situation, as given by Malacarne, is by no means clear; but perusal of the context, with examination of the parts described, can leave no doubt on the certainty of the object which he has in view. The flock (*il fiocco, il fiocchi,* Die Flocken,) is a minute body, of a shape not easily defined, situate in the angular hollow between the biventral lobe, and the branch or peduncle (*crus, gamba, braccia,* Die Arme) of the small brain. The lower or free surface of the latter object (the branch) possesses an anterior and posterior margin or corner. The latter is contiguous to the biventral lobe, from which it is separated by a small furrow, out of

which the flock seems to issue. Each flock consists of six or seven plates (*laminæ*) starting directly, as it were, from the beginning of the peduncle, and with the concave margins directed towards the protuberance.

Ruysch has represented in their site objects to which he applies the name of vermiform prominences; a circumstance which is in some measure to be ascribed to the vague manner in which this term has been used.

The valley (*vallecula*, valletta, das Thal) or hollow between the two hemispheres, is occupied by a numerous series of plates, which lie transversely, are parallel to each other, and which form a sort of uniting medium of the cerebellic plates of each side. The appearance of this region in the brain of the dog and monkey, the animals which the ancient anatomists chiefly dissected, might furnish them with some reason for applying to it the name of worm, or worm-shaped body; (σκωληξ, επιφυσις σκωληκοειδης.) But the modern anatomists are not bound to apply it to the corresponding part of the human cerebellum, which certainly by no means justifies the appellation. The confusion which has arisen from this practice of imitating the ancients is a sufficient reason to abandon the term for ever; since scarcely two anatomists agree in giving the name of vermiform process to the same part of the organ.

With a view to obviate all misconception on this point, Malacarne has recourse to distinctions

completely new. Beginning with the back end of the valley at the purse-shaped notch, where are seen the plates afterwards named by Reil the *short exposed cross-bands*, (Die kurzen und sichtbaren-Querbänder;) and the long *covered cross-bands*, (Die langen verdeckten Querbänder;) and proceeding forward, he distinguishes a group of parallel plates, or laminated leaves, to which he applies the name of *pyramid*. This body, which is bounded behind by the purse-shaped notch, and before by another cluster of plates called by Malacarne the *uvula*, consists of twenty parallel plates, of which six, he observes, are very short; and a triangular termination in the longer, forms the summit of the body. The *uvula* (*ugola*) (Der Zapfen,* Reil,) which is anterior, he found to consist of twelve laminated leaves, to have six lines of longitudinal extent, and four of breadth. It is smaller than the pyramid, and conical, with its base turned to that body, (Reil.) Lastly, anterior to the uvula, and separated from it by a furrow, is the laminar tubercle,† (*tuberculo laminoso*,) consisting of about ten thin leaves or transverse plates. This body, which is the smallest in the

* Mr Mayo, by translating this term *spigot*, makes it appear to be a different part from that meant by Malacarne, and understood by Reil. Though the word der Zapfen signifies *spigot*, it is also used to denote the uvula, and in this sense it is employed by Reil.

† Encefalotomia Nuova, &c. Parte iii. Articolo x. p. 61.

row, is the *nodule* or knot, (Das Knotchen) of Reil.

The second surface of the brain is very different from the first. In situation it is interior or central; and its configuration is such, that it may be named the *figurate or symmetrical surface* of the brain. Instead of presenting the uniform eminences and hollows which distinguish the convoluted surface, it is disposed or moulded into definite shapes, which correspond with each other, as they are situate on opposite sides of the middle plane,—or the parts of which, when situate on this plane, are exactly symmetrical. The surface formed by these variously figured objects, bounds what are termed in the common descriptions the *ventricles* or *cavities* of the brain. I shall show that they cannot justly be termed cavities any more than the hollows between the convolutions, but ought to be viewed as continuations of the exterior or convoluted surface. As the several objects of the figurate surface are well known, I shall at present, avoiding minute description, notice those circumstances only which have not been sufficiently studied, or correctly represented, or which are necessary to establish the general principle,—that the convoluted surface of the brain and the laminated surface of the cerebellum communicate directly with the inner, central, or figurate surface of these organs.

The commutual or dichotomous region of the convoluted surface is terminated below by a si-

nuosity, which is formed chiefly by a part of the brain, remarkable in appearance and organization. This, which was named by the ancient anatomists the smooth or polished body (*σωμα τιλλοειδες*, *corpus læve*) * to distinguish it from those surfaces which were formed by a cutting instrument, appears in the form of white fibrous matter, passing transversely between the hemispheres ; but is also marked by certain longitudinal lines, first correctly represented by Vicq-D'Azyr. The most conspicuous of these is that which lies exactly in the middle plane, and which is formed by the meeting of the transverse fibres, of which this body, termed *middle or central band*, (*mesolobe* of Chaussier, the beam (der Balken) of Reil,) † consists. These fibres, which issue like white parallel lines, exceedingly minute, from the substance of the hemispheres, either stop suddenly, or change

* This is the literal translation and the true meaning of the term used by the Alexandrian school. The name *corpus callosum*, which is adopted by modern anatomists, is a bad translation made at the revival of literature. In defence of the error, Vicq-D'Azyr contradicts nature by the assertion, that this is somewhat harder or firmer than the other parts of the brain. " Cette production a *plus de consistence* que le reste du cerveau.—Ce corps un peu plus dur que le reste de la substance blanche du cerveau." Of many brains examined, certainly with a different object than to prove the learning or ignorance of the translators of the Greek physicians, I never could perceive any difference in the consistence of this and other parts of the brain.

† Archiv. für die Physiologie. Neunter Band. Erstes Heft. 3. b. p. 172.

their direction at this point. Their sudden termination gives rise to an appearance, to which the expressive but erring epithet of suture (*raphe*) has been given. On each side of this other lines are remarked following the same direction. In general, they are situate about three or four lines from the median plane; but are in a few instances observed to be very regular in their disposition at the anterior end of the middle band. About its middle, however, a very distinct appearance of lines collected into a considerable bundle, may be observed proceeding backwards to its posterior end. As they advance they become more distinct, are about $1\frac{1}{2}$ line broad, and of a grayish colour; at the posterior end of the middle band, they diverge somewhat, and, passing over this, proceed in a lateral direction downwards, till they are lost about the spot where the limbs of the brain (*crura cerebri,* Die Hirnschenkel) issue from the optic eminences. This forms the inner, central, or gray portion of the cylindroid eminence.

The posterior extremity of this body is rounded; and when the membranes have been removed, the surface which forms this rounded end is found to communicate directly with the chamber named third or middle ventricle. This surface is in truth continued forward, and forms the vault or ceiling, (*fornix*, Die Zwillingsbinde, *the twain band*, Reil,) a point which, though sufficiently obvious, is never noticed in description, or perspicuously demonstrated. The names of *cal-*

lous body and *vault* are applied in the ordinary works, as if they were denominations of different objects, or rather of different bodies. If they are still to be retained, it ought to be stated, that they are names applied to opposite surfaces only of the same object.

The relations of the round or posterior end of the middle band are worthy of examination. The handle of a scalpel inserted beneath it will be found to be in the middle ventricle, with the vault above, the *conarium* or pineal body, and four eminences of the upper surface of the protuberance *(corpora quadrigemina)* below, and a part of each optic chamber on each side. I find it convenient to remove the posterior part of the hemispheres by a transverse section following the plane or level of the hinder end of the central band. A distinct view is thus given of this communication of the convoluted with the figurate surface; and it may be observed, not only in the middle, but on each side. The middle one is bounded above by the posterior end of the middle band and the back part of the vault; below, by the pineal body and the four eminences; before, it is continuous with the middle ventricle; behind, it looks to that space between the convoluted surface of the brain and the laminated surface of the cerebellum, which is occupied by the horizontal part *(tentorium cerebelli)* of the hard membrane.

On the sides,—that is beyond the margin of

the body with the four eminences, a different arrangement is observed. The posterior end of the middle band penetrates into the substance of the hemispheres; but the gray chords which we have already noticed, in pursuing their lateral course, are immediately enveloped in white plates, derived, as we shall see, from the sides of the vault, assuming thus a cylindrical appearance. Thus is formed exactly opposite to the cerebral limbs a body with a free rounded surface, which bends in a curvilinear direction laterally and downwards, and is found to be the great *hippocampus* or cylindroid process. (Chaussier.) In observing this curvilinear course, it rests on, and corresponds to, the upper margin of the cerebral limb, as it issues from the optic chamber. It must not, however, be imagined that it adheres to this body. The surfaces both of the beginning or upper end of hippocampus, and of the cerebral limb, are free and unconnected. They are indeed covered with vascular membrane, *(pia mater)* which keeps them in apposition; but if this be removed, as it ought always to be, the two surfaces will be found quite distinct, and in no manner connected, unless in corresponding with each other. The whole of this communication may be seen, and is best examined by keeping the organ in its natural position, and viewing it from behind, after the posterior parts of the cerebral hemispheres have been removed. It forms what was described by Bichat under the name of *the great cerebral fis-*

sure. * This denomination does not accurately express the idea intended; nor does the idea itself, it may be remarked, present a correct view of the natural arrangement. The conformation which I have attempted to describe does not form a fissure, but a regular symmetrical opening, by which the convoluted surface communicates distinctly and directly with that which is figurate.

The next step of the process in the further exposition of this opening or communication, requires the inversion of the brain, and the exposition of the inferior regions of the convoluted surface,—the base of the brain. We have seen the manner in which the convoluted passes into the figurate surface, above and behind the middle band. At the inferior regions this transition is effected in a mode somewhat different;—and the channel or means by which it is made is the curvilinear hollow. To understand clearly the relations by which this is established, the demonstrator should remove in small portions the membrane which covers the optic commissure and tracts, the pituitary peduncle, the pisiform eminences, and which binds together the adjoining convolutions, and especially those which are connected by it to the limbs of the brain. † When the convolutions are thus exposed, the furrows on

* Anat. Descriptive, Tom. III.

† This process is best performed by the scissors and forceps, with the occasional use only of the scalpel, and with the aid of an assistant with delicate fingers and forceps.

each side of the hollow will be found to be very deep, and the eminences proportionally high from the more solid part of the encephalic organ; and the hollow itself will appear almost like the furrow of a convolution on a large scale. Its peculiarity indeed is, that the bottom of the hollow is not convoluted, but presents an extensive uniform space of grayish cerebral matter, on each side of which, but especially behind, the convolutions are very large and distinct. This convoluted part begins insensibly at the outer or lateral edge of the hemisphere, where it is narrow; becomes broader as it advances forwards and inwards; and about one inch from the mesial plane, is particularly distinct, broader, and more spacious than at any other part of its course.

It here presents an infinity of holes or orifices of various size in the cerebral substance, not arranged in any regular order, but uniformly found in this situation. Some of these orifices are sufficiently large to admit the point of a small silver probe; but the greater number are more minute, and do not exceed the calibre of a common-sized bristle. The space over which they extend is various, and its figure cannot be accurately defined; it is generally equivalent to the half of a square inch. In numerous dissections, I have found it uniformly at this part, and of this size, as nearly as it is possible to estimate, in measurement of objects so variable as those of the organs of the animal body. I have not been able to re-

cognize any difference in the colour of this and other parts of the convoluted surface. I suspect, therefore, that Vicq-D'Azyr, who in noticing this part has called it the *white perforated substance*, (*substance blanche perforée*), applied the term of colour without examining the contiguous parts, when denuded of their membranous investments. The same name nearly (*lamina perforata*) has been given it by Reil. The orifices which characterize this part of the brain admit, from the Sylvian or middle artery, an infinity of blood-vessels, which here penetrate the part denominated the *hook-shaped cerebral band* (Der Haaken-förmige Mark-bündel) delineated by Reil. This circumstance renders the adjoining part the most vascular of the whole organ,—a fact which will be shown to be important in the pathology of the brain.

Anterior to the perforated spot at the extreme verge of the unconvoluted substance, is situate a small pointed eminence, of gray colour, shaped like a triangular pyramid, most conspicuous when cleared of the membrane which covers it. Proceeding backward from this, we remark two slender white lines of different lengths, and following different directions. The inner of these is short; and after a course seldom exceeding four or five lines in the adult brain suddenly ceases to be visible. The outer one is much longer, follows a curved direction, with the concave part of its course directed anteriorly, and is of a more vivid

white colour. These two lines are the generating or initial filaments of the first pair of nerves.

Within the perforated spot the curvilinear hollow is generally conceived to be terminated. The unconvoluted space, however, in which it consists, is here directly continuous with the figurate surface of the brain. This space indeed makes here a sharp turn backwards; and having on the inside the long cerebral band termed the *optic tract*, may be conceived to be bounded by the limb of the brain. This body, with that of the opposite side, will be imperfectly seen at first; and though the end which unites each with the bridge or protuberance is sufficiently conspicuous, the opposite extremity cannot be distinctly perceived. It is indeed covered by a portion of the convoluted surface, the inner and prominent surface of the medio-inferior or spheno-temporal region. This must therefore be gently moved outwards or laterally, and also raised; and with the aid of the handle of a scalpel and the fingers of a dexterous assistant, the cerebral limb may be shown to be here crossed or surrounded by the optic tract of the side. The purpose of this part of the exposition is to show the *geniculate bodies*, or posterior eminences of the optic chambers.

But the attention of the demonstrator is to be directed to that part of the convoluted surface which covers the anterior end and outer margin of the cerebral limb, and which has been raised on the scalpel-handle. When gently everted, it is

found to present the thin white body named the *tape or fringe* (*tænia*) of the hippocampus; and if the portion of convoluted brain most anterior or next to the curvilinear hollow be raised and everted in the same manner, the anterior end of this object termed the *foot (pes hippocampi)* will come into view. If this operation be properly performed, no part will be torn, broken, or displaced; the objects exhibited are free surfaces, not adhering to each other but only in apposition. The white plate or tape of the hippocampus forms, in the natural position of the organ, the outer and lower border of the opening, while the limb of the brain, and after that the outer and lower surface of the optic chamber, forms its inner border.

To obtain an idea yet more clear and distinct of this communication between the convoluted and figurate surfaces of the brain, it is convenient to follow the direction of the opening with the scalpel handle backwards and upwards, until it reach the upper margin of the brain-limb, where it is shown to be merely a continuation of the lateral part of the posterior opening. This step of the exposition requires cautious and gentle management; and the peculiar curvature which the parts forming the outer border of the communication follow, renders it difficult to avoid laceration or displacement. In general, it is best accomplished on a single hemisphere, from which the cerebellum has been previously removed; but it is desirable to preserve also the whole of the central

band, which shows not only the relative connection of the several parts, but serves also to demonstrate a curious fact in the configuration of the parts forming the outer border of the communication. This is the hippocampus through its entire course, or the body which its figure has led Professor Chaussier to name the *cylindroid process.*

This body consists essentially of two parts. The first is an inner or central portion, gray in colour, notched or indented in appearance, and though free at the indented edge, adhering to the cerebral substance by its opposite margin. This is *the gray indented band.* (Gordon;—*le corps godronnée,* Vicq-D'Azyr.) It is as thick as a large crow-quill. This is covered by the outer or second part, which is a broad thin plate of white cerebral matter rolled or folded over the gray indented band, precisely as a map is rolled over a cylinder of wood, and covering it unless removed by art. This last part of the cylindroid process is what is well known, and always described under the name of the *tape or fillet* of the hippocampus. Its arrangement with regard to the gray indented band is less generally understood, and is indeed never noticed in the ordinary descriptions. A correct idea of it may be formed in the following manner.

Divide, by successive transverse sections, the hippocampus from the part named the foot upwards, as far as it can be traced. It will be found that each section presents a central portion of gray

matter, enveloped in a thin curled plate of white matter, which is free at one edge,—the concave one,—and hangs over the gray band like a veil, but adheres, by its opposite, to the cerebral substance. It will be perceived, also, that the white plate does not adhere to the gray band, unless at its fixed margin, and that a probe or scalpel handle may be introduced into the angular furrow between them. * As the sections approach the upper end of the cylindroid process a new arrangement is observed. The white plate becomes unusually broad, and is less bent or rolled over the gray band ; while the latter, thus less completely covered, instead of following the same direction with the white plate which it does below, is much separated from it, and leaves a considerable angle between the plate and itself. This arrangement is most conspicuous where the process corresponds to the upper part of the optic chamber and the cerebral limb. The white plate of the hippocampus traced further is found to coalesce with the margins of the vault, and tapering as it approaches the anterior end of that body, is finally identified with its substance. The upper termination or connection of the gray band is different. When it begins to recede from the white plate, which it does nearly opposite to the optic eminence, it proceeds directly to the rounded posterior end of the central

* This last fact may also be demonstrated without transverse sections, by simple elevation of the white plate by the handle of the instrument.

band (*corpus callosum*,) over which, and along the upper surface about one inch, it may be traced; and beyond this it is seldom capable of being distinguished from the white matter of which the central band consists.* The *gray indented band*, there-

* The importance of this object in forming the outer border of the great communication, will render it not improper to glance at the history of its discovery. Vicq-D'Azyr is supposed to have been the first anatomist who observed and described its site and appearance with accuracy; and we find him, in a Memoir of the Royal Academy of Sciences in 1787, detailing its peculiarities with some minuteness, under the name of "Bord externe et dentelé de la Corne d'Ammon." He subsequently represented it in his great work in the year 1786, under the name of gray, cortical, external, notched portion of the Horn of Ammon, and speaks of it familiarly enough by the term of *corps godronnée*. Bichat, however, whose descriptive anatomy was published considerably later, though his accurate manner prevented him from overlooking it, and led him to give a sufficiently minute account of it, boldly asserted, that it had been entirely neglected by authors. Dr Gordon of this place, who was quite aware of this oversight in Bichat, took special care, in demonstrating it, to notice the merit of Vicq-D'Azyr; and he has mentioned this fact shortly in a note, in his description of the gray band. None of these eminent anatomists have been altogether right in this matter; and the truth is, that Vicq-D'Azyr is not the first who delineated this body. The gray indented band is distinctly represented by Pierre Tarin, in the second engraving of his Adversaria; and although this had been published at least thirty years before the engravings of Vicq-D'Azyr, yet it was requisite for the latter writer to make it the subject of a particular memoir, and Bichat to write a description of it, before it seems to have been known as a part of the organ.

fore, which forms the inner or central part of the cylindroid process, is continuous, or connected with the upper surface of the central band of the organ; and if the terms of origin or derivation be admitted, may be said to be derived from it; while the thin white plate which is rolled over the gray band, and gives the hippocampus its cylindrical figure, is connected with the under surface of the same central band, or that part which the usual nomenclature styles the vault *(fornix)* of the brain.

Such, as nearly as language can represent, is the configuration of the cylindroid process,—an object which it is impossible to know too accurately, if we reflect that it forms the entire outer border of the great communication between the convoluted and figurate surfaces of the brain. If, by the method now described, a clear idea of this disposition is not communicated, it is expedient to use another contrivance, which I have rarely found to fail in demonstrating the facts which I wish to impress. Let a brain, divested of its membranes, be inverted; and when the opening behind the outer margin of the cerebral limbs has been exposed, let a deep transverse incision between the feet of the hippocampus of each side be made. This incision must not touch the cylindroid process, but going deep into the substance of the organ, will detach the whole of that part which contains the several objects of the figurate surface from the anterior part of the

hemispheres. The portion thus separated will, however, still adhere by the sides to the substance of the hemispheres; and other incisions must be made, following the direction of the outer or lateral margin of the striated bodies *(corpora striata)* and the optic chambers *(thalami optici,)* until the whole be completely insulated. If these incisions be properly managed, the whole of the middle band, the vault, the cylindroid process, and the white tape, will be left uninjured, and will present a large hollow surrounded by an extensive border, the posterior part of which is made by the posterior end of the central band, while lateral divisions are formed by the cylindroid process of either side. The observer will likewise form a very just idea of the situation and connections of the middle band, and will perceive that its inferior surface is the same as that named *vault* or *ceiling*. He will further remark, that the thin white plates *(tæniæ)* which are attached to the margins of this object, and between which is the space improperly named the *lyre*, extend in a circular and revolute direction outwards and downwards, so as to cover, in the mode described, the gray band of the cylinder, and give this object its cylindrical aspect.

The correct understanding of the outer border of this communication should be followed by an equally just idea of those parts which form what we must name its inner border. These are more numerous and rather more complicated; but fre-

quent examination, with a little attention, will enable the student to overcome all the difficulties with which they may be attended. The parts contained in the mass of brain removed, as we described in the last section, will contribute also very much to render the knowledge of this border easy and intelligible. I have already said (p. 322,) that at the posterior end of the middle band the inner or lower border is formed by the four eminences *(c. quadrigemina)* situate on the upper surface of the thick mass named *protuberance.* On each side of these the inner border is formed by successive portions of the optic chamber, until it has reached the inferior region of this body, where the outer and lower margin of the limb of the brain becomes the border of the opening. To render this arrangement more intelligible, I shall here state some circumstances of the figurate surface, which are either omitted in the ordinary descriptions, or are mentioned indistinctly.

Its principal objects are familiarly known; and there are certainly none who can be ignorant of the situation of the striated bodies, the optic chamber, the semicircular chord between them, and other similar objects.

The posterior eminences, or the optic chambers, hold the most important place; and their connection and relative situation render them much more interesting than they are usually made in works of descriptive anatomy. Connected before and on the outside to the striated body by means of the

double semicircular chord (*centrum semicirculare geminum*, Vieussens,) each optic eminence presents four free surfaces—the upper, the inner, the posterior, and the lower. The upper, the first, is gently rounded and of white colour. Its figure and limits are not easily defined. The outer margin is bounded by the circular band, which even passes on anterior to it, so as to form its boundary in that direction also. Behind, it is less distinctly limited, unless by the appearance of a considerable prominence, which has been generally named the posterior tubercle of the optic couch. The inner margin of the upper surface is most distinctly marked by a small sharp gray line, which, beginning insensibly at the anterior part of the body, becomes more distinct as it extends backwards, and is ultimately found to bend gently toward the median plane. There it unites with a similar elevated line of the opposite optic eminence ; and to the point of union is attached a small conical body with a minute point, of a gray colour, and of a shape like that of the pine-apple. This is the object improperly termed pineal gland (*glandula pinealis, conarium;* Die Zirbel-drüse ; Reil) ; and the minute linear eminences or tracts, which form the inner edge of the upper optic surface, have been named *peduncles* of the pineal gland. The inner surface of the optic couch or chamber presents nothing important, save the small portion of soft cerebral matter, which unites it to the similar surface of the opposite body. Its posterior

edge, however, is terminated by the cerebral limb of that side; and the lower edge meets that of the opposite one, and is connected to it by a portion of brain, which, examined in this manner, has received no name, but forms the lower part of the middle ventricle. The portion of brain which corresponds to it on the outside (base of the brain) has been named the *bridge of Tarin. (Pons Tarini.)* This is the triangular space between the limbs of the brain which has been called by Vicq-D'Azyr *the pit of the oculo-muscular nerves.* It may be named the *triangular intercrural hollow.*

The posterior surface of the optic eminence is the most important, but the least understood. It is so intimately connected with the inferior, that they cannot be easily distinguished in description. Santorini, I believe, was the first who observed that the posterior part of the optic couch was terminated by a projection or process, which he named the *jointed or geniculate body*, and which, he had likewise the merit of observing, gives rise to the optic nerve.* More recently Malacarne re-

* "Quod tamen per repetitas diligenterque institutas disquisitiones ab eadem potius membrana eos non proficisci, sæpius vidisse visus sum; verum tum ab eorum Thalamorum interiori parte, tum a *quodam velut geniculato corpore circa eorundem Thalamorum posteriora locato adjunctoque*, cujus corticalis seu cinerea interior substantia est, medullaris et candida exterior facies luculentius prodire, sum assecutus: Ad horum tamen exortus locum a latere prominentiarum quod natiformes nuncupantur, conspicuus medullaris tractus transversim sic Thalamis conjungitur, ut vel in eo-

marked that this region is rendered unequal by a tubercle, from which the nerves seem partly to rise.* About the same time it was noticed by Vicq-D'Azyr that on the side, a little behind and below, there are three superficial tubercles of a rounded figure, and disposed in a triangle; and that one of them must have been the body mentioned by Gunz and Bonhomme, and of which Haller avowed his ignorance.† He afterwards mentions a slight prominence near the upper of the four eminences, of a white colour, but gray exteriorly, communicating with the optic tract;‡ while the external-lateral region of the optic couch presents several similar eminences, but less considerable. The notice given by Bichat is still more brief and less satisfactory. "Tout à fait en arriere cette parti inferieure offre une ou deux saillies, et se continue avec les tubercules quadrijumeaux."

The inaccurate manner in which these authors

rum substantia disjiciatur, vel inflexus cæterisque fibrillis involutus ad Nervorum opticorum exortum accedat, conjicere quidem, decernere autem minime valui." Observat. Anatomic. Joan. Dom. Santorini, cap. iii. § 14. See also a more minute description in his posthumous *Tabulæ Anatomicæ*, Tabula iii. fig. 1. p. 32. Parmæ, 1775.

* "La stessa faccia superiore—è coperta d'una lamina midollare tenuissima ed ha disuguale la posteriore estremità per un *bernacolo irregolare*, da cui sembra che in parte nascono i nervi ottici." Articolo, vii. 68.

† Elementa Physiologiæ, Tom. IV. lib. x. sect. 1. § 24.

‡ Recherches sur la Structure du Cerveau, &c. ix. Mémoires de l'Academie Royale des Sciences, Année 1781.

seem to have examined this part of the organ, the vague and unprecise terms in which they speak of it, as if its existence were apocryphal,—show the necessity of more correct researches. Soemmering and Gordon describe in this situation two eminences, termed the outer and inner geniculate bodies. The description of the former author is brief and precise, but not quite so satisfactory as could be wished. That of the latter is more minute; but in some respects it is either not clear, or it does not apply generally. On this point, however, I speak with the deference which I feel to the memory of a diligent anatomist.

The confusion and uncertainty which prevails on this piece of cerebral anatomy induced me to adopt a method which I find to be more certain in unfolding the objects in question, and which may be safely recommended to the practical anatomist. Let the brain be examined from below, and let the examination commence with the optic tracts. That the acceptation of this term may be definite, I observe that the optic nerves should be in accuracy counted from the commissure only. The cerebral extremity or origin, as it is named, of a nerve, should be reckoned from that point only at which it is quite free in its whole circumference from the organ. This happens to the optic nerves at the anterior part of the commissure only; for behind this body the longitudinal bands called *tracts* adhere by one side (the outer) to the cerebral substance. A narrow angular sinuosity,

admitting the point of a small probe, is found at the inner or mesial edge of the tracts; but beyond this they adhere indissolubly. As they pursue their course backward and outward, they reach the limbs of the brain, the inferior surface of which they cross, still adhering by their outer edge, but more extensively. Here likewise they are sensibly broader than at their anterior end.

When they have passed completely the limbs of the brain, at which they are about the breadth of three lines, they begin to present a linear furrow or depression, which extends in their long direction about one-half or three-fourths of an inch, and thus divides the tract into an *outer* and an *inner* limb. This depression, however, does not divide the tract equally, but leaves the outer broader than the inner limb. It is insensibly terminated at the upper surface of the optic eminence or chamber; and its last part (about three or four lines,) contemplated with care, will be found to separate two spheroidal eminences which are respective terminations of the outer and inner limbs of the tract. The outer of these eminences is the largest and most prominent, and is the body mentioned by authors as the posterior tubercle of the optic chamber. It is the body which Santorini named the geniculate (*corpus quiddam geniculatum*);—an epithet for which it is not easy to account, unless we suppose that his fancy had likened it to the appearance of a bent joint, especially that of the knee, to which, if viewed late-

rally in connection with the tract, it bears some remote resemblance. It is broader, larger, and more convex than the inner eminence, and is evidently the chief origin of the optic tract. The eminence on the inside of the linear furrow is much smaller, and often less distinctly marked than the outer. In ordinary circumstances it may be described as an eminence of cerebral matter contained between two circular segments, in such manner that its longitudinal extent, which is nearly vertical, is greater than its transverse. It is obviously connected with the smaller limb of the optic tract. Whether this body actually takes its origin from the four eminences (*corpora quadrigemina*,) depends on evidence of a different description.

The inner or mesial side of the geniculate bodies is contiguous to the four eminences, and is separated from them by a linear furrow. These eminences occupy the upper surface of the protuberance, and partly that of the limbs of the brain; and the linear furrow marks the point at which the limbs issue from the substance of the optic couches. The lower surface, indeed, of these bodies, presents the long thick cylinder of the limbs; and while they occupy this conspicuous situation, and a considerable proportion of the lower surface, it is impossible to assign them more cerebral space above, than that occupied by the upper two of the four eminences *(nates,)* and the adjoining part of the optic couch.

This view of the objects occurring in this region of the figurate surface, will show the formation and arrangement of the inner border of the communication. It will be seen that it consists of successive portions of that figurate surface, proceeding from the mesial plane, on each side to the lower and outer margin of the cerebral limbs. It will be seen, that, if we begin at the longitudinal furrow of the four eminences, we find first the upper eminence of one side; then the contiguous part of the optic couch; then the greater geniculate eminence; after this, as the cylindroid process pursues its winding and revolute course, the outer part of the cerebral limb; and, lastly, the outer and lower angle of that limb.

Not only, however, does the convoluted surface of the brain communicate with the figurate one, but the laminated surface of the cerebellum communicates with the analogous surface of that organ, and thus with the great figurate surface. This communication takes place on the middle plane, below the transverse or middle plates which form the pyramid, uvula, and nodule, and between these bodies and the restiform processes. This is the fourth ventricle of anatomical writers; and as it has never been denied that it communicates with the outer surface of the cerebellum, it is noticed here merely as an integrant part of those views which I apply to the organ at large.

The central or figurate surface exposed in the

manner now explained is smooth, polished, and possesses a degree of firmness and closeness of texture which prevents it from being readily broken or abraded. These qualities are ascribed by Reil to a thin membranous pellicle, which he terms *Epithelion*, and with which he conceives the proper matter of the brain is covered.* Trusting to ordinary inspection, aided by a good glass, I do not think there is any sensible proof of the existence of this covering. It is more natural to regard it as cerebral matter modified for its situation. In point of fact, the deep cerebral matter may be rendered equally firm with this by immersion in alcohol or dilute acids. But nothing can give the smooth, polished, close-grained surface which belongs to every spot of this part of the brain. After this explanation, I shall not scruple to use the term *Epithelion*, not in the sense given by Reil, but merely as a name to the firm smooth substance which forms the figurate surface of the brain.

In certain situations this surface is unusually firm, for instance in the narrow winding hollow between the striated bodies and the optic eminences. (*Centrum semicirculare geminum*, Vieussens; *tænia semicircularis*, Haller.) Of the central surface not only does every division mutually communicate, but the whole central surface of the convoluted brain communicates with the central sur-

* Archiv. für die Physiologie, 9ter Band, 3. Untersuchungen, &c. p. 143.

face of the laminated part of the organ. Thus the lateral divisions called *ventricles* communicate freely and directly with each other below the vault or twain-band, (*fornix*, Die Zwillingsbinde); the surface of which lies free over the top of the *thalami*. These again communicate with the intermediate space called the third ventricle, from which it is well known there is a passage to the space between the *medulla oblongata* and the cerebellum. The communication with the posterior and inferior divisions (*cornua*) is well known.

The whole of this surface is covered by a vascular membrane, which is a continuation of that (*pia mater*) of the convoluted surface. One part of this which lies over the objects in the lateral ventricles has been long known under the name of *choroid plexus;* and an intermediate portion by which those of the two sides are united, has been distinguished by the term *velum interpositum*. Not only are each of these parts of the same membrane, and connected with the *pia mater;* but individual portions of vascular membrane or choroid plexus, all continuous, are found in every division of the figurate surface of the brain. This membrane sustains the vessels going to and issuing from the cerebral substance.

Between the two surfaces now described is placed the proper matter of the brain, which in different regions of the organ is arranged differently. The intimate arrangement peculiar to individual parts, and the manner in which the ar-

rangement of each is mutually connected, are now to become the object of examination.

The convoluted surface first claims attention. The colour of this is well known to be of an ash-gray, passing in certain parts to pale brown. In whatever part the substance of the convolutions be examined, they never present any appearance of linear or fibrous arrangement. I have often examined the convoluted substance of the human brain after induration in alcohol and dilute nitric acid; and I never could recognize the distinct fibrous disposition observed in other parts of the organ. A portion of brain, hardened in the manner now mentioned, breaks with a small conchoidal fracture, and an uneven granular subordinate surface. The surface thus exposed presents, however, a very determinate aspect, which it is easy to recognize after repeated trials. It is ash-gray and without lustre. It is rough, and consists, when minutely examined, of roundish grains aggregated together. The direction of the fracture is more at right angles to the convoluted surface than obliquely or parallel to it. In some instances even it is possible to recognize depressed marks perpendicular to the surface, sending off angularly like branches smaller depressed marks, meeting similar ramifications from other perpendicular depressions.

I have often attempted to determine, by breaking portions of brain in every direction, whether this appearance is uniform; but I cannot say that

I have obtained satisfactory proof of the point. I am not unaware that Reil represents the intimate structure of the convolutions to be distinctly fibrous. So far as I understand his description, I admit the fact of the conchoidal fracture which I have often verified; but I am not prepared to allow that this arises, as he imagines, from the fibrous matter being arranged in plates or leaves, which are folded and rolled together. * Upon the whole, the convoluted substance I regard as chiefly granular, but so arranged as to be more frangible in the direction perpendicular to its surface than otherwise. It is said to be more abundantly supplied with vessels than the white matter; (Ruysch, Albinus, Prochaska, and Soemmering;) and indeed a greater number of large vessels enters it all over, and especially at certain parts, *e. g.* the perforated space of the Sylvian fissure. It is not, however, absolutely and at all points more vascular than the white matter. The transition from the gray convoluted matter to the white inclosed, is in all parts of the hemispheres sudden and distinct. It is more distinct, however, after induration by immersion in alcohol or dilute acid, than in the recent brain.

The only part of the convoluted surface which presents a distinct fibrous arrangement is that part of the Sylvian fissure which has been named by Reil the unciform bundle (der haakenförmige Markbündel.) This, however, can scarcely be said to

* Archiv. für die Physiologie, neunter Band, p. 145.

belong to the convoluted surface. It is situate on the outside of the perforated spot, and corresponds with a short smooth convolution, which passes between the middle and the anterior lobes. The unciform bundle, in short, unites these lobes, and is intimately connected* with the internal arrangement of the *nucleus* and its capsule, parts immediately to be noticed.

The white cerebral matter is arranged in various parts of the organ, in the form of inconceivably minute parallel lines, lying in juxtaposition. It is unnecessary to enumerate all the parts in which this arrangement may be observed; and greater advantage will result from a short view of the mutual relation and connection of the fibrous parts of the organ, so far as they are well ascertained.

In tracing this part of the intimate structure of the brain, several anatomists have imbibed the notion that one part of the brain gives rise to or generates another. From this assumption even Reil, whose name I have occasion so often to mention with respect in this inquiry, is not wholly exempt. Without entering on the subject of organo-genesy, or the question of which part of the brain in the fœtal existence is first, and which subsequently formed,—which will be considered in its own place—I begin with stating, that in the adult every part of the organ is supposed to be coeval;

* Archiv. für die Physiologie, 9 ter Band, pp. 184, 197, and 201.

that the idea of one part generating or reinforcing another is an effort of fancy which must not be admitted in strict science; that when a bundle of fibres, or a fibrous arrangement, is seen proceeding *from* one part *to* another, it is imagination only which suggests that the former produces the latter, or conversely; and that from this nothing more can be inferred than that the parts so arranged are mutually and generally connected.

The inner fibrous part of the brain proper is divided by Reil into the system of the brain-limbs (*crura*;—Das Hirnschenkel-system;) the system of the beam or mesolobe, (Das-Balken system;) and the striated ganglion (das gestreifte Hirnganglion;) and to one or other of these he refers the arrangement of all the other parts of which the organ is composed. I do not adopt all his views, nor is it requisite to follow his distinctions minutely. But I shall attempt to trace briefly what I conceive admits of demonstrable proof.

The beam or mesolobe (*corpus callosum*, Der Balken) consists of white cerebral matter disposed in transverse fibres, which meet on the mesial plane, and thus give rise to the longitudinal lines seen on its upper surface (*Raphe externa et interna*, Reil.) They appear to change direction, and bend down at right angles, parallel with those of the opposite half. At the distance of from four to five lines on each side, these transverse fibres undergo a similar interruption or change of direction, so as to form the *covered bands* (die bedeck-

ten Bänder,) which appear also in the form of long, firm, fibrous lines extending longitudinally along the upper surface of the beam. Between these bands and the inner margin of the olfacient groove a connection may be traced over the *knee* (das Knie,) or anterior end of the beam.

Beyond the covered bands the transverse fibres pass directly into the white matter of the hemispheres, where they are connected in different modes with different parts. The general direction is that of expansion, like the rods of a fan, or radiation, like the rays of a luminous body. The fibres which compose the knee or anterior end, sinking into the hemisphere near the anterior *cornu*, meet those forming the first and anterior staff of the brain-limb, which lie in the anterior knotty end of the striated body, and wind round the adjoining edge of the staff-wreath (der Stabkranz.) In the intermediate substance, which is knotty before, and spreads into a brush-shaped expansion behind, the middle rods of the staff-wreath unite with their anterior extremities, and with the fibres of the beam. This forms the *first* or *anterior* junction of the beam with the limbs.

The middle fibres, passing immediately into the hemisphere, meet more abruptly with those of the limbs. Suddenly contracting, as it were, they coalesce with those of the *tænia*, and are covered by the gray matter of the brush-like termination above-mentioned, and epithelion, which is here very thick. The radiating fibres of both systems

are here shortest. The deep layers form in some parts immediate mutual communications, especially in the posterior *cornu*; and at this point alone the inner layer of the beam descends directly on the fibres of the limb. In expansion, these radiating fibres receive between them white matter from the hemispherical circumference; and in this manner form connections, as remarked by Reil, with the peripheral or convoluted part of the hemispheres, and especially with those which form the Sylvian fissure.* This may be considered the *second* connection of the beam with the brain-limbs.

The hinder part of the beam is something firmer than the fore part reckoned towards the centre; a circumstance which depends on the closeness with which its fibres are here compacted in mass. After forming the elevated ridge which constitutes the hinder cross-bar of the vault, they plunge into the hemispheres in the form of thick bundles, which, running horizontally backwards over the posterior *cornu*, are expanded in the posterior parts of the hemispheres. The inner layer of these fibres, which falling on the outer wall of the *cornu* over the radiation of the limbs, covers it and part of the outer wall, is named by Reil the *tapestry*, or *hanging*. (die Tapete.) This may be viewed as a *third* point of junction between the beam and the brain limbs.

* Archiv. für die Physiologie, Neunter Band, p. 179.

I am now to trace the direction of the component fibres of the latter parts. These are connected below, above, and behind, with so many important parts, that it is requisite to comprehend several parts under the general denomination of *System of the limbs.* After the example of Reil, we begin from the head of the spinal chord ; (*medulla oblongata.*)

This part consists in the human adult of six eminences, three on each side of the mesial plane ;— the *pyramidal* or *pyriform* eminences before, the *restiform* bodies behind, and the *olivary* eminences on each side. Of these the olivary eminences are to be viewed as the most important, since by each containing a ciliary or moriform nucleus, (*corpus ciliare, c. dentatum, c. moriforme, c. rhomboideum,*) they make an approach in structure to the character of the cerebellum.

The pyriform or pyramidal bodies are important in another light. Varoli, who has the merit of first examining with attention what is termed the *base* of the brain, traced longitudinal fibres in these bodies passing upwards through the body, named after him *Pons Varolii,* the *annular protuberance, (protuberantia annularis ;* Willis ; *nodus cerebri ;* Rau;) towards the limbs and substance of the brain. By Vieussens and Morgagni the fact of this arrangement was afterwards verified ; and it has been fully confirmed by the observations of Reil on the adult brain, and by those of Tiedemann in the fœtal organ.

The pyramidal bodies, situate on the anterior part of the *medulla oblongata*, and mutually separated by the median furrow, consist entirely of bands or rods of whitish fibres, (Die Mark Stabchen,) extending longitudinally through them. Becoming thicker, but not less compact at the upper end, where they are connected with the part named bridge, *(pons Varolii;* der Brucke ;) or annular protuberance, *(nodus cerebri;)* these longitudinal fibres undergo a new arrangement. *First*, They are covered with a firm layer of transverse fibres, which proceed, as it were, from the middle line on each side circularly round. These fibres are white, firm transversely, and abundantly distinct. When peeled off to the depth of about $1\frac{1}{2}$ line or two, the longitudinal fibres of the pyramids begin to appear; but no longer collected in mass as below. Numerous transverse or circular-transverse fibres are interposed between them, so as to separate them into layers. Hence results the complex structure of the bridge, which externally appears to consist of circular-transverse matter, but internally presents many longitudinal bands. It is worthy of notice, that in transverse and longitudinal sections the part which appears gray on the transverse section is white on the longitudinal, and conversely. The closeness with which the circular fibres are compacted render the bridge decidedly the firmest part of the whole brain.

Proceeding from the lower to the upper sur-

face of the bridge, this combination of long and cross bands is less distinct. Part, if not the whole of the transverse fibres, sink into the peduncles or *crura* of the cerebellum; and they evidently predominate here over the longitudinal.

The posterior-upper part of the *medulla oblongata* consists of two longitudinal bodies separated on the median line by a deep furrow. These, which are the *restiform* or rope-like processes, *chordal processes* of Ridley, *(corpora restiformia,) (processus restiformes*, Morgagni,) are described in most works as the pyramidal eminences. (Haller, Malacarne, Reil.) As there is no doubt that this part of the spinal chord presents six eminences, three on each side, as above stated, with the view of avoiding the confusion with which anatomists speak on these bodies, I adhere to the plan originally adopted by Willis, Ridley, Ruysch, and Morgagni, of distinguishing the anterior eminences as *pyramidal*, and the posterior as the *restiform processes.* *

* "The third descends from this part (the cerebellum) backwards upon the upper side of the *medulla oblongata*, like two longish thick chords on each side, making the *medulla* look somewhat thicker and broader in that place, and not unfitly styled the *chordal process.*" The Anatomy of the Brain, &c. By H. Ridley, Coll. Med. Lond. Soc. London, 1695, chap. xiv. p. 136. The term *processus restiformis* is a literal translation of this, given by his Latin translator, and in the collection of Mangetus. It is remarkable, that, though thus early noticed by Ridley, and afterwards distinguished as posterior pyramidal eminences by Ruysch, the restiform pro-

Stretching in the form of thick strong bands between the peduncles of the cerebellum above, and the spinal chord below, the restiform processes are mutually parted by a deep furrow, (*calamus scriptorius,*) in the bottom of which, when slightly separated, white chords proceeding from the process of one side are observed to be plaited or crossed with those of the other. This arrangement was first observed by Dominico Mistichelli,* a physician at Rome, in 1709, and shortly after by Pourfour de Petit † at Namur. Though subsequently verified by the observation of Santorini, ‡

cesses have been completely neglected, and are scarcely known even by name. It is not uncommon both in books and in demonstration, to see them pointed out as the *corpora pyramidalia.* By those who wish to avoid the confusion resulting from this oversight, they are termed *posterior pyramidal bodies ;* and in support of this, the authority of Ruysch, Prochaska, and Soemmering * may be adduced.

* Trattato dell' Apoplessia. Roma, 1709. Lib. i. cap. vi. ix.

† Lettre d'un Medecin des Hospices du Roi. Namur, 1710.

‡ " Nos autem sic eam luculenter conspeximus, sic evidenter, ubi apta incidere cadavera demonstravimus, ut nulla amplius nobis de hac re supersit dubitandi ratio. Id autem triplici potissimum in loco animadvertere potuimus ; in utraque scilicet priore posterioreque annularis protuberantiæ crepidine, atque maxime in imo medullaris caudicis, qua in spinalem abit. In priore itaque annularis protuberantiæ parte qua superius reflexa pro comprehendendis oblongatæ me-

* Frederici Ruyschii Responsio ad M. E. Ettmuller de Corticali Cerebri Substantia, &c. p. 25. Amstel. 1721. Georgii Prochaska De Structura Nervorum Tractatus, &c. Sectio 3. tabula i. fig. 1. S. T. Soemmering De Basi Encephali, &c. Tab. II. sect. 3. § 18. Apud Ludwig, Tom. II.

Winslow,* Lieutaud, and Soemmering †, it had escaped the notice of Haller, Vicq-D'Azyr, Monro, and others, and was, therefore, doubted till revived by M. Gall. Independent of the testimony of the above authors, it is easy to demonstrate by slight separation of the restiform bodies the fact, that whitish chords are seen lying obliquely across the linear depression, and that those connected with the right process cross to the left, while conversely those of the left cross to the right.

It is to the inner or mesial fibres of the restiform processes only that this cross plaiting is confined. Neither the pyramidal, nor the olivary,

dullæ cruribus in anguli formam interius producta tenuatur, sic ex concurrentibus fibris, strictiorique agmine coeuntibus, altera alteram scandit, ut præter mirum implexum, decussatio luculentissime appareat. Id ipsum ferme in postica ipsius crepidine occurrit. Eo iterum in loco, qui quarto ventriculo subjicitur, (the space between the restiform processes,) præter varios fibrarum ordines et colores, in adversum latus productas, et decussatas fibras commodé spectavimus. Si ea tamen evidenter uspiam conspicitur, profecto quam evidentissime duas vix lineas infra pyramidalia, atque adeo olivaria corpora conspici potest. Qua enim in longitudinem producta linea, seu rimula pyramidalia corpora (the restiform processes) discernuntur, si leniter diducantur, probe prius eo potissimum loco arctissime hærente tenui meninge nudata, non tenues decussari fibrillas sed *validos earundem fasciculos in adversa contendere*, quam apertissime demonstravimus." Observ. Anatom. J. D. Santorini. Lug. Bat. 1739. Cap. 3. § 12. p. 61. Also Tab. ii. apud Girardi, p. 28, 29.

* Exposition Anatomique, &c. Par J. B. Winslow. Paris, 1732. Traité de la Teste, 110, p. 626.

† S. T. Soemmering de Basi Encephali, lib. ii. sect. 3. § 18.

nor even the whole of the restiform bodies partake of it. It is sufficient, however, to establish a communication between the right and left halves of this part of the spinal chord. It was seen by Tiedemann in the fourth and fifth weeks of uterine life.

The interior fibres of these bodies are longitudinal, and proceed partly to the cerebellum, partly to the protuberance. The deep-seated layer is partly interwoven with the transverse circular fibres of this body, in the same manner in which those of the pyramidal eminences are, partly bends up to the peduncles of the cerebellum, with the bands of which they are then combined. The superficial layer is connected chiefly with the substance of the *corpora quadrigemina*, (Die Vierhugel,) which constitute the upper surface of the protuberance.

The structure of the olivary body is more complex. Though its surface consists of longitudinal fibres, which, like those of the other eminences, are lost in the protuberance, these form a sort of superficial covering to a capsule of gray matter arranged in a serrated form, inclosing a nucleus of white. This arrangement constitutes a ciliary or moriform body, (*corpus ciliare, c. dentatum, c. rhomboideum,*) precisely similar to that in the white trunks of the cerebellum, to which, therefore, the olivary eminence approaches in organization.

The longitudinal fibres of these several parts passing through the protuberance are observed beyond this body to be in direct continuation with

those of the cerebral limbs. (*Crura*, Die Hirnschenkel.) These are cylindrical masses, stretching obliquely between the protuberance behind and the optic chambers or eminences before. The longitudinal bands of which they consist give their lower surface a fluted appearance, at least to the inner margin of the optic tracts, by which they are obliquely crossed. Connected before with the posterior-inferior region of the *thalami*, they may be traced into the substance of these parts, where they undergo an arrangement new and peculiar.

Though the name couch or *thalamus* be still applied to these bodies, it conveys an erroneous idea of their anatomical relations. With the striated bodies, they form the central portion and most perfectly organized nucleus of the organ.

Each optic thalamus may be said to be united behind with its fellow by means of the quadrigeminous eminences. These consist superficially of epithelion or capsular cerebral matter, below of a semilunar stratum of fibres derived from the cerebral limbs, while a similar production forms the deep layer of the *corpus geniculatum internum*.

In each optic thalamus may be distinguished, according to Reil, four layers, each consisting of gray and white matter. The uppermost is merely the epithelion or condensed matter which forms the covering. The second is connected with the inner *corpus geniculatum*, from which fibres appear to spread or expand in the manner of rays, over the outer edge of the limb, and embracing the part to be mentioned as the nucleus of the

brain. The third layer consists of a set of fibres which, issuing from the upper layer of the brain-limb at their entrance into the thalamus, are firmly tied as it were into a loop or knot, (der Schleife,) and are then expanded like a brush into the substance of the thalamus. The lower is formed chiefly by the cerebral limb. It is partly in the former, partly in the latter, that the dark-coloured matter constituting the *locus niger* is placed.

The *thalamus* is so intimately connected with the limbs, that they must be viewed as essential parts of the same organized whole. The component rods or fibrous bands (seine Markstabchen) of the latter, partly combining with the former, but chiefly receiving them, spread out near the outer edge of the thalamus circularly, and constitute the radiated expansion called by Reil the Staffwreath. (Der Stab-Kranz.) These rods, at first obliquely horizontal, gradually, as they expand, assume a more vertical direction. Inwards, or towards the mesial plane from the first band or rod ascends the anterior pillar of the Twainband *(fornix)* to the knobs of the beam. Then follow the first band or spoke of the wreath, and the rest in succession. The anterior rods are long, slender, numerous, and thickly crowded on each other. The middle or lateral are short, thick, roll-like, and form a sort of crest or comb. The posterior are long and of fibrous structure. As they expand they form nearly a complete circle, which radiates through all the lobes. The *radii* of this circle are connected in the anterior lobes with the knee of

the beam, cross the *fossa Sylvii* near the anterior and posterior *cornua* to the outer edge of the thalamus, and terminate in the lateral *cornu* in the apex of the middle lobe, at the beginning of the Sylvian furrow. In this course the anterior rays of the Staffwreath are longer than the middle and lateral rays, the interruption of which forms the *comb* or crest. (Der Kamm.) The posterior, which go to the border of the outer wall of the capsule, are the longest; and shorter ones are again seen below in the region of the lateral cornu.

The last part, the organization of which can be here made the subject of short consideration, is the striated body. When observed, this part presents a singular arrangement of white and gray matter in the form of alternate streaks. This arrangement, though constant, it is unnecessary to describe minutely, unless so far as it is connected with the appearances already mentioned. The parts which chiefly claim attention on this head are the *cerebral nucleus*, its *capsule*, and the *walls of the capsule*.

The striated part of the brain may be regarded as a nucleus, (Der Kern) or organized central mass,* which is contained within a capsule consisting of three walls or enclosing plates of white matter; a *lower*, an *outer*, and an *inner wall*.

The lower wall of the capsule, which is acci-

* Reil considers it a ganglion, (Das Gestreifte grosse Hirnganglium.) But this idea is hypothetical; and while I use the term *nucleus*, I wish to convey no idea but that of one part contained within another.

dental, consists chiefly of the *tractus innominatus*, (Die ungenannte Marksubstanz,) the perforated spot, and that part of the convoluted space from which the olfacient nerve issues.

The outer wall is the most remarkable. It rests on the unciform band (Der haakenförmige Markbündel) at the entrance of the Sylvian fossa, which connects the convolutions of the anterior lobes by the perforated spot with the middle lobe. From this unciform band as a centre the fibres of the whole outer wall radiate; and as the deep ones are beneath the level of the cerebral limb, Reil regards them as connected neither with this, nor with the beam or mesolobe. He represents, nevertheless, the radiation of the outer wall as too much detached from the unciform band. Frequent examination of this part leads me to represent the outer wall and the unciform band as parts of the same system of fibres. The unciform band is situate not on the same vertical plane with the rest of the outer wall, which not only radiates in every direction forward, upward, and backward, but swells out laterally, or towards the convoluted region of the hemispheres. The result of this arrangement is, that the section which shows the unciform band most distinctly shows only the peripheral or marginal fibres of the outer wall. A section more external or lateral, however, shows the radiating fibres of the part between the centre, (the unciform process,) and the circumference; and in order to see them distinctly all

at once, and to have a correct conception of their assembled disposition, it is requisite to pare off from its outer surface the exterior white matter, or to excavate externally, so as to form a spherical segment.

The outer wall of the capsule is in short a spherical shell, consisting of fibres radiating from a point above the *fossa Sylvii*. So far as I have been able to observe, it has no connection with the limbs of the brain.

The inner wall of the capsule is composed, on the contrary, of the stem of the limb, and the fore-part of the staffwreath, which sends fibres under the round part of the inner portion of the nucleus. Joining the outer wall above by means of an arched margin, and at acute angles, it gives the capsule the shape of an inverted boat.

In this capsule is lodged the outer part of the large striated nucleus of the brain; the inner, usually named *corpus striatum*, being covered only by epithelion within the ventricle. Both are parts of one organ which should not be separated.

Of the cerebellum, the internal arrangement is nearly the following.

The restiform processes I have already mentioned as connected partly with the protuberance, partly with the four eminences *(corpora quadrigemina)* situate on its upper surface. The circular transverse fibres of the protuberance, which enclose the longitudinal ones produced in a lateral-posterior direction, plunge into the cerebellic he-

mispheres in the form of thick, strong, white chords, named *stalks* or *peduncles* of the cerebellum. At the point at which they take this direction they further receive a considerable accession from the restiform processes, the fibres of which are here seen to make a slight bend upwards, in order to follow the direction of the peduncles. Thus is composed a thick strong trunk of white matter, which on each side forms a sort of central pillar (Die Marksäule, Die Pfeiler) to each cerebellic hemisphere. The interior arrangement of this pillar or trunk is distinctly fibrous longitudinally, at its origin, or parting from the protuberance, and for a considerable distance from this point through the hemisphere. Unless I am misled by optical deception, the part derived from the restiform processes is also fibrous, and changes direction to accord with that of the peduncular bands.

In the centre of the white fibrous pillar thus formed is contained a body consisting of a capsule of brownish matter enclosing a nucleus of white. The serrated or indented form in which both the nucleus and its capsule are arranged gives it the name of ciliary or moriform body; (*corpus ciliare*, v. *dentatum*, c. *moriforme*, or *rhomboideum*.) The capsule is incomplete at one end, that turned towards the base or root of the trunk. Each trunk or stem (Stämm) divides into a certain number of branches, (Aeste); each branch into a number of twigs, (Zweige); and to

each twig is attached a number of leaves. (*Foliæ*; Blättchen.)

Of these plates or leaves the structure is uniformly the same,—white matter internally, covered with a thicker layer of gray. Whether the white is really fibrous or not, as Reil describes, is not easy to say, in consequence of its extreme tenuity and small quantity. It is certainly fibrous in the stems and branches, in which the linear appearance can be seen almost by the eye, and always by a glass. I cannot say that it is so evident in the twigs, in which it is in very small quantity; and in the leaves the intimate disposition is still more difficult to recognize. In the gray matter it is impossible to trace any thing like the fibrous structure.

The ramification (die verzweigung, die zerastelung,) in the cerebellic hemispheres is connected with the circular-transverse fibres of the protuberance and the restifom processes exclusively. Some would say that from this, this ramification is derived,—the precise meaning of which I have already endeavoured to determine. In the middle of this organ, however, or on its mesial plane, is found a ramification which appears to be connected with a different source. This is the structure of the upper and lower worm. Between the lower of the quadrigeminous eminences and the cerebellum is a thick semicylindrical band on each side, known under the name of *pillars of the valve*, and *processus a cerebello ad testes*. These a lit-

tle below the lower margin of the valve seem to sink directly into the cerebellic substance, mutually join, and form a whitish stem, which is ramified in the middle of the cerebellum. About four lines or half an inch from their first entrance into the organ, a branch set off almost straight upwards is the vertical branch, (Der Stehende Ast,) which, after giving off its first twig (der erste zweig) to the central lobe, divides into other seven, which are distributed to the anterior or mesial lobules of the quadrilateral lobes, as they meet on the mesial plane. The white stem of this vertical branch is thick and large.

A more slender stem, the continuation of the original white band, proceeding horizontally backwards towards the purse-shaped notch, is the horizontal stem (Der liegende Ast,) which constitutes by ramification a number of important parts on the mesial plane of the cerebellum. After giving three or four twigs generally small, and also vertical, to the last leaves of the quadrilateral lobes, the branches are parted in the following order:—1*st*, A twig under the cross commissures of the posterior-upper lobes, forming the *short exposed cross-bands* (die Kurzen und sichtbaren Querbander,) and the *long covered cross-bands;* (die versteckten und langen Querbander;)—2*d*, A branch dividing into three strong twigs, forming the leaves of the *pyramid*;—3*d*, A long branch dividing into three twigs, forming the leaves of the *uvula* (der Zapfen;)—4*th*, The last generally a single twig,

constituting the *laminar tubercle* or *nodule* (das Knötchen.)

The spinal chord is the last part of the central class of organs coming under the head of brain. It may be viewed as two longitudinal bands united by the middle. Both are fibrous internally throughout their entire length; and in the lumber region of the canal these fibres are separated and expanded into a true brush-like arrangement, named *cauda equina.* Some anatomists have imagined they could recognize cross fibres in the chord; but, with the exception of what has been stated regarding the connection of the restiform processes, nothing of this nature can be regarded as established.

Some anatomists have also thought it possible to demonstrate the existence of a longitudinal cavity or canal in the spinal chord. In the adult this never exists in the normal state. The canal of the chord is part of the fœtal structure only; and in this respect it is to be viewed as one of many peculiarities of formation belonging to the lower animals, through which the human fœtus passes in the early stage of developement. A longitudinal canal is found in the spinal chord, during the whole course of existence, in reptiles, fishes, and birds. In mammiferous animals in general it is always found in the fœtus, and continues in several for some time after birth. (Sewel, F. Meckel, and Tiedemann.) As the animal grows, however, it ceases to be found; and the

only trace of its previous existence is a longitudinal depression on the anterior part of the chord. In the young of the human subject it has been found after birth by Charles Stephen, by Columbo, Piccolhomini, Bauhin, Malpighi, Lyser, Golles, Morgagni, Haller, and Portal. No doubt can be entertained, however, that in such cases it was part of the fœtal structure continued to an unusual period by the slow progress of growth, or in consequence of some interruption to the usual process of developement. The chord, in short, is formed in two portions; and when these are incomplete, the longitudinal cavity exists between them. As by progressive enlargement they mutually approximate on the mesial plane, this canal necessarily diminishes until it entirely disappears.

I am now to consider shortly the minute anatomical structure of cerebral matter in the several parts of the organ. The three divisions of brain, small brain, and vertebral prolongation, and their constituent parts, do not present every where the same aspect or obvious qualities, but appear to consist of substances which are distinguished chiefly by their colour.

The outer convoluted part of the first division (*cerebrum*) consists of peculiar substance of a gray or ashen colour. Its convoluted surface, which is covered by the adherent surface of the soft or vascular membrane (*meninx tenuis, pia mater,*) is smooth and uniformly gray, without spots or streaks. At various situations it presents minute

holes or orifices, which correspond to arterial or venous branches. It is not easy to apply accurate terms to denote the kind of colour; but, according to Gordon, this surface is of the wood-brown or lead-gray tinge;* and the substance so coloured extends only one-eighth or one-tenth of an inch in depth, and is then succeeded by a tinge of orange-white substance. Of the correctness of this observation I am not assured; for if sections of the convoluted part be made, no difference can be observed in the recent brain; and the cut surface appears to consist of homogeneous and uniform gray matter, from the outer or free margin to that which adheres distinctly to the white substance.

The consistence of the convoluted cerebral substance is considerable; but it is less than those of the white matter.

If we trust to the observations of Father Della Torre, the gray and the white substance of the brain, *cerebellum* and spinal chord, consist of an accumulation of transparent globules, floating in a transparent *crystalline*, but somewhat viscid fluid.† These globules he imagined are largest in the brain, smaller in the cerebellum, and still smaller in the spinal chord.

According to the observations of Prochaska, however different in colour the gray cerebral sub-

* Syme's Nomenclature of Colours.

† Nuove Observazione Microscopiche. Napoli, 1776. Osserv. 16, 17, 18, 19, &c.

stance be from the white, no difference in minute structure can be recognized by the most powerful lens. Each appears to consist of an infinite multitude of globules, connected by a peculiar, elastic band; and he observes that this cerebral globule does not float in a fluid as Della Torre imagined, but is connected to the contiguous ones by a thin and transparent cellular web, *(tela cellulosa subtilissima et pellucidissima,)* which is a series of membranous partitions derived from the soft membrane and minute vessels. This last conclusion is not quite certain, and would require to be made the subject of further researches. *

On the structure of these globules nothing is known with certainty. They are not exactly spherical, but are said to be irregularly round. The observation of Della Torre, that they are largest in the convoluted brain, (*cerebrum*,) smaller in the laminated, (*cerebellum*,) and most minute in the vertebral portion, is fanciful, and perhaps unfounded. Prochaska, however, admits that the globules are not all of the same size, but that it is impossible to ascribe their variable magnitude to a regular principle, unless the proximity or remoteness of the lens. *

The accuracy of these observations is confirmed in general by the testimony of Soemmering, whose inferences, derived from the observations of Lewenhoek, Della Torre, Malacarne, Metzger,

* Georgii Prochaska De Structura Nervorum, &c. Viennæ, 1779. Sectio 2. caput. iv.

and Prochaska himself, are found in the conclusion of his description of this organ. *

From thirty-one experimental observations on the cerebral matter of the human subject, in various mammiferous animals, fowls, and fishes, Joseph and Charles Wenzel of Tubingen have drawn the conclusion ;—that the gray and white (cortical and medullary) matter of the human brain, the substance of the *colliculi*, (optic chambers and striated bodies,) that of the conarium, spinal chord, and nerves ; in short, the mass of brain in mammiferous animals, birds, and fishes, consists of the same small roundish bodies, mutually cohering, of which the substance of muscle, liver, spleen, and kidney is composed ; that as these minute bodies derive their shape from the cells of the cellular tissue, the substance of brain, spinal chord, and nervous matter, appears to consist of the same roundish minute bodies; but that the relative size of these cells cannot be determined.

These conclusions throw little light on the point at issue,—the minute structure of the cerebral matter in general ; and it must be said that the microscopical observations and chemical experiments of these anatomists do not communicate information proportioned either to their number or to the elaborate assiduity with which they appear to have been conducted. More recently

* Samuelis Thomae Soemmering De Corporis Humani Fabrica, Tom. III. Trajecti ad Moenum, 1800.

still the atomic constitution of different parts of the brain and cerebellum has been investigated by Sir Everard Home, aided by the powerful microscopes of M. Bauer.

According to this observer, white cerebral matter consists of innumerable globules, aggregated or connected in rows, so as to constitute fibres, by means of a transparent, colourless, jelly-like matter, somewhat viscid, elastic, and readily soluble in water. The globules are whitish, semitransparent, and vary from $\frac{1}{24000}$ to $\frac{1}{4000}$ of an inch in diameter, the average being $\frac{1}{32000}$.

Upon different proportions of these two constituent elements, and partly upon differences in size of the component globules, the chief peculiarities of structure in the several sorts of cerebral substance depend. Thus the gray matter of the convoluted surface of the brain, and the laminated surface of the cerebellum, consists chiefly of globules from $\frac{1}{32000}$ to $\frac{1}{4000}$ of an inch in diameter, the smaller globules being most numerous, of a large proportion of the gelatinous, elastic, viscid substance, and a yellowish fluid resembling the serum of the blood, probably albuminous. In the white matter, on the contrary, the large globules ($\frac{1}{4000}$ of an inch) predominate; the connecting jelly is more tenacious, but less abundant in proportion to the globules; and the latter are more distinctly arranged in rows, so as to constitute fibres.

The mesolobe contains the greatest quantity of

the small globules ($\frac{1}{2400}$ of an inch;) and the viscid jelly is said to be at least equal to the globules in quantity. In the limbs of the brain and peduncles of the cerebellum, the jelly is said to be in greater proportion than the globules. The annular protuberance is chiefly composed of globules of the average size ($\frac{1}{3200}$,) with abundant viscid matter. In the restiform processes, the pyramidal bodies, and the olivary eminences, the fibrous structure consists chiefly of the large globules, with abundant viscid jelly, which is rapidly soluble in water.*

When the brain by immersion in alcohol is hardened, the elastic jelly is coagulated and rendered opaque, and the appearance of globules is lost. †

These observations partly verify those of Della Torre, partly explain those of Prochaska. They show, that, so far as the microscope can be trusted, the globules of which cerebral matter consists vary in size and proportion in different parts; and that the white cerebral matter generally consists of larger globules, or at least contains a larger proportion of these globules than the gray.

The sources from which the brain derives its

* The Croonian Lecture. Microscopical Observations on the Brain, &c. By Sir Everard Home, Bart., V. P. R. S. Philosophical Transactions, 1821, Part i. v. p. 25.

† The Croonian Lecture. On the Internal Structure of the Human Brain, &c. By Sir Everard Home, Bart., V. P. Philosophical Transactions, 1824, p. 3.

blood are well known. It is highly vascular throughout. These vessels, first divided in the productions of the *pia mater*, are afterwards subdivided to an incredible degree of minuteness, in the substance of the organ. They never anastomose. (Home.) They are accompanied with very minute veins, provided, it is said, with valves. Of these the most delicate branches are found, according to Sir Everard Home, in the gray convoluted matter, contrary to the statements of Ruysch, Albinus, and others; and conversely in the white matter they are much larger.*

The substance of brain has been examined by several chemists; but the analysis most to be trusted is perhaps that of Vauquelin, who found that 100 parts of cerebral substance consist of 80 of water, 7 of albumen, 4.43 of a white adipose matter, 0.70 of a red adipose matter, 1.12 of osmazome, 1.5 of phosphorus, and 5.15 of acids, salts, and sulphur. Upon the presence of the albuminous matter depends the solidification which the brain undergoes when immersed in alcohol, acids, or solutions of the metallic salts, which coagulate that substance. Upon the presence of the white adipose matter depends the formation of those brilliant white crystalline plates, resembling cholesterine, observed by M. Gmelin in the brains preserved in the anatomical cabinet of Heidelberg.† The opinion of this physician, that it pre-

* Philosophical Transactions, Lond. 1821, pp. 29 and 30.

† Zeitscrift für Physiologie, Von Tiedemann, Treviranus, und L. C. Treviranus, Band I., 1 Heft, 1824.

exists in the brain, in the form of the adipocerous or cholesterine matter (waxy brain-fat,) is improbable, and requires more decisive experiments than those on which he has founded it.

The developement or growth of this organ has been recently investigated with much care by Tiedemann, who has ascertained the following points. In the embryo of six weeks, the spinal chord is represented by a flat long substance, the upper end of which is slightly enlarged. In the second month, when the brain is little developed compared with the spinal chord, it may be said to consist, 1*st*, of a cerebellum, with considerable transverse extent; 2*d*, of brain proper, exceedingly small; 3*d*, of a third portion placed between these two, and the size of which exceeds that of the brain. This third portion corresponds to the protuberance, or rather to that part of the organ, the upper surface of which is formed by the four eminences, *(corpora quadrigemina,)* and the lower surface by the annular protuberance. * According to M. Serres, it is formed in man and animals before the brain and cerebellum, and immediately after the spinal chord. In the fifth month, the brain covers a part of the protuberance; it advances to the cerebellum, and in the seventh exceeds it. At the same time, the other parts, and especially that which we have

* Anatomie und Bildungs-Geschichte des Gehirns im Fœtus des Menschen u. s. f. Von Dr Friedrich Tiedemann, Professor der Anatomie, u. s. f. Nurnberg, 1816, 4to.

mentioned as the third or central portion, do not grow at the same rate.

At the beginning, that is about the seventh week, the brain is found to be divided in two portions by a longitudinal fissure. Each half mutually approaches as growth continues, and are at length united, so that at the third month the only parts found separate are the middle ventricle, the aqueduct or canal, which is at this time a large cavity continuous with it, and the fourth ventricle. The developement of the cavities called lateral ventricles is closely connected with that of the contiguous parts of the organ. These appear nearly in the following order.

The lateral lobes appear first about three months after conception; and about the same time the mesolobe, *(corpus callosum,)* is formed by union of the hemispheres; and the cylindroid processes, *(cornua ammonis)* vault, *(fornix)* mammillary eminences, posterior commissure, and cerebral limbs or peduncles, may be recognized. Shortly after may be seen the *ergot*, or small hippocampus, and the anfractuosity from which it issues, and the *conarium* and its peduncles; then the anterior commissure, the thin partition *(septum lucidum)* and its cavity, which at this time communicates with the middle ventricle; lastly, the semicircular fillet, *(tænia semicircularis,)* and the infundibulum, which correspond to the seventh month; and about the same time the outer surface of the brain begins to present the eminences

denominated convolutions, and the cerebellum its laminated or foliated appearance.

In the early weeks of existence the brain is fluid, soft, and homogeneous. The white matter and its fibrous structure is first seen; and the cross structure of the fibres of the pyramids are observable about the eighth week, according to M. Serres. About the sixth month the cerebral substance appears, when microscopically examined, to consist of globules immediately beneath the *pia mater*, and of fibres at a greater depth. In the seventh month a section of the ventricles shows very distinct layers of radiating fibres. After these are seen new ones, which form convolutions, and which are termed converging fibres. At the ninth month the organization is complete.

The gray substance appears a long time after the white. At the end of the sixth or seventh month this substance is formed in the olivary eminences, which then assume their proper appearance; about the end of gestation the spinal chord is also filled with gray matter, and about the ninth month this substance is distinctly seen in the convolutions, the plates of the cerebellum, &c. These results are much like those of Serres, unless as to what regards the brain proper, in which, according to this anatomist, the optic chambers and striated bodies consist originally of gray substance entirely, to which white cerebral matter is afterwards added.

Of the process of growth, the principal, indeed

the sole agent is the vascular membrane; (*meninx tenuis, pia mater et plexus choroides;* das Gefässhaut.) The two divisions of this, viz. the external, or that belonging to the convoluted surface, and the internal, or that pertaining to the figurate, may be distinguished previous to the formation of any part of the brain, and when the two portions, which are afterwards destined to be separate, are the same, and indistinguishable from each other. The formation of the organ appears to commence at once upon two orders of vessels mutually looking towards each other; that which is to be the central *(plexus choroides)* being merely a mesh of vessels looking to that which is to be peripheral. *(pia mater.)* The first portions of newly deposited cerebral matter form the barrier between these extremities, which continue to be more widely parted as the process of developement advances. This membrane is then more vascular than at any subsequent period. The cerebral matter is first deposited soft, and firmly adherent to these vessels, which are ramified in every direction through its substance. It becomes firmer afterwards and less vascular the longer the period from deposition. Hence the two surfaces, the outer and inner, are much softer and more pulpy, and more firmly attached to the vessels, than the intermediate deep matter. Tiedemann appears to regard the process of developement as proceeding from the centre to the circumference. This is correct, but not in the exact sense in which he under-

stands it. The centre is not in this case the figurate surface of the brain, but the centre of the optic and striated bodies which is first deposited, and from which the process of deposition advances to both surfaces at the same time, and nearly at equal rates. These inferences are established by the phenomena observed in the developement of the organ in the young of mammiferous animals in general.

Section II.

Cerebral substance is liable to inflammation, acute and chronic, to hemorrhage, to effusions of serous fluid, to alterations in its natural consistence, and to tumours.

1. *Encephalia Acuta; Encephalitis.* (Frank, Costantin.) Acute inflammation of the brain is a rare disease, and, perhaps, if always carefully investigated, would be found never to take place spontaneously or primarily. As the effect of accidental violence, and the result of morbid poisons, it is much more frequent; and it is chiefly under such circumstances that its phenomena and effects are known. (Pott, Dease, Hill, Malacarne, Desault, J. Bell, M. A. Petit, O'Halloran, Abernethy.) As the effect of mechanical injury, the disease is found to be generally circumscribed. Part of the brain becomes very vascular, acquires a red colour of various shades of intensity, and eventually becomes brownish or green, and much softer than natural. The

formation of matter in a distinct cavity appears not so common in this form of the disease as in another which I am soon to mention. An abscess is not very frequently remarked under such circumstances, unless when a foreign body, as a bullet, a stone, or a piece of bone has been driven into the brain. This process gives rise to intense headach, delirium, and intolerance of light, quickly succeeded by convulsions, coma, and death. Of the effect of morbid poisons in inducing cerebral inflammation more or less acute, an example is found in the severe form of fever prevalent in jails and camps. In several examples of this disease abscesses of the brain have been found, (Pringle); and it is often possible to trace the process from the first marks of injection to the complete formation of purulent matter.

2. *Encephalia Subacuta.* (Pulpy destruction; *ramollissement*, Rostan, Lallemand, &c.) Subacute or chronic inflammation of the brain is greatly more common. Its anatomical characters are much the same as those of the acute form; but the longer duration of the process gives rise to modifications which the pathologist should distinguish. At first a part of the brain becomes more or less red and vascular. As this goes on, it passes successively into crimson, violet or purple, brown, or claret colour, while the consistence of the part is much diminished. A shade of green announces the formation of purulent fluid; and in proportion as this process continues before life is extinct,

the part becomes yellow, or gray, or grayish brown, *(subfusca)* very soft and pulpy, or even semifluid. It is perhaps equally rare in this as in the former case, to find perfect purulent matter in a distinct cavity. This change, which is often mentioned by Morgagni, * is one form of the disease described by Rostan † and Lallemand, ‡ under the name of *softening* (ramollissement) *of the brain*. The softening is a mere effect of the process of inflammation, subacute or chronic. In some instances the softening is attended with effusion of serous fluid, without much discoloration of the part.

Subacute or chronic inflammation, terminating in softening of the brain, may take place either on the convoluted surface of the organ, when it generally occupies an extent of two or three square inches ; or at the figurate surface, when it is most common on the middle portion, (*septum lucidum*,) and extending along the twain-band ; or in the substance of the organ, when it affects most fre-

* Epistola, V. 6, 7. IX. 16, 18, 19. In the brain of Marchetti, the anatomist, who, after two epileptic attacks, died apoplectic, the gray matter was so tender, that on the slightest touch it was converted into a fluid substance, as if it never had cohered.—L. vii. 14, 15.

† Recherches sur une maladie encore peu connue, qui a reçu le nom de ramollissement du Cerveau. Par L. N. Rostan, Medecin de la Salpetriere, &c. A Paris, 1820.

‡ Recherches Anatomico-Pathologiques sur l'Encephale, et ses dependances. Par F. Lallemand, Prof. de Clinique, &c. Paris, 1820–1821.

quently the striated bodies, the optic *thalami*, the central part of the hemispheres, the cerebellum, and the cerebral prolongations, (*crura cerebri*,) in the order now enumerated. Its occurrence in the spinal chord, in which the same series of changes takes place, has been described by M. Pinel the younger, * M. Olivier, † and M. Velpeau. ‡

What is the intimate nature of this disease, and wherein does it differ from suppuration of the organ? This question must be determined by considering the anatomical characters of the lesion, and the circumstances under which it takes place. In the part affected, the portion of brain is never entirely removed. The cerebral substance is separated, broken down, and mixed either with serous, with bloody, or with purulent fluid.

It may succeed at least four morbid states of the organ. 1. It may be the consequence of the blood-stroke, (*coup de sang*,) or injection of the vessels of a given region of the organ. The softened part is then reddish, rose-coloured, amaranth, crimson, or brown. 2. It may follow the effusion of red blood, which nearly in the same manner separates and breaks down the delicate

* Sur l'Inflammation de la Moelle Epiniere. By M. Pinel Fils. Journal de Physiologie Experimentale, Vol. I. p. 54.

† De la Moelle Epiniere et de ses Maladies. Par C. P. Ollivier. Paris, 1824.

‡ Memoire sur une Alteration de la Moelle Allongée, &c. Par M. A. Velpeau. Archives Générales, Tom. VII. p. 52 and 329. Paris, 1825.

substance of the organ in which it is effused. The softened portion is then generally brown, or a wine-lee-colour; but if a considerable time has elapsed after effusion, it may be of a dirty or ashy-colour, tending to green, and not unlike softened bread. 3. It may either accompany r follow the process which terminates in hydrocephalic effusion. It is then of a milk-white colour. (Rostan, Lallemand.) 4. It may take place in the cerebral substance surrounding tumours, (Meckel, Blane, Powell, &c.) when its colour varies from pale-red, to green, yellow, and brown.

From these facts it may be inferred, that *softening* or *pulpy disorganization* of the brain is not so much a proper disease as the effect of a morbid process, which takes place in different conditions of the brain.

When it occurs in the first manner it is the result of a species of diffuse inflammation, in which there is no tendency to limit the action of the disease by the effusion of lymph, or the formation of a vascular cyst. This is well illustrated in those cases recorded by Morgagni, in which parts of the brain had become yellowish or greenish, with much diminution of consistence, (Epist. iii. 2. ix. 20. xxv. 10. lii. 23.); and in the eighth delineation of Dr Hooper, (p. 23.) In cases of this description a sero-albuminous or semi-purulent fluid is infiltrated into the cerebral substance, portions of which are thus separated and detached from each other. The process is allied to in-

flammation ; but it is an abortive form, in so far as it fails to concentrate the action to a definite spot.

That it takes place in the inflammatory or disorganizing process which succeeds mechanical injury is established by the necrological appearances found in the brain in such circumstances. (Fantoni, Morgagni, Louis, Le Dran, Schmucker, O'Halloran, Dease, Abernethy, Thomson, Hennen, &c.)

When softening takes place in connection with serous effusion, it is partly the concurrent effect of inflammation, partly of the effused fluid. This is well illustrated in those cases in which the *septum lucidum* is attenuated, reticular, and perforated, or at length ruptured. This form of destruction, accompanied with more or less softening of the twain-band, *(fornix)* is repeatedly mentioned by Morgagni, and has been noticed by most authors who have described cases of water in the cerebral cavities. I have seen it both in the true hydrocephalic effusion, and in that which takes place in continued fever.

Not only does pulpy disorganization occur in this part of the organ in continued fever, but it takes place in the substance of the hemispheres. Of this pathological fact good instances are given by Jemina, as they occurred in an epidemic at Montreal, in the territory of Turin, in 1783–84. In one the white mater of the hemisphere (*centrum ovale*) was soft, pulpy, *(fracidum,)* of an ash-colour, passing into yellow, and pasty ; in another it was soft and tawny-coloured, like spoilt fruit ; and in a third the cerebellum was similarly

changed.* The same change was observed by Dr Black of Newry in the cerebral hemisphere. (Transactions, Vol. II.)

When pulpy disorganization is connected with effusion of blood, it has been supposed by M. Rostan to be the cause of that effusion. That this supposition is inadmissible, I infer from the following facts, which I have witnessed more than once. 1*st*, That the portion of brain inclosing the clot is soft and pulpy all round, but sound in proportion to the distance from the clot. 2*d*, That in some instances in which partial recovery takes place, part of the red clot has disappeared, and its place is supplied by serous fluid. 3*d*, That in cases in which death takes place early, the pulpy disorganization is less complete than those in which it takes place at a later period. In short, the extent of the disorganization is proportionate to the interval which elapses between the effusion of the blood and the period of death.

When pulpy disorganization accompanies tumours of the brain, that it is the effect of the presence of these tumours, and the chronic congestion which they cause, is sufficiently obvious to render superfluous any minute induction. It is enough to say, that, though not constant, it is a very general effect. (Morgagni, Meckel, Sandifort, Powell, Yellowly, Blane, &c.)

The morbid change now described was sup-

* De Febre, Anno 1783–84, Monteregali Epidemica, auctore Marco Antonio Jemina, M. D. &c. Extat in Brera Sylloge, Vol. X. p. 218, 247.

posed by Morgagni and Lieutaud, to the former of whom it was well known, to be of the nature of gangrene in other parts. This idea, which is also that of Jemina * and of Baillie, has been revived by Dr Abercrombie. † Though unwilling to dissent from the opinion of a pathologist distinguished for accurate induction, it appears to me exceedingly doubtful, for the reasons above stated, how far this analogy can be demonstrated.

A part of the brain changed as above described is indeed disorganized, may be said to be dead, and in this sense the change may be termed *gangrene of the brain.* But when it is found in different degrees, and in so many different morbid states of the brain, some of them of long continuance, it is difficult to be satisfied that every one of them must be viewed equally as gangrene. In the present work I avoid as much as possible whatever is hypothetical or doubtful. Upon this principle I conceive it improper to offer, on the nature of this change, any further opinion than can be collected from the circumstances above stated of its history and connections.

* " Aliud etiam ex hoc morbo defuncti caput aperui; et memini inter cætera observata substantiæ cerebri pulposæ portionem magnitudine nucis avellanæ, colore, et consistentia vitiatam, ita ut esset coloris *tané* et mollior, non secus ac poma vel pyra cum intus marcescere incipiunt. Annon gangræna hujus visceris?" De Febre, annis 1783-84. Monteregali Epidemica, auctore Marco Antonio Jemina. M. D., &c. Apud Brera Sylloge, Tom. X. p. 247.

† Pathological and Practical Researches, p. 25.

The effects of this disease on the system are not very well distinguished. They may be divided into common and proper. The common effects are dull pain, or sense of weight in the head, dullness, impaired memory, frequent drowsiness, and occasional peevishness at trifles, and paralytic affections of the face, head, and members. The proper effects are sense of formication, numbness, and rigidity, or occasional involuntary contractions of the muscles of the upper extremities, followed by delirium or fatuity, and a peculiar odour about the head, not dissimilar to that of the mouse. In the spinal chord it gives rise to numbness and rigid contraction of the muscles of the lower extremities, and eventually palsy more or less complete.

These symptoms, which are chiefly those given by the French authors already mentioned, apply to the acute form of the disease. In more chronic states it seems not to affect the muscular motions considerably, but rather to induce fatuity, and other forms of impaired intellect. This inference at least results from some of the observations of Morgagni, * and those of Dr John Hunter. † This is the state of brain which takes place in cases of fatuity succeeding coup-de-soleil.

3. *Suppurative Inflammation, Apostema Cerebri.* Collections of purulent matter have been often found in the substance of the brain. That

* Epist. viii.

† Apud Baillie, Morbid Anatomy.

these collections may take place spontaneously, as a consequence of previous inflammation, is established by the testimony of Morgagni,* Lieutaud,† Baader,‡ Baillie,§ Powell,‖ Brodie,¶ Hooper,** and Abercrombie.†† Of the observations of these authors the result is, that, though a collection of purulent fluid to a greater or less extent may take place in either of the hemispheres, and in almost any part of these hemispheres, its situation is influenced much by the kind of abscess. The ordinary abscess, consisting of an irregular cavity containing purulent matter, sometimes mixed with flakes of lymph, and rendering it curdly, may take place either in the anterior lobe (J. Earle,‡‡ Hooper,) or in the centre of the hemisphere (Chizeau,§§ Baillie). An abscess, consisting of several small communicating cavities, takes place in the anterior lobe, and occasionally in

* Epistola. V. † Historia Anatomico-Medica.

‡ Josephi Baader, Observat. Med. Obs. 22. Extat apud Sandifort Thesaurum, Vol. III. p. 28.

§ Engravings to illustrate the Morbid Anatomy, &c. X. Fasciculus, Plate vi. p. 221.

‖ Some Cases illustrative of the Pathology of the Brain. By Richard Powell, M. D. Transactions of the College of Physicians, Vol. V. p. 198, Case 6 and 8.

¶ Case of Abscess in the Brain. By B. C. Brodie, Esq. F. R. S. &c. Transactions of a Society, Vol. III. p. 106.

** The Morbid Anatomy of the Human Brain. By Robert Hooper, M. D. London, 1826. Plate ix. p. 25.

†† Abercrombie, Cases 31, 32, 33, and 34.

‡‡ Med. and Phys. Journal, Vol. XXIII. p. 89.

§§ Recueil Periodique, No. xxxiv.

the substance or in the vicinity of the striated nucleus of Reil. The abscess consisting of a firm cyst, containing purulent matter, is generally found in the centre of the hemispheres. (Powell, case 8; Hooper, Pl. 9, Fig. 3; Abercrombie, cases 16, 17.)

Collections of purulent matter have been found in the lobes of the cerebellum by Bianchi,* Janus Plancus, † Stoll, ‡ Weikard, § and Abercrombie. ‖ In general they are contained in a cyst more or less distinct, the walls of which are membranous and vascular. In the case of Weikard he represents the whole white matter almost of the left lobe to be converted into a millet-like, something foul, purulent matter, by which I understand it to have been flocculent and lymphy. Suppuration, less distinctly defined, and deposited generally in small irregular cavities, takes place in the *medulla oblongata*, especially in that part of the olivary body which contains the *corpus dentatum*. Abercrombie mentions a case at the junction of the protuberance. (39.) In the chord itself, though more rare, and generally confined to the surface, yet it has been seen in the form of infiltration by Brera;¶

* Giovan. Bianchi Storia, d'un Apostema nel lobo destro del Cerebello. Rimini, 1751.

† Jani Planci Storia, d'un Apostema nel Cerebello. Rimini, 1752.

‡ Maximil. Stoll Rationis Medendi, Pars i. 178, et iii. 159.

§ Vermischte Schriften von M. A. Weikard fürstl. Fuldisch Leibartz. Frankfurt am Main, 1782. Viertes St. p. 74.

‖ Pathological and Practical Researches, case iii. and xl.

¶ Cenni sulla Rachitide.

and in a distinct cavity in the cervical portion by Velpeau.*

The origin of these collections is not well known. That they are the result of a form of inflammation cannot be denied; but that it is not ordinary inflammation, is to be inferred from the slow progress which they generally observe, and from the variable effects to which they give rise. They are said in general to be connected with the strumous diathesis; and they are most commonly found in subjects who present the usual marks of this diathesis. This, however, is only expressing, in different terms, an obscure fact, the real cause of which is quite unknown. The encysted abscess, especially that such as is delineated by Dr Hooper, is of the kind called by the old pathologists *abscess* by *congestion*, or *cold abscess*.

One variety of cerebral abscess, that connected with discharge from the ear, originates in a more obvious manner. Purulent discharge from the ear-hole is indeed generally connected with inflammation, subacute or chronic, of the *dura mater*, or vascular membrane, or both; and in some instances the disease takes an unfavourable turn in this manner, and speedily proceeds to a fatal termination. (Morgagni, Powell, case 5; Itard, Duncan Junior, Abercrombie.) In other circumstances, however, either with or without this meningeal inflammation, a similar affection strikes sud-

* Revue Medicale, 1826.

denly a part of the cerebral substance, and, proceeding rapidly to the suppurative stage, forms a distinct cerebral abscess. Cases of this description were early noticed by Ballonius, Gontard, and more recently by an anonymous writer, * Mr Brodie, † Dr O'Brien, ‡ Mr Parkinson, § and Dr Duncan Junior. ‖

By Bonetus this affection of the cerebral substance was believed to precede and to cause the discharge from the ear. Although this idea was refuted by Morgagni, who regards the cerebral abscess as consecutive to the ear-discharge, especially its suppression, it has been revived by Mr Brodie, who seems to think the affection of the brain coeval at least with that of the ear. I shall afterwards show that the internal affection, to which Bonetus and Mr Brodie ascribe this character, and which they think causes the ear-discharge, is disease either of the tympanal cavity, or of the *dura mater* investing the temporal bone. The inflammation which terminates in abscess of the cerebral substance is the effect of inflammation of the membranes, and in some instances of

* Medical Commentaries, II. 180. The History of a Suppuration of the Brain, &c.

† Transactions of a Society, &c. Vol. III. p. 106.

‡ Trans. of King and Queen's Coll. Dublin, Vol. II. p. 309.

§ Medical Repository. London, 1817.

‖ Edinburgh Medical and Surgical Journal. Contributions to Morbid Anatomy, No. ii. Vol. XVII. p. 331. By A. Duncan Jun. M. D. &c. Cases 4th, 5th, and 6th.

the discharge being suddenly checked, and the chronic external inflammation being suddenly converted into an acute internal disease. 1*st*, It is generally remarked to succeed quickly the suppression or the disappearance of the external discharge. This, which was the opinion of Morgagni, is proved by the cases of Mr Brodie, Mr Parkinson, Dr O'Brien, and Dr Duncan. 2*d*, That it does not exist from the origin of the discharge may be inferred when the patient is suddenly attacked with acute pain deep in the head, intolerance of sound, and delirium, quickly followed by insensibility and coma. 3*d*, It is improbable that a disease, commencing with the acute symptoms to which the formation of this abscess can generally be traced, should be going on for years without deranging more considerably the faculties of sensation, thought, and motion.

This disease is generally observed in young subjects of the habit named *strumous*. So far as I have observed or read, though it takes place in one of two modes, either as an extension of the original disease of the ear and cerebral membranes, or an alternating and vicarious result, the latter is most frequently its genuine character. The abscess is contained in an irregular cavity, surrounded by lymph and cerebral matter, which is very vascular. It is in all cases attended with inflammation, thickening, and suppuration of the membranes. The *pia mater* is highly vascular, and more or less covered with lymph. The *dura*

mater is thick, opaque, dark-coloured, and detached from the bone.

The variety of abscess now mentioned is understood to depend upon the operation of internal causes only. At least no external cause can be recognized; and if it were, it would be such as in other subjects would perhaps be inadequate to the effect. There is, however, a class of purulent collections in the brain, which in general it is possible to trace to mechanical violence inflicted on the head; and it is remarkable how long a period may elapse between the date of the injury, and that destruction of the organ which renders the continuance of life impossible.

Pigray gives a case in which an abscess, the size of a nut, proved fatal at the end of six months;* and Morand mentions one in which a soldier, who had received a shot in Italy, after slight treatment of the wound, proceeded thence to Paris; and nine months elapsed before suppuration and total destruction of the right lobe terminated life. †

In a case mentioned by Prochaska, the first foundation of the disease appears to have been frequent beating on the head for years, finally carried to intensity by a blow on the forehead, five months after which death took place. ‡ In a case by Sir E. Home, nearly nineteen months elapsed

* Libre iv. chap. ix.

† Opuscules de Chirurgie, l. c. p. 159.

‡ Obs. Patholog. Section iv. apud Opera Minora, p. 304.

between the receipt of the injury and the fatal termination. * In one by Dr Denmark, the interval between the supposed injury and the period of death was twelve months. † Many similar cases are found in the writings of surgeons. ‡ The result is, that a portion of brain more or less extensive is converted into purulent matter, contained in general in a membranous cyst, more or less thick and vascular, according to the interval between the infliction of the injury and the time of examination.

Between suppuration of the brain, from internal and external causes, a distinction has been drawn by Baillie, in the circumstance, that in the former it is generally in the substance, and in the latter on the surface of the organ. This distinction does not hold good in several respects, and requires modification. 1*st*, Where a long interval elapses after the infliction of the injury, the collection of purulent matter is almost invariably deep-seated. 2*d*, In like manner, when the injury operates in the manner of counter-stroke, the collection is also often within the substance of the organ. (Pigray, Quesnay, Petit, Cho-

* Transactions of a Society, Vol. III. p. 94.

† Medico-Chirurgical Transactions, Vol. V. p. 24.

‡ See especially several cases of this kind in the writings of Louis, Le Dran, Ravaton; and by Volaire, Journal de Med. Vol. XX. p. 503. Thilenius, Med. und Chir. Bemerkungen. Walther, Obs. 33. Thulstrup Physicalks Bibliothek. für Danmark, 1 Band. April. Bailey in Med. and Phys. Journal. Vol. XXIII. p. 376.

part.) * For example, several weeks or months after a blow on the upper or fore part of the head, from which the patient never perfectly recovers, but is more or less paralytic, perhaps occasionally lethargic, deaf, blind, or fatuous, death takes place, and an abscess is found in the substance of the hemispheres, in the *corpus striatum*, or even in one of the lobes of the cerebellum. 3*d*, In some instances of suppuration after injury, the collection does not take place at the part at which the blow struck the skull, but either in the line of the force passing through the brain, or in some of the lines into which this force may be resolved. 4*th*, It is chiefly when the force has been directly expended on the part, *i. e.* when the bone has been immediately broken, and its membranes injured, that suppuration takes place on the surface of the brain. This suppuration is then the result rather of the affection of the membranes, especially of the *pia mater*, than of the cerebral substance itself.

Suppuration may take place in any part of the brain; but it is most frequent in the hemispheres. The effects which it produces vary according to the situation and the extent of the purulent collection. They are much the same as from the presence of blood, tumours, or other unusual substances.

* Mémoire sur les contre coups dans les lesions de la tete. Par M. Chopart. Mémoires pour le Prix. de l'Academie Royale de Chirurgie, Tom. XI. 12mo.

In the circumstances now mentioned, purulent collections are the result of primary inflammation, spontaneous or traumatic. I must further repeat explicitly what has been already said, that they take place in a secondary manner in fever. Collections of purulent matter within the brain after fever were first distinctly found by Pringle, afterwards by Borsieri and Eisfeld,* and more recently by Jackson and Mills. These are doubtless the effects of inflammation, which, however, is in this case a secondary and adventitious circumstance in the progress of the disease.

These, nevertheless, and similar phenomena, have been conceived to afford evidence that fever consists in inflammation of the brain. It is unnecessary to examine the origin of this theory; the first traces of which may be found in the writings of Willis, Werlhof, Torti, Donald Monro, and a paper of M. Marteau de Grandvilliers.† Reil appears to have entertained the idea, that cerebral inflammation, though not the cause of the symptoms, takes place in fever. The first attempt, however, to connect the phenomena of fever with those of inflammation, was made by Ploucquet of

* J. F. A. Eisfeld Meletemata, &c. apud Brera, Vol. VI. p. 72.

† Description des Fievres Malignes avec une Inflammation sourde du Cerveau, &c. &c. Par M. Marteau de Grandvilliers Medecin de l'Hopital à Aumale, Journal de Medecine, Tome VIII. 1758, p. 275.

Tubingen in 1800,* and this was more expressly undertaken by Costantin of Lipsic in the same year. According to the latter author, *Encephalitis*, by which he understands that form of fever which happens to the cerebral and cerebellic vessels and membranes, comprehends three *genera*, *Synocha*, *Typhus*, and *Paralysis*;—the first distinguished by increased irritability, with normal or increased reaction; the second by increased irritability, but impaired reaction; and the third by irritability and reaction being equally impaired, inert, and more or less abolished. †

These ideas, though carried to an extreme, derive some support from the phenomena of fever, and the morbid changes left in the brain. They were afterwards more fully developed by Clutterbuck ‡ and Mills § in this country, and by Marcus || and others in Germany.

The merits of this theory I have already attempted partially to appreciate. Though autoptic examinations prove that the capillaries of the brain, in common with those of other organs, are

* G. F. Ploucquet Expositio Nosologica Typhi. Tubingen, 1800. Tubing. Anz. 1800.

† Caroli Fred. Costantin, M. D. Dissertatio de Encephalitide. Lips. 1800. Ext. in Brera Sylloge, Vol. VI. p. 72.

‡ An Inquiry into the Seat and Nature of Fever, &c. By Henry Clutterbuck, M. D. &c. Lond. 1807, and second edition, London, 1825.

§ On the Utility of Blood-letting in Fever. By Thomas Mills.

|| Ephemeriden der Heilkunde. Band I. Heft. 1.

much overloaded with slowly moving blood, this state differs from inflammation in several respects. Suppuration especially, is not a constant, or is rather an exceedingly rare occurrence, and is to be regarded as adventitious, or depending upon accidental peculiarities and idiosyncrasies, and not essential. The overloaded state of the capillaries, though taking place in those of the organ itself, is nevertheless more remarkable, according to my observation, in those of the proper cerebral membrane.

5. *Ulceration; Erosion.* From the various forms of pulpy destruction and abscess, the transition to ulceration is easy. By this is understood destruction of part of either of the surfaces of the brain, so as to present a hollow or depressed surface, rough, irregular, and covered partially either with bloody or albuminous exudation. In the former case its claim to the character of a genuine ulcer may be doubtful, since it may be viewed as the residue of a partial effusion of blood. It is possible that this may have been the origin of the case of erosion of the *corpus striatum* described by Morgagni, in which that body is said to have been entirely detached from the brain; * and I think it is next to certain this was the cause of the *ulcerous cavity*, † which he shortly after states was found in the base of the left ventricle of another case. This is almost admitted by Morgagni himself, who regards these ulcers as ruptured cavities

* Epist. xi. 2. † Ibid. 4.

or cells, originally formed by effused serum. (Ibid. art. 8.)

So far as accurate observation hitherto goes, the genuine ulcer is found chiefly at the convoluted surface of the brain ; (Ridley, p. 212 ; Powell, case 6,) or the foliated surface of the cerebellum, (Haller, Tom. IV. p. 351,) and is always connected with an unsound state of the proper or vascular membrane. Of this sort of ulcer, Stoll found an instance on the cerebellum of a young man of twenty-six, accompanied with redness, thickening, and erosion of the *pia mater*. * Two cases of the same nature are recorded by Scoutetten. In one, the lower part of the right anterior lobe presented a hard, dry, irregular surface, thirteen lines long and seven broad, with irregular indented edges, with the contiguous cerebral substance sound. In the other, the extremity of the posterior lobe presented two small ulcerated patches, one oval, six lines long, and covered with deep gray pulpy matter ; the other a linear depression,—both with wine-lee colour of the adjacent brain. In both cases, the investing proper membrane was red, injected, and somewhat eroded. † From these facts, it results that ulceration of the brain is an effect of circumscribed inflammation of the *pia mater*.

The instances of erosion, or ulceration from the

* Ratio Medendi, pars tertia, p. 122.

† Memoire sur quelques cas rares d'Anatomie Pathologique du Cerveau, &c. Par Scoutetten, D. M. P. &c. Archives Generales, Tome VII. 31.

penetration of foreign bodies, mentioned by Morgagni and various surgical authors, are rather examples of suppurative destruction.

6. *Encephalæmia; Hemorrhagia Cerebri,* Hoffmann. *Hemorrhage. Apoplexia Sanguinea,* Sauvages, Cullen, &c. *Apoplexie Cerebrale* of Serres. One of the great uses of the proper or vascular membrane *(pia mater)* is to sustain and convey, as it were, the minute arteries into the substance of the brain. No artery, however minute, enters this organ without previously passing through the *pia mater;* and if the carotid and vertebral arteries be injected, the cerebral matter may be washed away entirely; while all the vessels by which it was traversed are seen issuing from the attached surface and numerous processes of this membrane. The vessels thus demonstrated consist of minute arteries and veins, through which, in the sound or normal state, the blood moves uniformly and easily, without undergoing any permanent retardation. Dissection, however, shows, that from various causes, either the whole of these vessels, or a certain cluster or set of them, may become inordinately distended with blood; while others, which, in consequence of conveying colourless fluid previously, eluded observation, now becoming injected with red blood, are rendered visible. The existence of this state is proved by cutting into thin slices the brains of persons cut off in this condition, when numerous blood-drops follow each incision, and each part is

penetrated by a much greater number of vessels than natural. * The exquisite or most perfect degree of this state is when the blood-drops enlarge immediately after incision,—a circumstance from which a very inordinate quantity of fluid blood in the cerebral vessels is indicated. †

This state of the cerebral vessels is similar to that of inflammation. The patient is highly sensible to transitions of heat and cold; the skin is hot and dry; the tongue foul; the stomach disordered, and the urine high-coloured and sedimentous. The pulse is full and strong, sometimes hard, but not frequent. The local complaints are dull pain and weight of the head, occasional giddiness, indistinctness of vision, or dazzling of the eyes, and more or less abolition of memory. When blood is drawn, I have found it present a thick, tough, buffy coat; an observation in which I find I am anticipated by Stoll ‡ and Sir Gilbert Blane.

When the above phenomena have continued for a few hours, sometimes a day or two, according to circumstances, the individual falls down destitute of sense and motion, and continues so for a short time. After a little, recollection gradually returns, and with it sensation and the power of moving the limbs, though not with such freedom as before. A sense of tingling and numbness may remain in an arm or leg for some time.

* Morgagni passim, especially iii. and iv.

† Morgagni epist. x. 17 and 18.

‡ Ratio Med. Pars V. p. 31. Viennæ, 1789.

This is the simplest and mildest form of the apoplectic seizure. *(Cataphora.)*

It has been thought that this could not happen unless blood is effused; but various instances have occurred to competent observers in which the cerebral vessels were loaded only, and in which effusion had not yet taken place. It may further be inferred, that the instances in which persons recover from complete apoplectic seizure without suffering palsy depend upon vascular injection only. That fatal cases even may result from mere accumulation, is admitted by Morgagni, * afterwards by Baillie, † without being aware that the observation had been made, and by Rochoux, who thinks, however, that it is not uniform. ‡ I observe, nevertheless, that M. Rochoux forgets that the cases in which it occurs being less frequently fatal, are more rarely the subject of inspection.

According to M. Serres, indeed, cases of apoplectic seizure without palsy depend on injection

* Epist. iii. 25 and 26.

† "The milder forms of apoplexy depend upon a distention of some of the vessels of the brain from undue accumulation of blood in them. I have known, however, one instance of fatal apoplexy, where many of the blood-vessels were found, upon examination after death, to be much distended with blood; but no blood had been extravasated in any part of the brain."—Lectures and Observations on Medicine. London, 1825. p. 167.

‡ Recherches sur l'Apoplexie. Par J. A. Rochoux. Paris, 1814.

of the membranes exclusively. * This point shall be afterwards considered when speaking of the cerebral membranes. In other respects, however, the researches of this physician tend to establish the general inference, that extravasation is not necessary to apoplexy. 1*st*, From experiments made on living animals, † from the phenomena of effusions of blood either spontaneously, or from wounds and injuries of the head, it appears that a considerable quantity of blood or other fluid may be effused in various parts of the brain without causing apoplectic symptoms. (Wepfer, Valsalva, and Serres.) 2*d*, From various cases it appears that the apoplectic symptoms connected with extravasation disappear, while the extravasated blood remains. (Serres's Cases, 7, 8, 9, 10, 11, 12, and others.) 3*d*, It results from cases recorded not only by Morgagni, Baillie, and Rochoux, as above-mentioned, but by the physicians of Breslau, ‡ by Quarin, by Stark, § and more recently, I may add, by Dr Abercrombie, that complete symptoms of apoplexy may result from

* Nouvelle Division des Apoplexies; par M. Serres; Chevalier, &c. Annuaire Medico-Chirurgicale des Hopitaux et Hospices Civiles de Paris. A Paris, 1817. 4to, p. 246, 277.

† Annuaire Medico-Chirurgicale, 260, 261.

‡ Historia Morborum Vratislaviensium.

§ Clinical and Anatomical Observations. Part iv. § 4. p. 73. This appears, however, to have been a case depending on vascular injection of the *medulla oblongata* and spinal chord.

mere general injection of the cerebral vessels. The same phenomenon appears to have been witnessed by Cheselden. (Book iii. chap. 14, p. 224.) If, on this point, my own observation be entitled to any weight, I may add, that in 1817 I had occasion to examine the body of a young woman who died with all the symptoms of well-marked apoplexy; and though every part of the brain was cut into minute portions with the utmost care, no effusion of red blood could be recognized. The only anormal appearance was some injection of the vessels going to the annular protuberance and *medulla oblongata.** *4th,* Though in several cases of persons cut off with well-marked apoplectic symptoms, I have found extravasated blood, it bore no proportion to the severity of the disease. Instead of being in the shape of clots in distinct cavities, it consisted simply of long linear streaks of blood stretching through parts of the brain, sometimes in the neighbourhood of blood-vessels. In such cases, however, the blood-vessels were much injected, especially in the vicinity of the membranes.

Upon the whole, I conceive it legitimate to infer, that the essential anatomical character of apoplexy is injection of the vessels of the brain more or less general. This may terminate in one of two modes, both of which are accidental and accessory. The first is effusion of serous fluid; the second is effusion of red blood.

* Case of Ann Dinwiddie. Clinical Ward.

Serous fluid exhaled from the capillaries has been supposed to constitute a peculiar form of apoplexy entirely distinct from that termed sanguine, and depending on extravasation of blood. In the writings of Morgagni and others are cases in which the effusion of serous fluid was associated with distinct and general vascular injection. Cases of this description are referred by Stoll to the head of *sanguine* apoplexy, in which the pathological character is injection, or *accumulation*, which is at once the cause of the serous effusion and of the apoplectic symptoms. * It was afterwards demonstrated by Portal, that serous infiltration and effusion invariably arise from the same state of the vessels as hemorrhage; † and this inference has since been confirmed by the observations of Dr Cheyne, Dr Abercrombie, of M. Serres, and others. In short, if from any cause the circulation within the head becomes unusually slow, and the vessels of the brain become inordinately distended, either red blood or serous fluid

* "In apoplecticorum secto cerebro frequenter leguntur *vasa cerebri sanguine turgida, et serum multum effusum.* Hujus generis apoplexiæ plerumque *serosæ* audiunt. Verius *sanguineæ* appellarentur; accumulatus enim intra caput sanguis, et seri effusi, et apoplexiæ causa est: serum ipsum effusum *ad concausas pertinet serius accedentes, quæve morbum ipsum non produxere, attamen productum augent.*" Rationis Medendi, Pars i. p. 138. Lugduni Bat. 1780.

† Sur la Nature et le Traitement de Plusieurs Maladies, &c. Tome I. p. 280; et Sur l'Apoplexie, et Sur les Moyens de la prevenir. Paris, 1811. Tome II. p. 216.

is poured out from the extremities of the arteries. The latter process, if we admit the testimony of Cheselden,* Morgagni,† and Willan,‡ takes place in the slow and gradual drowsiness and stupefaction which distinguish the form of the disease termed lethargy. *(veternus.)* § The cause of the symptoms, however, is not the effusion as Willan imagined, but the general vascular distension and injection from which the effusion arises.

Hemorrhage, nevertheless, takes place in a considerable proportion of cases. Howship says in nine of ten; but this is evidently a general assertion, founded on no accurate elements. From the distended vessels blood escapes, though whether by exhalation or by actual rupture is not agreed; and, forcing its way through the cerebral substance, breaks it down, and forms a sort of hollow or cavern, in which it coagulates. If the quantity be considerable; if it be effused suddenly, and in certain parts of the brain; (optic thalamus, annular protuberance, brain-limbs, and *medulla oblongata;)* if the cerebral injection continues, notwithstanding the discharge and the use of remedies, complete coma very soon terminates in death; and on dissection more or less blood is

* The Anatomy of the Human Body. Book iii. chap. 14.

† Epist. vi.

‡ Reports on the Diseases in London. By Robert Willan, M. D. &c. 1799, p. 338. 8vo edit. 1821.

§ Thomæ Willis, De Anima Brutorum, Pars Pathol. Cap. 14.

found in some part of the substance of the brain, and the vessels are much, sometimes exceedingly injected with fluid blood.

When the effusion is not copious, or dependent upon very general injection of the cerebral vessels, nor takes place suddenly, or in a vital part of the brain; or if the injection is thereby, or by other means moderated; then further changes take place, and continue until the natural structure of the organ is so much altered that life can no longer be continued. The effused blood, both when fluid, and especially after coagulation, acts as a foreign body,—breaks down, softens, and disorganizes the part with which it is in contact. After some time the clot begins to change, assumes a brown or brownish-black colour, and is separated into fragments floating in a wine-lee fluid. The further dissolution of these forms a homogeneous chocolate-coloured matter, which is eventually removed more or less perfectly;* while the part, which the extravasation converted into a hollow, is filled with serous fluid, and softened or pulpy cerebral matter. In some cas-

* "The appearance of the effused blood differs according to the duration of its effusion. When death ensues quickly, at the end of three or four days for example, it is in the form of soft blackish clots. After a month or six weeks it becomes firmer, assumes a deep-brown colour, and resembles the blood of aneurismal tumours. At a more remote period it becomes still more compact and of a pale red colour, bordering on ochreous yellow. Lastly, it is entirely absorbed." —Rochoux, p. 86.

es of complete recovery this is gradually converted, by a slow process of adhesive inflammation, into a membranous substance, harder than the surrounding brain, which, however, is generally softer than sound cerebral matter. (Lerminier, cases 1, 2.) In this manner are formed the cavernous sacs described by Wepfer and Morgagni, (Epist. iii. 7, 8, 9, lx. 2, 6,) and the cavities described by Baillie, (450, 455,) Wilson, Abernethy,* and others.

The contiguous enclosing cerebral matter also undergoes peculiar changes, which vary with the interval between extravasation and death. The portion in immediate contact with the clot is generally dark red, wine-lee colour, or, at later periods, of a chocolate brown, and rather pulpy. The portion exterior to this is paler, and of an orange colour, but generally much penetrated by distended vessels. Exterior to this again may be in general distinguished a layer of bluish-white or bluish-yellow matter, gradually terminating in sound brain, but all more or less traversed by blood-vessels. In other cases, in which a longer period elapses between extravasation and death, the portion of brain enclosing the clot is pulpy, of a dun-red or orange-colour, passing to yellow, and terminating gradually in brain of natural colour and consistence. In both cases minute shreds of cerebral matter and filamentous threads may be

* Surgical Works, Vol. II. On Injuries of the Head, pp. 18, 19, and 20. London, 1811.

traced in the pulpy matter and in the bloody clot, either recent or dissolved into the chocolate-coloured fluid. By some these filamentous threads are supposed to be the fine cellular tissue of the brain; but I think it impossible to doubt, that they are minute capillary vessels. This general description I have derived partly from the descriptions of Rochoux,* but especially from those of Lerminier and Serres,† and partly from personal observation.

The change in the structure and consistence of the brain surrounding the clot forms one variety of softening (*ramollissement,*) or pulpy disorganization; and notwithstanding the opinion expressed by Pariset, Recamier, Rochoux, ‡ and others, that it is the cause of the effusion, it is invariably the effect either of this or of the preliminary injection. This is established not only by the facts already mentioned, but by the cases of Morgagni, of M. Dan de la Vauterie, § and especially by those of Lerminier and Serres. ‖

Vascular injection, with or without bloody effusion, may take place in any part of the brain; but certain parts are much more commonly the seat of this discharge than others. Thus Mor-

* Recherches, Cases, passim. Article vi. pp. 87, 88. Section ii. art. 2.

† Annuaire Medico-Chirurgicale. Lerminier, Cases 4, 5, 7, 8. Serres, various cases in § 12. *Apoplexie Cerebrale.*

‡ Recherches, &c. pp. 88 and 89. § These soutenue, &c.

‖ Annuaire, loco citato.

gagni, treading in the steps of Bonetus, justly remarked, that either bloody effusion, or the caverns formed by it, are found almost always in the striated bodies, or in the optic *thalami*, or in both, while the anterior part of the hemisphere was very rarely, and the posterior part almost never affected.* The general accuracy of this conclusion is in some degree confirmed by modern observation, which, in a majority of cases, has found the striated and optic bodies diseased. Rochoux particularly shows, that of forty-one cases of bloody effusion terminating fatally, twenty-four were found in the *corpus striatum*, two in the optic thalamus, one in the *corpus striatum* and optic thalamus, and one beneath the *corpus striatum;* while only thirteen, not more than one-half, were found in other parts of the brain. The reason of this is to be found in the anatomical relations of this part of the brain. Near the beginning of the fissure of Sylvius is situate the *white perforated spot* of Vicq-d'Azyr (" substance blanche que j'appelle *perforée.*") Through these orifices the Sylvian or middle artery of the brain, which lies in the fissure, transmits a great number of arteries of various sizes into the substance of the brain, and through the cerebral nucleus *(corpus striatum,)* which lies immediately over this perforated spot. This arrangement renders the striated body, or rather the striated nucleus, the most vascular part of the whole organ, and

* Epistola iii. 18.

the most liable, when the cerebral vascular system is overloaded, to effusion of blood.

This doctrine is not, however, altogether free from objection. By M. Serres especially it has been said that hemorrhagic cavities are formed in the fore part, the middle, or the posterior part, of the hemispheres, without affecting the *thalami* or striated bodies, much more frequently than is represented by Bonetus, Morgagni, and Rochoux. I find from examining the cases of Howship, Lerminier, Serres, Tacheron, and others, that this is not entirely without foundation. Of 6 cases of cerebral hemorrhage given by Lerminier, 3 are in the hemispheres, 1 in the right optic *thalamus*, 1 in the left optic thalamus, and 1 in the left *corpus striatum*.* Of 7 cases of cerebral hemorrhage given by Serres, 2 are in the centre or posterior part of the left hemisphere, 1 in both hemispheres, 1 in the left hemisphere and in the mesolobe, and 3 in the annular protuberance.† Among 19 cases of cerebral hemorrhage or its effects, recorded by Tacheron, 5 were in the right hemisphere, and 4 in the left, 2 were in the posterior part of the right hemisphere, 2 in the substance of the optic eminences, 2 in that of the striated bodies, 1 in the mesolobe and adjoining part of the left ventricle, 1 in the annular protuberance, 1 in the optic eminence and striated body at once ; and in one, in which the last extravasation took place in the

* Annuaire Medico-Chirurgicale, p. 213, et ensuite.

† Ibid. p. 324. § xi. et ensuite.

right optic thalamus, one cyst was found in the neighbourhood of the cylindroid eminence, another in the centre of the left optic thalamus, and a third in the annular protuberance. *

Upon the whole, we are in possession of few very accurate elements to determine this question. From the authentic cases, however, which I have perused, for it is in vain to draw conclusions from individual observation only, I think there are grounds to infer, that, next to the striated nucleus, the hemispheres are the most frequent seat of cerebral injection and hemorrhage. It is worthy of remark, that the extravasation, when it takes place, does so chiefly on the outer side of the lateral ventricle, generally towards its posterior end, and in that portion of brain which forms the external-lateral boundary of the optic *thalamus*, separated from the ventricle by a thin plate. Into the ventricle it rarely takes place primarily; and when blood is found there, it is the result either of bloody extravasation in the hemisphere breaking down the floor,† the wall, or the ceiling of the ventricle, or, as shall be afterwards shown, it issues from the choroid *plexus*. The same remark applies to blood on the surface of the brain.

Next to the hemispheres in hemorrhagic tendency may be placed the protuberance, the limbs

* Recherches Anatomico-Pathologiques, &c. par C. F. Tacheron, Doct. à Medecine, &c. Tome IIIme. Paris, 1823. Ordre 4trieme, 2ieme genre. Case 31st.

† Howship, Case 15, 19.

of the brain, the *medulla oblongata*, and the *cerebellum*, in the order now enumerated.

When hemorrhage takes place into the annular protuberance, the blood is generally deposited in layers in the interstices between the transverse fibres. In one fatal case I observed this so distinctly, that the blood and cerebral matter formed alternating layers. When it is very abundant, however, the transverse fibres are broken through, and the effused blood is contained in irregular cavities. (Cheyne, case 9, Serres, Tacheron.) The proximity of the protuberance to the large transverse branches of the basilar artery affords some reason for the readiness with which it may be affected with vascular injection and hemorrhage.

Of effusion into the cerebellum little is accurately known. Morgagni records two cases, one in both hemispheres, most in the left; and it is interesting to remark, that he lays particular stress on the pulpy state of the surrounding substance of the cerebellic hemisphere.* In the other, it appears to have been more recent. In a case by Dr Abercrombie a clot was found in the right hemisphere. Howship furnishes a curious case of extravasation into the *medulla oblongata*, in which parallel layers of blood were deposited transversely in the substance of the part.† (Case 20.)

* "Ea autem portio cerebelli quæ corpus ejusmodi circumstabat, *fracida* erat." Epistola ii. 22. Epist. lx. 6.

† Practical Observations on Surgery and Morbid Anatomy, &c. By John Howship. London, 1816.

Genuine hemorrhage of the brain, as now described, though issuing from the capillaries, is thought not to take place by exhalation.* It is never possible to trace it to a single vessel; and hemorrhage from rupture of an arterial trunk, though producing the same symptoms, belongs anatomically to a different head. Cheyne, † and more recently Lerminier and Serres, appear to have found always many minute capillaries opening into the hemorrhagic cavity.

On the greater frequency of affection of the right side of the brain nothing very satisfactory has been ascertained. Morgagni believing it, ascribes it to the greater frequency with which the muscles of the right side are used than those of the left. In 41 cases, however, given by Rochoux, the number in the left was 18, that in the right 17, and that in both sides 6, which proves that this cannot be established with any precision.

It is important to ascertain the influence which bloody effusion in different parts of the brain, exerts on the functions of sensation, voluntary motion, and the muscles of respiration. For there is reason to believe, that, according as congestion or hemorrhage takes place in the hemispheres, in the striated bodies, in the annular protuberance, in the cerebellum, or in the *medulla oblongata*, the effects produced will be palsy, or apoplexy more or less violent, and with different

* Bichat, Anatomie Generale, Tome II. article iii. p. 279.

† Cases of Apoplexy and Lethargy. 8vo, London, 1812.

degrees of lethargic or comatose affection. The inquiry is beset by this difficulty, that not the extravasation, but the injection, is the essential cause of death. Scarcely a part of the brain has been found unaffected in fatal cases. It is certain that effusion into the white matter of the hemispheres, and into the striated nucleus, is not essentially and invariably fatal; for from cases of this kind temporary recovery has taken place. Neither is the inference of Bichat, that effusion into the protuberance is invariably fatal, well-founded. Tacheron records a case in which temporary recovery was effected. It must be admitted, nevertheless, that effusion into this part is more likely to be fatal than into any other. The cases of Serres afford the explanation of this fact, by showing, that injury done to the protuberance causes a severe and permanent lesion of the function of the lungs, the vessels of which become distended with unrespired blood, while the air-vesicles are ruptured, and death is effected by asphyxia.

The state of the cerebral vessels which terminates in hemorrhage may occur, perhaps, at any period of adult life. But these blood-vessels are liable to a peculiar state which predisposes to extravasation. This consists in deposition of earthy matter between the coats of the internal carotid arteries, and of the basilar artery and their branches. In consequence of this deposition, they lose part of their contractile and distensile powers, and some of their tenacity; and whenever blood is accumu-

lated in unusual quantity, as they do not so readily admit of distension, rupture is the consequence. (Baillie, 454.) Hodgson also shows how generally this morbid state of the cerebral arteries is connected with extravasation. *

This cause, however, is predisponent only. A fit of apoplexy may occur and prove fatal in persons in whom neither ossification of the arteries of the brain, nor any other state, except mere vascular injection, is found. And, on the other hand, the cerebral arteries may be ossified or steatomatous, in many persons who have never had a single fit of apoplexy. The general result of the cases observed by Vater, Morgagni, Cheyne, Howship, Rochoux, Serres, and Tacheron, is, that disease of the arterial coats is connected with vascular injection, which may terminate, according to circumstances, in serous effusion, pulpy destruction, or bloody extravasation. It is a well established fact, however, that the extravasation does not take place from the diseased arterial trunks, but from the minute capillaries in which these arteries terminate.

Old age has generally been regarded as a predisponent cause of apoplexy; and it is attended with two circumstances, which are perhaps not altogether without reason regarded as of some moment. The first of these is the venous plethora, so ingeniously maintained by Cullen. The

* A Treatise on the Diseases of Arteries and Veins, pp. 25 and 26.

second is the tendency which the arterial system more especially betrays to become diseased after the meridian of life. The proofs of the existence of venous plethora, and the theory of its operation, may be found in Cullen, who, perhaps, overrated its influence. There is little doubt that the circulation in the veins, either in consequence of diminished pressure, and tension of the skin and other coverings, does not go on with the same perfection and facility which it does in early life. But whether there is a greater venous plethora in the head at that period than before or not seems doubtful. There is reason to believe, that the fulness resides as much in the arteries as in the veins. Of the effect and reality of arterial disease I have spoken already.

In point of fact, cases of apoplexy occur at all ages, but are most frequent between the 50th and the 65th, or 70th year. Willan informs us he has seen young persons from 12 to 18 years of age affected with apoplexy and hemiplegia. In Bonetus and Morgagni, instances of apoplexy are found occurring in persons below the age of 30; but in general they were induced by external violence or organic diseases. I have seen an instance of cerebral hemorrhage terminating in hemiplegy in a young man of 19, labouring under disease of the left auriculo-ventricular orifice. The young woman to whose case I have already alluded, was, I think, about 22. Of eighteen cases described by Bonetus, five occurred in persons above 60, and

six in persons below 40. Morgagni relates the cases of thirty apoplectic persons, seventeen of whom were above the age of 60, and five below that of 40. Of thirty-one cases of bloody extravasation in the ventricles or the substance of the brain, recorded by Lieutaud, one was at the age of 25, eight between the ages of 30 and 41, eleven between 41 and 51, six between 51 and 61, two between 61 and 71, two between 71 and 81, and one only above 100. Of twenty-nine cases seen or dissected by Portal, two were between 19 and 23, four between 30 and 41, seven between 41 and 51, eight between 51 and 61, four between 61 and 71, and the same number between 71 and 81. Of 6 cases of cerebral hemorrhage given by Cheyne, three were between 30 and 35, two at 50, and one at 63. Rochoux, however, has given the fullest and most accurate results on this point. Among sixty-three cases of apoplexy, two occurred between the age of 20 and 30, eight between that of 30 and 40, seven between that of 40 and 50, ten between that of 50 and 60, twenty-three between that of 60 and 70, twelve between that of 70 and 80, and only one between that of 80 and 90. According to this view apoplexy is extremely rare before the 30th year; from that period to the 50th it is not common, but may occur; after 50 it becomes more common; between 60 and 70 is more frequent; becomes of the same rate of frequency after 70 as before 60, and is very rare after the 80th year. Of the cases given by Lermi-

nier and Serres, though two are between 30 and 35, the great part are between 60 and 75.

The state of the cerebral circulation now described is understood to depend exclusively on the vessels of that organ, and to constitute, therefore, primary apoplexy. The same state, or a near approach to it, may take place secondarily in at least two different states of the system ; first, as a consequence of injuries of the head ; and, secondly, in the course of fever intermittent, remittent, or continuous. The first shall be considered afterwards. The second, or the febrile apoplexy, belongs to this place.

The best example of this occurs in certain forms of ague, accompanied with marks of great accumulation in the head. It takes place chiefly at the termination of the cold stage, and the commencement, or in the course of the hot. In a slight degree the paroxysm is attended with drowsiness or lethargy, from which the patient may still be roused. When this recurs once or twice, the insensibility is more complete till the phenomena of perfect apoplexy are induced. In other instances after dull heavy pain of the head, dizziness, impaired vision, and some affection of the urinary secretion, the individual falls down suddenly with the mouth open, the eyelids fluttering, and other marks of relaxed muscles ; and continues during the rest of the paroxysm in a stertorous sleep. This may cease spontaneously, or terminate in death, unless the paroxysm, which is generally

protracted to twenty-four hours, and follows the tertian type, is finished. Though this is most frequent in the tertian, it is not uncommon in the quartan and quotidian.

The cases examined necroscopically show the cerebral vessels to be much distended with blood, sometimes bloody extravasation. In other instances which belong to a different head, the distended vessels are accompanied with serous effusion between the membranes, or into the cavities. The anatomical character of soporose ague is therefore inordinate injection of the cerebral capillaries.

This constitutes in various degrees the *sleepy quotidian* (C. Piso, Obs. 178,) the *sleepy, lethargic, hemiplegic, carotic, and apoplectic tertian,* (Werlhof, Torti, Lautter, Morton,) and the *comatose quartan* (Piso, Werlhof;) and is the disease which has been named by Baglivi * and Lancisi † epidemic apoplexy *(apoplexia febricosa, carus febricosus),* and which Morgagni ‡ and Casimir Medicus § represent as periodical and intermitting. When it is known that the apoplectic symptoms are regulated by the motions of the ague,

* G. Baglivi Dissertatio 8vo, De Observationibus, &c. Appendix de Apoplexiis fere epidemicis proximo elapso biennio in Urbe et per Italiam Observatis. Op. Om. Antwerpiæ, 1715, p. 683.

† De Noxiis Paludum Effluviis. ‡ Epist. iii. iv. et v.

§ Geschichte Periode haltender Krankheiten. Erstes Buch Erstes Capitel. § ii. Periode haltender Schlagfluss, p. 5. Frankfurt und Leipzig, 1794.

which alone is epidemic, or rather endemial, the nature of the periodical and epidemic apoplexy is easily understood.

These soporose agues may be sporadic or general; prevail mostly in the summer or autumnal months in warm countries; and after a few paroxysms, sometimes the second or third, are generally fatal. Their mortality is so uniform that they have been named *death-fevers* (Todten-fieber) in Germany and Hungary, where they used to be very common. They were observed at Rhodes by Praxagoras, the master of Herophilus; afterwards at London in 1678 by Sydenham; at Rome and in various parts of Italy by Baglivi in 1694 and 1695, and by Lancisi the same year, and at Bagnarea in 1707; at Hanover by Werlhof; and by Cleghorn in Minorca.

The extravasations into the cavities of the brain, observed by Jackson in yellow fever, belong to the head of meningeal hemorrhage.

In continued fevers of this and other countries, apoplectic death is so common, that I need only refer to the works of Stoll, Mills, Bateman, Cheyne, Barker, and Harty. It appears to be at once cerebral and meningeal.

In purpura and sea-scurvy death not unfrequently takes place from hemorrhage within the brain, or on its surfaces. The latter is most common, and as such belongs to the head of meningeal hemorrhage.

On a form of apoplexy termed *nervous* much

has been said by Zuliani of Brescia, * Kortum of Dortmund in Westphalia, † and Kirkland of Ashby de la Zouche; ‡ and the subject has been revived by Mr Abernethy, § and Dr W. Philip. In this, apoplectic symptoms are said to take place without any anormal state of the brain or its vessels, and from some disorder in the chylopoietic organs, which is supposed to induce a torpid condition of the brain, or suspension of its proper energy. It may be doubted whether satisfactory proof of such a state has yet been adduced. 1*st*, A fallacy results from the doctrine that hemorrhage is in all instances requisite to give rise to apoplectic symptoms. I have shown that congestion, injection, or distension of the cerebral vessels, is adequate to produce this effect; and whether this state is to disappear, remain unchanged, or produce serous effusion, or bloody extravasation, so as to remain after death, will depend much on the constitution of the individual and the treatment employed. No satisfactory conclusion can be drawn from the absence of hemorrhage or serous fluid. 2*d*, Disorder of the chylopoietic or-

* F. Zuliani De Apoplexia præsertim Nerveâ. Lipsiæ, 1780.

† C. G. Theod. Kortum Tremoniæ Westphali Dissertatio de Apoplexia Nervosa. Gœttingæ, 1785. Ext. in Frank. Dilectu, Vol. IV. p. 1; et Ludwig Scrip.-Neur. Tom. IV. p. 379.

‡ A Commentary on Apoplectic and Paralytic Affections, &c. By Thomas Kirkland, M. D. 1792.

§ On the Constitutional Origin of Local Diseases.

gans is an accessory remote cause, which may operate on the meningeal and cerebral circulation. *3d,* The instances adduced as examples of this disease are at least ambiguous. The fourth case of Kirkland cannot be admitted. The case of Stark (§ iv. p. 73,) I have already mentioned as one of injection either of the spinal chord or its membranes. The first case of Dr Powell might have been similar, for the spinal chord was not examined. * In other instances, as in that recorded by Morgagni, (Epist. v. 17 and 19,) air in the meningeal vessels, and in the vascular system in general, might have been the cause of death. *4th,* It has been shown by M. Serres, that many of the cases of supposed nervous apoplexy must have been examples of what he terms meningeal apoplexy, *i. e.* injection of the meningeal vessels, with or without effusion or extravasation. The first and fourth cases of Dr Abercrombie I am unable to explain. *5th,* In other instances a very slight and incipient degree of the state which is to proceed to pulpy destruction may cause death. When it affects a whole hemisphere, which it may sometimes do, (Morgagni, Epist. v. 15, 16; li. 7, 11,) it may alter the appearance so little as readily to escape observation.

For the reasons now assigned, it may be justly questioned whether there is ground for admitting such a state of the brain as the *nervous apoplexy*

* Medico-Chirurgical Transactions, Vol. III. p. 102. Account of a Case, &c. &c. By Thomas Chevalier.

of Zuliani, Kortum, Kirkland, and Abernethy. According to the present state of evidence, it is wisest to adopt the side which does not recognize this form of apoplectic disease.

In the foregoing account of the state of the brain giving rise to apoplectic symptoms, I have said nothing of that loss of voluntary muscular power known under the name of palsy, *(paralysis, resolutio nervorum ;)* because I suppose it to depend on the same state of the cerebral capillaries which causes the general apoplectic affection, which it either precedes, accompanies, or follows; or on that state of the brain or spinal chord which I have already described as terminating in pulpy destruction. In attempting to establish clearly the anatomical characters of palsy, two circumstances merit particular attention.

First, several cases of apoplectic death are preceded by paralytic affection of one side, more or less extensive, in the successive forms of distortion of one side of the face, loss of speech, loss of power in an arm, a leg, or the entire side. When these phenomena are followed by coma and death, necroscopic inspection shows as in apoplexy, capillary injection with or without extravasation, and generally more or less destruction of brain. The commencement of the morbid process in this instance is doubtless the same capillary injection of part of the organ, which in a more exquisite degree produces the comatose state. *Secondly,* Though there are not a few instances in which an attack

of loss of consciousness, sensation, and motion, is not followed by loss of voluntary motion, these, I have already attempted to show, depend on that capillary injection which is removeable by the use of remedies. When the capillary injection proceeds to destruction either by hemorrhage, by softening, or by ulceration, *i. e.* by superficial pulpy destruction of cerebral substance, consequent on hemorrhage, it almost invariably leaves after it more or less loss of voluntary motion, generally on the side of the body opposite to that of the brain which has sustained the lesion. (K.) One of the most frequent effects of cerebral hemorrhage and its consequences, indeed, is palsy of the hemiplegic form; and in the brains of such persons as have laboured under this disease, either a broken down and softened spot, or one or more hemorrhagic cavities or cysts are found after death. (Wepfer, Willis, Morgagni, John Hunter, Baillie, Wilson, Abernethy, Rochoux, Serres, Lerminier, Tacheron, Abercrombie.) The general accuracy of these conclusions is confirmed not only by the necroscopic appearances of the brains of those who die of coma succeeding to palsy, but of those who die of the effects of injuries of the head, of abscess of the brain and cerebellum, and of tumours and other organic changes taking place either in the brain or in its membranes.

The situation of these destroyed spots and hemorrhagic cavities, when inducing palsy, corresponds much with that of the cerebral injection

or hemorrhage from which they arise. The region most generally affected is that already described as the striated *nucleus* of Reil. Willis, for example, states, that in several dissections of persons dead after long-continued and obstinate palsy, he invariably found the *corpora striata* unusually soft, discoloured like wine-lees, and with the usual alternation of white and gray streaks much obliterated.* The accuracy of this inference regarding the part of the organ most frequently affected is confirmed by cases given by Petit; by several of those given in the Essay of M. de la Peyronie; † by Antonio Caldani; by Morgagni in repeated observations both of paralytic cases terminating in coma, and of those originally apoplectic, accompanied with distinct palsy; (Epist. xl. 2, 4, 6, 11; li. 12; lxii. 7, 9;) by three cases given by Prochaska; ‡ by Cheyne, by Rochoux, by Lallemand, by Tacheron, (26, 27, 28, 29, 30,) and by Abercrombie, (p. 252, cases 112, 113, 114, 115.)

On this point, however, the remarks already made on the seat of cerebral hemorrhage are applicable. Though the striated nucleus and the

* Thomæ Willis, Cerebri Anatome, cap. xiii. p. 43, et De Anima Brutorum, cap. ix. p. 144 et 145.

† Observations par lesquelles on tache de decouvrir la partie du Cerveau où l'ame exerce ses Functions. Chez Mémoires de l'Academie Royale des Sciences, 1741.

‡ Georgii Prochaska Op. Minorum, pars ii. Viennæ, 1800. Observat. Patholog. sect. iv. *Casus tres complectens, &c.*

contiguous part of the hemisphere forming the outer and upper walls of the capsule, are the most frequent seat of hemorrhagic cavities and pulpy destruction, other parts of the brain are not exempt. In the work of Dr Abercrombie are given cases in which the diseased spot was nearer the surface of the organ; (111, 116, 117, 118.) I met with one instance in which hemiplegia was connected with pulpy disorganization of the posterior part of the hemisphere, so near the convoluted surface that the lesion could be immediately recognized after removing the *dura mater*, by the unusual change of colour and consistence. Dr Duncan Junior records two excellent examples in which pulpy destruction of the anterior and middle lobes of the brain caused hemiplegy, and that of the *cerebellum* gave rise to palsy of the paraplegic form, without disorder of intellect. * It appears also from the testimony of Dr Cheyne, that the form of disease which he terms *creeping* palsy depends on the progressive softening of the substance of the hemispheres. In the only case of this recorded by the author, the morbid change was vascular injection, and pulpy destruction of the white matter of both cerebral hemispheres, which was of the consistence of thick cream. †

The circumstances of cases in which this change

* Contributions to Morbid Anatomy, No. II. By A. Duncan Jun. M.D., &c. Ed. Med. and Surgical Journal, Vol. XVII. 328, 329.

† Dublin Hospital Reports, Vol IV. p. 270.

takes place, show, that it is not so much the destruction of the cerebral substance as the capillary injection or inflammation with which it is attended, that produces the loss of power in the muscles of voluntary motion. In some instances of paralytic disorder lasting for a considerable time, instead of finding hemorrhagic cavities or destroyed spots in the brain, it is impossible to recognize any thing but some vascular injection and effusion of serous fluid, which doubtless proceeded from the overloaded vessels. This injection is not confined to one spot, but is diffused in different degrees through the brain, and is in some instances strongly marked in the cerebellum, annular protuberance, and the meningeal vessels towards the base of the organ. The effects which this state of the brain produces vary somewhat from genuine apoplectic palsy. They constitute a double but unequal hemiplegy, approaching very gradually, and very often simulating paraplegia. From this, however, they differ, in the lower extremities being seldom affected in the same degree and at an equal rate. It is often attended with some loss of memory, or sensation, and some slight degree of mental imbecillity. The anatomical character of the disease may be represented as a chronic congested state of the cerebral capillaries. It may terminate either in serous effusion from the meningeal vessels, in softening of the cerebral substance, or in induration. In the first instance, it belongs to the head of meningeal injection, to be afterwards noticed. In the second case,

it will often correspond with the *creeping palsy* of Dr Cheyne; or it may give rise to epileptic attacks. (Morgagni, ix. 16, 18, 20, 23; Greding, No. 49, p. 494; No. 42, p. 524; Wenzel, Portal.) In the third, it is one of the morbid states of the brain causing insanity.

The spinal chord is liable to the same species of vascular injection and hemorrhage which takes place in the brain. The capillaries, which, in the sound or normal state, are small, and convey almost colourless fluid, become enlarged and penetrated with red blood. In a stage of the process, which is to be regarded as further advanced, drops of blood, and occasionally clots of some magnitude, are found deposited in the substance of the chord. These undergo and give rise to the same changes which have been already described as taking place in the brain, and are a cause by no means unfrequent of pulpy disorganization of the chord. In the case given by Gaultier de Claubry, which is the most distinct on record, the chord opposite the seventh cervical vertebra was of a deep-red colour from vascular injection, but still unbroken in structure; from the seventh cervical vertebra to the third dorsal it was not only deep-red on the surface, but in the substance, and so soft as to sink under the knife or finger; and from the third dorsal vertebra to the lower part of the sacrum, it was a red blood-coloured pulp destitute of organization.* The cases of Chevalier, which

* Journal General de Medecine de Chirurgie et de Pharmacie, &c. 12ieme année, Tome XXXII. A Paris, 1808. P. 129.

belong rather to the head of meningeal hemorrhage, shall be noticed afterwards.

The effects produced by capillary injection and hemorrhage in the spinal chord vary according to the stage of the process and the region of the chord in which it occurs. In the stage of injection it produces irregular involuntary twitches of the muscles of the trunk and extremities, numbness and coldness of the skin about the back, and occasionally of the limbs, and more or less loss of muscular power. In the advanced stage, whether that of hemorrhage or of pulpy destruction, numbness and palsy of the paraplegic form are complete.

In some instances the state of capillary injection appears to give rise to tetanic symptoms. This fact, which was observed by Dr Robert Reid in Ireland,* Duchatelet, Martinet,† and Ollivier ‡ in France, and by Dr Duncan Junior, in the stage of suppuration,§ has led to the recent revival of an opinion originally proposed by Galen, and reproduced in modern times by Fernel, Willis, and Hoffmann,—that tetanus depends on a morbid state

* On the Nature and Treatment of Tetanus and Hydrophobia. By Robert Reid, M. D. Dublin, 1817.

† Recherches sur l'Inflammation de l'Arachnoide cerebrale et Spinale, &c. Par MM. Parent-Duchatelet et L. Martinet. Paris, 1821.

‡ De la Moelle Epiniere et de ses Maladies, &c. Par C. P. Ollivier d'Angers. A Paris, 1824. Pp. 307, 308, 317, 349.

§ Contributions to Morbid Anatomy, Case 5th. Medical and Surgical Journal, Vol. XVII. p. 332.

of the spinal chord or its membranous coverings. This inference, nevertheless, is not in its present state susceptible of that degree of accuracy which entitles it to a place among the established principles of pathology. Though in some instances capillary injection of the chord and the origins of the spinal nerves is attended with tonic spasms of the muscular system, in a great number, perhaps a larger proportion, no contractions of this kind take place, notwithstanding every morbid change from vascular injection to pulpy destruction or suppuration. Tetanic spasms, Ollivier infers, are connected with the advanced and intense forms of the disease; but the cases collected, not only by this author himself, but by Pinel, Velpeau, and Abercrombie, show, that in some of the most aggravated forms of the disease no spasms had taken place till the last few hours of existence. In short, the circumstances under which tonic spasms occur in connection with vascular injection and inflammation of the chord, have not yet been distinctly indicated. From the cases observed by Reid, Duchatelet, and Martinet, Jones, Ollivier, and Duncan Junior, tetanic spasms appear to be more frequently connected with injection of the membranes than of the substance of the chord.

The variation of effects according to the region of the chord affected may be distinguished into three heads;—as the morbid process affects the longitudinal extent, the transverse breadth, or the antero-posterior thickness of the chord.

α. When it is seated in the upper or cranial portion of the chord, (*medulla oblongata*,) the effects are more or less disorder of the senses, locked-jaw, gnashing of the teeth, impaired articulation and deglutition, respiration oppressed, disordered, and panting, palsy, and death by asphyxia.

When it is seated in the cervical portion it gives rise to tetanic rigidity, convulsion, or palsy of the muscles of the neck, more or less palsy of the intercostals, and muscles of the trunk and extremities in general, paralytic weakness of the diaphragm, and eventually, as this advances, death by suspension of the mechanical agents of respiration.

In the dorsal region it induces convulsive throes of the trunk, palsy of the intercostal muscles, with short, languid, diaphragmatic respiration, palpitation, and irregular throbbing of the heart, hiccup, squeamishness, vomiting, and eventually death, partly by impaired respiration, partly by failure of the action of the heart.

In the lumbar region palsy of the lower extremities is always a prominent symptom ; but to this are added paralytic retention of urine at first, afterwards incontinence and involuntary voiding of the contents of the rectum.

β. The transverse diameter of the chord is so small, that in general the capillary injection and its consequences are not confined to one side only. When this happens, however, which is rare, it produces hemiparaplegia, or palsy of the lower

extremity of one side. Though this has been so frequently observed to occur on the same side with the lesion of the chord, that it may be stated as a general result, it is nevertheless requisite to mention, that to Portal we are indebted for a singular case, in which capillary injection and pulpy destruction of the right side of the lumbar division of the chord, gave rise to palsy of the left inferior extremity. *

γ. To the antero-posterior diameter of the chord the same observations nearly apply; and it is rare to find the anterior part diseased without affection of the posterior, and conversely. Instances of this, nevertheless, have been observed; and it is interesting to remark, that the effects which respectively result from lesion of either singly, tend to confirm those inferences which Charles Bell and Magendie have drawn regarding the anterior and posterior roots of the spinal nerves. Thus when the anterior part of the chord is affected without the posterior, the effect is loss of muscular power more or less complete, while sensation remains. Conversely, when the posterior part of the chord is injured without the anterior, sensation is more or less obliterated, while voluntary motion is little affected. Thus in a case recorded by Dr Jones, vascular injection of the posterior surface of the chord impaired sensation remarkably, but left motion little affected. †

* Anatomie Medical, Tome IV. p. 116.

† Medical and Surgical Journal, Vol. XXI. p. 81, 83.

In like manner, in a case communicated by Royer-Collard to Ollivier, (Obs. 47, p. 334,) pulpy destruction of the anterior part of the chord, from the restiform and olivary eminences, down to the lumbar portion, without affection of the posterior, caused palsy of the trunk and lower extremities without impairing sensation.

Malakencephalon. Diminished consistence of the brain. The change above described in the consistence of the brain is always accompanied with more or less destruction of its texture. Under certain circumstances, nevertheless, its consistence may be diminished without change of texture.

The natural consistence of the recent adult brain, though well known, it is difficult to describe in exact terms. In general it possesses a degree of toughness which prevents it from being easily divided, unless by a very keen instrument; and after incision minute fragments are left on the sides or edge of the knife. A very thin slice of white cerebral matter is sufficiently tenacious and consistent to sustain its own weight, and to admit of considerable stretching without being broken or lacerated. If put into pure water it continues unchanged for at least eight, ten, or sometimes twelve hours, and without any portion of it being either dissolved, or rendering the water in any degree turbid. A newly cut surface of brain communicates to the finger a peculiar clammy or viscid sensation, in consequence of which

it moves with less facility over the skin of any opposite surface.

These qualities, the existence of which may be easily demonstrated, pertain especially to the white substance of the adult brain, when death takes place either accidentally or by an acute disease, without direct lesion of the organ. The consistence of the gray matter of the convoluted surface is inferior to that of the white. The white matter of the twain-band *(corpus callosum)* is firm and tough in the direction of its cross fibres, and may be pulled to a considerable degree without giving way. The cylindrical fluted masses forming the *limbs* of the brain, *(crura)* which consist chiefly of white matter, are much firmer than the substance of the striated nucleus, which is mostly gray; and the annular protuberance, which is chiefly white matter, is the firmest and most tenacious part of the organ. The cerebellum, which consists chiefly of gray matter, is invariably less firm than the brain; and the firmest part of the former is the substance of the peduncles and the white matter of the cerebellic hemispheres. Of the spinal chord, the cranial part, especially the olivary eminences, are the firmest; and the consistence, though less than that of the brain, is tolerably uniform to the lumbar region, in which it undergoes a distinct diminution, and finally becomes very loose in the caudiform expansion.

The degree of consistence now attempted to be

defined, varies at different periods of life, and under different circumstances of health and disease.

In early life the substance of the brain is very different in consistence and tenacity. In the fœtus and at birth its softness approaches to semi-fluidity. Some weeks after it passes from a soft pulpy substance to a state of greater firmness and tenacity; but at the distance even of many months after birth, it is still much inferior in these qualities to the brain of an individual who has attained the fourteenth or fifteenth year. In three cases of infants cut off by different acute diseases, between the ages of 20 months and $2\frac{1}{2}$ years, I found the brain soft, compressible, elastic, but not tough; of the consistence of custard-pudding; but not quite so firm as to bear much handling or stretching, without being broken or torn. In several cases of children dead between the 7th and the 11th year of scarlet-fever or measles, the brain was firmer, and had acquired greater tenacity, but was still considerably softer and less tough than the brains of adults, who had attained the 18th, 20th, or 22d year. Between 12 and 15 the brain in general acquires a decided degree of firmness and tenacity; for, though still highly elastic, it is much less compressible, and much more distensible without laceration than before. This increase of firmness and tenacity is particularly conspicuous in the twainband or mesolobe, in the limbs, in the optic *thalamus*,

in the annular protuberance, and in the olivary eminences. It is impossible to say when the organ may be said to attain its maximum of firmness. But after the 22d year I have not been able, in a very considerable number of human brains, to recognize much variation of consistence not connected with some morbid state, either of the system at large, or of the organ itself.

In extreme old age, it has been said the brain generally becomes firmer, harder, and drier than in the meridian of life. This, I believe, is not altogether without foundation; though it is doubtful how far this is to be regarded as a uniform change, independent of disease or morbid effects. It is further exceedingly difficult to define the time at which this change in the consistence of the brain commences, or is accomplished. In persons between 50 and 60, I have seen the brain as firm as in others between 70 and 80, or above that age. Conversely, the brain is found sometimes soft, even in persons much advanced in life.

The brain of the adult is liable to lose its normal consistence, and become preternaturally soft in chronic diseases of emaciation, as dropsy, pulmonary consumption, and other pulmonary disorders, mesenteric wasting, marasmus, diabetes, and organic diseases in general. The diminished consistence now remarked is most frequently observed in dropsy, diabetes, and pulmonary disorders.

In the first the brain is almost invariably soft

and flaccid throughout. It cannot sustain itself, but falls down much more quickly than in the natural state. It is not easily cut, but rather gives way before the knife; and a portion of such a brain is easily lacerated, and falls down quickly in water. This diminished consistence, which, though greatest at the centre, extends through the whole organ, depends partly on the deposition of the proper cerebral matter being interrupted, and partly on the admixture of serous fluid with its minute atoms. The texture or atomic constitution of the organ is not altered.

In diabetes a similar change takes place, chiefly from the former cause.

In pulmonary consumption, whether depending on chronic bronchial inflammation, chronic pleurisy, or on tubercular disorganization, the brain is invariably found softer than natural. When the disease which induces death has continued long, this softness is very considerable, and amounts almost to semifluidity. It may then constitute a true cause of adventitious disease. This state of the brain, combined with a languid and retarded motion of the blood through the cerebral capillaries, may be the pathological cause of the delirium, which, either alone or alternating with coma, not unfrequently precedes the death of phthisical patients. The cerebral capillaries in such subjects I have found large and numerous. Is the density of the brain diminished? Meckel states that he found a cube of six lines of the brain of a man

of 24, cut off by phthisis, to be $1\frac{1}{4}$ grain lighter than the same bulk of sound brain.

Confinement, with inactivity and low diet, tend to impair the firmness of the brain. Thus in condemned felons and others who have been imprisoned for some time previous to death, either violent or natural, the brain is found unusually soft. Dr Monro *tertius*, the present Professor of Anatomy in the University of Edinburgh, who has had numerous opportunities of examining the brains of persons cut off under these circumstances, states that in criminals in general he found the brain unusually soft; and in a young man otherwise healthy, who was put to death for piracy, the brain was so soft that it gave way at the *corpus callosum*. The softness appears, from the account of Dr Monro, to be greater internally than externally, so that it was impossible to demonstrate the deep-seated parts of the organ.* In opposition to this, however, I must not omit to mention that Littre found the substance of the brain, cerebellum, and *medulla oblongata*, unusually compact and dense in a felon, who, to avoid public punishment, killed himself by dashing his head against the wall of his cell.†

To the same head probably is to be referred a form of diminished consistence, without change of texture, which is occasionally observed in the

* The Morbid Anatomy of the Brain. By Alexander Monro, M. D. &c. &c. Vol. i. Edinburgh, 1827, p. 35 and 160.

† Histoire de l'Acad. Royale des Sciences, An. 1705.

brains of persons in whom chronic encephalo-meningeal congestion caused mental derangement. The brain in fatuous persons appears to have been early observed by Tulpius, Kerkringius, King, and Scheide, to be soft and flaccid. This fact, which was repeated by Morgagni, was afterwards verified by John Ernest Greding of Waldheim, who in 1771, in an elaborate description of the anormal changes found in the brains of epileptic maniacs, states, that in more than one-half (fifty-one cases) the brain was either universally or very generally, especially its central parts, unusually soft and flaccid; and that though this may not be a uniform cause of deranged intellect, it is a frequent accompaniment of the state of the brain on which this depends.* In twelve cases the vault and *septum* were so soft, that spontaneously or by a slight touch they were reduced to thin pulp.

Among thirty-seven cases of this form of cerebral disorder inspected by Haslam, in seven the substance of the brain was soft, very soft, or doughy with abundance of red points, the usual indications of capillary injection, and effusion of serous fluid, the effect of meningeal injection.† Among the dissections of Dr Marshall not more

* Melancholico-Maniacorum et Epilepticorum in Ptochotropheo Waldheimensi demortuorum sectiones tradit Joannes Ernesto Greding. Cint. 2*da*, apud Ludwig Adversaria, &c. Vol. ii. partem 3tiam, p. 533.

† Observations on Madness and Melancholy, &c. By John Haslam, 2d edition. London, 1809. Cases 4, 10, 18, 25, 28, 30, 37.

than one belongs to this head,* (case 6th, p. 202.) This change depends on chronic injection of those capillaries of the vascular membrane (*pia meninx*) which are distributed through the brain.

8. *Sclerencephalia.* Induration of the brain.—That the brain may acquire an unnatural degree of firmness, and perhaps of density, is well established from the observations of Morgagni, Meckel, Greding, Haslam, Marshall, Serres, Lallemand, Lerminier, Pinel Jun. Bouillaud and Gaudet. Instead of the usual compressible elastic character which it presents in the sound state, it may become like coagulated or boiled albumen, or may approach in consistence to that of the brain which has been immersed in strong alcohol or dilute acid. From the facts hitherto collected, this induration appears to be of two kinds, according as it takes place in a shorter or longer period.

α. According to the facts collected by M. Bouillaud, a general induration of the brain may take place within ten or fifteen days before death, with more or less redness and injection of the cerebral substance. By M. Gaudet this change is conceived to be one of the material causes of ataxic (typhoid) fever.† This is not very widely different from the view of Bouillaud, who, like M. Broussais, regards it as the result of meningo-encephalic inflammation.‡

* The Morbid Anatomy of the Brain, &c. London, 1815.

† Recherches sur l'endurcissement general de l'encephale, considerée comme une des causes materielles des fievres dites ataxiques, par M. Le Docteur Gaudet. Paris, 1825.

‡ Observations et Reflexions sur l'induration generale de

Notwithstanding the authority of these observers, I think it doubtful whether this change can be supposed to take place in the short period assigned for it. Is it not more reasonable to think that this change had pre-existed for some time, and that it terminated in a more acute disorder of the organ or its membranes, which proved fatal?

β. The chronic induration of the brain has been long known. Originally observed by Littre, Geoffroy, Boerhaave, Lancisi, and Santorini, it was recognized by Morgagni as a morbid change which occasionally caused more or less mental derangement.* J. F. Meckel afterwards undertook to establish this doctrine more fully, and to show that the organ is harder and more elastic than natural. With this change, however, he rather paradoxically connects another, diminution of specific gravity, and finds that a cube of six lines of indurated brain is from $1\frac{1}{2}$ to 2 grains lighter than a cube of the same size of sound brain. In six among fifteen cases given by this author, the brain was much firmer than natural; in some as hard as indurated white of egg, and always elastic.†

This result, though not entirely, is partly veri-

la substance du Cerveau, considerée comme un effet de l'encephalite generale aigue, par M. Bouillaud. Archives Generales, tome viii. p. 477.

* Epistola Anatomico-Med. viii. 4—18.

† Recherches Anatomico-Physiologiques sur les causes de la Folie qui viennent du vice des parties internes du corps humain, par M. Meckel. Mem. de l'Academie Royale de Berlin, Tom. vii. p. 306, art. 92. Avignon, 1768.

fied by the researches of subsequent inquirers. Greding, whom I have already mentioned as having found the brain in a large proportion of cases softer than natural, found it in thirty-nine cases natural in consistence, firm, or even exceeding the natural firmness.* He thinks, however, that this difference is more in word than reality. Of the thirty-seven cases inspected by Haslam, in nine the brain was unusually firm, in one (24) remarkably so, and in one (29) elastic.† In all the cases given by Dr Marshall, except two, again, amounting to fifteen, the brain was unusually firm and generally elastic. ‡

The cause of this change, and the means by which it is effected, are entirely unknown. It is conjectured that it is a result of inflammation; and it may be admitted as a proof of this, that the brain is almost invariably penetrated with numerous loaded capillaries, and that more or less effusion of serous fluid is found beneath the arachnoid membrane and in the cavities. These, however, might be effects of the induration, or at least of the concomitant capillary injection. M. Serres has seen cases of cerebral injection and hemorrhage causing apoplectic symptoms terminate in

* Adversaria Medico-Practica. Ludwig. Tom. ii. p. 3tiæ, p. 533.

† Observations on Madness and Melancholy, &c. Lond. 1809.

‡ The Morbid Anatomy of the Brain, &c. Lond. 1815.

induration ; * and Lallemand † Bouillaud, ‡ and Pinel, § have found portions of the brain indurated in connection with chronic inflammation. But whether this is to be viewed as the result of capillary injection or of some derangement in the process of nutrition, it is at present impossible to determine. It would be desirable to ascertain chemically the exact nature of the change which takes place, and in what respect the indurated cerebral matter differs from that of the normal state. It is possible that the albuminous substance may be either changed, or in greater proportion; but on this point no accurate observations have hitherto been made.

Whatever be the agent or means of this change, nevertheless, enough is known to show that when it exists, it is in general accompanied with an injected state of the cerebral capillaries, and that it gives rise to loss of memory, confusion of thought, and derangement of the mental faculties. It appears, indeed, to be a frequent cause of insanity, especially when permanent, without lucid interval; and if long continued, it may cause that complete obliteration of the intellect which constitutes

* Annuaire Medico-Chirurgicale.

† Recherches Anatomico-Pathologiques, &c. Lettre 2dme, cases 30, 31, p. 305, and 313.

‡ Traité Clinique et Physiologique de l'Encephalite, Obs. 40, p. 198.

§ Recherches d'Anatomie et de Physiologie Pathologiques sur les Alterations de l'Encephales. Bulletins, &c. chez Revue Medicale, Tome vi. Paris 1821, p. 298 and 315.

fatuity; *(dementia.)* The cerebral arteries are generally found opaque, and affected with steatomatous deposition. (Marshall.)

From slight induration of a great part or the whole of the cerebral mass, to inconsiderable induration of particular regions, the transition is easy. According to the researches of M. Pinel the younger, who has examined the subject with particular attention, in the change from sound brain of natural consistence to that of final, compact, and apparently inorganic induration, two distinct stages may be recognized.

a. From the observations of MM. Foville and Pinel-Grand-Champ, it results that in certain persons the exterior or peripheral part of the brain is liable to a state of capillary injection or chronic inflammation; in other words, that the meningeal and encephalo-meningeal capillaries may become the seat of a process of injection partly chronic, partly intermittent, or variable, according to the state of the vascular system in general, and the operation of various exciting causes. One of the effects of this encephalo-meningeal injection is to tinge of a red colour more or less deep, the gray matter of the convoluted surface; and while the injection produces more or less mental derangement, this red tint is connected almost invariably with furious and maniacal paroxysms. When it proceeds to fatuity albuminous deposits take place on the surface, or on the membranes of the brain; and the gray

substance becomes very pale, and softer or firmer than natural. *

I have above said, that the subacute or chronic cerebral inflammation which terminates in pulpy destruction is a frequent pathological cause of mental derangement. In general the disease is then of shorter duration, and terminates sooner either in convalescence or in death. A more chronic form, however, is connected with this encephalo-meningeal congestion, the duration of which may vary from twelve or fifteen months to as many years. At the termination of these periods the cerebral substance is compact, remarkably white, appears void of blood-vessels and capillaries, is diminished in volume, no longer falls under the fingers, but is torn with difficulty, and recoils with elasticity when stretched. It assumes a horny hardness under the action of fire or nitrous acid. These circumstances show that it contains altered albuminous matter. The gray matter also is thinner and paler than natural, and seems to be confounded with the white.

The effects observed to accompany this change are defect and progressive loss of memory, inattention to momentary impressions, apathetic indifference to the present and the future, and slight difficulty of articulation, followed by abolition of appetites, desires, and ideas, increased loss of

* Recherches sur les Causes Physiques de l'Alienation mentale. Par M. Pinel Fils, D. M. P. Journal de Physiologie, Tom. vi. p. 44. A Paris, 1826.

speech, palsy, or at least want of command over the muscles, fatuity, wasting, and death.

That this change in the consistence of the brain is the result of a slow organic process succeeding to inflammation, M. Pinel infers from the symptoms during life, from the collateral effects after death, and from the state of the meningeal and cerebral vessels which is known to precede the change. That this is not remote from the truth many circumstances tend to show. I have above mentioned the relation between hemorrhagic injection of the brain and induration, as noticed by M. Serres and Bouillaud. A proof still more unequivocal is found in the fact, that inflammation, both in the membranes and in the cerebral substance, is known to be followed by induration of the latter. Thus Abraham Kaawe Boerhaave mentions the case of a soldier cut off by an epileptic attack, in the head of whom, besides firm adhesion of the *dura mater* to the inner table and the *pia mater*, with tubercular deposition, the subjacent convoluted gray substance was *hard* and *scirrhous* in various places. * The cheese-like induration recorded by Lallemand in the thirtieth case of his second letter is adduced elsewhere. Here, however, I may mention, that in a man of 55, in whom fixed pain of the forehead, slight palsy of the face, and confusion of memory were soon followed by death, he found the mem-

* Commentarii de Rebus in Scientia Naturali, Vol. i. Pars i. p. 234.

branes firmly matted together for the extent of a thirty sous piece at the outer * end of the left hemisphere, and the subjacent cerebral matter, also adhering to the membranes, hardened to scirrhous or cartilaginous firmness.

Lastly, M. Bouillaud records a case in which a man of 68, who, after cerebral disease regarded as chronic softening, had impaired memory, headach, and difficulty of expressing ideas, terminating in muscular weakness, and fatal convulsions. In this, with injection of the cerebral substance, was induration passing from the striated body of the left hemisphere through the nucleus, at the upper region of which it formed a cavity with hard yellow walls, and a similar hardened portion in the posterior lobe. †

From these and similar facts no doubt can be entertained of the tendency of the process of inflammation to indurate the brain under certain circumstances. The difficulty consists in ascertaining what are the conditions under which a process usually terminating in softening should give rise to an opposite change. It is probably premature to attempt any explanation of a process so contradictory in appearance. I shall merely say, that induration seems in general to be occa-

* Recherches Anatomico-Pathologiques sur l'Encephale et ses dependances, par F. Lallemand. Paris, 1820. p. 313.

† Traité Clinique et Physiologique de l'Encephalite, Observ. xl. p. 200.

sioned by the encephalic capillaries having their nutritive action so much injured by the inflammatory process, that they cease to deposit healthy cerebral substance.

The induration now described commences generally in the base of the brain by the *hippocampus major, (cornu ammonis)* and thence extends to the neighbouring parts. If confined to the brain only, it causes, according to M. Pinel, mere fatuity, *(dementia,)* with more or less palsy. But if it affect the annular protuberance, the limbs, or the olivary bodies, or the chord itself, epilepsy, general palsy, and death by marasmus, are the usual consequences.

b. The change which produces fatuity is the early stage of a more serious lesion of the cerebral substance, atrophic hardening, (*l'endurcissement,*) an extreme state of induration found in the brains of idiots. From that already described, it differs chiefly in degree. A portion of brain so changed becomes a compact inorganic looking mass, resembling in colour, consistence, and density, indurated egg or even cheese. The cerebral substance is depressed, shrunk, and condensed, and seems utterly void of vessels or capillaries. When exposed to the action of fire, instead of swelling up without odour, and leaving a brownish light residue, it assumes a horny hardness, emits a strong heavy smell, and leaves a compact shining blackish residue. This hardening affects the white

matter more than the gray, in which M. Pinel has not yet recognized it.*

This change is connected with idiocy either congenital or observed soon after birth, in some instances with fatuous stupidity and palsy. In one of the cases, however, the individual appears to have possessed faculties of the ordinary degree of intelligence till the age of 49, after which repeated attacks of palsy terminated in calm but complete fatuity, (*dementia.*)

That the spinal chord is liable to the same change in consistence is proved by the case of Count de Lordat, (Med. Obs. and Inq. Vol. iii. p. 270,) and that of M. de Causan, recorded by Portal, in which the cervical portion was so hard as to resemble cartilage, and the membranes were red and injected. This change gave rise to palsy, proceeding from the fingers up the arms of the right side, and from the feet till the legs lost power, and the whole side became atrophied, and eventually the same phenomena in the left side. Similar examples are given by Bergamaschi. †

9. *Organic changes, morbid growths, or tumours.* —Of these various forms have been observed by different authors. But they have not in all instances distinguished accurately between tumours originating in the cerebral substance, and those which, originating in the membranes, affect the substance of the organ secondarily. As this dis-

* Recherches d'Anatomie Pathol. sur l'Endurcissement, &c. par M. Pinel Fils. Journ. de Physiol. Tome ii. p. 191.

† Sulla Mielitide Stenica, &c. Pavia, 1820. 2d, 4th, 8th.

tinction must be observed, at least in pathological anatomy, I shall not be liable to the charge of futile innovation, if I attempt to trace the distinction in the following sketch.

The different forms of tumour occurring in the brain may be referred to the following heads: *α*, the simple cerebral tumour; *β*, the adenoid or fleshy tumour; *γ*, strumous tumours, comprehending tubercles and tubercular deposits; *δ*, the adipose, lardaceous, or wax-like degeneration, (*ceroma;*) *ε*, the cartilaginous tumour, *(chondroma;)* *ζ*, calcareous or bony deposits; *η*, encysted tumours, including *a*, the hydatid-cyst or vesicular tumour, *b*, the blood cyst, *(hæmatoma,)* *c*, the fungoid tumour; and *d*, the melanotic cyst.

Simple cerebral tumour, *(Scleroma.)* Of considerable induration of particular regions of the brain, I have already spoken. When the indurated portion is definite in limits, and the rest of the organ preserves its usual characters, these indurated portions have been vaguely described under the general name of *tumours*. It is more correct, however, to regard them as portions of brain indurated to an unusual degree, and perhaps changed in intimate structure. As the simplest form of tumour incident to the brain, this claims the first place.

The most authentic cases of this change have been recorded by Platerus, Meckel, Roederer, Perotti, and Greding. From the descriptions given by these authors, part of the cerebral substance appears to acquire unusual firmness, and

to become somewhat like coagulated albumen. It is not much changed in colour, unless in losing some of its whiteness, and assuming a pale yellow or orange-gray tint. The surrounding cerebral substance is almost invariably softened. Water is effused into the ventricles; and if the indurated mass is seated near the convoluted surface, the membranes become opaque and thick, and morbidly adherent.

The following references to the cases will communicate some idea of the nature of this change.

Felix Platerus, lib. i. p. 108.—In the fore part of the left hemisphere of a man of 24, who had headach, amaurosis, and mental imbecillity, a globular tumour like a gland, as large as a hen's egg, but irregular, and like a pine cone; its interior substance white, firm, and uniform, like boiled egg, but harder, inclosed in a firm vascular membrane. Weight ʒ14.

Buonaventura Perotti in Raccolta d'Opuscoli Scientifici e Fisiologici in Venezia, Tom. xlvii. p. 339. 1751.—A woman of 25, who had headach for several years, died lethargic. The convoluted gray matter of the left hemisphere was destroyed. In the right hemisphere, though externally sound, a hard body as large as a nut penetrated from the gray to the white interior substance.—Commentar. de Rebus in Scientia Naturali et Medicina observatis, Vol. iii.

Meckel, Mémoires de l'Academie Royale de Berlin, 1761. Tom. vii.—In a man of 50, right hemisphere externally harder, more resisting and more elastic than natural. Left hemisphere before the same; posterior lobe soft; upper posterior part of left hemisphere firm; *pia mater* opaque and thickened; arachnoid adhering to *dura mater;* substance of the hemisphere posterior to *corpus striatum* soft, diffluent, and moist with fetid serum. In the posterior part of the left hemisphere, behind the *ergot*, a hard body, the size of

three nuts, consisting of three spherical protuberances, aggregated together, weighing ℥2 and ʒ2; surrounding substance soft and pulpy.

In a child of 4, the white matter of the posterior lobe of the left hemisphere a scirrhus (hardened mass) the size of a nut; surrounding part vascular and injected.

Roederer J. G. Programma de Cerebri Scirrho, Goettingæ, 1762. This after some search I have not been able to see.

Vincenzio Galli negli atti dell' Academia della Scienzi di Siena detta Fisico-critici, Tom. ii.—A man of 40, who had laboured under severe cephalalgia, which was relieved by venesection, but afterwards recurred with giddiness and delirium, terminating in death. Inflammation of the membranes; effused serum in the cavities; in the right ventricle, stretching from the optic *thalamus* to the *corpus striatum*, a tumour as large as a hen's egg, with irregular surface, and external substance dense, firm, and ash-coloured.

M. Marcot, chez Mémoires de la Société de Montpellier, Tom. i. p. 334. Lyon, 1766.—A man of 47, attacked with giddiness, headach, impaired vision, palsy of right side, followed by paraplegia, convulsions, lethargy, and apoplectic death. The posterior part of the brain corresponding to the tentorium, to the branches and limbs of the vault *(fornix)* was scirrhous and almost cartilaginous, requiring to be divided by good scissors, and grating against the cutting instrument.

F. Lallemand, Recherches Anatomico-Pathologiques. Paris, 1820. Lettre 2ieme, No. 30. 1820.—A girl of 14, with right hemiplegy, followed after four months by paraplegy, insensibility of the skin, palsy of the sphincters, and paralytic dyspnœa advancing progressively to fatal asphyxia. The white matter of the left hemisphere, immediately above the lateral ventricle, for the space of 1½ inch long, 1 inch broad, and 2 or 3 lines thick, converted into a hard substance like Gruyere cheese, and resisting the knife.

Dr Abercrombie, Researches, &c. p. 431. Notes.—In a child of 4, unable to walk, with imperfect articulation, deficient in-

telligence, difficult deglutition and respiration, and frequent convulsions, terminating at the end of eighteen months in death, the olivary bodies, peduncle of the cerebellum, and mammillary eminences, were in a state of cartilaginous hardness.

M. Andral Fils, Journal de Physiologie, Tome ii. p. 111. 1822.—In a girl of about 20 months, with alternate motion of the head to the right and left, terminating in fatal coma, without convulsion or palsy, several of the convolutions of both hemispheres had become extremely hard, and assumed the colour of ivory. When pressed between the fingers they resisted like fibro-cartilage; when drawn, they recoiled. Similar indurations were found in the substance of the hemispheres to their base. The right hemisphere of the cerebellum contained a round cyst with smooth walls, of the capacity of a nut, containing minute, hard, irregular-shaped concretions, of strong consistence, and similar to the spiculæ of a fractured bone.

M. J. Bouillaud, Traité de l'Encephalite. Paris, 1825. P. 161, Obs. 33.—A man of 57, with impaired speech, after a cerebral disorder; in the anterior lobe of the left hemisphere an albuminous mass, the size of an egg, sprinkled with drops of blood, and drops of purulent fluid.

Ibid. Observat. 36. p. 183.—A man of 57, with right hemiplegy, intellectual imbecillity, and involuntary repetition of the last words spoken to him, after an apoplectic attack, terminating in complete fatuity and death, with injection of the membranes and cerebral substance, in the anterior third of the left hemisphere was found an indurated nut, the size of an egg, surrounded by bloody clots and distinct injection. A longitudinal section presented yellowish colouring and red-brown points, depending on the presence of blood coloured with the substance in which it was effused. The substance of the indurated mass resembled concrete pus mixed with blood, grating under the knife, and containing minute bloody effusions with filamentous substance, and, though much firmer than the rest of the brain, falling easily under

the finger. It was separated from the surrounding brain by a circle of well injected capillaries. In the middle lobe of the same hemisphere was a similar mass, less extensive, and rather softened than indurated.

This appears to be an albuminous tumour in its early stage.

In the following cases the diseased change was found in the cerebellum.

Joannis Harderi, Apiarum Basileæ, 1687. 4to. Observat. 58. p. 238.—A girl of 17, of scrofulous habit, who suffered severe lancinating pains of the head, followed by fatal convulsions. The membranes containing much yellow serum; vessels minutely injected; in the cerebellum, near its termination, three hard globular bodies, (*scirrhi*,) one as large as a nutmeg in the beginning of the spinal chord. They contained yellowish matter of considerable consistence.

Ephemerides Naturæ Curiosæ, Decade iii. Ann. iv. p. 148.—In a hydrocephalic subject, the cerebellum indurated, adhering to the *dura mater* and skull without intermediate cavity.

J. Mar. Lancisi, De Noxiis Paludum Effluviis, Lib. ii. Epid. iii. c. vi. 218.—In the cerebellum of a man subject to convulsions, cut off by intermittent fever, was a hard white body, two inches broad and three long, composed of several globular masses aggregated, invested with membranes.

Mémoires de l'Academie Royale des Sciences, 1705, No. 13.—In a boy of $4\frac{1}{2}$, who was stupid for two years before death, the cerebellum, with the posterior half of the *medulla oblongata* (the restiform bodies?) was changed into a hard white homogeneous mass.

Morgagni, Epist. lxii. 15.—A man aged 48, pursuing the occupation of a cook, and exposed to charcoal fumes, laboured for a year before death under acute pains of the head and weakness of the lower extremities, which terminated in paraplegy, without affection of the arms, finally became soporose during the day, with slight raving at night,

and with lucid intervals, and died. The cerebellum was hard to the knife. Instead of the usual appearance of ramified arrangement, which had disappeared, was one of parallel white streaks, firm, (*scirrhosa*), of a uniform colour, approaching to pale carnation; and when minutely examined appearing to consist of roundish atoms, mutually aggregated, without membrane or blood-vessel. This change, which affected the whole left hemisphere, encroached a little only on the right.

La Peyronie, Mémoires de l'Academie Royale des Sciences, 1741. P. 208, 4to, 283, 12mo.—A man of 30, who for ten years passed for a melancholy hypochondriac, complained during the three last months of life of weight and pains of the head towards the occipital region and neck; had convulsions about half an hour in all the members; and two days after perished in a fresh attack, lasting only a quarter of an hour. Attached to the fourth ventricle was a hard tumour as large as a hen's egg, occupying the place of the cerebellum, which was reduced to a glairy membrane as thin as a line, investing the tumour. This tumour, which compressed the *tubercula quadrigemina*, appears to have been attached to the choroid plexus of the fourth ventricle, and probably grew from it originally.

Brisseau mentions a hard tumour, as large as a pigeon's egg, in the middle of the cerebellum, producing palsy.—Obs. iii. p. 27.

From this list, which contains, if not the whole, at least the most authentic cases of this form of cerebral tumour, it may be inferred, that it consists in a portion of brain becoming unusually hard, assuming a white or yellow white tint, and in losing much of its appearance of organization, especially fibrous structure and vascular ramification. The hardness of these tumours varies from that of granular cheesy matter to firm indurated

albumen. Of some the structure is said to be fibrous; but in such cases the fibrosity of sound cerebral substance is not meant. In the presence of a capsule or a vascular spherical shell there is some variation, which seems to depend on the stage of growth which the tumour has attained. If recent, it is generally surrounded by such a vascular cyst. If of long standing, it is generally surrounded with a layer of softened brain, the result of the vascular irritation established in the confines of the tumour.

β. Adenoid or flesh-like tumour, (Adenoidea.) To the second head may be referred a sort of tumour which has been described sometimes under the vague name of scirrhus; sometimes under that of scrofulous tumour; but which cannot be admitted to possess unequivocal characters of either. It is generally described as similar to a mass of flesh, or an enlarged absorbent gland. Its colour is light pink or pale flesh-colour; its firmness is considerable; and in some instances it is compared to the kidney. To this head belong the following cases:—

Felix Platerus Observation. Lib. i. p. 13.—A military man of equestrian rank, who had for two years laboured under mental derangement, with much loss of memory and natural appetites, and with frequent somnolence at table, at length expired. Upon the mesolobe, upon separating the hemispheres, was found a remarkable globular tumour, fleshy like a gland, hard, but spongy *(fungosus)*, of the bulk of a moderate pippin, enclosed in a proper tunic, vascular, and free from all connection with the brain.

Did this originate in the *pia mater*, in which it appears to have been enclosed?

Joannes Rhodius, Centuria i. Observat. 55.—In the ventricle of the brain of a noble Bolognian a fleshy tumour gave rise to epileptic fits.

Miscellanea Curiosa. In the substance of the brain a tumour like a strumous gland.

Johan. Jac. Wagner, Miscellan. Curios. Dec. ii. Ann. 10.—A boy of 14, suffering pain in the forehead and occipital region near the junction with the vertebræ, coming on in paroxysms, relieved by vomiting; epileptic symptoms and death. In the white matter of the posterior part of the brain (occipital,) a preternatural hard sebaceous gland, friable; in the convolutions of the anterior lobe two glands; in the end of the cerebellum, near the *calamus scriptorius*, one as large as a walnut.

Mémoires de l'Academie Royale.—In the right *corpus striatum* a glandular substance the size of a bean.

Joh. Gottfr. Zinn. apud Comment. Soc. Reg. Scientiarum Gottingensis, Tom. ii. 1752.—In an infant affected with enlarged lymphatic glands a hard substance as large as a walnut. Of this, however, he neglected to preserve an accurate account.

In another infant, part of the left hemisphere of the cerebellum, to the extent at least of two inches, was converted into five hardish bodies of different sizes, yellow, like hardened lymphatic glands, mutually adhering. In some parts the traces of the circular leaflets of the cerebellic plates was left; in others they had disappeared, and left a uniform inorganic mass. The *pia mater* was readily detached, except at the middle of the hard mass, where it adhered so firmly that it could not be removed without laceration. The contiguous vessels were injected.

In an adult female, he observed beneath the parietal bone in the convoluted part of the brain three similar hard bodies, each as large as a nutmeg. They adhered to the *dura mater*; and, in all probability, they originated in that membrane.

Haller, Opusc. Pathol. Obs. 1.—In a beggar-girl of 6 years, with enlarged mesenteric, inguinal, and bronchial glands, the left hemisphere of the cerebellum was found adhering to the occipital *dura mater;* the whole substance, white and gray, changed into a hard mass two inches in diameter on both sides, uniformly thick, fibrous like the kidney, fissile, destitute of vessels, and without remaining trace either of gray matter or of white ramification.

John Jac. Huber, Nova Acta Physico-Medico Academ. Cæsareæ Leopoldino-Carolinæ, Tom. iii. p. 533; also Comment. de rebus in Scientia Naturali, Vol. xviii. p. 335.—In the brain of a boy of 3, cut off by decay *(tabes)*, a hard glandular tumour, of the size of a filbert, in colour, hardness, and other qualities like a lymphatic gland. When divided it was found to consist of a thin coat enclosing a hard nucleus, which, though compared to purulent matter, was firm and coloured.

Jo. Ernest. Greding, apud Ludwig Adversaria Medico-Practica, Vol. ii. p. ii, p. 492. 1771.—A woman of 30, of delicate constitution, unmarried, labouring under mania, with paroxysms of great violence; apoplectic attack followed by palsy of left side; death in about twenty days after. In the right hemisphere, about one inch below the convoluted surface, an ovoid mass, five inches long, three broad, convex-shaped like a lens, one-fifth of an inch thick at middle, resting on the *centrum ovale* and mesolobe, consisting internally of dark-red (*atro-rubens*) hard granular substance, like half-rotten sandy pear, enclosed all round in gray, soft, inodorous puriform matter, (*ramollissement.*)

Mr Henry Earle, in Medico-Chirurgical Transactions, Vol. iii. p. 59. 1812.—A boy 2 years and 9 months old. Dilated pupil; palsy of lower extremities and sphincters, followed by convulsions of the face, and palsy of the upper extremities and trunk; death by paralytic asphyxia. In the anterior lobe of the right hemisphere a large dusky red tumour, rather rough. In the posterior lobe of the same hemisphere, and in that of the left, a tumour each. In the

cerebral substance, on a level with the mesolobe, four more tumours; the largest the size of an orange, the smallest not less than a chestnut. They were very firm, of a dusky red colour, and with streaks of white interposed.

Dr Powell, in Medical Transactions, Vol. v. Case xi. p. 241.—A man of 30, with excruciating pain of the head more or less constant, followed by impaired vision, dilated pupil, and at length an apoplectic attack, which in two days terminated life. From the inferior part of the anterior lobe of the left hemisphere projected a firm mass, of the size of a large walnut, and when cut into resembling a large absorbent gland. It was surrounded by softened cerebral substance, which was of a light-brown colour, and so pulpy as to give the sensation of a semifluid.

γ. Tubercular Deposition, (Tyroma.)—Under the head of tubercles and scrofulous growths of the brain, various changes, some not very similar, have been described. Though the terms tubercle and scrofula have been perhaps applied too vaguely, these differences, however, if well examined, will be found to consist more in the external form in which the tubercular matter is deposited, than in any essential change in its intimate characters. The term *tubercular deposition*, therefore, I adopt for the purpose of designating matter of a white or pale-yellow colour, firm, like soft cheese, but less tough, sometimes granular and friable, and consisting chiefly of a large proportion of albuminous matter. The substance thus defined may be deposited in various forms. In the brain these seem referable chiefly to two;—1. one, two, or more homogeneous individual masses of considerable size; and 2. several, sometimes many, minute

spherical or spheroidal bodies separate from each other.

a. One or two homogeneous masses of considerable size. Mangetus is among the first who notices near the *corpora quadrigemina* a body like a sebaceous gland, hard and friable, which there is reason to believe was one solitary tubercular mass. The two similar which he found in the same brain between the convolutions, if not belonging to the membranes, were examples of the same growth in the convoluted substance.

I have already mentioned under another head the case of Huber, which is probably an example of the same nature. The second one of Merat, if really tubercular, is also an instance of this form of the tubercular deposit. Many others are recorded by different authors. Thus Rochoux gives an instance of a tubercular tumour in the cerebellum, in all respects similar to those of the lungs.* Dr Powell's seventh case is an instance of large tubercular masses in the white matter of the right hemisphere.† To the same head also belong the cheese-like tumour described by Sir Gilbert Blane;‡ the white tubercle represented by Baillie, (Plate VII. Fascic. 10;) and the instance given by Coindet in the annular protuberance;§ the instance of an albuminous mass as large as an egg in the ante-

* Recherches sur l'Apoplexie, Obs. xxxix. p. 151.

† Transactions of the College of Physicians, Vol. v. p. 222.

‡ Transactions of a Society, Vol. ii.

§ Mémoire sur l'Hydrencephale, p. 106 and 107.

rior lobe of the left hemisphere by Bouillaud ;* that recorded by the same author as a steatomatous tumour in the left hemisphere, containing an opaque homogeneous substance, like white paste or thick starch, (*l'empois blanc*, p. 195 ;) the 76th, 77th, and 78th cases of Dr Abercrombie ; perhaps that of Dr Chambers ; † a very good instance recorded by M. Piedagnel ; ‡ another by M. Berard in the anterior lobes ;§ and perhaps those given by Dr Hooper, (Plate XI. XII. Fig. 1.)

The physical characters of this form of tubercular deposit are tolerably uniform. Varying in number from one or two to four, five, or six, and in size from that of a pea to a walnut, they consist of opaque white matter, with a tint of pale-yellow, of the consistence of soft cheese, sometimes granular, but always without vessel or trace of organic structure. It is chiefly albuminous, and friable. In general they are surrounded by a vascular cyst of variable thickness. Of the manner of their formation little is known. Several of the cases of Dr Abercrombie would lead to the idea, that the white albuminous matter of the tubercle is deposited in a fluid or semifluid shape, which afterwards undergoes a slow coagulation. ‖

* Traité Clinique et Pathologique, p. 161.

† Medical and Physical Journal, Vol. lvi. New Series, Vol. i. 1826. p. 5.

‡ Journal de Physiologie, Tome iii. p. 247.

§ Ib. Tome v. p. 17.

‖ Pathological and Practical Researches, &c. Cases, 83, 84, and 85, in which the cysts contained soft or semifluid albuminous matter, coagulable by heat. Pp. 176–181.

M. Bouillaud adduces various facts and arguments to show that they are the result or product of an inflammatory process; and if the idea attached to this term be sufficiently comprehensive, the opinion may not be remote from the truth. The tendency of this process is to produce albuminous secretions or depositions in various forms; and it is not improbable, that, under certain circumstances, it may be so modified as cause the deposition of this substance in an indivisable mass, in a limited situation, and from a proper cyst.*

Whatever be the origin of these bodies, it is understood, that, sooner or later, they undergo a change in their interior, which sometimes at the centre, sometimes in several points, simultaneously begins to soften and become fluid. It is at least known that such bodies are found to have fluid or semifluid contents, consisting chiefly of serous liquor with albuminous flakes or curd-like masses in it. Of this description are the tumour of the protuberance represented by Dr Yelloly as in a state of imperfect suppuration; † the cerebral *vomicæ* described by Coindet as similar to tumours of meliceris; the seventy-fifth case of Dr Abercrombie; that in the protuberance given by Dr Kellie, (Monro, p. 178,) and by Dr Moncrieff in the same work, (pp. 50—53.) When the softening or liquefying process is complete, the tubercular mass assumes the form of an encysted abscess. Of such

* Traité Clinique et Pathologique, p. 181.

† Medico-Chirurgical Transactions, Vol. i, p. 182.

abscesses, it may indeed become a question whether the fluid or the solid state is the incipient one. The principal facts in favour of the latter idea are, the circumstances of the fluid being found in the centre while the circumference is solid, and the larger bodies being found soft while the small are firm. According to this, which is the general opinion at present, in the incipient stage the tubercle is said to be *crude*, in the more advanced to be softened or dissolved.

b. The second form in which tubercular deposition takes place is when it is found in numerous minute spherical or spheroidal bodies, disseminated through the substance of the brain. Of this the best examples with which I am acquainted are recorded by Reil and M. Chomel. In the case given by Professor Reil more than 200 oblong spherical bodies were found in the gray matter of the brain and cerebellum. They were a little firmer than the brain itself; mostly of a pale yellow; some few of a very pale blue colour; of the size of a lentile or a pea; and when divided, showed internally an adipose-like substance, resembling in colour and consistence boiled or beaten potatoes. From some which were marked in the centre with a dark point, and seemed to be covered by a thin cyst, the slightest incision discharged a matter like vermicelli. These bodies were confined to the gray or external matter, none being found in the white cerebral substance.* Not dissimilar were the bodies found by M. Chomel in the brain of a

* J. C. Reil, Memorabilia Clin. Vol. ii. Fasc. i. No. 2. 1792.

woman of 30, who, with obstinate vomiting and epigastric pain, had headach at first slight and confined to the hind head, latterly extending to the frontal region, when it was constant and severe. Though the intellectual powers are stated to have been unimpaired to the last, death was preceded by sudden aggravation of her sufferings and loss of consciousness. In the brain were found about thirty or forty small round bodies, resembling the human crystalline lens in colour, size, and consistence. In the cerebellum were two similar, and in the spinal chord opposite the last dorsal vertebra one. In several parts of the organ also were minute abscesses, supposed to be produced by the softening of similar tubercles.*

The two cases now noticed are considered as of a strumous nature by the authors under whose observation they fell. It is unfortunate that they have given almost no information on the physical and chemical qualities of the matter thus deposited in the substance of the brain. Though its nature is thus left undetermined, I have ventured to refer them to the present head, because they seem to be deposits of albuminous matter slightly modified, and because they doubtless present some alliance with certain of the forms of tubercular deposition in other textures.

* Nouveau Journal de Med. Mars 1818, p. 191—196. A similar is given in the supplement to Dr Abercrombie's work, from Prof. Nasse, p. 431. The case of Dr Hawkins, (Med. and Phys. Journal, Vol. lvi. p. 8,) may probably be of the same description.

δ. *Adipose tumour, lardaceous degeneration. (Ceroma.)* Peter Borelli is the first who notices the existence of much fat-like matter in the brain of an epileptic subject. The adipose tumour described by the Wenzels seems to be the same with that which was previously mentioned by Merat, and which has since been noticed under the name of *lardaceous degeneration* by the late M. Hebreart of the Bicetre. The first author describes, under the name of tubercle behind the upper part of the *medulla oblongata*, a fatty, reddish, or rose-coloured body, the size of a nut, consisting internally of homogeneous substance traversed by minute red lines, probably blood-vessels. It was contained in a fine thin envelope. A similar one, though somewhat less, was found in the middle of the left cerebellic hemisphere. By the Austrian anatomists it is represented as externally smooth, and of a yellow colour, and internally, when divided, as consisting of adipose ash-coloured solid substance, tending in some parts to bony.* Among the many brains which these anatomists examined two only presented this change of

* "Tumor exterius lævis erat, *colore luteo*, (couleur jaunatre, of M. Hebreart,)" &c.

Persecantes tumorem, intrinsecus inveniebamus quandam adiposam, ("une degenerescence de consistence lardacée" of M. Hebreart,) subcineream, admodum solidam, ("substance devenue dure, lardacée, de couleur jaunatre") substantiam quæ parvo quodam loco tactu velut ossea erat." Josephus et Carolus Wenzel de Penitiori Structura Cerebri Hominis et Brutorum. Tubingæ apud Cottam, 1812. Fol. p. 104 et 105.

structure. Though found near the exterior or convoluted surface, they penetrated pretty deep into the substance of the organ.

According to the cases given by M. Hebreart this change may occur either under the shape of a conversion or degeneration of the cerebral substance into matter of a yellowish colour and lardaceous consistence, or in the formation of a distinct tumour in the substance of the organ. Though from his account it appears to be by no means so rare as might be expected from the observations of the Austrian anatomists, he gives only two cases of its occurrence in the brain, and two in the cerebellum. In the first of the former, a distinct tumour, consisting of matter of a yellow-colour and lard-like consistence, the size of a nut, in the anterior part of the anterior lobe of the right hemisphere, gave rise to idiocy. In the second, a square inch of the posterior lobe of the left hemisphere was converted into a yellowish pulpy substance, which was separated from the contiguous sound brain by hardened cerebral matter. This in a man of 40 caused epileptic paroxysms once or twice a month, terminating in asphyxia, which at length proved fatal. In the first of the cerebellic cases, in a young man, who had been idiotic for six years, the cerebral substance forming the walls of the fourth ventricle had for the depth of more than a line, been converted into yellowish lardaceous matter. In the second, that of an incurable maniac, a space six lines in diameter of the lower part of the right hemi-

sphere of the cerebellum had become hard, lardaceous, and of a yellowish colour, not only in the gray lamellated matter, but penetrating for some lines into the white substance. In this change the membranes also participated.* A similar case is related in the Bulletins de la Faculté de Medecine, May 1816.

I know not whether to these cases should be added the third, given by the same author. In this a man of 50, who became maniacal, with lucid intervals, however, lost judgment, speech, memory, and finally became paralytic and idiotical. These symptoms were found to depend on the conversion of the lower surface of the left cerebellic hemisphere into a jelly-like matter, separated from the sound part of the organ by walls of hard polished cerebellic substance. It is possible that this jelly-like matter may have been either the result of the process of softening in a part previously hard, or the incipient stage of what was afterwards to acquire the lardaceous consistence.

6. *Cartilaginous induration ; Scirrhus ; (Chondroma.)*—This is probably to be regarded either as a variety of the first kind, or as intimately connected with it. Unhappily the term *scirrhus* has been so vaguely applied to every kind of tumour, if a lit-

* Observations sur quelques maladies du cervelet, du cerveau, et de leurs membranes, recueillies à l'hospice de Bicêtre ; par M. Hebreart, Medecin ordinaire des Alienés, &c. Annuaire Medico-Chirurgical, &c. Paris, 1819. p. 579.

tle hard, that no precise idea is communicated by it. In the brain especially all authors have comprehended, under this general appellation, every change of texture which was harder than that of the surrounding organ, without much regard to the anatomical characters of the new substance. Hence we find all the instances already adduced recorded as examples of scirrhus, though in many of them no proof of this structure is given, and in none is there any other proof than the greater consistence of the part.

Without attempting to define the character of scirrhus when occurring in the brain, I refer to the present head those instances of morbid structure in which, with hardness approaching to that of cartilage, there is a fibrous arrangement, and more or less tendency to cancerous ulceration. Even with this limitation it may be doubted whether this disease occurs primarily in the cerebral substance. Meanwhile, however, for want of more satisfactory elements in the arrangement of the organic changes incident to the brain, to this head may be referred the following examples:—

M. Jean Cruveilhier, Essai sur l'Anatomie Pathologique, Tome ii. p. 80. Paris, 1816.—A woman of 40 was brought to the Hotel-Dieu in a state of idiocy, in which she was stated to have been for six months after severe mental distress. She lived a month without much sign of intellect, became comatose and died. In the right hemisphere, beneath the mesolobe, corresponding to the striated body on the outside, and projecting into both ventricles, was found a hard tumour of a triangular shape, the posterior angle elongated, the right anterior angle advancing to the anterior ex-

tremity of the right lobe. It consisted of two sorts of structure ;—one in the centre, as large as a pigeon's egg, had the consistence of fibro-cartilage, and resembled fibrous substances proceeding to the cartilaginous state ; the other exterior, grayish, was confounded with the cerebral substance from which it appeared to be formed.

L. N. Rostan, Recherches sur une Maladie encore peu connue. Paris, 1820. P. 84. Observ. 20ieme. 1820.—A woman of 62 had during the course of life been deranged several times, during which she committed extravagant acts, though rare and of short duration. She had now constant headach, with occasional raving, giddiness, and vomiting, followed by palsy of the right side, and complete derangement. In a few days more she became comatose, and, with complete right hemiplegy and stertorous respiration, she expired. In the upper middle of the left hemisphere, which was softened all round, a little beneath the convoluted substance, was a small yellowish granular nut. Anteriorly in the striated body was a cancerous tumour as large as a nut, compressing the ventricle. In the right hemisphere, which was sound and consistent in its anterior $\frac{3}{4}$ths, but injected towards the posterior-inferior region, was a cancerous tumour as large as a small nut, with pulpy destruction of the surrounding substance.

This account is deficient in failing to state the physical characters of the several tumours. A record more instructive is found in the following:—

M. Andral Fils, Cancer du Cerveau, from La Charité, in the words of M. Lerminier, Journal de Physiologie, Tome ii. p. 105. 1822.—A man of 58 felt fifteen years before acute pain of the right temple, radiating in the right side of the head and face, and lasting for six weeks. During subsequent years it returned at irregular intervals, and continued for periods of various duration till two months previous to admission, when it became so intense as to oblige the patient to give up his usual employments. Without affection of sen-

sation, intellect, or motion, he suffered severe tearing pain in the whole right side of the head, and slight convulsive motions of the face followed after eight days by palsy of the lower limbs, and soon after by coma, which continued in a greater or less degree for a few days, when he died. In the centre of the right hemisphere, outside of the optic *thalamus* and *corpus striatum*, the space of four finger-breadths long, and two or three wide, was a reddish-gray, knotty, rough, unequal surface, which when cut resisted like the scirrhous masses of the stomach or liver. In the resisting points was a substance of areolar texture, bluish-white colour, semitransparent, very hard, presenting here and there minute cavities containing a fluid like apple-jelly, scirrhus proceeding from the crude to the softening stage. In other points was a firm texture of dirty white colour, traversed by reddish lines crossing in various directions (supposed to be encephaloid texture in the crude stage.) In other points was seen a reddish purple, which appears to have been simply softened brain.

Bouillaud, Traite Clinique et Physiologique de l'Encephalite. 1825.—A lady of 77, with convulsive motions of the left arm, followed by palsy of that and of the left leg, impaired speech, complete hemiplegy, and death by exhaustion, without loss of consciousness, a firm, yellowish, lardaceous, bulky, many-lobed mass, occupying the greater part of the posterior lobe, almost the whole of the middle lobe and part of the anterior lobe of the right hemisphere. Contiguous to the optic thalamus, which was entirely softened, a lobule penetrated below the striated body, and reached the exterior of the middle lobe, where it was connected with the membranes and the bone. Softening all round.*

* This case is stated to be already published in the work of M. Rostan. This, however, appears to be a mistake. The only example of cancer in the brain recorded in that work is the case above mentioned of *Marie Gerard*. With this it evidently does not correspond, either in age or in

Ibid.—A man of 66. Right hemiplegy twice, followed by raving, unintelligible speech, insensibility, coma, and death. In the central and posterior part of the left hemisphere a hard irregular mass, internally of a saffron-yellow colour in some parts, of a rust-yellow in others, jaspered, marked by numerous small white bodies varying from the size of a lentile and a pea to that of a filbert, furrowed in various directions by minute filaments. The hardest of these bodies M. Bouillaud regards as scirrhous matter in the crude stage. Others resembling a white concentrated glue, he thinks might be the *colloid* or glue-like cancer of M. Laennec. While the greater part of this body was hard, its centre was reduced to a yellow diffluent pulp.

Mr R. Wade, Medical and Physical Journal.—In the upper part of the left lobe (hemisphere) of the brain, a hard body of the size of a small hen's egg, like medullary sarcoma, but as firm as scirrhus of the female breast. The greatest part consisted of yellow-white striæ, as hard as cartilage, the remainder dark gray and less firm, not very distinguishable after maceration. Pulpy destruction around.

Under his fifth head, Dr Monro has shortly noticed seven specimens of this change of structure preserved in the University Museum. Its hardness, irregular surface, and cartilaginous structure, with a resemblance to a section of the kidney, are the circumstances principally remarked.

From the above accounts, which I consider to be the most authentic on record, a general idea of the anatomical characters of what is meant by scirrhus of the brain *(chondroma)* may be obtained. A mass generally of irregular shape, dis-

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other circumstances. A case of tumour called cancerous is also given in the "Observations" of M. Lerminier.—Annuaire Medico-Chirurg. p. 225.

tinguished from the surrounding cerebral substance by its firmness, sometimes a lobulated structure, by its interior substance consisting of a proportion more or less considerable of yellowish matter as hard as cartilage, arranged sometimes in streaks or bands, in other cases in round nodules, constitutes the principal characters of this morbid growth in its crude or early stage. At a more advanced period cavities begin to be formed, in which is contained a fluid or semifluid matter sometimes jelly-like, at other times thinner, and occasionaliy tinged with blood. Before this process of softening has advanced far death takes place in general by suspension of the functions of the organ.

The cartilaginous tumour may be deposited in a tubercular form, and perhaps consisting partly of tubercular or albuminous matter. Of this a good instance is given by Bayle in his Treatise on Pulmonary Consumption. A printer of 58, with complete paraplegy, and obliteration of the intellect almost to idiocy, followed by weakness of the arms and sudden loss of speech, died with lethargy and paralytic dyspnœa. In the anterior part of the right hemisphere was a tubercular and cancerous mass the size of a turkey's egg, nearly spherical, and of considerable consistence and specific gravity. With a reddish-gray surface irregularly knobbed, traversed by blood-vessels, it consisted internally of a canary-yellow, thick, granular, pasty matter, void of vessel or trace of or-

ganization, resembling scrofulous tubercles beginning to soften, with this difference, that in some points it was humid and infiltered with serous fluid. This was the case in the walls of an anfractuous irregular cavity without membrane, and containing two spoonfuls of clear yellowish fluid. The tubercular matter formed the centre and the three upper fourths of the tumour. The rest was what is described as cancerous,—a firm grayish-white shining tissue, traversed in all directions by blood-vessels, and presenting even a minute bloody effusion. Though the tumour was without cyst, its surface was covered by a celluloso-vascular tissue, which sent numerous irregular productions into the substance. It was surrounded by a layer of cerebral matter, reduced as usual to the consistence of thick cream. *

ζ. *Calcareous or Bony deposits, and Concretions.*—This morbid deposition is by no means so common in the brain as in its membranes; and a large proportion of the cases termed ossification or petrifaction of the brain are doubtless examples of ossific tumours originating in the membranes. It appears, nevertheless, that some instances have occurred to different observers. Kerkringius mentions as a cause of fatuity, a concretion weighing thirteen grains in the right ventricle.† Kentmann notices an ash-coloured one, the size and

* Recherches sur la Phthisie Pulmonaire, &c. Par G. G. Bayle. A Paris, 1810. P. 305 and 307.

† Observat. Anatom. 35.

shape of a mulberry; * Deidier found the left *corpus striatum* osseous;† and Tyson mentions the case of a man who died of the effects of a blow on the head, in whom one of the inferior *corpora quadrigemina* was as large as a nutmeg, and contained a chalk mass like a cherry-stone, with pulpy destruction of the organ. ‡ Blegny saw a stone as large as a bean at the union of the optic nerves in the brain of a lady, who, after violent pains of the head with fever became blind, and died. § In the brain of a man who had suffered long from acute pain of the hind head, notwithstanding the use of blisters, setons, &c. M. Boyer found a hard plaster-like concretion as large as a nut. ‖ In the brain of a boy of 16, an idiot from birth, Sir E. Home found the protuberance, cerebellic peduncles, and part of the cerebellum, containing so much earthy matter as to be with difficulty cut by the knife. ¶ Professor Nass found in the left lobe of the cerebellum a body one inch long and ten lines broad, composed of alternate layers of chalky matter, fluid albumen and solid albumen. ** Lastly, Andral in a phthisical subject found, in the substance of the left hemisphere, near its upper anterior extremity, a granulation

* De Calculis Libellus.

† Des Tumeurs, p. 351.

‡ Philosophical Transactions, No. 228.

§ Zodiacus Gallicus, Obs. xiv. p. 81.

‖ Cruveilhier, Essai sur l'Anatomie Pathologique, T. ii. p. 84.

¶ Phil. Trans. 1814.

** Abercrombie, Pathological and Pract. Researches, p. 426.

the size of a large pea, with the consistence of the calcareous concretions of the lung.*

In such cases a minute portion of brain appears not to be converted into bone, but to be infiltrated with chalky matter, void of animal substance so far as can be discovered. Of these earthy deposits no analysis has yet been made. It is, however, not improbable that they consist chiefly of lime, united either with carbonic or phosphoric acid, or both. Dr Hooper has delineated in his twelth engraving a bony tumour, or what he names a tubercle, which is said to consist of the same materials as healthy bone, with a little more animal matter. It it not stated whether this was found in the cerebral substance or connected with the membranes. From its appearance, however, and the fact now stated of its chemical character, I think it next to certain that it was of the latter description. Upon the whole, it may be inferred, that the substances denominated *concretions of the brain* consist of infiltrations or depositions of calcareous matter in the substance of the organ.

To this head may be referred the concretions found in the *conarium* or pineal gland. In this body small sabulous or calcareous particles have been very often found; and it was long supposed, partly in consequence of the hypothetical opinions of Descartes, that this change could not fail to affect materially the functions of the entire organ. For correct information on this point, we are in-

* Journal de Physiologie, Tome ii. p. 110.

debted to Soemmering, who showed by the collation of numerous cases, that scarcely any person arrived at the age of puberty, though in the best health and the most perfect enjoyment of his faculties, could assure himself that his conarium did not contain calcareous matter. He regards it as part of the natural structure.

Though Soemmering states that sabulous deposition is found in the conarium of infants as well as adults, he nowhere specifies the exact authority for this fact; and the youngest subjects on which he records its occurrence were 14 and 16.* The Wenzels assert that they have seen stony particles so early as the 7th year, and a substance very similar a few months after birth. † I am satisfied that I have seen in the pineal glands of young children, whose ages I could not ascertain, but who certainly did not exceed 9 or 10, small sabulous particles; but my personal observation does not enable me to say how far the statements of the Austrian anatomists as to earlier periods is correct.

The conarium itself consists chiefly of firm reddish gray cerebral matter, at the basis or posterior end of which are two whitish threads, which proceed on each side to the optic thalamus, and form what are termed the *peduncles* of the gland, from which they are separated by a small linear depression. Behind the union of these peduncles,

* S. T. Soemmering, de Acervulo Cerebri Dissert. Apud Ludwig. Scriptorum Neurolog. nunc Delect. p. 322, 329.

† De Penitiori Structura Cerebri, pp. 155—157.

covered here by part of the choroid web, is placed invariably an irregular-shaped mass, varying in size from that of a small pin-head to a grain of hemp-seed. When seized by the forceps this is found to grate like sand or grains of stone; and when examined it actually consists of minute granules aggregated together by membranous filaments of animal matter. This irregular-shaped sandy mass is what is termed by Soemmering *acervulus conarii.* The granules in the centre are generally larger than those at the surface; and its irregular shape depends on the number and size of the small superficial granules. They are generally yellow or citron-coloured, hard, rough, semitransparent, and distinctly grating on a steel instrument.

Besides the situation now mentioned,—the union of the peduncles,—sandy particles are occasionally found anterior to the peduncles close on the basis of the gland, or disseminated in its substance. In infants before the 7th year, it is never found in the substance of the conarium, but generally in the plate which connects it to the *thalami.* The most ordinary place for it in adults is the pit between the conarium and its penduncles; and in aged subjects it may be found in all the three situations. It has been found in natives of every European nation almost, and in Africans.

According to the analysis of Muller these stones contain calcareous earth; and from some experiments of Münch it appears that the lime is united with oxalic acid.

Whatever be the quantity of this deposition, it

is well ascertained that it exercises no influence on the cerebral functions. It is nevertheless difficult to imagine it to be a natural or healthy product. From its situation I have often been inclined to think that it is a secretion from the vessels of the choroid web.

Petrifaction, or osseous induration of the whole brain, has not been seen in the human subject. Instances, however, of this in the lower animals have been recorded by Duverney, Simson, Pitchell, and Renauld.

η. *Encysted Tumours.*—Of these any of the forms may probably be found in the brain. Hitherto, however, those actually said to occur may be referred to one or other of the following heads.

a. Hydatoid or vesicular tumours. It may be justly doubted whether the genuine animal hydatid (*Cysticercus cellulosus*, Rudolphi), has ever been found in the brain. Though stated generally by Bremser, he mentions no authority;* it is never noticed by Rudolphi;† and seems to be denied entirely by Blainville. None of the social hydatids (*Coenuri* and *Echinococci*) were found in that situation, till M. C. Rendtorff discovered in 1811 a cluster of the latter sort in the right ventricle of a girl of 8, who, after remaining hemiplegic for some months, died lethargic.‡

Notwithstanding this, instances of bodies described as *hydatids* occurring in the brain have

* Traité Zoologique, &c. Paris, 1824. P. 141. Chap. ii.

† Entozoorum Synopsis. Mantissa, Gen. 28, p. 546.

‡ De Hydatidibus præsertim in cerebro repertis.

been mentioned by Scultetus, Panaroli, Paw, Borelli, Lancisi, Wepfer, Home, Rostan, Headington, and Morrah. In the case of Scultetus, a cyst as large as a hen's egg, not unlike a hydatid, was found in the left hemisphere.* In that of Panaroli, several whitish round bladders, containing pituitous fluid (*hygroma?*) were found in the mesolobe.† In that of Paw, a bladder containing half-a-pound of limpid fluid was situate over the commissure of the optic nerves.‡ The case of P. Borelli was a cyst containing watery fluid, attached to the nates and infundibulum.§ That of Lancisi is styled a hydatid as large as a pigeon's egg, thin, yellowish, jelly-like lymph, in the posterior part of the right hemisphere.‖ The case of Wepfer, which was a cyst as large as a hen's egg, containing a turbid brownish liquor, appears to belong rather to the head of *hygroma.*¶ Those of Home,†† Rostan,‡‡ Headington,§§ and Morrah,‖‖ though more recent, are not more unequivocal, since their authors give no description of the physical characters by which their claim to the title of hydatids might be determined.

* Armamentarium, Obs. 10 and 11.

† Pentecoste i. Obs. 17. ‡ Petri Pawii, Observat. 2.

§ P. Borelli, Obs. Medico-Physicæ.

‖ De Mortibus Subitaneis, Lib. i. cap. xi. 13.

¶ Historiæ Apoplecticorum.

†† Phil. Trans. 1814, p. 483.

‡‡ Recherches, &c. chap. x. Acephalocystes, p. 166.

§§ Medical and Surgical Journal, Vol. xv. 504.

‖‖ Medico-Chirurgical Transactions, Vol. ii. p. 262.

Upon the whole, though the occurrence of the genuine solitary animal hydatid in the brain may not be impossible, it is not clear that any of the cases hitherto recorded belong to this head. They are to be regarded rather as serous or vesicular cysts, (Portal, Anat. Med. Tome iv. p. 72,) or examples of the tumour called *(hygroma)*. Of this kind also are the case described by Forlani of Sienna, containing glutinous matter like white of egg,* and the globular cysts so beautifully represented by Dr Hooper in his fourteenth engraving. The cases mentioned by Fischer, Zeder, and others, belong to the membranes.

b. Steatoms are mentioned by Drelincurtius, Thomann, Home, and Bouillaud.

c. The blood-cyst, (*hæmatoma*). The occurrence of this in the brain, though not common, has been observed. Like hæmatoma in other regions, it consists of a membranous cyst, sometimes containing small cysts, the inner surface of which is composed of a vascular tissue, from which blood or bloody fluid exudes by exhalation, forming a mass resembling layers of coagulated blood. Of this disease the most distinct example is given by Rochoux. A man of 65, about twenty months after a violent blow on the head which stunned him, began to feel pain and weight of the head, with occasional moments of forgetfulness. These symptoms became more severe and more frequent, were followed by embarrassed speech, palsy of the left

* Caspar M. Forlani, Obs. Med. Pract. Anat. Senis, 1769.

side of the face, great general weakness, coma, and death. In the anterior and external part of the left hemisphere was found a firm red-brown tumour, the size of an egg, round, flattened, filled with blood, which in certain places appeared to be contained as in the spleen, in others in small clots of a line diameter of an areolar-cellular tissue, grayish, dense, and analogous in appearance to the matter of tubercles. Adhering without to the dura mater of the arachnoid, which was red and much thickened, it was lodged in a depression of the hemisphere. The contiguous cerebral matter was in the state of yellow ramollissement.*

In his tenth engraving Dr Hooper gives a good delineation of an example of this disease. In this case the tumour, which was of an irregular oblong spheroidal shape, about $3\frac{1}{2}$ inches long and $2\frac{1}{2}$ broad, arose by a broad base from the white cerebral substance of the left hemisphere near the ventricle, but not communicating with that cavity. Externally it was of a pink-red, or pale carmine colour, and of an irregularly lobulated arrangement. Though soft to the touch, it was elastic and cut firm, exposing a vascular mottled surface of a reddish-yellow colour, with portions of blood-like structure here and there. Besides the *pia mater*, which it raised, it was covered by a delicate and very vascular membrane, laminated and shaggy.

* J. A. Rochoux, Recherches sur l'Apoplexie. A Paris, 1814. Obs. 38. p. 149.

A tumour of similar characters is described by Dr Monro *Tertius*,* the present Professor of Anatomy, under his sixth head. In a young man who had suffered from headach, impaired vision, and nausea, followed by epilepsy terminating fatally in a few hours, in the middle lobe of the right hemisphere was a body the size of an orange, somewhat soft, but elastic, and of the colour and consistence of clotted blood. The surrounding brain was in a state of pulpy destruction.

These two last cases are regarded as similar to the tumour named hæmatoid fungus. I am not prepared to prove that they do not belong to this head; but their general resemblance in anatomical characters to that described by Rochoux, induces me to refer them to the head of *Hæmatoma.*

To the same head may be referred that described by Dr George Gregory,† who, in a man labouring under headach, irritable stomach, and epileptic fits, and finally destroyed by epilepsy, found within a cyst in the anterior *cornu* of the left ventricle, before the striated nucleus, a body as large as a nutmeg, hard and fleshy, laminated interiorly an inch thick like coagulated blood, with a cavity in the centre.

d. Fungus Hæmatodes. Encephaloid or Cerebriform tumour.—This morbid growth has been often found in the brain either exclusively or in

* The Morbid Anatomy of the Brain. By Alexander Monro, M. D. &c. p. 56. chap. i.

† Medical and Physical Journal, Vol. liv. p. 462.

common with other textures. Enclosed almost invariably in a cyst, it consists of soft, compressible, spongy matter, of the consistence of fœtal brain, and not dissimilar in colour to gray cerebral matter with a tinge of red, a shining aspect, divided into lobulated masses, which move on each other when slightly touched. Though found chiefly in young subjects, it may occur in the brains of adults; but is rarely seen in the aged.*

Melanosis.—The melanotic deposit has not been very often found in the brain. Streaks of dark matter along the blood-vessels were seen by Dr Alison and Mr Fawdington; † and Dr Hooper delineates melanotic masses of small size in the substance of the organ. ‡

Of these several changes now enumerated, the effects, in general uniform, may be said to vary only according, 1*st*, to the morbid changes induced in the contiguous cerebral substance; 2*d*, according to the extent which the organic change occupies; and 3*dly*, according to its relative situation in the organ.

1. All the tumours above enumerated, independent of the changes proper to their own structure, agree in producing certain common changes in the contiguous cerebral substance. All of them tend

* Observations on Fungus Hematodes, by James Wardrop. Edinburgh, 1809. To this belongs the case of Dr Latham, in Medical and Physical Journal, Vol. lvi. p. 1.

† A Case of Melanosis, &c. by Thomas Fawdington.

‡ The Morbid Anatomy, Plate XII.

to derange the capillary circulation of the brain and its membranes. In the former they induce not only a general injection of the cerebral capillaries, but a local action in the immediate confines of the tumour, and pulpy destruction of the cerebral substance. It often happens also that the whole organ is, in consequence of the capillary injection, infiltrated by pale or bloody serous fluid. In the membranes these tumours also induce injection, terminating in infiltration of the subarachnoid tissue, and effusion from the choroid web into the ventricles. The effects on the cerebral functions are then precisely similar to those which result from derangement of the capillary circulation taking place primarily. If local and intermittent, that is, recurring on the operation of certain causes, it induces chronic headach, with epileptic attacks. When the vascular orgasm becomes more general and constant, loss of memory, and sometimes of judgment, irregular contractions of the members, and more or less palsy, are the consequences. As it advances to pulpy destruction, the involuntary contractions of the muscles are followed by palsy; the abolition of sensation, recollection, and intellect, give rise to fatuity; and life may be terminated either by coma, with or without convulsion, or by a sudden apoplectic attack.

2. Most of these organic changes, if small or limited in extent, exercise little influence on the functions ascribed to the brain. Even when large

their influence seems to be referable chiefly to the morbid changes in the capillary circulation now mentioned. In many instances no change in sensation, intellect, or locomotion is induced till within a few days before death, when the convulsions, palsy, and coma, which preceded this event, must be ascribed chiefly to vascular injection taking place a little before these external effects became manifest.

3. The situation of the morbid substance and of the disordered action is certainly of some moment in modifying the effects produced. To determine the influence of local situation in this respect, attempts, direct and indirect, have been made by La Peyronie, Zinn, Lorry, Haller, and Saucerotte, and more recently by Rolando, Flourens, Serres, Bouillaud, and others. Without attempting to inquire into the merit of the experimental and argumentative investigations of these authors, I shall merely state some of the most important conclusions which they have thought their researches justified.

1. Injury done to the anterior lobes of the brain causes, according to M. Bouillaud, more or less loss of speech, depending either on disorder or abolition of memory, or on that of the muscular motions of the organs of speech.*

* Recherches Cliniques, &c. par M. J. Bouillaud, D. M. Archives Génerales, Tome viii. p. 25. Traité Clinique et physiologique, p. 157—161. Paris, 1825; and Note sur une article de M. Pinel Fils, &c. Journal de Physiol. Tome vi. p. 19.

2. According to the observations of M. Serres * and MM. Foville and Pinel Grandchamp, when the *corpus striatum*, that is, the anterior part of the striated nucleus, is injured, the motions of the legs are disordered and impaired; and when the optic *thalamus*, or the posterior region of the striated nucleus, is injured, the motions of the arms are impaired.

3. Though M. Serres has endeavoured to demonstrate the position of M. Gall, that lesions of the middle lobe of the cerebellum have a particular influence on the generative organs, this is rendered very doubtful by the researches of Rolando, Flourens, and especially Bouillaud. M. Flourens endeavours to show that the cerebellum regulates, influences, or co-ordinates the voluntary motions. Bouillaud shows that, though it cannot be said to regulate the whole of these motions, it co-ordinates those concerned in equilibrium, the state of rest, and the different forms of locomotion. It seems further to be the seat of a modification of memory, that of voluntary motion. When disordered, the memory is obliterated, the motions are impaired or disordered, and the patient exhibits all the phenomena of imbecility, in willing any regular or steady motion, or in preserving any sensible attitude of rest.†

* Annuaire Medico-Chirurgical et Journal de Physiologie, Tome iii. p. 123—128, et ensuite.

† Recherches Experimentales, &c. par J. Bouillaud, Mem-re-Adjoint, &c. Archives Générales, Tome xv. p. 64.

10. *Anencephalous monstrosity.*—This should be noticed elsewhere. But it may perhaps render the history of the anormal states of the brain more complete, to introduce here a species of malformation arising from interruption of the process of developement. Instances of acephalous fœtuses, as they have been named, are numerous from the first records of anatomy to the present time. They vary in degree from deficiency of the whole brain to that of more or fewer of its parts. All of them depend, so far as is hitherto ascertained, on the same general cause, a sudden check given to the process of growth in this organ, while the others continue to increase. The general accuracy of this conclusion is established by the researches of Meckel,* of Duncan Junior,† of Breschet,‡ and of Serres.§ The mode in which this is effected may be understood from the history of the progressive developement of the organ, which I have stated above is formed by deposition from the vascular membrane, commencing near the centre of the hemispheres, and proceeding in both directions towards the convoluted and the

* Handbuch der Pathologischen anatomie, von J. F. Meckel. Leipzig, 1812.

† Case of Hydrocephalus with Bifid Brain, in Medico-Chirurgical Trans. Edin. Vol. i. p. 205.

‡ Note sur deux enfans nouveaux-nés hydrocephales et nianquant de cerveau, par J. Breschet, Journal de Physiologie, Tome ii. p. 269. IIde Note, sur des enfants Nouveaux-nés, &c. par G. Breschet, Jour. de Phys. Tome iii. 232.

§ Essai sur une Theorie Anatomique des Monstrosites animales, Revue Medicale, Tome vi. p. 180. Paris, 1821.

central surfaces. When the process of nutritious deposition is arrested at an early period, the brain is entirely wanting, and one or two imperfectly shaped tubercles only denote the site of the *corpora quadrigemina*, the *thalami*, or the protuberance. If at a later period, the cerebellum and the lower part of the brain, with several of its objects, may be completed. But separating the two hemispheres above, there is found a large chasm filled by water, and in which neither mesolobe, vault, septum, nor thalami can be recognized. This interruption M. Serres ascribes to imperfect developement of the arterial system going to the brain. But this is only a collateral effect. (L.)

CHAPTER XIV.

Section I.

Flesh, Thew, Muscle, Μῦς,—Μυες,—*Musculus*,—*Lacertus*,—*Tori*,—Muscular Tissue,—*Tissu Musculaire.*

The ordinary appearance of the substance named flesh or muscle must be familiar to all; and it is unnecessary to enumerate those obvious characters which are easily recognized by the most careless observer. A portion of muscle, when carefully examined, is found to consist of

several animal substances. It is traversed by arteries and veins of various size; nervous twigs are observed to pass into it; it is often covered by dense whitish membranous folds *(fasciæ,)* or by serous or mucous membranes, all which will be examined afterwards; and it is found to contain a large proportion of filamentous tissue. But it is distinguished by consisting of numerous fibres disposed parallel to each other, and which may be separated in the same manner by proper means. The appearance, arrangement, and characters of these fibres demand particular notice.

According to Prochaska, muscle in all parts of the body may be resolved, by careful dissection, into fibres of great delicacy, as minute as silk-filaments, but pretty uniform in shape, general appearance, and dimensions. Their diameter appears not to exceed the $\frac{1}{40,000}$ part of an inch, whatever be their length. They seem all more or less flattened or angular, and appear to be solid diaphanous filaments. Prochaska appears not to doubt that these muscular threads *(fila carnea)* are incapable of further division; and he therefore terms them *primary muscular fibres.*

The microscopical examination of the atomic constitution of the muscular filament, which was first attempted by Lewenhoeck, and afterwards prosecuted by Della Torre, Fontana, Monro, and Prochaska, has been recently revived M. Bauer, the indefatigable assistant of Sir E. Home. From the observations of this accurate inquirer, each

muscular filament appears to consist of a series of globular or oblong spheriodal atoms, disposed in a linear direction, and connected by a transparent elastic jelly-like matter. *

The primary muscular fibres are placed close and parallel to each other, and are united in every species of muscle into bundles *(fasciculi, lacerti,)* of different, but determinate size; and, according as these bundles are large or small, the appearance of the muscle is coarse or delicate. In the deltoid the bundles are the largest. In the *vasti glutaei* and large pectoral muscles the bundles are greatly larger than in the *psoæ*. In the muscles of the face, of the ball of the eye, of the hyoid bone, and especially in those of the perinæum, these bundles are very minute, and almost incapable of being distinguished. The number of ultimate filaments which compose a bundle varies in different muscles, and probably in different animals. In a muscular fibre of moderate size in the human subject, Prochaska estimates them to vary from 100 to 200; and in animals with larger fibres at double, triple, or even four times that number.† There is reason to conclude, from correct microscopic observation, that the largest

* The Croonian Lecture. On the changes the blood undergoes in the act of coagulation. By Sir Everard Home, Bart. V. P. R. S. Phil. Trans. 1818, p. 175.—The Croonian Lecture. On the structure of a muscular fibre, from which is derived its elongation and contraction. By Sir E. Home, Bart., &c. &c. Phil. Trans. 1826, Part 2d, p. 64.

† De Carne Musculari, Sect. i Chap. iii.

do not exceed the $\frac{1}{8}$ of an inch, and that the smallest are not less than $\frac{1}{16}$.

By cutting a muscle across, these bundles are observed to differ not only in size but in shape. Some are oblong and rhomboidal; others present a triangular or quadrangular section; and in some even the irregular pentagon or polygon may be recognized.

These bundles are united by filamentous tissue of various degrees of delicacy, as may be shown by the effects of boiling; and the muscle thus formed is penetrated by arteries, veins, and nervous twigs, and is enclosed by filamentous tissue, which often contains fat.

This fascicular arrangement appears to be confined to the muscles of voluntary motion. It is not very distinct in the heart or diaphragm; and in the urinary bladder and intestinal canal I have not recognized it. Nor is the parallel arrangement of the ultimate filaments always strictly observed in the involuntary muscles. The component fibres of this order of muscles are often observed to change direction, and unite at angles with each other. This fact, which was observed by Lewenhoeck, has been verified by Prochaska.

The colour of muscle varies. In man and the mammiferous animals, at least adult, it is more or less red; in many birds and fishes it is known to be whitish; in young animals it is grayish or cream-coloured; and the slender fibres which form the middle coat of the intestines in all animals are

almost colourless. The colour of the muscles of voluntary motion in man is red or fawn; but repeated washing or maceration in alcohol or alkaline fluids renders them much paler.

The examination of the physical properties of muscle have occupied the industry of Muschenbroek, Croone, Browne Langrish, Wintringham, and others of the iatro-mathematical school. I cannot perceive that minute knowledge of these properties is of much moment to the elucidation either of its sound or its morbid states. Amidst the variable results necessarily obtained in such an inquiry, the only point which is certain is, that muscular fibre has much less tenacity and mutual aggregation than most other tissues. It sustains much less weight and force of tension without giving way.

Chemical analysis has not yet furnished any satisfactory results on the nature of muscular tissue; but the general conclusion of the numerous experiments already instituted show that muscle contains fibrin, albumen, gelatine, extractive matter (osmazome), and saline substances. It is difficult to say how far the gelatine is to be regarded as proper to muscle, or derived from the filamentous tissue in which it certainly exists. The saline matters are common to muscle with most other organic substances. There is reason to believe that fibrin in considerable quantity, and albumen and osmazome in smaller proportion, are the proper proximate principles of muscle. Though the

various proportions of these principles have been stated in numbers by chemists, there can be no doubt that in the present condition of animal chemistry it is impossible to place any reliance on them. It is also to be remembered, that the relative proportion of the proximate principles varies at different periods of life. In early life the muscular fibre contains a large proportion of gelatine, and very little albumen, fibrin, or osmazome. In adult age, however, the gelatine is very scanty, and the fibrin is abundant. The albumen and gelatine found in muscle seem to be derived chiefly from the filamentous tissue and the aponeurotic intersections.

During life the muscular fibre possesses the property of shortening itself or contracting under certain conditions. These may be referred to the following heads. 1*st*, The will in the voluntary muscles. 2*d*, Proper fluids in the involuntary muscles, as the blood to the heart, articles of food or drink in the stomach, chyme in the small intestines, excrement in the large intestines, urine in the bladder, &c. 3*d*, Mechanical irritants in all muscles. 4*th*, Chemical irritants; and, 5*th*, Morbid products generated in the course of disease.

This property of contracting has received various names; contractility (*vis contractilis* of L. Bellini), irritability (Glisson), (*vis vitalis* of De Gorter and Gaubius), excitability, mobility, *vis insita*, *vis propria* of Haller, and the organic contracility of Bichat.

It is peculiar to muscular fibre, and is found in no other living tissue.

The influence of the brain and nerves over muscular contraction, and the inquiry of the properties peculiar to muscles, form an interesting subject of investigation, on which many facts have been communicated since the time of Haller and Whytt, and especially within the last ten years by Nysten, Le Gallois, Wilson Philip, Bell, Magendie, Flourens, Fodera, and Rolando, But it is too extensive to be considered in this place; and, for information on the subject, I refer to the ordinary physiological works, and to those journals in which these researches are detailed. *

The muscles have been divided according to the manner in which the phenomena of contraction take place,—into 1*st*, muscles obedient to the will, or voluntary; 2*d*, muscles not under the influence of the will, or involuntary; and 3*d*, muscles of a mixed character, the motions of which are neither entirely dependent or independent of the will.

The first order comprehends all the muscles of the skeleton; the second comprehends the hollow muscles, as the heart, stomach, and intestinal canal; and the third comprehends such muscular organs as the diaphragm, intercostal muscles, bladder, rectum, &c.

* Elementa Physiologiæ, Tome iv. Lib. xi. Sect. ii. Journal de Physiologie, Tom. i. ii. &c. &c. Archives Generales, *passim*.

Section II.

1. *Myositis.*—Muscle is liable to inflammation, which may be acute or chronic in duration, and may differ according to its kind. One form of muscular inflammation seems to constitute a species of rheumatism (Carmichael Smyth),* and when this continues long, it terminates in loss of power, constituting a local palsy.

α. *Myositis Purulenta.*—Another form, equally serious and more certainly injurious, is the suppurative form of muscular inflammation. In this the muscular structure suppurates and sometimes sloughs extensively; and, whether acute or chronic, is generally a fatal disease. The most familiar instance of the chronic form of suppurative inflammation in muscle is that which constitutes lumbar abscess,—inflammation of the great psoas muscle.† Of this Schoenmezel records a good example in the person of a muscular young man of 28, in whom the whole of the *psoas magnus* and *iliacus* of the right side was destroyed and converted into purulent matter, forming a sac extending from the last lumbar vertebra along the surface of the

* Medical Communications, Vol. ii. pp. 217, 218.

† "The most remarkable and complete destruction of muscle which occurs from suppuration is that which is seen in the disease called psoas abscess, where the whole or the greater part of the muscle often disappears, and its capsule is filled with the matter of suppuration."—Thomson on Inflam. p. 152.—Lectures, p. 159.

ilium to the small trochanter.* Three similar cases described by Mr Howship form the clearest account of the anatomical characters of this disease.† In such instances, since there is either no affection, or at least no primary affection, of the bones of the spine, it must be inferred that the disease consists in suppurative inflammation either of the muscular tissue, or at least of the filamentous tissue of the muscles. The structure of these muscles, especially that of the psoas, is greatly more delicate than that of any other large muscle, and may have some influence in the destructive seropurulent secretion which follows. Is the muscular texture destroyed or merely separated? I have seen discharged along with the fluid of lumbar abscess capillary filaments, brownish, firm, and evidently the remains of the muscular fibres. At the same time, in the dissections above quoted, no fibres are mentioned in the purulent cyst.

The acute form of muscular inflammation is more rare, but sometimes occurs in the muscles of the abdomen, of the chest, of the thigh or leg, in persons of broken constitution and diseased habits. By some authors, however, the muscular fibre is believed to be incapable of inflammation; and the instances ascribed to it are by them said to be inflammation of the intermuscular cellular tissue. On

* Francisci Schoenmezel, Med. Prof. Heidelbergensis Observatis de Musculis Psoa et Iliaco suppuratis. Heidelbergæ, 1776. Frank, Delectus, Vol. v. p. 169.

† Practical Observations on Surgery and Morbid Anatomy.

this head, I refer to the section on Diffuse Inflammation of the Cellular Membrane.

β. *Carditis.*—Another example of inflammation of muscular tissue is presented in that of the heart. The testimony of Dr Baillie shows that this is a rare disease, and is almost never primary, but the result of inflammation of the pericardium, from which it spreads to the filamentous tissue, and partly to the muscular fibres of the organ. The general accuracy of this statement is confirmed by Laennec, who contends, that though partial inflammation in minute spots is not uncommon, yet general inflammation of the cardiac substance, either acute or chronic, is a thing almost unknown in the records of medicine. The cases adduced by Corvisart he regards as examples of pericarditis; and the same may be said of those of Dr Davis.* The possibility of the fact, nevertheless, he admits on the evidence of the case of Meckel.† Stronger proof he might have found in a case by Mr Stanley, in which the cut substance of the heart was exceedingly dark-coloured from injection of the capillaries; the fibres were soft, loose, easily separable, and compressible between the fingers, while sections of each ventricle exhibited numerous small distinct collections of dark-coloured purulent matter among the muscular fasciculi, —some deep, approaching the cavity of the ventricle, others superficial, raising the pericardium.

* Inquiry into the Symptoms, &c. of Carditis. By J. Ford Davis, M. D. Bath, 1808.

† Mémoires de l'Academie de Berlin.

The muscular substance of the auricles was softened and loaded with blood; but without purulent deposits.* It cannot be denied that in this case the muscular tissue of the organ exhibited marks of inflammation; but the purulent deposits might be seated in the intermuscular filamentous tissue, which, though delicate, is abundant.

Abscess and ulceration of muscular tissue are the result of local or punctuate inflammation. In the former case a cavity, with smooth walls, containing purulent matter, is formed in one region of the muscular substance. In the latter a rugged irregular surface, produced by ulcerative absorption or erosion, takes place near the surface of the muscle. The examples of both forms, as they take place in the heart, are the most interesting to the pathologist. Of abscess in this organ, instances are given by Poterius, Benivenius, Cornax, Nicolaus Massa, Fanton, and Laennec. Of ulcers on the outer surface, instances were seen by Olaus Borrichius, † Riverius, ‡ Job à Meckreen, § Peter de Marchettis, || Malpighi, ¶ Peyer, ** Graetz, and Morgagni. †† The ulcer occurring in the inner surface of the heart was seen by Morgagni, (Epist. xxiv. 17,) and by Laennec, who found one an inch long, half an inch broad, and more than four lines

* Medico-Chirurgical Transactions, Vol. vii. p. 323.
† Bartholini, Acta Med. Haf. Vol. i. Obs. 69.
‡ Cent. i. Ob. 87. § Obs. Chirurg. 35.
|| Observ. Med.-Chir. 46. ¶ Morgagni Ep. xxv. 17.
** Method. Hist. Anat. c. vi. in Schol.
†† Epist. xvi. 17.

deep in the centre, in the inner surface of the left ventricle, which was hypertrophied, and at length ruptured.

γ. *Myositis emolliens.*—To this head may be referred the softened or pulpy state occasionally observed in the substance of the heart in weak extenuated subjects liable to fainting-fits, and also in those cut off by fever. The muscular fibres then assume a light fawn colour or pale yellow, like the dead leaf, become flabby and friable, and so easily lacerable as scarely to sustain handling. By Laennec this is regarded as the result of error of assimilation or defective nutrition; while Bouillaud ascribes it to inflammation. One variety of softening appears to be the consequence of inflammation, and may be considered as gangrene of the heart, Most usually, however, it is the result of imperfect nutrition of the organ during disease, either chronic or subacute.

2. *Hypertrophy.*—There is reason to believe that the condition described as hypertrophy of muscles is mere enlargement depending on chronic inflammation. It is certainly quite different from the enlargement occasioned by exercise, to which it has been erroneously compared. In the heart and bladder, in which it has been most frequently found, not only is the muscular substance thickened and enlarged, but it is rendered hard, firm, and in some parts almost cartilaginous. In the early stage the colour is simply brown; subsequently it acquires in certain parts a leaden gray tint, which seems to

depend on parts of the muscle assuming the cartilaginous induration. The substance of the organ then cuts firm, and resists the knife. The change seems either to depend on, or to be connected with, a process of chronic injection; for the vessels are large, distended, and abundant. In the deltoid and biceps of the fencer, and the *glutaei* and *gastrocnemii* of the dancer, though large and well developed, no change of this description can be recognized. They are indeed firm and tough, like the muscle of entire male animals, but present nothing of the morbid enlargement, congestion, and induration found in the hypertrophied heart and bladder. In proof of the justice of these views it may be added, that the instances in which the muscular coat of the stomach is admitted to be hypertrophied, are those in which scirrhus, or some similar chronic inflammatory state, affects the collateral tissues. (Louis.)

3. *Atrophy* of muscles, or diminution of size, is more frequent, and may arise either from general disease, as in consumption, dropsy, &c. or from local debility, as in rheumatism, palsy, &c.; or, in short, from defective local nutrition, or, as after unreduced luxations, from want of exercise of particular muscles. The best example of complete atrophy is that which takes place in muscles poisoned by lead, which become small, shrunk, pale, and void of irritability.

4. *Steatosis; Adipification.*—I cannot understand upon what grounds the fatty degeneration of mus-

cle is denied by Beclard; for there is no doubt that authentic instances are recorded of this change occurring in the muscles both of man and of the lower animals, under certain diseases. Independent of its being seen in the muscles of the sheep by Vaughan,* it has been observed in those of the human subject by Haller, Louis, Maugre, Vicq-D'Azyr, Dumas, Emmanuel, Laennec, and Adams. Louis, so early as 1739, in amputating the right leg, found the *gemelli*, *plantaris*, *poplitaeus*, *solaeus*, the long common flexor of the toes, the proper flexor of the great toe, and the *tibialis posticus* converted into fat.† Maugre found the muscles of the same region, excepting the *gemelli*, which were greatly diminished in size, converted into an adipose mass easily divisible by the knife.‡ Vicq-D'Azyr, in an old subject, saw the *psoas* and *iliacus*, the *glutaeus medius* and *minimus*, the adductors, the deep posterior muscles of the leg, and the plantar muscles, completely changed into fibro-cellular fat, without traces of remaining fibre. In the sciatic portion of the *semitendinosus* and biceps, the *gemelli*, the extensors of the toes, that of the great toe, and the *tibialis anticus* only, was it possible to recognize fibres with distinct direction. The *sartorius* presented the gradual transition from muscle to fat, being muscular above

* Some account of an Uncommon Appearance, &c. By W. Vaughan, M. D. London, 1813.

† Rapport sur une Observation, &c. Journal General de Medecine, Tome xxiv. p. 5. ‡ Ibid. p. 6.

and adipose below. The fat into which these muscles were changed is described as white, firm, contained in numerous minute cells; the uniting cellular tissue whitish, looser, and more separable than usual; and the fat is not deposited between its filaments, but forms part of their substance. Examined by a good glass, it presents a mass of soft transparent fibres of various diameters, in different parts of their length. * Dumas saw the muscles of the fore part of the chest, and those of the posterior region of the shoulder and arm, reduced to an adipose mass, contained in condensed cellular membrane; those of the abdomen and the *triceps adductor* much changed; and the *glutaeus maximus* and first adductor half changed into fatty matter.† Emmanuel, in the person of a woman of 38, dead of child-bed fever, found the abdominal muscles entirely changed into fat. ‡

Lastly, it was seen by Laennec and Adams in the human heart. The changed portions assume a pale yellow colour, which is most distinct externally, and approaches to the natural tint as it proceeds inwards, at which the muscular fibres are less changed. According to an analysis by Cruveilhier it consists of solid adipocerous fat, oily fluid, (*elaine,*) and a little gelatine.

5. Elongation and shortening of muscular fibres are mentioned among morbid changes.

6. *Rupture or laceration.*—Of this occurrence in

* Journal General de Medecine, Tome xxiv. p. 11.

† Ibid. Tome xxiii. p. 61. ‡ Ibid. Vol. xxiv. p. 4.

muscular organs, the most important example is that of rupture of the muscular substance of the heart. Instances of this have been collected by Morand,* Morgagni, † Haller, ‡ Portal, § Brera, ‖ Baillie, Rostan, ¶ Blaud, ** Rochoux, †† and Adams. ‡‡ According to the results obtained by these observers rupture of the heart is most frequent in the left ventricle, which gives way by a longitudinal fissure near the base and middle of the ventricle. In most of the cases, this rupture may be traced to previous ulceration, (Morgagni, Haller, Portal, Brera, &c.) and appears to be the result of the ulcerative process advancing from one surface of the ventricle to the other. Of rupture of the right ventricle too little is known to determine whether it be also the result of ulceration or not. So far, therefore, as is hitherto known, laceration of the muscular substance of the heart is not so much the consequence of being violently or forcibly torn, as of its being previously wasted, extenuated, and weakened.

Transverse laceration of muscular fibres, or forcible detachment from the tendons, may happen in consequence of external violence. This was

* Mem. de l'Acad. Roy. des Sci. 1732.

† Epist. xxvii. 2, 5, 8; lxiv. 15. ‡ Elem. Physiolog.

§ Mem. de l'Acad. Roy. des Sciences, 1784.

‖ Sylloge, Vol. x. Opusc. vi. p. 202.

¶ Nouv. Journ. de Med. Avril, 1820. Tome vii. p. 280.

** Bibliotheque Med. Aout, 1820.

†† Sur les Ruptures des Cœur.

‡‡ Dublin Hospital Reports, Vol. iv.

seen by Wolfius,* Wynandts,† Cheselden,‡ Portal,§ Deramé,‖ Bichat,¶ and Wardrop.‡‡

Rupture of the muscular coat of the stomach, which is not unfrequent, is in like manner the consequence of ulceration or erosion of its villous membrane, and shall be noticed under that head.

7. *Bony induration or deposition.*—This, though not very frequent, is not unknown. Morgagni mentions in his first case of ulcerative rupture a bony mass an inch thick, shaped like a half ring, being found in the muscular substance of the left ventricle, adhering, however, to the mitral valves, also ossified. A similar case is recorded by Haller; and to such instances it may be justly objected, that they are not so much examples of conversion of muscular fibre into bone as deposition of bony matter in collateral tissues progressively encroaching on the muscular layer. One of the most distinct examples of seeming conversion of muscular fibre into calcareous matter is given by Renaudin in the person of a man of 33, subject to violent palpitation. The substance of the left ventricle was infiltrated with sabulous and crystalline grains. This calcareous deposition must not be confounded with ossified pericardium,—the usual example of ossified heart.

* Haller Bibl. Chir. I. p. 223. † Verhand. von Haarlem.
‡ Anatomy, p. 207. § Anat. Med. ii. p. 412.
‖ Mem. de la Soc. Med. i. p. 159.
¶ Anat. Gen. Tome iii. p. 234.
‡‡ Medico-Chirurgical Transact. Vol. vii. p. 278.

8. *Accidental productions and tumours.*—Muscular structure is liable to tubercular deposition, to scirrho-carcinoma, to lardaceous degeneration, *(ceroma)* to encephaloid tumours, and to the melanotic deposit, (Cullen.) Serous cysts *(hygroma)* are said to be rare; but the solitary hydatid *(cysticercus cellulosæ)* is not uncommon. * The latter especially has been seen in the *trapezius, serratus posticus, psoas, iliacus, glutaeus,* and other large muscles, (Werner, Rudolphi,) and in the heart by Morgagni, (xxi. 4.) Portal, and Price.

CHAPTER XV.

Section I.

Sinew, Tendon, *Tendo.*

Sinew or tendon was united by Bichat with ligament, fascia, aponeurosis, and periosteum, under the general name of *fibrous system;* and the substance of this arrangement has been adopted by Gordon, Meckel, and Beclard. I am inclined, however, from personal observation, to regard tendon as essentially distinct, at least in the present state of knowledge, from these substances. Examined anatomically, it does not bear a very close resemblance to any of them, and in its known chemical properties, it is considerably different.

The appearance of this substance must be fa-

* Bremser, Traité Zoologique, xi. p. 280.

miliar to all. Almost cylindrical in shape, but flattened at the muscular end, and tapering where inserted, a tendon consists of numerous white lines as minute as hairs, of satin-like glistening appearance, placed parallel and close to each other. A tendon is easily divided, and torn into longitudinal or parallel portions, and by the forceps very minute fibres may be detached and removed with ease, its whole length. These facts show the great tenacity of this tissue, and the regular parallelism with which the component fibres are united. The last circumstance distinguishes them completely from ligaments and periosteum, in which the fibres cross in all directions, and in consequence of which these tissues cannot be so easily split or separated. These fibres are united by filamentous tissue.

Tendon is softened and more easily separable by maceration in water or alkaline fluids; it is crisped by acid fluids, and rendered translucent by immersion in oil of turpentine. It has not been injected, but it is presumed to have blood-vessels and absorbents. No nerves have been traced into it.

Tendon when boiled becomes soft and large, assumes the appearance of a transparent gelatinous substance; and finally, if the boiling be continued, is dissolved and converted into gelatine. This fact, which is well known to cooks, who prepare jellies from tendinous parts of young animals, shows that tendon consists principally of gelatine, disposed in an organized form.

A species of flattened tendons, to which the name of *aponeurosis* has been given, may justly be united with this tissue. The best examples are in the aponeurotic or tendinous expansion of the external oblique muscle of the abdomen, the aponeurotic part of the occipito-frontal muscle of the head, and the upper or broad end of the *tendo Achillis*. The anatomical structure and the chemical properties of each of these varieties of animal substance are quite similar, and somewhat different from that which has been termed *fascia*.

Section II.

In tendon inflammation is rarely spontaneous, and is generally the result of cut, tear, bruise, twist, wrench, or burn, when the effects vary according to the nature of the injury. Simple division of tendon may unite without much difficulty, though the medium of reunion appears to be filamentous tissue with some gelatino-albuminous matter. In laceration complete reunion will depend upon the extent of the injury. That of the *tendo-Achillis* is the most frequent. I have seen complete rupture of the extensor tendon of the middle finger unite in the course of four months without perceptible trace of the accident, and with complete restoration of the functions of the finger in about four or five months more. Twists or wrenches of the joints often injure not only tendons, but ligaments, fasciæ, and even cartilage, and occasion inflammation of all these textures at once. Of this the injury termed sprain

is an example. Tendinous texture readily sloughs under inflammation, either spontaneous or from injury. In whitloe the tendons of the flexor muscles of the fingers are often killed and thrown off by ulceration; and when tendons are injured by burns or gunshot wounds death of their texture is almost invariable. In this state tendon loses its silvery white appearance and lustre, assumes a dull leaden gray aspect, and becomes thick and doughy.

The process of inflammation is most distinctly seen in wounds of the extremities, and in lacerations or ruptures of the tendons. They become enlarged, sometimes expanded, in various affections of the joints. Punctured or lacerated wounds of tendinous structure are sometimes succeeded by tetanic motions, which terminate fatally. Ossification, so common in the tendons of birds, is almost unknown in the human subject; unless the sesamoid bones be admitted as examples of this transformation.

CHAPTER XVI.

SECTION I.

WHITE FIBROUS SYSTEM. *Ligament,*—Δεσμος, οἱ δεσμοι; *Periosteum; Dura Mater; Fascia.*

AGAINST the formation of this order of tissues fewer objections can be urged, though ligament and periosteum undoubtedly furnish its most perfect examples; and it may be doubted whether *fascia* ought to be referred to it, or arranged with

tendon and aponeurosis. The *dura mater*, the *tunica albuginea*, and the fibro-synovial sheaths, are to be regarded as compound membranes.

Ligament and periosteum are easily shown to consist of strong whitish or gray fibres, as minute as threads or hairs, interwoven together in various directions, and thus forming an animal substance which is not to be split or torn asunder as tendon; but when ruptured by extreme force presents an irregular ragged surface or margin. Maceration in water or alkaline fluids separates the component fibres, and shows their irregular disposition more distinctly. They are crisped by affusion of boiling water, or immersion in acids; and they become translucent by immersion in oil of turpentine.

The properties of this tissue are chiefly physical. Those which are vital are referable to its organization and nutrition. It is powerfully resisting, and is one of the toughest and strongest tissues in the animal body, as is shown by the numerous experiments recorded in the writings of the iatro-mathematical physiologists. It is supposed to possess the exhaling ends of arteries and colourless veins. No nerves have been recognized; and Bichat expresses his ignorance of absorbents being traced into it.

Ligament when boiled yields a small portion of gelatine, but obstinately resists the action of boiling water, and retains both its shape and tenacity or cohesion. The crispation which it undergoes in boiling water, alcohol, and diluted acids, seems

to indicate that albuminous matter forms its chief chemical principle.

As to their mechanical shape, the ligaments are divided by Bichat into two sorts; those in regular and those in irregular bundles. The former comprehends all the distinct clusters of ligamentous structure, which sometimes in a cylindrical, sometimes in a flattened shape, connect the articulating ends of bones, and form the lateral ligaments of the various articulations. The latter consists of those loose parcels of ligamentous fibres which are found in various regions of the skeleton, not in regular cylindrical or longitudinal bands, but irregularly connecting bones not admitting of articular motion; for instance at the *symphysis pubis* and the sacro-iliac junction. The division of Beclard into articular, non-articular, and mixed, is more comprehensive and more natural. The first are those which connect the articular extremities of different bones. The second are those which, attached to different parts of the same bone, convert notches into foramina, as in the orbitar arch and the supra-scapular hollow, or close openings, and give attachment to muscles, as the obturator ligament. The last are those which, like the sacro-ischiatic or the interosseous ligaments of the fore-arm and leg, connect bones susceptible of little or no motion, and especially give attachment to muscles. The two latter species of ligaments approach closely in their characters, physical and anatomical, to periosteum, and are probably to be regarded as modifications of this membrane.

The articular or perfect ligaments are naturally divisible into two subgenera,—the capsular and the funicular.

The capsular ligaments or the fibrous capsules, (Bichat,) consist of cylindrical ligamentous sheaths attached all round to the ends of the articulating bones, and intimately interwoven with the periosteal tissue. Consisting essentially of fibro-albuminous matter strongly compacted, they are surrounded by cellular tissue, or rather celluloso-adipose tissue, and are lined internally by synovial membrane. Though the most perfect examples of the capsular form of ligament are presented in the scapulo-humeral and coxo-femoral articulations, less complete ones, nevertheless, are seen in the other joints. In those of the knee and elbow, an arrangement of this kind may be demonstrated; and minute capsules may be shown to connect the oblique articular surfaces of the vertebræ with each other.

The funicular ligaments, which consist of round chords or flat bands, are employed in connecting the articular ends of bones either without or within the cavity of the joint. Of those of the former description, the best examples are seen in the elbow and knee-joints, and in the wrist and ankle, where they are termed *lateral* ligaments, *(l. lateralia, accessoria.)* Of the latter instances, are the round ligaments, *(ligamenta teretia,)* of the shoulder and hip-joints, and the crucial ligaments of the knee-joint. These receive an investment of synovial membrane.

Of the white fibrous tissues one of the most important is that denominated *fascia*. Consisting in intimate structure of long fibrous threads placed in parallel juxtaposition, sometimes obliquely interwoven and closely connected by filamentous tissue, it forms a whitish membranous web, variable in breadth, of some thickness and great strength. Fascia is perhaps, not excepting the skin, the most extensively distributed texture of membranous form in the animal body. It not only covers, if not the whole, at least by far the greatest part of the muscles of the trunk and each limb, but it sends round each muscle productions by which it is invested and supported, and even penetrates by minute slips into the substance of individual muscles. Of several of the larger muscles it connects the component parts, as is seen in the *recti abdominis;* to many it affords points of origin or insertion; and to all it furnishes more or less investment and support. Most of the tendons, especially the flexor and extensor tendons, are enclosed by it; and their synovial sheaths derive from it their exterior covering. At the extremities of the bones it is connected with the ligaments and periosteum, with which it is closely interwoven; and it forms a general investment to the articular apparatus.

Though fascia may thus be viewed as one membranous web consisting of many parts all directly connected with each other, it is the practice of anatomists to distinguish its divisions according to the region which they occupy. Thus

in the fore part of the neck and chest is found a fascia, the relations and uses of which have been well described by Mr Allan Burns.* In the cervical region we find a firm fascia descending from the occipital bone along the vertebræ, covering and connecting the muscles of each side till it reaches the loins, where, in the form of a thick strong membrane, it forms the *lumbar fascia, (fascia lumborum.)* It may further be traced over and between the *glutaei* muscles ; connected afterwards with the broad femoral fascia, *(fascia lata ;)* and thence over the knee and leg to the foot. Much in the same manner a membranous web, thinner and more delicate, but of the same structure, may be traced from the chest along the upper extremity, till at the wrist it is identified with the annular ligament, and in the hand with the palmar fascia. In all these situations the general fascial envelope sends slips or productions *(fasciæ intermusculares)* between the muscles, and into their substance. †

Section II.

The morbid relations of this system are important. But in consequence of their being often combined with other tissues, it is difficult to distinguish them properly.

1. Inflammation in various forms is not uncommon, and may take place either spontaneously, or as the effect of accident.

* Surgical Anatomy, pp. 33, 36.

† Surgical Anatomy, by Ab. Colles. Dublin, 1811.

α. *Desmodia.*—Inflammation of ligament may be spontaneous or the result of injury. In the former case it is generally chronic, and is attended with much thickening of the desmoid tissue. The morbid action spreads to the synovial membrane on the one side, causing it to thicken and effuse morbid fluid, and on the other, to the peridesmoid cellular tissue, which is then infiltrated with jelly-like fluid, and becomes separated and somewhat indurated and granular. These changes take place in those forms of articular disease commonly known under the vague name of *white swelling;* (*tumor albus; fungus articuli;* der Gliedschwamm.) After some time this morbid state of the extra-articular cellular tissue may proceed to suppuration, but without necessarily opening the cavity of the joint. The capsular ligament, however, and even the funicular ones, may be so much changed in structure as to become unfit for their functions.

Though the progress now described is that which takes place in inflammation of ligament when primary, it is necessary to mention, nevertheless, that inflammation in these tissues is much more frequently the consequence of previous disease in the synovial membrane or the articular cartilages. This is particularly the case in the knee-joint and elbow.

β. *Ulceration* of ligament is the result either of traumatic inflammation proceeding to suppuration, or of suppuration within the articular cavity. Even in the latter case the desmoid tissue itself is rarely destroyed; and the opening takes place be-

tween its fibres, which are loosened and separated. The most frequent instances of ulcerative destruction of this tissue are seen in destruction of the round ligament and part of the capsule in the coxo-femoral articulation, and in that of the crucial ligaments in the femoro-tibial articulation.

γ. Periostitis.—Periosteum is liable to inflammation either from injury, spontaneously, or from the operation of the syphilitic or the mercurial poison. In fractures of the extremities the periosteum may be seen reddened, thickened, and depositing semifluid substance, which appears to coagulate and unite the broken or wounded portions. When it takes place spontaneously, it is said to depend on the strumous diathesis, of which it is believed to be an indication. The membrane becomes thick, painful, unusually vascular, and, unless the action subsides, or is controlled by art, semifluid lymph is effused beneath it, and even bloody, sanious, purulent matter may be formed. If the inflammation be confined to one spot, the thickened membrane, with the lymphy induration beneath it, gives rise to the swelling termed node, (*nodus.*) When suppuration takes place, it is too often followed by caries of the subjacent bone if of soft spongy texture, as in the sternum; or death (*necrosis*) if in one of more compact structure, as in the scull. The distinction, however, is not invariably observed; for caries of the *tibia* or *ulna* is seen to follow

periosteal inflammation in these bones.* The appearances produced in the bones by this process belong to another head. Though any part of the periosteum may be attacked by inflammation, certain regions seem more liable to it than others. Node, whether from strumous, syphilitic, or mercurial origin, generally takes place in parts of the periosteum where that membrane approaches the surface. Thus the anterior surface of the tibia, the posterior internal surface of the ulna, the outer surface of the radius, and the anterior surface of the clavicle and sternum, are usual situations for periosteal inflammation. Strumous periosteal inflammation in the phalanges of the fingers I have seen only in young children. The phalanges are then rough and denuded; and the discharge of fetid sanious matter gives rise to sinuous ulcers not easily healed. These effects are to be attributed to the suspension of the nutritious powers of the periosteal vessels. (See p. 535.)

In some instances inflammation of the periosteum terminates in a bony swelling, or a deposition of hard osseous matter on the surface of the bone. *(Exostosis.)* The exact nature of the process is not well understood. But there is reason to believe, that what is originally a deposit of lymph, as in node, becomes eventually penetrated by calcareous matter. (Med.-Ch. Tr. Vol. viii. p. 90.)

* Practical Observations in Surgery and Morbid Anatomy, &c. By John Howship, London, 1816, p. 176. See Note (M.)

The perichondrium is not very dissimilar in morbid relations to the periosteum. Its inflammation may cause in like manner thickening, morbid deposits, and ulceration, or even death of the subjacent cartilage. Such is the course of phenomena occasionally observed in the cartilages of the larynx and those of the ribs.

δ. *Sparganosis. Rheumatismus.* Rheumatism. Fascial inflammation. Though I have above admitted, on the authority of Carmichael Smyth, inflammation of muscular tissue as a cause of rheumatism, I doubt whether it is entitled to the character of a genuine or uniform pathological cause of that disease. Independent of the fact, that the rheumatic pains occur often round joints in which there are no muscles, the theory is at best only an ingenious assumption, and is not supported by any strong facts or arguments.

Though rheumatic pain is often referred to muscular parts, it is less frequently so than to joints and parts covered by aponeurotic sheaths and *fasciæ*. Of 520 cases, Haygarth observed in 388 the rheumatic action to be seated in joints, in 118 in muscular parts, and in 14 wandering, general, or migrating through the limbs. Of 170 cases, in 154 one or more joints were inflamed; in 33 cases, both joints and muscles were simultaneously affected; and in some cases only were the muscles affected without the joints.

Though from these facts Dr Haygarth infers that acute rheumatism is seated chiefly in the

joints, he does not attempt to ascertain the particular texture, in the affection of which the disease consists. It is further manifest, that while it is impossible to exclude affection of the muscles entirely, it results that this affection is only secondary. The proof adduced by Dr Scudamore from pressure of the whole course of a muscle, and grasping its substance during severe rheumatism, to show that the fleshy part is not the seat of complaint, is entitled to attention. Combined with those already mentioned, and with other considerations to be adduced immediately, it results that the rheumatic action is seated in a texture, which, confined neither to the site of the joints, nor to that of the muscles exclusively, is common to both, and which, from its extensive distribution and complicated arrangement, accords best with the phenomena, progress, and effects of the disease. It is unnecessary to repeat the considerations above adduced from the anatomical relations and characters of fascia and its various divisions. That they are the chief seat of acute rheumatism may be inferred from the following circumstances.

1. When the rheumatic action is seated in muscular parts, instead of being confined to the muscular fibres, it may always be referred to the aponeurotic membrane which covers or penetrates them. 2. The peculiar pains of rheumatism are always most distinct in those situations in which several folds of aponeurotic membrane meet; and

their migrations may be traced from one extremity to another of an aponeurotic membrane, and along the course of its principal divisions. 3. The kind of pain which attends rheumatism resembles that of the fibrous tissues in general when inflamed in undergoing aggravation under the influence of external heat and during the night. 4. This view of the seat of rheumatic disorder affords the most probable explanation of the effusion which takes place in the tendinous sheaths *(bursæ mucosæ;)* for since each sheath is partly enveloped in aponeurotic membrane, the inflammatory process which takes place in the latter soon gives rise, as in analogous cases, to effusion, critical or non-critical, from the contiguous synovial membrane. 5. This view also affords the most rational explanation of the fact remarked by all authors, that rheumatism almost never terminates in suppuration. To suppose that muscle does not suppurate, is perhaps erroneous from what has been above adduced. That fascia and fibrous tissue in general is little disposed to suppurate, unless when mechanically injured, is manifest from a number of circumstances; and this may perhaps be regarded as the true explanation of the fact now noticed. 6. It must further be remarked, that inflammation in this tissue renders it thick, hard, and rigid, and occasionally causes between its fibres effusion of lymph, which increases this thickening, induration, and rigidity. On these changes depend the immobility of rheumatic parts,

and the loss of power which follows long and obstinate, or neglected and repeated, attacks of the disease.

The question, whether there be any thing peculiar in the nature of rheumatic inflammation is not undeserving attention. This, however, is not the place for discussing it; and if the views now advanced be well-founded, it may be inferred that its peculiarities consist in the anatomical and physical qualities of the texture in which I have attempted to show it is seated.

Though in acute rheumatism the inflammation affects a large proportion, if not the whole of the fascial system, local forms of the disease may occur, in which it is confined with more or less accuracy to one or two fasciæ. Thus inflammation of the fascia of the temporal and masseter muscles produces rheumatism of the temple and rheumatic locked jaw; that of the occipito-frontal fascia rheumatism of the head; that of the cervical fascia crick in the neck; that of the pectoral fascia and the intersections of the intercostal muscles spurious pleurisy (*pleurodyne;*) that of the abdominal fasciæ a rheumatic belly-ach; that of the lumbar fasciæ *lumbago;* and that of the aponeurotic parts of the glutaeal muscles genuine *sciatica* or hip-gout.

2. *Tyroma.*—The tyromatous deposition in the tubercular form may take place in the periosteum. The tubercles which in colour and physical qualities resemble tyromatous matter in other situa-

tions are minute, irregularly spheroidal, and occupy the substance of the membrane. Their presence gives rise to chronic inflammation of the membrane, which becomes thick, spongy, and vascular, and is at length detached from the bone by effusion of purulent fluid; and their liquefaction eventually forms a bad suppuration. This is one of the forms of what is usually termed strumous disease of the bones.

3. *Chondroma.*—Cartilaginous induration of the white fibrous tissue is so common that it scarcely requires separate notice. The ligaments are often affected with this, especially in stiff and ankylosed joints, and appear then to acquire the properties of genuine cartilage. This, which may be regarded as one of the effects of chronic inflammation, with long disease of the articular tissues, I conceive, is what is meant by inordinate *rigidity* of the ligaments, much dwelt on by practical authors It never occurs, I am satisfied, unless under the circumstances now mentioned. In the periosteum I have seen the same change resulting from the same causes. It takes place after compound fractures, occasionally after amputation, and, in short, in all circumstances in which the membrane is inflamed.

4 *Ossification.*—Partial or general conversion into bone, though not uncommon in the white fibrous system, is nevertheless restricted in a peculiar manner. It is, for instance, much less frequent in ligament than in periosteum; and in fascia it is

scarcely known. Ossification in ligament commences at the point connected with the periosteum; and it is uncommon to observe it extend over the whole ligament, unless in cases of anchylosis and stiff joint, in which it is rather a sort of cartilaginous rigidity and induration than actual conversion into bone. The former appears to be the origin of the bony nodules or sesamoid bones occasionally found in the substance of the funicular ligaments. In the irregular ligaments, especially the sacro-ischiatic, it is not unusual to find ossification in aged subjects.

That the periosteum may be converted into bone is a point which has been alternately admitted and denied during eighty years. While the numerous experiments of Du Hamel* and Troja† tend to establish it in the affirmative, it is rendered very doubtful by the facts and arguments of Leveillé and Richerand. From the experiments of the former authors it results that the periosteum becomes thick, highly vascular, very firm, and eventually acquires a bony hardness in its inner layer under either of the following circumstances:—1*st*, when it is detached from the bone; 2*d*, after fractures during the process of reunion; and 3*dly*, when the marrow or its membrane is destroyed. That in the two former instances the inner layers of the periosteum truly undergo conversion into bone, may be regarded as established, not only by the experi-

* Mem. de l'Acad. des Sciences, 1741, &c.

† Mem. de la Societé Roy. de Med. 1776.

ments of Du Hamel and Troja, but by those of Dupuytren,* Cruveilhier,† Breschet,‡ and Villermé,‖ and especially by the phenomena of reunion after fractures by gunshot wounds. The third case, that of injury of the marrow and its vessels, is perhaps more ambiguous. It appears, nevertheless, from the experiments of M. Cruveilhier, that only when the medullary membrane is destroyed, with the permanent continuance of a foreign body in the canal, ossification at the surface of the bone takes place at the expence not only of the periosteum, but even of the muscles. The condition necessary for the ossification of the periosteum after injury appears to be that the concomitant inflammation produces albuminous effusion only; for when the membrane is in contact with purulent matter, effusion of albuminous or coagulable fluid is precluded; and in this sense only, perhaps, are the inferences of Leveillé to be admitted.

In fascia, I have said, and I may add tendinous aponeurosis, ossification is almost unknown. To this head, however, may perhaps be referred the instance recorded by Hoernigk of alleged ossification of the tendinous centre of the diaphragm and part of the intercostal muscles§; that of chondro-osteoid induration of the right half of the diaphragm by Lieutaud from the Petersburgh Trans-

* Journal Univers. des Sci. Med. T. xx. p. 131.

† Essai sur l'Anatomie Pathologique, Tome ii. p. 25, &c. Paris, 1816.

‡ Quelques Recher. Hist. et Exper. sur le Cal. Paris, 1819.

‖ Quart. Journ. of Foreign Medicine, No. ii. London, 1819.

§ Haller, Disputationes Medico-Pract. Tom. vi. p 344.

actions*; a similar case seen by Leveillé in 1793; and that of ossification of the tendinous centre of the same muscle mentioned in the body of Collalto by Cruveilhier. The instance of cartilaginous induration of the deep-seated muscles of the leg, found by Dupuytren in the body of a man affected with Arabian elephantiasis, though considered by Cruveilhier as ossification of the muscles, is probably with greater justice to be viewed as of the same description. †

A singular instance of ossification of the fibrous *septum* of the *corpus cavernosum* so complete as to require excision occurred to Dr M'Lellan of Baltimore in the United States. ‡

5. Some of the forms of *osteo-steatoma* and *osteo-sarcoma* appear to originate in the periosteum. The former is generally an encysted tumour, and, according to the observation of Meckel, may primarily affect this membrane. The latter, from its anatomical characters, bears a greater affinity with this source; and I think, in several cases, I have been able to trace osteo-sarcomatomatous tumours to the periosteum. ‖ Of neither, however, are the local relations, when examined, so simple or distinct as to enable the pathologist to determine the question positively. Does true

* Historia Anatomico-Med. Tome ii. p. 99.

† Essai sur l'Anatomie Pathologique, Tome ii. p. 73.

‡ Philadelphia Monthly Journal, Nov. 1827. Vol. i. No. 6. p. 256.

‖ Mr Howship in Medico.-Chir. Trans. Vol. viii. p. 95 and 99; where the same conclusion is formed.

cancer *(scirrho-carcinoma)* ever originate in the periosteum? The tumours to which this name has been applied are rather examples of *osteo-sarcoma* than of genuine scirrhus. Such at least is the character of most of the tumours of the maxillary sinus.

6. When the encephaloid degeneration *(fungus hæmatodes)* appears in the periosteum, it may often be traced to the contiguous muscles, or to some of the adjoining articular tissues, or to the bone itself. In the latter case, however, it is almost impossible to determine whether the bone or periosteum were the original seat of the disease.

7. Punctured and contused wounds of the white fibrous system, especially of the ligaments and periosteum, are liable to be succeeded by tetanic motions, more or less general; and wounds with much laceration in subjects of all ages are too often followed by gangrenous inflammation terminating fatally. This I have seen several times, not only in compound dislocations of the larger joints, but in contused wounds of the feet, in which the white fibrous system is much injured. Partial laceration of the capsular ligaments occasionally takes place in dislocation. (A. Bonn, Desault, Howship, Sir A. Cooper.)

8. *Desmectasis. Excessive relaxation* is mentioned as an anormal state occurring in ligaments. It is the result of repeated overdistension, as in luxation or subluxation, or in consequence of the weakness sometimes left after local inflammation, or long-continued disease. Though this may hap-

pen to the ligaments of any joint, it is most frequently seen in those of temporo-maxillary and scapulo-humeral articulations. Distortions of the spine are ascribed by Dr Harrison to relaxation of the vertebral ligaments. But if this be the cause, it is merely as the effect of previous disease; and it is quite inadequate to produce the extreme deformity so frequently observed in the vertebral column of young persons.

On the new or accidental production of the fibrous system in other tissues, much has of late years been written by Bichat, Bayle, Laennec, and other foreign authors. Without positively denying the principle, that the fibrous system may be accidentally developed, I think with Meckel, that in general these new products partake of the cartilaginous character. The notice of them, therefore, will more conveniently be introduced under that head.

CHAPTER XVII.

YELLOW FIBROUS SYSTEM. *Ligamenta Flava; Ligamentum Nuchæ. Tissu Fibreux jaune,* Beclard.

THE yellow ligaments (*ligamenta flava*) which connect the spinous processes of the vertebræ to each other differ considerably from the articular ligaments and the periosteum, and suggested to Beclard the necessity of establishing a particular

order of fibrous tissues, to which he applied the denomination of *yellow or tawny fibrous system.* Under this he includes also the proper membrane of the arteries; that of the veins and of the lymphatic vessels; the membranes which form excretory ducts; that of the air-passages; the fibrous covering of the cavernous body of the urethra, and perhaps that of the spleen. The actions and occasional distensions of which these parts are the seat require, it is said, a tissue, the resistance and elasticity of which may at once counteract any extraordinary effort, and cause them to resume their original state, when the distending cause ceases to operate. In the lower animals this purpose is more conspicuous than in the human subject. The posterior cervical ligament (*ligamentum nuchæ*, Arab.; *cervicis*, Lat.) counteracts the tendency to inclination of the head; and a similar membrane strengthens the abdominal parietes, and resists the weight and distending power of the *viscera.* In the feline tribe, an elastic ligament inserted into the unguinal phalanges retains them extended so long as the muscles do not alter their direction. The shells of the bivalve molluscous animals, as oysters, mussels, &c. are opened by a similar fibrous tissue as soon as the muscles which close them are relaxed.

The disposition of the component fibres is the same in the elastic as in the common white fibrous system. Their colour, which is yellow or tawny, is generally more distinct in the dead subject. They are said to be less tenacious, but more elas-

tic than those of any other tissue. In respect to chemical composition, they appear to contain a considerable quantity of fibrine in a peculiar condition, combined with some albumen and a little gelatine. Their other properties are not very conspicuous. The morbid changes incident to them are quite unknown.

CHAPTER XVIII.

SECTION I.

BONE, ὀστεον. *Os,—Ossa,—Tissu Osseux.* DIE KNOCHEN.

No animal substance has been more frequently or thoroughly examined than bone; and the greatest difficulty in describing its general anatomy consists in selecting and concentrating information. *

* The principal authors on the structure of bone are Dominici Gagliardi, *Anatome Ossium, novis inventis illustrata.* Romæ, 1689. Malpighi, *De Ossium structura ex Op. Post.* who corrected the fictitious views of the former. Clopton Havers, *Osteologia Nova.* London, 1691. De La Sone, *Mémoire sur l'organisation des os,* Mém. de l'Academie, 1751. G. C. Reichel, de *Ossium ortu atque structura.* Lips. 1760. Ext. in Sandifort Thesaur. Vol. ii. p. 171. Antonii Scarpa, *de Penitiori Ossium Structurâ Comment.* Lips. 1799. Republished in *De Anatome et Pathologia Ossium Commentarii,* Auctore A. Scarpa. Ticini, 1827. Papers by Mr Howship in the sixth and seventh volumes of the Medico-Chirurgical Transactions.

Several attempts have at different times been made to ascertain the atomic constitution of bone, but without much success. Malpighi, though he corrected the extravagant fiction of Gagliardi regarding the osseous plates and nails, fancied bones to be composed of filaments, which Lewenhoeck represented as minute hollow tubes; *(tubuli.)* By Clopton Havers, again, the ultimate particles of bone were imagined to be fibres aggregated into plates *(laminæ)* placed on each other, and traversed by longitudinal and transverse hollows or pores, *(pori.)* * This view was adopted by Courtial, † Winslow, ‡ Palfyn, § Monro, ‖ and Reichel, ¶ who was at some pains to demonstrate this arrangement of plates and minute tubes by microscopical observation. These notions were first questioned by Scarpa, who, in 1799, undertook to show by examinations of bone deprived of its earth by acid, and long macerated in pure water, that it consists, both externally and internally, of reticular or cellular structure. ** So far as I understand what idea this eminent anatomist attaches to the terms *reticular* and *cellular*, I doubt whether this opinion is better founded than any of the previous ones. After repeating his experiment of immersing in oil of turpentine, bone macerated in acid, I cannot perceive the re-

* Osteologia Nova. London, 1691, p. 34, 37, 41, 46.
† Nouvelles Observations sur les Os. A Leide, 1709.
‡ Exposition Anatomique. § Anatomie Chirurgicale.
‖ Anatomy of the Bones. ¶ De Ossium Ortu, &c. § v.
** De Penitiori Ossium Structura, 4to. Lips. 1799.

ticular or cellular arrangement which Scarpa describes as demonstrable in bone. It must, I conceive, be the result of the mode of preparation. Recently bone has been submitted to microscopic examination by Mr Howship, who has been led to revive the opinion of the existence of minute longitudinal canals, as maintained by Lewenhoeck, Havers, and Reichel, but with Scarpa maintains the ultimate texture not to be laminated but reticulated.* *Lastly*, the existence of fibres and plates, which is admitted by Blumenbach, Bichat, and Meckel, apparently on insufficient grounds, is to be viewed as an appearance produced by the physical, and perhaps the chemical qualities of the proper animal-organic matter of which bone consists. Though it does not demonstrate, it depends on, the intimate structure of this body.

The minute structure or atomic constitution of bone is probably the same in all the pieces of the skeleton, and is varied only in mechanical arrangement. When a cylindrical bone is broken, and its surfaces are examined with a good magnifying glass; or when minute splinters are inspected in a powerful microscope, it appears to be a uniform substance without fibres, plates, or cells, penetrated everywhere by minute blood-vessels. Its fracture is uneven, passing to splintery. In the recent state its colour is bluish-white; but in advanced age the blue tinge disappears. Delicate injection,

* Experiments and Observations, &c. Medico-Chir. Trans. Vol. vi. p. 287, and Microscopic Observations, &c. Vol. vii. p. 392, &c.

or feeding an animal with madder, shows the vascularity of this substance.

To have a clearer and more accurate idea of the minute structure of bone, it is requisite to break transversely a long bone, and examine its fractured surface by a good glass, or to examine in the same manner the transverse fracture of a long bone which has been burnt white in a charcoal fire. The broken surface presents a multitude of minute holes, generally round or oval, which are larger towards the medullary cavity, but become exceedingly minute towards the outer surface of the bone. Of these minute holes no part of the bone, however compact in appearance, is destitute; and the only difference is, that they are more minute, and more regularly circular towards the outer than towards the medullary surface. These circular holes are transverse sections of the *tubuli* of Lewenhoeck, the longitudinal pores of Havers, (*Osteologia*, p. 43 and 46,) the pores and *tubuli* of Reichel, and the longitudinal canals of Howship. They communicate with each other by means of their great multiplicity and slight obliquity and tortuosity. They contain not blood-vessels exclusively, but divisions of the vascular filamentous tissue, which secretes the marrow. They are seen very distinctly in bones which have been burnt. After many careful examinations, I have never been able to observe holes in longitudinal fractures of bones; and I therefore infer that there are no transverse pores.

These capillary pores are seen in the flat bones

of the skull. I find them in the compact matter of the outer and inner tables of the occipital bone when well burnt, in which they seem to pass gradually from the lattice-work of the *diploe* to the distinct pores of the tables. I doubt, however, whether these pores can be said, as in the long bones, to indicate canals. They seem rather to belong to a very delicate cancellated structure.

These pores are most numerous and distinct in the bones of young subjects. In the humerus of a child burnt to whiteness, I find them to be large, numerous, and distinct, even at the periosteal surface of the bone. In that of a young man of 28, they are larger, more numerous, and more distinct than in bones of older subjects. In a very dense ulna before me, though distinct through a good glass, they are exceedingly minute, and quite imperceptible to the naked eye.

Though these circular pores are most distinct in calcined bones, and might therefore be thought to be the result of the burning, yet that they are not, I infer from the circumstance that they are seen by a good glass in the transverse fracture of splinters of the femur and other large bones.

If a portion of bone be immersed in sulphuric, nitric, muriatic, or acetic acid properly diluted, it becomes soft and pliable, and when dried, is found to be lighter than before; yet it is impossible to discover that any particle of its substance has been mechanically removed, or that its shape and appearance are changed.

If a portion of bone be placed in a charcoal fire, and the heat be gradually raised to whiteness, it burns first with flame, and at length becomes quite red. If then it be removed carefully and slowly cooled, it appears as white as chalk, is found to be very brittle, and to have lost something of its weight. Yet neither in this case does any part of its substance appear to be removed, nor is its mechanical figure or appearance altered.

Chemical examination, however, informs us that in the first case, a portion of earthy matter (phosphate of lime) is removed by the agency of the acid, and held suspended in the fluid, while the pliant, but otherwise identical piece of bone consists chiefly, if not entirely, of animal matter; and that in the second case, this animal matter is removed by destructive decomposition, while the earthy matter is left little changed by the action of fire. It is therefore to be concluded, that every particle of bone, however minute, consists of animal or organic, and earthy or inorganic matter intimately united; and that it is impossible to touch with the point of the smallest needle any part of bone which is not thus constituted. A piece of bone consists not of cartilaginous fibres varnished over, as Herissant imagined, with earthy matter, but of a substance in which every constituent atom consists essentially of animal and earthy matter intimately combined.

There is therefore no rational ground for dividing osseous tissue into compact and spongy, as the

older anatomists did; for though the middle or solid parts of long bones are denser and heavier than the ends of these bones, or the bodies of the vertebræ, the difference consists not in chemical composition, but in mechanical arrangement and structure. On dividing the head of a long bone, the lattice-work or *cancelli*, as they are named, are formed by many minute threads of bone, crossing and interlacing with each other. But each thread is quite as dense, and consists of the same quantity of animal and earthy matter, as the most solid part of the centre of the same bone. These threads, however, instead of being disposed closely and compactly with each other, so as to take a small space, are so arranged that they occupy a large one, and present a considerable bulk.

Though bone has been submitted to analysis by many eminent chemists, the results hitherto obtained cannot be said to be quite satisfactory. The most recent is that of Berzelius, who, in 100 parts of bone from the thigh of an adult, gives the following proportions: of gelatine, 32.17; blood-vessels, 1.13; phosphate of lime, 51.04; carbonate of lime, 11.30; fluate of lime, 2.00; phosphate of magnesia, 1.16; hydrochlorate of soda and water, 1.20.

These results by no means agree with those obtained by Fourcroy and Vauquelin, who found neither fluoric acid nor phosphate of magnesia, but discovered oxides of iron and manganese, silica, and alumina, in bone. Sulphate of lime, which

was found in the experiments of Hatchett, was shown by Berzelius to be formed during calcination. It is, however, pretty obvious that a little more than a third part of bone consists of animal matter, which appears to be either entirely gelatine, or a modification of that principle; and that the remainder, nearly equal to two-thirds, consists of earthy matter, which is chiefly phosphoric acid combined with lime. Is the carbonic acid said to be united with lime also not a result of the decomposition of the animal matter? The other saline substances are not peculiar to bone, but, being common to it and the other animal tissues, and even the fluids, may be supposed, without much injustice, to be derived from the blood left in the bone at the moment of death.

It is most difficult to say what is the nature of the animal matter of bones. At one time it was presumed to be cartilage; but this appears to be a mere assumption, derived from the superficial resemblance which it bears to this substance. It does not appear to be mere gelatine; for though this principle is obtained from bone in quantity, and bones are economically used in manufacturing glue, they do not furnish the same proportion of jelly as tendon, nor are they so useful in making soups, as was once paradoxically and absurdly enough maintained by some chemists. It is probable that the gelatine, as we have already stated, is under a peculiar modification, or combined with some principle which is not well understood. Is

there no albumen in this animal matter? The sulphur formed during calcination seems to show that there is. There is no fat in bones; and in the experiments in which this substance has been found, it is evident that it was merely marrow which had been mingled with the bones employed, or which had not been removed.

Though bones were arranged by the ancients among the bloodless organic substances, they receive a considerable proportion of this fluid, and injection shows them to be highly vascular. In early life especially these vessels are numerous; and even in the grown adult, when death takes place by strangulation or by drowning, the bones are found to be naturally well injected. In old age the vessels are less numerous, but they are larger. From the capillary vessels distributed through their substance, bones derive the pale blue or light pink colour by which the healthy bone is characterized. When this tint becomes intense, it indicates inflammation or some morbid state of the vessels of the bone. When it is lost, and the bone assumes a white or yellow colour, the part so changed is dead.

Anatomists distinguish three orders of vessels which enter the substance of bones; the first, those which penetrate the bodies of long bones to the medullary cavity, *(arteriæ nutritiæ, arteriæ medullares;)* the second those which go to the cellular structure of the bone; and the third those which go to the compact or dense matter of the

bone. This view is only partially correct. The large vessels termed nutritious certainly proceed chiefly to the cavity of the bone, and are distributed in the medullary membrane. These, however, are not the only vessels which proceed to this part of the bone. *First*, I have often traced several large vessels, entering not by the middle, but the ends of the long bones, into the loose cancellated texture, and actually distributed on the *medulla* in this part of the bone. In dried bones also the canals of these vessels may be demonstrated extending from the surface to the body of the bone. *Secondly*, the nutritious vessels are not constant; and when they are wanting, those of the ends of the bone, or of the *cancelli*, are much larger and more numerous than in ordinary circumstances. The communication between these and the branches of the nutritious vessels, which is admitted by Bichat, may be easily demonstrated. The third order of vessels are those which may be termed *periosteal*, in so far as they consist of an infinite number of minute capillaries, some red, some colourless, proceeding from the periosteum to the bone, and contributing to maintain the connection between the two. The short bones and the flat bones, which are destitute of nutritious arteries, receive blood from the two latter orders, but principally from the periosteal vessels. In the skull these vessels are often highly injected in apoplectic subjects, and in persons killed by drowning or strangulation.

The veins of bones are peculiar in their arrangement. The nutritious artery is accompanied by a social vein; the articular and periosteal vessels are said to be destitute of corresponding venous vessels. According to Dupuytren, however, minute venous capillaries arise from the substance of the osseous tissue, precisely as in other tissues, and, uniting in the same manner, form twigs, branches, and trunks, which finally terminate in the neighbouring veins.

Lymphatics are not found in the substance of bones. Bichat, however, thinks analogically, that nutrition implies exhalation and absorption; but it is manifest that this does not demonstrate the existence of true lymphatics. Nerves in like manner have not been traced into this substance.*

To complete the anatomical history of bone, it is requisite to examine shortly the marrow. The interior of the long bones contains a notable quantity of fat, oleaginous matter, which has been long known under the name of *marrow* (*μυελος ὀστης*, *medulla*;) and a similar substance, though in much smaller quantity, is found in the loose cancellated tissue of the flat and short bones. It is in the first situation only that it is possible to examine the anatomical characters of this substance. It is sufficiently similar to fat or animal oil in other parts of the body to lead us to refer it at present to that head. In other respects, its

* On these points see Scarpa, *de Anatome et Pathologia Ossium Comment.* p. 38, &c.; and Howship, Med. Chir. Tr. Vol. viii. p. 66.

chemical qualities have not been much examined; but an analysis by Berzelius shows that it consists chiefly of an oily matter, not unlike butter in general properties. The filaments, blood-vessels, albumen, gelatine, and osmazome found by this chemist in marrow, are to be regarded as derived from the filamentous tissue in which the medullary particles are deposited, and by no means to be arranged with it. They did not exceed 4 parts in the 100. The medullary membrane, which has been considered as an internal periosteum, is but imperfectly known. There can be no doubt, however, of its existence, which is easily demonstrated by opening either transversely or longitudinally the medullary canal of a long bone, and boiling it for about two hours. The marrow then, as is well known to cooks, drops out; and it will be found on examination to be deposited in the interstices of a filamentous net-work of animal matter, which is not unlike very fine filamentous or cellular tissue, which may be traced not only into the lattice-work of the extremities, but into the longitudinal canals of the cylindrical bones. It is traversed by blood-vessels, which are observed to bleed during amputation. No nerves have been found in it. The medullary membrane, in short, may be regarded as an extensive net-work of very minute capillaries united by delicate filamentous tissue. From these capillaries the marrow is deposited as a secretion.—(Mascagni, Howship.)

The developement or progressive formation of the osseous system has given rise to many interesting researches by Kerckringius, Vater,* Baster, † Duhamel, ‡ Nesbitt, § Haller, ‖ Dethleef, ¶ Reichel, Albinus, ** Scarpa, John Hunter, †† Senff, ‡‡ Howship, §§ Meckel, ‖‖ Troja, Medici, Serres, Lebel, Schultze, Beclard, and Dutrochet; and it is perhaps a proof of the difficult and complicated nature of the subject, that it still continues to give rise to fresh investigation. The inquiry naturally resolves itself into two parts,—the history of the process of ossification as it takes place originally in the fœtus and infant, and the history of its progress as a process of repair when bones are divided, broken, or otherwise destroyed or removed.

From the first formation of the embryo to the termination of fœtal existence, and thenceforth to

* De Osteogenia Naturali et Præternaturali. Haller, Disput. Anat., Vol. vi. p. 227.

† De Osteogenia. Haller, Disp. Anat. Vol. vii. p.

‡ Mém. de l'Academie Royale, 1741–42, &c.

§ Human Osteogeny, &c. By Ro. Nesbitt, M. D. Lond. 1736.

‖ Opera Minora, Tom. ii. xxxiii. p. 460.

¶ Dissert. Ossium Calli generationem exhibens. Goett. 1753.

** Annot. Anat. et Eicones Os. Foet. Hum. Lug. Bat. 1737.

†† Medical and Chirurgical Transactions, Vol. ii.

‡‡ Nonnulla de Incremento Ossium, &c. Halle, 1781.

§§ Medico-Chirurgical Transactions, Vol. vi. p. 263.

‖‖ Journal Complementaire, Tom. ii. p. 211.

the completion of growth, the bones undergo changes in which various stages may be distinguished. In the first weeks of fœtal existence it is impossible to recognize any thing like bone; and the points in which the bones are afterwards to be developed consist of a soft homogeneous mass of animal matter, which has been designated under the general name of mucus. Sometime between the fifth and the seventh week, in the situation of the extremities, may be recognized dark opaque spots, which are firmer and more solid than the surrounding animal matter. About the eighth week, the extremities may be seen to consist of their component parts, in the centre of each of which is a cylindrical piece of bony matter. Dark solid specks are also seen in the spine, corresponding to the bodies of the vertebræ; and even the rudiments of spinous processes are observed in the shape of minute dark points. In the hands and feet rings of bones are seen in the site of the metacarpal and metatarsal bones. All the joints consist of a semi-consistent jelly-like matter, liberally supplied by blood-vessels. At ten weeks the cylinders and rings are increased in length, and are observed to approach the jelly-like extremities, which are acquiring the consistence of cartilage, and when divided present irregular cavities. At the same time the parts forming the head are highly vascular; and between the membranes are deposited minute points of bony matter, proceeding in rays from a centre,

which, however, is thinner and more transparent than the margin or circumference.—(Howship.)

Between thirteen weeks and four months the cavities in the jelly-like cartilaginous matter receives injection. The membranes of the head are highly vascular, transmitting their vessels through the intervals of the osseous rays, which are occupied abundantly by stiff, glairy, colourless mucilaginous fluid.

In the seventh month, the bony cylinder of the thigh-bone and its epiphyses contain canals perceptible to the microscope. In the head, the bones are proceeding to completion; the pericranium and dura mater are highly vascular; and a quantity of reddish semitransparent jelly between the scalp and the scull, which contained numerous minute vessels, Mr Howship regards as the loose cellular state of the fœtal pericranium. This is, however, doubtful. The cylindrical bones have at this period no medullary cavity, but present in their interior a loose bony texture.

Between the seventh and eighth months, in a fœtus ten inches long, I find the humerus consisting of a cylinder of bone placed between two brownish firm jelly-like masses, which correspond to the epiphyses, enclosed by periosteum, which adheres loosely by means of filamentous and vascular productions. The radius is a thin bony rod, also between two jelly-like epiphyses. The ulna is still thinner, more slender and flexible, and even compressible. The interosseous ligament is a continuous dupli-

cature of the periosteum. The metacarpal bones are much as before, only larger. The hands and fingers are complete; but the phalanges consist of minute semi-hard grains, enclosed in periosteum, which forms a general sac to them, and to the intermediate connecting parts. The middle and unguinal phalanges can scarcely be called osseous. The *femur*, like the *humerus*, is an osseous cylinder between two jelly-like epiphyses, enveloped in loosely adhering periosteum. The *tibia* and *fibula* like the *radius* and *ulna*. The metatarsal bones are cylindrical pieces, firm, but not very hard. The first phalanx of the toes is complete; the other two, though the toes are fully formed, are much of the consistence of cartilage. The carpal and tarsal bones are in the state of the epiphyses, but of a gray colour.

In this state of the osseous system, the periosteum, which is continuous, and appears to make one membrane with the capsular ligaments and the deep-seated portions of the fascia, adheres to the bone chiefly by arteries and filamentous productions; and so loose is this connection, that a probe may be inserted beneath it, and carried round or inwards, unless where these connections are situate. Another point where the periosteum adheres firmly is at muscular insertions. Thus, in the fœtus before me, it adheres to the *humerus* most firmly at the insertion of the deltoid, and to the *femur* at that of the *glutæus*; and at these parts the bone is already rough.

In the vertebral column the bodies of the vertebræ and the spinous plates are formed; and minute specks are beginning in the site of the transverse processes.

In the skull, the parietal bones are well-formed shells of bone, though very deficient at the mesial plane, the anterior margin, and the upper anterior angle. The pericranium is distinctly membranous and vascular; and the red jelly-like fluid noticed by Mr Howship is exterior to this membrane.

At the period of birth, the cylindrical bones contain tubular canals filled with a colourless glairy fluid, and terminating in the surface of ossification. As the bones previous to this period are homogeneous, and contain no distinct medullary cavity, but present in their interior a soft or loose bony texture, it is reasonable to suppose that the developement of the longitudinal canals is connected with the formation of the medullary cavity. At birth in the *femur* may be distinguished a medullary cavity beginning to be formed, about half a line broad, but still very imperfect.

After birth the two processes of the formation of tubular canals and medullary cavity go on simultaneously; and at the same rate nearly the outer part of the cylindrical bones acquires a more dense and compact appearance. The epiphyses, also, which are in the shape of grayish jelly-like masses, begin to present grains and points of bone. Preliminary to this, Mr Howship represents them,

while still cartilaginous, as penetrated by canals or tubes, which gradually disappear as ossification proceeds. The carpal and tarsal bones appear to observe the same course in the process of ossification.

In the bones of the skull, however, a different law is observed. The osseous matter is originally deposited in linear tracts or fibres, radiating or diverging from certain points termed points of ossification. Each bone is completed in one shell without *diploe* or distinguishable table. Afterwards, when they are completed laterally, or in the radiating direction, the cancellated arrangement of the *diploe* begins to take place apparently in the same manner in which the medullary cavity and compact parts of the long bones are formed.

It has been generally supposed that the formation of cartilage is a preliminary step to that of bone. This, however, seems to be a mistake, arising from the circumstance that cartilage is often observed to be converted in the living body into bone. Neither in the long nor in the flat bones is any thing like cartilage at any time observed. The epiphyses, indeed, present something of the consistence of cartilage, but it has neither the firmness nor the elasticity of that substance. It is a concrete jelly, afterwards to be penetrated by calcareous matter. The flat bones are from the first osseous; and though their margins are soft and flexible, in consequence of their recent formation and moist state, they have still a dis-

tinct osseous appearance and arrangement, and bear no resemblance to cartilage. In short, true bone seems never at any period of its growth to be cartilaginous.

The period at which ossification may be said to be completed varies doubtless in different individuals. It may be said to be indicated by the completion of the medullary canal, by the ossification of the *epiphyses*, and their perfect union with the osseous cylinder, *(diaphysis.)* The first circumstance is always indefinite. The two latter, though more fixed, are still liable to great variation. The epiphyses are rarely united before the age of 14 or 15; and they may continue detached till the 20th or 21st year. I preserved the greater part of the skeleton of a man who stated himself to be about 28, and in whose bones the epiphyses are still imperfectly united, and many have dropped off. In general, however, they begin to unite, or to be *knit*, as is said, between the 15th and 20th years.

Little doubt can be entertained that the main agents of original ossification are the periosteum and the periosteal arteries. The proofs of this inference are manifest. The formation of bone has never been ascribed but to the vessels of two agents,—the periosteum and the medullary membrane. That the latter cannot be concerned in the production of bone in the fœtus must be inferred from the fact, that at that period it cannot be said to have existence. To the periosteum, there-

fore, and its vessels must be ascribed the process of fœtal ossification. Of this a cumulative proof may be found in the circumstance, that the periosteum adheres more firmly at the ends than the middle of the bones ; and that the pericranium and *dura mater*, which perform the part of periosteum to the bones of the scull, are visibly concerned in the formation and successive enlargement of these bones. But though the periosteal vessels are the main agents of ossification originally, there is reason to believe that the medullary vessels contribute to its growth and nutrition after it is formed. This may be inferred from the phenomena of fractures, of diseases of the bones, and of those experiments in which the medullary membrane is injured. The periosteum, however, does not act by ossification of its inner layers, as Du Hamel, misled by a false analogy between the growth of trees and bones, laboured to establish. This leads naturally to the examination of the phenomena of ossification as a process of repair. This, however, is introduced more properly under the next section.

The teeth, as a variety of bone, demand attention. Every tooth consists of two hard parts ; one external, white, uniform, somewhat like ivory ; the other internal, similar to the compact structure of bone.

The first, which is named enamel, is seen only at the crown of the tooth, the upper and outer part of which consists of this substance. It is white, very close in texture, perfectly uniform

and homogeneous, yet presenting a fibrous arrangement. Extending across the summit of the tooth in the manner of an incrustation, it is thick above, and diminishes gradually to the root, where it disappears. This fact is demonstrated by macerating a tooth in dilute nitric acid, when the bony root becomes yellow, while the crown remains white.

The enamel is not injectible, and is therefore believed to be inorganic. It is also filed and broken without being reproduced; nor does it present any of the usual properties which distinguished organized bodies. The piercing sensation which is communicated through the tooth from the impression of acids seems to depend on the mere chemical operation, and not on the physiological effect. Upon the whole, the enamel is to be viewed as the result of a process of secretion or deposition, but as inorganic entirely.

The bony part of the tooth is the root and that internal part which is covered on the sides and above by the enamel. It consists of close-grained bony matter, as dense as the compact walls of the long bones, or the petrous portion of the temporal bone. The fibres which are said to be seen in it are exactly of the same nature as those in bone.

In the interior of the bony part of each tooth is a cavity which descends into the root, and communicates at its extremity with the outer surface by openings corresponding with the number of

branches into which the root is divided. This cavity, which is larger in young or newly formed teeth, and small in those which are old, contains a delicate vascular membrane, which has been named the pulp of the tooth. It is best seen by breaking a recent tooth by a smart blow with a hammer, when the soft pulpy membrane may be picked out of the fragments by the forceps. It then appears to be a membranous web with two surfaces, an exterior adhering to the bony surface of the dental cavity by minute vessels; the other interior, free, and, so far as can be determined of a body so minute, resembling a closed sac.

The developement and growth of the teeth is a process of much interest.

At what time the first rudiments of teeth appear seems not to be determined with accuracy. In a fœtus before me, between the seventh and eighth month, I can merely distinguish in the centre of the vascular membrane of the alveolar cavity a minute firm body like a seed. I have, however, seen the crowns of teeth formed in fœtuses, which I have reason to believe had not attained the seventh month. But whatever may be the exact period, the process is nearly as follows.

As the bones of the upper and lower jaw are in the process of formation between the third and fifth months,* cavities at their lower and upper margins are gradually formed by the growth of the osseous plates, which afterwards form the

* Fourth and Fifth, Bichat, p. 93, Tome iii.

alveoli. As these cavities are formed, they are lined by a large, soft, membranous, vascular sac, which, in the manner of a serous membrane, consists of two divisions, one lining the *alveolus*, the other folded within that, and forming a closed cavity. In the inside of this cavity the process of dentition commences some time between the fifth and seventh month, by the deposition of matter from the vessels at the lowest point of the alveolar division of the sac. This matter is to constitute the crown of the tooth, which is invariably formed first. After the deposition of the first portions, these are pushed upwards by the addition of successive layers below them, and necessarily carry the inflected part of the sac before them. As this process of deposition advances, the tooth gradually fills the sac, and rises till it reaches the level of the alveolar margins. If a tooth be examined *in situ*, near the period of birth, it is found to consist of the crown, with portions of enamel descending on every side, and forming a cavity in which a cluster of blood-vessels, proceeding from the sac, is lodged.

After the enamel has been deposited the bone begins to be formed; and as this process advances, the tooth is still forcibly thrust upwards by the addition of matter to its root. When the latter is well completed, the vessels become smaller and less abundant; until, when the tooth is perfect, they shrink to a mere membrane, which lines the cavity of the tooth, and still maintains

its original connection with the alveolar membrane, by the minute vascular production which enters the orifice or orifices of the root.

Physiological authors have thought it important to mark the period at which the teeth appear at the gums; and in general this takes place about the sixth or seventh month after birth. This mode of viewing the process of dentition, however, gives rise to numberless mistakes on the period of teething. The process, as we see, commences in the early period of fœtal existence; and the time at which they appear above the gums varies according to the progress made in the womb. In some the process is rapid; in others it is tardy; and even the fabulous stories of Richard III. and Louis XIV. may be understood physiologically, without the aid of the marvellous. Generally speaking, the crown is completed at the period of birth; and, according as the formation of the root advances with rapidity or slowly, dentition is early or late.

What is here described is the process of the formation of the first or temporary set of teeth, which consist, it is well known, of twenty. In that of the second set the same course is observed. In the same manner is observed a row of follicular sacs, though not exactly in the original *alveoli*; in the same manner deposition begins at the bottom of the free surface of the sac by the formation of the crown; and in the same manner the crown is forcibly raised by the successive accretion of new matter to its base. The moment this

process commences, a new train of phenomena takes place with the primary teeth. The follicular sacs of the new or permanent teeth are liberally supplied with vessels for the purpose of nutrition; and as these blood-vessels increase in size, those of the temporary teeth diminish; and the supply of blood being thus cut off, the latter undergo a sort of natural death. The roots which, as being last formed, are not unfrequently incomplete, now undergo a process of absorption; and the tooth drops out in consequence of the destruction of its nutritious vessels. Some authors have ascribed this expulsion to pressure, exercised by the new tooth. They forget, however, that before the new tooth can exert any pressure, it must be in some degree formed; and to this a vascular system is indispensable.

The increased number of the teeth when permanent, the enlargement of the jaws, and the consequent expansion of the face, though interesting, are foreign to the present inquiry.

Another part of the osseous system requiring notice are the sesamoid bones. These derive their name, it is well known, from their minuteness, (σησαμη, a grain,) most of them, excepting the knee-pan, being of the size of a grain or pea. They are confined to the extremities, and are situate chiefly in positions in which they give points of support to the tendons of the flexor muscles. (Tendons of the *gemelli*, *tibialis posticus*, *peronæus largus*, &c.) The peculiarity of these bones

is, that they are formed invariably in the substance of fibrous organs, as tendons in the case of the knee-pan and the sesamoid bones of the *gemelli, tibialis posticus,* and *peronæus l.;* or ligaments in the case of those situate between the metacarpo-phalangeal and metatarso-phalangeal articulations. With this peculiarity their mode of ossification corresponds. At first albuminous or fibro-albuminous, in process of time they are penetrated by calcareous matter, and present an osseous texture, which, however, is much less firm than that of genuine bones. The period at which this deposition commences and is completed varies in different individuals; and hence, scarcely in any two persons of the same age is the number of sesamoid bones the same. Though the patella may be ossified at the 20th year, the minute sesamoid bones are sometimes not formed before the 30th or even the 40th. In the patella, when ossified, we find a medullary organ. But it is uncertain whether the others acquire this mark of osseous character. These bones resemble the epiphyses in uniting, when divided, by fibro-albuminous matter.

Section II.

Osteitis; Inflammatio.—Though all practical authors admit that bones may be inflamed either spontaneously, or in consequence of injury, yet it is remarkable that none have communicated any

precise idea of this process; and while they admit it as a pathological fact, they have too often lost sight of it in one or more of the changes to which it gives rise. To Mr Howship we are indebted for the first attempt to determine with precision the anatomical characters and pathological nature of this process.

It may at first sight seem doubtful whether genuine bone is susceptible of such a process as inflammation. For though a bone constituted as already described is doubtless an organized substance, and therefore liable to the actions of organized bodies, yet whether a particle of completed bone, as in the compact parts of the cylindrical bones, becomes itself the seat of inflammation, may seem questionable. The morbid process, however, to which the actual bony particles may not be competent, the membranous covering and the vascular filamentous penetrating web, are unquestionably powerful agents in effecting. In short, while bone as a secretion is almost passive in its morbid relations, we observe it obeying the slightest influence of the periosteum and its vessels on the one hand, and those of its medullary system on the other.

Having premised these remarks, it is to be observed that inflammation occurring in bone may assume various forms.

1. *Adhesive Inflammation.*—Of these the simplest is that which takes place in the process of union after fractures,—*the healthy ossific inflammation* of

Mr Hunter, a variety of the adhesive. In this three distinct stages are enumerated. In the first, effusion of blood from the periosteal vessels into its substance, and from the medullary vessels into the fracture, is after coagulation followed by effusion of a colourless viscid fluid, which also coagulates into a jelly. (J. Hunter, Bichat, Howship, &c.) In the second, the soft parts, and especially the periosteum, become hot, red, swollen, and, in short, are in a state of inflammation. (Du Hamel, Howship, &c.) If at this time the fracture be examined, the periosteal and medullary arteries at the line of fracture are large, numerous, and are seen emitting vessels into the coagulated blood and lymph effused beneath the periosteum, and from the broken ends, and converting them into organized masses, sometimes distinct like granulations, sometimes irregularly continuous. This substance, which is of a reddish-gray colour, and of the consistence of firm jelly, is what is named *callus*. The third stage may be distinguished by the appearance of osseous points which now begin to be deposited from the new vessels, which penetrate from the periosteum and medullary filaments to the *callus*. As the arterial action advances, these osseous points extend from the broken surface and coalesce. The exterior swelling at the same time diminishes and disappears; the periosteum falls to its natural size and its ordinary rate of vascularity; the medullary canal is restored in greater or less perfection; and the

broken portion of bone after some time recovers the same organization and firmness nearly which it originally possessed. Instead of the longitudinal canals which are found in compact healthy bone, however, the renewed part presents a series of irregular cavities, varying in size and direction, and which contain a vascular, filamentous, medullary web. (Howship.) According to Mr John Bell it remains for years more vascular than the contiguous bone. * According to Howship it possesses a larger proportion of animal matter. †

In some instances of fracture union is not accomplished in this perfect manner; but is effected merely by a fibro-albuminous cicatrix, which unites the fragments loosely. This is observed especially in fractures of the neck, of the thigh-bone, (Bell, Desault, Cooper, Howship;) of the knee-pan, (Camper, Callisen;) of the *olecranon*, and other parts of loose cancellated structure. Upon the reasons of this physiologists are not agreed. By some it is ascribed to defect of periosteum, as in the neck of the thigh-bone (A. C. Hutchinson;) by others it is attributed to ineffi-

* Principles of Surgery, Vol. i. p. 507. Disc. 12. "Having cut off the limb of a soldier whose limb had been broken in America twelve years before, I found upon injecting the bone, that while the bone itself received the red colour of the injection pretty freely, the callus, which goes in a zig-zag form, joining together the several ends and points of a very oblique fracture, was very singularly red."

† Experiments and Observations, &c. By J. Howship. Med. Chir. Trans. Vol. ix. p. 143.

cient nutrition in the part broken off, which is then certainly less freely supplied by blood-vessels. (J. Bell, Sir A. Cooper.)

Further, in fractures in which there is much contusion and comminution, and especially where it is complicated by a communicating wound of the soft parts, reunion is rarely complete. The suppurative inflammation which then succeeds precludes the adhesive and ossific, and generally renders the latter imperfect or entirely abortive. In such circumstances more or less of the bone dies, and is thrown off in dead splinters. In some instances even necrosis may be produced, as is exemplified in compound fractures produced by gunshot.

Even in simple fracture may occur a variety of incomplete union. In some subjects, in whom the fragments have been badly applied, in whom they have been often moved, or in whom the vessels are inadequate to assume the ossific action, though blood and lymph are effused from the periosteum and medullary vessels, and undergo coagulation, adhesion is only partial and imperfect. It is not penetrated by vessels so as to become organized; or those vessels are rent asunder by repeated motions. Under such circumstances, the intermediate substance, instead of acquiring solidity, and becoming penetrated by bone, is partly absorbed; while the broken ends are converted into a secreting surface, which discharges serous, purulent or sero-purulent fluid in small quantity. This forms what is termed *false joint.*

In the pregnant, or persons labouring under

scurvy, and in those affected with the constitutional symptoms of syphilis, fracture is not united by bony union.

2. *Diastasis.*—Next to fracture may be placed detachment or disunion of the epiphyses, *(diductio epiphysium.)* In young subjects, while the epiphyses are still imperfectly united to the *diaphysis*, this may occur, in consequence of forcible stretching, or injury of the bone. In this manner it is noticed by Palfyn, Reichel,* Wilmer,† and others. Reichel saw it in the humerus, and Wilmer in the tibia. I have seen it in the humerus and in the femur, in which chiefly it occurs. Sometimes it may be traced to injudicious efforts by bone-setters in pulling a thigh-bone supposed to be dislocated. It is liable to be confounded with fracture of the neck of the thigh-bone. If not disturbed, the injury is repaired by union either in the ordinary manner, or with more or less extensive ossification of the neighbouring parts, causing generally stiff-joint. Consecutive disunion of an epiphysis may happen in *mollities ossium* and in *spina ventosa.* (Trioen, Reichel.)

The variety of disunion now mentioned is generally confined to the epiphysis of one bone. A more general disunion, however, occurring in most of the epiphyses of the skeleton, may take place in scurvy. This was remarked especially in the scor-

* M. Georgii Ch. Reichel, de Epiphysium ab Ossium Diaphysi Diductione. Sandifort Thesaur. Vol. i. p. 1.

† Cases and Remarks, &c. Lond. 1779. P. 228.

butic epidemic of Paris 1743, and has since been occasionally seen. (Lind.) Inspection shows that the bones are penetrated by bloody extravasation, —that the vessels are relaxed and atonized,—and that nutritious deposition is suspended. This scorbutic diduction, which depends on a disease affecting the whole system, may be removed by the same means which remove that morbid condition. Too often, however, it takes place in that stage of the disease in which recovery is impossible.

3. I have above stated that it may be justly questioned whether bone itself undergoes the organic process of inflammation. Most of the facts hitherto collected, when well investigated, favour the inference, that the inflammatory conditions of bone are to be referred to inflammation taking place either in the periosteum; or the tomentose medullary web; or, finally, in the articular synovial membrane or cartilage; and most of the morbid states observed by authors in bone may be traced to some variety or degree of inflammation in one or more of these textures.

a. When the periosteum becomes inflamed, one of several effects may follow.

α. It may induce effusion of coagulable lymph into its substance, or between that and the bone, —constituting simple node, and the tumour termed *gumma*. (Bromfield, p. 14.)

β. By a modification of this action it may effuse lymph, which afterwards becomes ossified,— constituting the *ossific node* of Hunter and How-

ship, a simply, osseous node, (*periostosis.*) This appears in the form of loose bony masses, plates, or scales, on the surface of such cylindrical bones as the *tibia* and *ulna*, which are, nevertheless, quite natural. In some instances this osseous node appears to consist in ossification of the inner part of a circular area of inflamed periosteum. In both cases, instead of the regular arranged longitudinal canals, the new osseous deposition presents irregular cavities, varying in size and direction.* This, together with great vascularity, constitutes the anatomical character of such deposits. In the skull of a child under 7 before me, periosteal inflammation has produced on the parietal bone a circular area the size of a shilling, of minute spherical or spheroidal eminences, surrounded by a smooth whitish ring, and that inclosed by a darker coloured ring. The circular area, with rough eminences, marks the space from which the periosteum was detached. It is thicker and less translucent than the rest of the bone. The white ring indicates the tract where the pericranium was inflamed, but not detached.

γ. If the inflammation be acute, as in that from injury, it may produce ulcerative absorption of the subjacent bone, which then presents a denuded, rough, reddish surface, progressively increasing in extent and depth. This occurs particularly in young subjects. I have seen it in the

* Howship in Medico-Chirurg. Trans. Vol. viii. pp. 90, and 105, 106.

bones of the skull destroy both tables, and expose the *dura mater*. It takes place also in the tibia, in the sternum, and other superficial bones. In a more chronic form I have seen it cut through both nasal bones by insensible ulcerative absorption. This process corresponds with the *insensible exfoliation* or *decomposition* of Tenon; the *absorption* produced by tumours, aneurisms, and other compressing agents; (Louis, Wilmer;) and the peculiar absorption described by Mr Russell. (Ed. Med. Chirurg. Tr. Vol. i. p. 74.)

δ. A similar process, by causing suppurative destruction or even death of the periosteum, may kill the subjacent bone (*necrosis*,) which then becomes white, yellow, or black, and presents a denuded but uniform surface, bounded at certain points by an irregular rough line, (*crena*.) This line, which denotes the establishment of ulceration on the confines of the living bone, becomes more complete and deeper, till the dead portion is loosened and removed. This process is denominated *exfoliation*, and the part so removed is said to be *exfoliated*.* By Weidmann, who justly remarks that these terms are too limited, the process is designated by the general name of *separation*; while the part separated is distinguished by the epithet *ramentum*. Though it takes place chiefly in the bones of the skull and in the front of the tibia, it may occur in the low-

* Mémoires sur l'Exfoliation des Os, par M. Tenon, dans Mém. de l'Academie R. des Sciences. 1758. P. 661, &c. and 1760. See, among others, good cases in Howship's Practical Observations, Case 107, pp. 404, and 113, p. 434.

er jaw, * in those of the pelvis, † in the femur, and wherever the structure is close and compact. In this manner the odontoid process of the *epistrophe* (*vertebra dentata*) has been known to be removed.‡ In bones containing much cancellated structure, for instance the *vertebræ*, *sternum*, the carpal and tarsal bones, this suppurative destruction and death of the periosteum produces not death and exfoliation, but *caries* or ulceration, (τερηδων) with death of minute particles of bone, (*separatio insensibilis.*)

ε. Certain forms of periosteal inflammation give rise simultaneously to osseous deposition and ulceration or caries. Thus nodose inflammation of the tibia and fibula may terminate in ulcers of the periosteum, and produce irregular deposition on the surface of these bones which appear thick, but without the usual aspect of healthy bone, present irregularly shaped masses of structure, partly like honey-comb cells and partitions, partly like confused network. The course of phenomena here is first chronic thickening and induration of the periosteum, with deposition of bone beneath it; then ulceration of the periosteum; and lastly, ulceration or caries in the new bony matter, which appears to continue to be deposited irregularly.

* Exfoliations of the lower jaw from disease or injury of the alveolar processes are common.

† In Mr J. Bell's case of Gluteal Aneurism exfoliation from the ilium and sacrum took place. Principles, Vol. i. p. 423.

‡ Mr James Syme's Case in Med. and Surg. Journal, Vol. xxv. p. 311.

This, which is the *carious ulcer (ulcus cariosum,)* of practical authors, may be seen in the legs of those who have been affected by the constitutional symptoms of syphilis, and who have undergone for it repeated courses of mercury.* In the cases in which I have seen it, it gave rise to extreme local pain and great constitutional disorder, requiring amputation; and one case terminated fatally. Occurring in the bones of the cranium, which it occasionally does, it is one of the forms of the disease described by the older authors under the fantastic appellation of the garland of Venus; *(Corona Veneris.)*

ζ. That the periosteum may be concerned in extensive but morbid secretion of osseous matter, giving rise to that form of tumour which has been termed by some *exostosis*, and by others *osteo-sarcoma*, has been already noticed. (P. 522.) The periosteum becoming thickened and morbidly vascular and painful, assumes additional energy in the deposition of bony matter over a certain space. But the bone so deposited is never arranged in the manner of healthy bone. Sometimes it is in the form of a large shapeless prominence deposited on the outer surface of the original bone. This, which was remarked by Pouteau,†

* Of this kind appear to be the tibia and fibula delineated by Roberg. See his Dissert. in Haller Disp. Chirurg. Tom. iv. p. 561.

† Œuvres Posthumes, Tom. iii.

Houstet,* Herissant,† Flajani,‡ and Monteggia, has been verified by Howship. Sometimes it occurs in one point of the bone in the form of a spheroidal tumour, in which the osseous matter is arranged in the form of long needle-like fibres, radiating from one or more points, not unlike radiated zeolite. In other instances it occurs in the form of amorphous masses of bone, much like pieces of calcareous sinter. (Houstet.) In others again, a central granular mass is surrounded by acicular bony fibres.

Of these growths the interior structure varies. They are never masses of solid bone; but the bony matter is so arranged that it leaves spaces or intervals filled in some instances with soft flesh-coloured spongy matter, (the *fungous exostosis* of Sir A. Cooper;) in others with cartilage, (J. Bell, A. Cooper,) (the *cartilaginous exostosis;)* in others with colloid or jelly-like matter, (J. Bell;) in others with semifluid blood-like matter, (Houstet;) and in some instances they have been known to contain hydatids. (Keate, &c.) In all cases the periosteum is thickened; the tumour is penetrated by numerous large vessels; and the bone in which the exostosis is formed is more or less thinned and destroyed by absorption. (Houstet, J. Bell, Sir A. Cooper.)

Though periosteal exostosis may take place in

* Mém. de l'Acad. de Chir. Tom. iii. p. 130.

† Mém. de l'Acad. Roy. des Sciences. 1758, p. 676.

‡ Collezione d'Osservaz. e Rifless. Tom. ii.

any bone of the skeleton, it most frequently appears on the inner side of the thigh bone above the internal condyle, or upon the shaft, which it may enclose completely, (Houstet;) next upon the *tibia*, which, with the *fibula*, it may encompass more or less perfectly; next upon the humerus, (J. Bell and Cooper;) next in the bones of the pelvis, (Cheston and Sandifort;) and finally, on such bones as the lower jaw, the temporal, and other bones of the cranium. It is most likely to take place at muscular or tendinous insertions.*

In these forms of osseous deposition the vitality of the new deposit is small. Its organization is indistinct and imperfect; and in no long time it proceeds, apparently by pressure, to destroy the structure of the adjoining bone, which then becomes rough, yellowish, or even black, and undergoes absorption. The bony mass at the same time is changed interiorly, presenting cavities containing gelatinous or sanious fluid. The adjoining soft parts are generally destroyed by pressure; and when they give way are wasted by bad, but not cancerous ulceration. The bone thus exposed is generally black, rough, and carious. Though no exact analysis of these osseous tumours has yet been made, it is known that they consist of phosphate of lime with animal matter.

The bony tumours occurring in the carpal, metacarpal, and phalangeal bones, as described

* On Exostosis, by Sir A. Cooper in Surgical Essays, Part i. London, 1818, p. 155.

by Severinus, Mery, and Mr John Bell, I am inclined to refer to the head of exostosis depending on disease of the medullary membrane.

b. The medullary filamentous web is perhaps still more important in its morbid influence on bone than the periosteum. It is, in the first place, liable to inflammation; and, according as this takes place in the medullary web of the cylindrical bones, or in that of their epiphyses, or of the short irregular bones, different effects result.

α. Necrosis.—That the medullary web of the cylindrical bones is liable to inflammation is a well established point. The tendency of this is not so well understood. It may proceed either to suppuration, forming a collection of matter within the cavity of the bone; or by producing effusion within the interstices of the medullary web it may, by causing induration and swelling, induce expansion of the walls of the diaphysis; or by destroying the medullary membrane, it may kill the bone from within outwards.

That inflammation of the medullary web causes swelling and effusion into its interstices may be regarded as established by the phenomena of fractures, simple and compound, and especially by those experiments in which this texture is expressly injured. When it proceeds without being resolved, it may cause a uniform expansion of the bone, which very often precedes the extinction of its vitality. Thus in most of the instances of the incipient stage of necrosis a local enlargement, or

rather dilatation of the bone, takes place, while the bone, though its texture is softened, is still alive. This is the process which Scarpa distinguishes under the name of *expansion*, and in which he imagines the reticular structure to be relaxed or unfolded. The fact is well established, but the explanation is gratuitous. It is doubtless the early stage of the process which terminates in necrosis.

Suppuration in the cavity of the long bones, which was seen by Cheselden, (p. 40,) Gooch, (vol. ii. p. 357,) Hey, (p. 26 and 32,) and others, is generally a process so severe as to cause death by constitutional irritation. If it fails to effect this, it first distends and softens the bone, and then kills it from within outwards, inducing *necrosis*. This may affect either part or the whole of the diaphysis, which is then separated from the periosteum and epiphysis, which is rarely killed. In process of time the dead portion or portions (*ramenta*,) become enclosed more or less completely by a thick shapeless cylinder of new bone, with or without openings in its sides, and which is placed between the epiphyses and covered by the periosteum, which is much thickened. If death take place at this period, the bone thus formed is found to contain the original shaft, loose and dead. If life be still prolonged, the old bone generally piecemeal is gradually brought to the surface through the openings in the new osseous case and expelled. The fragments thus discharged, which are of a dirty yellow, drab, or black colour, and some-

what corroded or worm-eaten at the ends and margins, are named *sequestra* by Troja,* David,† and other French surgeons, and *ramenta* by Weidmann. The channels or openings through which they are expelled, which are temporary deficiencies in the new bone, are termed *cloacæ*.‡

The above is a brief description of the process of necrosis with regeneration as it occurs in the cylindrical bones. Its effects were known long before its mechanism was understood. The fact of one bone being found within another was remarked by Duverney, Ruysch,§ a Mekren, Cheselden, and others of the older anatomists and surgeons; and even Portal speaks of the circumstance of one bone rattling within another as a curious and unexplained phenomenon.‖ Amyand, Mackenzie, Hunter, Ludwig, Bromfield, Laing, and others, describe the disease with the process of regeneration under various names, as *spina ventosa*, detachment of the epiphyses, *caries*, loss of a bone, or reproduction, according as any one part of the process was most prominent, without appearing to be aware of its true nature. Louis appears to have first applied the epithet *necrosis;* but Chopart and David were the first who di-

* De Novorum ossium regeneratione exp. Paris, 1775.

† Observations sur une Maladie connue sous le nom de Necrose. Paris, 1782.

‡ J. Petr. Weidmann, M. D. &c. De Necrosi Ossium. Francofurti ad Mœnum, 1794.

§ Thesaur. Anatom. viii. Fig. 2, 3, 4.

‖ Anatomie Medicale, tome i, p. 32.

rected the attention of surgeons to the process of regeneration; and about the same time the latter and Troja, and afterwards Blumenbach, Koeler, Macdonald, and Desault, investigated the manner in which this is effected.

Two circumstances in the history of necrosis merit attention; *first*, the cause of the death of the bone; and, *second*, the agent of its reproduction. I have already stated inflammation of the medullary web to be the cause of the former; and this I conceive to be proved not only by the phenomena of the disease, but more directly by the experiments of Troja, David, and others, who have performed experiments of the same description. From these experiments it may be inferred, that suppurative destruction or death of the medullary web is necessarily followed by death of the surrounding bone.

The same experiments, with the relative situation of the new bone, unequivocally prove that the periosteum and its vessels are the agents of reproduction. Whether by accident or spontaneously the medullary web is destroyed, if the periosteum be uninjured, it becomes thick, swollen, and highly vascular; bony matter is then deposited with more or less regularity from its interior surface; and after this has acquired a due degree of thickness, the vascularity and swelling of the periosteum gradually diminish, till the membrane is restored to its natural state. When, on the contrary, the periosteum is injured or destroyed, re-

generation is imperfect or altogether deficient. (Weidmann.) In some instances also, in which necrosis affects one portion only of the internal surface of a cylindrical bone, reproduction appears not to be effected. The outer part of the bone then becomes soft, and at length carious, and forms apertures (*foramina grandia*, Troja,) (*cloacæ*, Weidmann,) similar to those in new osseous cases, through which a *sequestrum* is discharged. (Weidmann, p. 31.)

Regeneration is most frequent in the *diaphyses* of the cylindrical bones. Many cases of reproduction of the *humerus*, the femur, and especially the *tibia*, are on record. Of the ulna three only are mentioned, and of the radius only one, of the clavicle one, and of the scapula one. Of the lower jaw regeneration, either partial or total, has been recorded by various observers.

The flat bones of the scull are very rarely regenerated; and perhaps it would be difficult to produce an authentic and unequivocal example, unless that given by Weidmann (pl. xii.) be admitted. Mr Russell, however, states that he has seen instances of apertures of the cranial bones being supplied by solid matter which, to his observation, possessed all the qualities of solid bone. This nevertheless resembles more the reproduction after fracture than that after necrosis.

The short or cuboid bones appear never to be reproduced.

β. *Spina Ventosa. Paedarthrocace.*—Inflamma-

tion of the medullary web of the epiphyses and the cuboid or short bones produces very different effects; and is indeed the cause of the disease so vaguely spoken of under the name of *spina ventosa*. By Rhazes, who is believed to have first described this disease, it is represented to consist in swelling, erosion, and corruption of the bone; and much the same view is entertained by Avicenna. Fuller ideas were given by Pandolphinus, who represents it as commencing in the texture of the bone, which first becoming corrupted, then affects the soft parts. By M. A. Severinus it is represented as an abscess in the substance of the bone near the joint, partly putrid, partly gangrenous, but produced in the manner of the cold or congestive inflammation.*

A still nearer approach to the true pathology of this malady was made by Friend, who placed the primary action in the marrow, which becoming diseased and enlarged, separates the outer *lamella*, and distends the periosteum with pain and swelling. Similar opinions appear to have been entertained by the first Monro, Cheselden, Amyand, Schlichtling, Cheston (p. 117,) Bromfield, who regards it as abscess of the marrow, (p. 20 and 22,) and Warner, who places it in the marrow and vessels of the bone, (p. 322.) (N.)

These views, nevertheless, appear to have been overlooked by Petit, Bordenave, Portal, and others, who, regarding it as a variety of *exostosis* occur-

* De Abscessuum recondita Nat. Lib. v. cap. 11, 12, 13.

ring in the scrofulous, and complicated with suppuration in the substance of the bone, by a wish to simplify, have rendered the subject more complex. Scarpa, especially in his recent work, maintains that *spina ventosa* differs in degree only from exostosis and *osteo-sarcoma.* * The opinion of Bichat is not very distinct. † That of Monteggia and Palletta ‡ is much more explicit. The former represents it as commencing in the marrow, which inflames slowly, swells and wastes, or passes into a slow suppuration, distending the parietes of the bone all round, and then bursting its compact shell, giving vent to the medullary sanies, and causing the inflammation and suppuration of the soft parts, at the bottom of which the bone is found bare and carious, or covered with fungous granulations, but with one or more orifices penetrating into the medullary cavity. ||

This view errs only in placing the disease in the marrow, which as an inorganic secretion is incapable of orgasm, healthy or morbid. The true agent of the process is the vascular medullary web, especially of the *epiphyses*, of such bones as the vertebræ, the carpal and tarsal bones, and the phalanges. The cancellated arrangement of the osseous matter and of its medullary web in these bones explains the progress and phenomena of the disorder. That this is the seat of its action is to be inferred first from the phenomena of the

* De Anatome et Pathologia Ossium, p. 76 and 78.

† Anatomie Generale, Tome iii. p. 112

‡ Exercitationes Patholog. Mediolani, 1820, p. 120.

|| Instituzione Chirurgiche, Vol. ii. 645, p. 275.

disease; and secondly, from its effects, as seen in diseased bones. *Spina ventosa* never occurs in a bone with distinct medullary canal, unless at the epiphyses, where the structure is cancellated. When it takes place in these situations, it first induces enlargement of the epiphyses, with extreme pain deep in the bone. Soon after the periosteum becomes thick and swelled; and in no long time sanious matter is found beneath it issuing from the *cancelli*, which are then softened, partially destroyed, and excavated. If in this state such a bone be examined, the broken cancelli are filled with a reddish, soft, spongy vascular mass, producing flabby granulations *passim*, and secreting bloody sanious fluid. The compact shell is partly destroyed by irregular ulceration, and partly extruded by the distending force of the swelled medullary web. The diseased epiphysis then presents a large irregular anfractuous cavern filled with soft spongy substance, which is either the web itself, or the new products which its inflammation has generated.* In this manner it is frequent in the upper end of the tibia or the lower end of the femur, or in the extremities of the radius or ulna.

With deference therefore to the observation and assiduity of Mr Howship, I cannot agree with this author, that *spina ventosa* is an enlargement affecting the cylindrical bones, unless with

* See Observations on the Morbid Appearances and Structure of Bones, &c. By John Howship, Esq. Med. Chir. Tr. Vol x. p. 176, and several fine delineations of the disease.

the limitation above stated. The only cylindrical bones in which its occurrence may give colour to this opinion are the phalanges. These, however, have no distinct medullary cavity, and resemble in all respects the epiphyses and the short irregular bones in general. In these the disease occurs in children and young persons. It occurs also in the lower jaw, and occasionally in the vertebræ.

γ. *Enostosis. Medullary Exostosis.*—To this head I do not refer the examples quoted by Houstet from Ruysch, Cheselden, and Daubenton, and which I conceive belong to necrosis. There are nevertheless instances of cylindrical bones having an accretion of bony or osteo-colloid matter deposited in their interior, to such an extent as at once to enlarge much the dimensions of the bone, and obliterate the medullary cavity. Examples of this are recorded by Cheselden,* Mery,† Tripier, Houstet,‡ and J. Bell; and Sir A. Cooper describes the disease at length under the name *exostosis* of the medullary membrane. According to the observation of this experienced surgeon, the disease occurs in two forms, the *fungous* and the cartilaginous. Both originate from the medullary web; both produce enlargement, expansion, softening, and separation of the osseous walls; and both ultimately terminate in ulcerative absorption of the affected bone. In certain circumstances, however, they differ from each other. The

* Osteographia, p. 53.

† Mém. de l'Academie des Sciences, 1706, p. 245.

‡ Mém. de l'Acad. Roy. Chirurgie, Tome iii. p. 130.

fungous exostosis consists of lobulated masses of soft, spongy, vascular substance like fat, brain, or clotted blood, which emits malignant *fungi*, and discharges blood-coloured serum. After some time it not only distends, separates, and destroys the bone, but it undergoes an alternate process of sloughing and hemorrhage. Though, in compliance with the views of Sir A. Cooper, I place it under this head, it is scarcely entitled to the character of *enostosis* or *exostosis*, but is manifestly of the nature of the encephaloid tumour. The cartilaginous, or genuine enostosis, consists of masses of firm chondrodesmoid structure, whitish-red or gray, producing by its enlargement progressive separation and destruction of the bone, but not possessing the fungating or malignant tendency. *

M. A. Severinus, Mery, and Mr J. Bell have described a variety of monstrous enlargement of the bones of the hand, which I think is to be viewed as belonging to the head of enostosis. Though they are termed tumours of the phalanges, it is impossible to doubt, from perusing the authentic description of Mery especially, that the disease consisted of inordinate enlargement of the ends or articular heads of the phalanges. † This enlargement was confined to the ends of the metacarpal and middle row. The shell of the bones

* Surgical Essays by Sir A. Cooper. Part i. Pp. 165–173.

† Mémoires de l'Acad. des. Sciences, 1720, p. 583. See also J. Bell's Principles of Surgery, Vol. iii. pp. 73 and 80.

was extenuated, and in some parts broken. The interior structure consisted of irregular bony masses, fibrous and cellular, or cavernous, containing reddish semifluid jelly. The contiguous articulations were ankylosed. These changes depend doubtless on morbid action of the medullary web. Any change in the structure of the bone and periosteum in such circumstances is secondary. A similar case is given by Scarpa, (Tab. 6.)

c. The third source of disease in the osseous texture is the articular synovial membranes and cartilages. Inflammation of the first soon passes to the second, in which it causes erosion or ulcerative absorption. From the cartilage this may proceed progressively to the epiphyses, the upper surface of which is sooner or later excavated into numerous holes or caverns of various size and shape. This process, which I refer to the vessels passing from the cartilage to the medullary web of the epiphyses, is accompanied with deep-seated aching pain, particularly distressing during the night. It is very common in that form of disease of the joints which arises from inflammation of the synovial membrane and cartilages; and several instances are recorded by authors.* It occurs in the hip-joint and knee-joint especially, and is one of the preliminary steps to ankylosis. I have seen this take place in the knee-joint, and have ascertained the point by dissection.

This also is one of the modes in which the

* See Cheston, who delineates two examples of it, and is at some pains to distinguish it from *spina ventosa*.

vertebræ become carious. Chronic inflammation affects the synovial membrane and cartilages of an oblique process, and passing into the bone produces ulceration and carious excavations. This process not unfrequently causes in the incumbent and contiguous textures, irritative suppuration constituting an extensive abscess, which, according to circumstances, may take the anterior, the posterior, or the inferior direction. As the original seat of the disease is generally the lower dorsal or upper lumbar vertebræ, the disease is termed *lumbar abscess*.* It may appear either in the lumbar region, at the margin of the rectum, or in the groin. Several vertebræ are found excavated or destroyed by caries. As in the other articulations, however, this disease may terminate in irregular osseous union of several vertebræ, forming a species of ankylosis.

The forms of disease now enumerated are chiefly varieties or effects of the inflammatory process. Those which yet demand attention, though dependent in like manner on some anormal action of the periosteal or medullary vessels, are nevertheless so peculiar, that it is impossible to refer them to the same general head.

4. ***Rickets.*** ***Rachitis.*** This disease, of which no distinct trace is found in the writings of the ancients, or in those of the authors of the middle ages, was first described by Glisson as appearing in England in the course of the 17th century.

* Camper, Demonst. Anat. lib. ii. cap. 1. art 6. Howship, Morbid Anatomy, chap. vii. p. 365.

Though still frequent in these islands, it is not peculiar to them; and it is by no means unknown in other countries of Europe. Notwithstanding the fact above-mentioned, the disease is not to be regarded as new. Its occurrence in infancy only was the cause of its escaping observation. Its influence, however, in leaving more or less deformity of the skeleton must have at all times attracted notice. Deformed dwarfs have been known in all ages. The *gibbi*, the *vari*, and the *valgi* of the Romans must have been more or less rachitic in infancy. From this cause the deformity of Thersites might have originated. It is also to be remarked, that Fabricius Hildanus delineates the serpentine lateral curvature of the spine in a girl of 8, whose bones were soft as wax,* which could be produced by no other cause save rickety softness.

When the disease first attracted notice, and the chemical constitution of bone was understood, it was believed that rickets consisted merely in the late deposition of phosphate of lime. Of this theory the defect is its simplicity. Though the earthy matter is doubtless very deficient, this is not the sole change in the rachitic skeleton. The bone is light, spongy, and cellular. The close or compact structure is said to disappear. The truth is, that it is not yet formed. The interior of the bone is homogeneous like that of a fœtal bone, without distinct medullary cavity, without cancellated structure, and without compact bone; but

* Cent. 6, Obs. 75.

presenting the loose cellular or areolar arrangement observed at that period of life. The interstitial cells are filled with brownish jelly-like substance,* which appears to be a secretion from the medullary arteries. The bone is soft, of the consistence of cartilage, and is easily cut by the knife. Its colour is some shade of red, but varies from light pink or brown to an orange or fawn-coloured tint. This it derives from its vessels, which are numerous, large, and loaded with dark-coloured blood deficient in fibrin. The periosteum is generally thickened, and occasionally detached. (Cheselden, Bichat, Bonn.) In short, the rachitic bone is the fœtal bone in internal structure, but destitute of its proportion of calcareous matter.

One of the peculiarities of the rachitic condition of the osseous system is, that though the bones present the characters now enumerated during its continuance, they afterwards acquire equal or even greater firmness and density than sound bones, by the deposition of calcareous matter. While this takes place, the distinction between the cancellated and compact structure begins to be established, and the formation of medullary canal is also begun. When this process once commences, it proceeds much as in healthy bone. In one respect, however, its completion is peculiar. Instead of the compact matter of the bone being equally distributed on each side of the me-

* Morel in Jour. de Med. Paris, 1757, Vol. vii. p. 432 ; Portal sur la Nature du Rachitisme, 2de Partie, Art. iii. p. 246. Tacconi in Comm. Bonon ; and Stanley in Med.-Chir. Tr. Vol. vii. p. 407.

dullary canal, as in sound bones, it is more abundant at the internal than the external side of the incurvated bone. Thus if the femur, as generally happens, is incurvated outwards, the greatest deposition of compact bone is at the internal wall. This deposition may be so considerable in bones which are much bent, as to obliterate entirely the medullary canal.* The restored rachitic bone is said to contain more earthy matter than healthy bone.

5. *Mollities Ossium,—Malakosteon,—Osteomalacia,—Osteo-sarcosis.*—To the ancients this peculiar state of the osseous system appears to have been as little known as rickets. Omitting the uncertain traces of its existence, which are found in the writings of Ebn-Sina, and several of his European commentators, the first distinct record of the malady was given in 1688 by Gabriel, who found all the long bones of a lady soft, flexible, and converted into a reddish flesh-like substance, void of fibres.† Still more distinct cases were published by Saviard in 1691,‡ and by Courtial and Lambert in 1700. § About the same time Valsalva

* Observations on the condition of the Bones in Rickets, &c. By Edward Stanley, Esq. &c. Med. Chirurg. Tr. vol. vii. p. 404.

† Eph. Nat. Cur. Dec. 3, An. 2, Obs. 3. This is the case also noticed by Gagliardi the following year, 1689, which Scarpa also mentions as the first. The Professor of Pavia seems not to be aware that the case did not belong originally to Gagliardi but to Gabriel.

‡ Nouveau Recueil, &c. Obs. 62, p. 274. 1702.

§ Histoire de l'Acad. R. des Sciences, 1700, Obs. 2, et Relation de la Maladie de Bernard d'Armaignac, &c.

met with an instance which, however, was published only in 1760 by Morgagni.* Previous to this, however, had been published a case by Mr S. Bevan in 1742;† that of the woman Supiot; ‡ the case of Mary Hayes by Pringle and Gooch,§ and that of E. Winckler by Ludwig. ‖ Since that time cases have been published by Mr H. Thomson,¶ Acrel,** Renard,†† and Howship.‡‡

From these and similar cases it results that in this disease the bones gradually lose their firmness and consistence, become soft, flexible, and may even be broken. The change is remarked first in the cylindrical bones, and though it extends to the others, it there continues to be most conspicuous. It consists in the bone becoming soft, sectile, reddish, and something like a mass of flesh. When any part remains unchanged, it is in the shape of thin scales or crusts at the outer part of the *diaphysis*, or occasional bony plates like portions of egg-shell intermixed. The cancellated

* Epist. lviii. 4. † Phil. Tr. Vol. xlii. p. 488.

‡ Histoire de la Maladie Singulière, &c. par M. Morand Fils, 1752. Mém. de l'Acad. 1753. The particulars of this case are published also in the Philos. Transact. for 1753–1754, Vol. xlviii. where she is called Queriot, and in Bromfield's Chirurgical Observations and Cases, Vol. ii.

§ Phil. Tr. 1753, Vol. xlviii. p. 297.

‖ Haller Disp. Med.-Pract. Tom. vi. p. 327, Lips. 1757.

¶ Med. Obs. and Inquiries, Vol. v. p. 259.

** Dissertatio, &c. Upsalæ, 1788.

†† Ramollissement Remarkable, &c. Mayence, 1804.

‡‡ Medico-Chir. Tr. Ed. Vol. ii. p. 136.

structure of the epiphysis entirely disappears, and in its place is found a soft homogeneous reddish mass. The situation of the marrow is occupied by a red, thick, semifluid matter like clotted blood, mixed with grease or suet. The flat bones of the scull are generally equally soft, flesh-like, and sectile. The cancellated structure of the *diploe* is equally destroyed, and its place is occupied by a uniform soft reddish substance, from sections of which bloody serum exudes. The periosteum is sometimes thickened, but is often unchanged.

The cause of this change is quite unknown. The most ingenious and probable conjecture regarding it is that by Howship, who, from the necroscopic appearances of a well described case, infers that it is the effect of a morbid action of the capillary arteries upon the medullary membrane within the bone; and that the disappearance of the latter is the effect of absorption exercised by the morbid secretion. *

6. *Friability. Fragility.* In the disease now described the bones may be broken by the weight of the person, or slight action of the muscles; and perhaps most cases of spontaneous fracture are referable either to incipient *osteo-sarcosis*, to *necrosis*, or to *spina ventosa*. One instance of this I certainly traced to incipient necrosis. Others, perhaps, are more equivocal. Is the animal matter absorbed?

7. *Interstitial absorption.*—Under this name Mr

* Case of *Mollities ossium*, &c. Med.-Chirurg. Tr. Edin. Vol. ii. p. 136.

B. Bell Jun. describes a peculiar sinking or condensation of the cancellated texture of the neck of the thigh-bone, occurring chiefly in aged subjects. * The affected part of the bone is highly vascular. In the only instance of this in my possession, the head of the bone has lost its spherical shape, and is flattened down upon the neck not unlike the *pileus* of a mushroom. The most internal part of its cartilaginous covering presents a series of holes passing into the *cancelli*. The neck is about one-third of its usual length, so that the head of the bone is lower than the great trochanter. This change must have been effected by the medullary vessels of the head and neck of the bone.

8. *Angiectasis.*—The arterial system of bones is liable to a peculiar anormal developement, in which they become much enlarged, and forming a cyst in the substance of the bone, gradually effect its absorption. Cases of this description I have already stated were observed by Pearson and Scarpa. Recently similar cases have occurred to M Lallemand and M. Breschet. †

9. *Eburneoid, or Ivory-like Induration.*—This, which consists in bone acquiring extraordinary hardness, density, and closeness, is occasionally seen in bony tumours, or exostosis, in bones which have been fractured, and sometimes in those of the scull, without evident morbid condition. In the case of Petit, however, an osseous tumour as

* Essay on Interstitial Absorption of the thigh-bone, Ed. 1824.

† Repertoire Gen. de Breschet, T. ii. part 2d. Paris, 1826.

large as a melon, and of the ivory aspect and consistence, was developed in the temporal bone. *

10. *Osteo-sarcoma.*—Though this is mentioned as a distinct variety of morbid change, it is probably of the same nature as exostosis. In this light it is viewed by Scarpa and Boyer. Upon the whole, though I cannot agree with the former in accounting it of the same nature as *spina ventosa*, I think the examples of osteo-sarcoma may be referred to the cartilaginous variety either of periosteal or medullary exostosis.

11. *Encysted Tumours. a. Osteo-steatoma.*—The formation of steatomatous tumours in the substance or at the surface of bones, has been noticed by Kulm†, Hundtermark‡, Herrmann,§ Pott,‖ Murray ¶, Sandifort **, Reil ††, Von Siebold ‡‡, and above all, by Palletta §§ and Weidmann. ¶¶ The tumour is generally encysted; and though it is represented by J. Bell as originating in the medullary tissue, it seems occasionally to arise from the periosteum. Its contents are not invariably,

* Maladies des Os. Tome ii. p. 292.

† Haller, Disp. Med.-Chir. Vol. v. p. 653.

‡ Haller, Disput. Med.-Pract. Tom. vi. p. 349.

§ Diss. Inaug. J. G. Herrmanni de Osteo-steatomate, Lipsiæ, 1767.

‖ Phil. Trans. No. 459.

¶ Dissert. de Osteo-steatomate, Upsalæ, 1780.

** Mus. Anat. i. 161. †† Archiv. iii. B. 453.

‡‡ Sammlung Chirurg. Beobacht. u. s. w. ii. B. p. 310 and 412.

§§ Exercitat. Patholog. p. 111.

¶¶ De Steatomatibus, Mog. 1817.

as its name seems to indicate, of an adipose nature. They vary from gelatinous, oleaginous, and meliceritious to atheromatous and sebaceous, irregularly intermixed with *spiculæ* and *lamellæ* of bone. Their progressive enlargement causes by pressure and absorption destruction of the contiguous bone. This is the process which by Palletta is termed *ossivorous*.

b. Hæmatoma, (blood-cyst.)—Of all the examples of this disease *(abscessus sanguineus,)* collected by Palletta, one only I find originated in the substance of a bone,—the tibia in its upper epiphysis, which was consumed by carious absorption. (Case 22.) In several, however, the tumour, though originating in the adjoining tissues, had produced by progressive encroachment the same effect.

c. Fungus Hæmatodes.—This is the same as the fungous medullary exostosis above noticed. Whether it originates in this manner, or from the contiguous textures, it produces the same erosive destruction of the bones. An instance of this originating in the peritonæum I saw destroy the bones of the pelvis, and reduce the upper half of the right *os femoris* to a thin net-work of bone, which broke asunder a few days before death.

12. *Scirrho-Carcinoma.*—Though this seems never to originate in the osseous texture, it often spreads to it from the contiguous one. Thus most surgeons have seen cancer of the lip or scirrhus of the parotid affect the lower jaw; cancer of the female breast erode the ribs; cancer of the penis affect the *ossa pubis;* and cancer of the eye or eye-

lids, in both sexes, affect the frontal, malar, or superior maxillary bones.

13. Tubercular destruction may occur in bones; but it most frequently originates in the periosteum or adjoining tissues, and passes thence to the enclosed bone, in which it produces the usual destructive erosion. (Palletta.)

14. Hydatids of the social form were seen in the tibia by Cullerier. *

15. In early life the growth of the osseous system may be suspended or interrupted, so that the parts of the skeleton are incomplete. This deficiency generally takes place on the mesial plane, at the line where the bones of each side are approaching to unite with each other. It is most common in the spinous processes of the vertebræ, in the bones of the head, and those of the upper jaw and palate. In the spine it is generally connected with the anormal effusion of fluid from the membranes of the chord, or the chord itself, when it constitutes *spina bifida* or cleft spine. The same deficiency I have seen in the frontal and nasal bones; and in hare-lip it is by no means uncommon in those of the palate and superior jaw.

16. Before concluding this chapter, a few words may be said on the morbid states incident to the teeth.

The enamel is liable to be worn down by the mutual attrition of the teeth of the upper and lower jaw. This detrition, which has been particularly described by Prochaska, is most conspicu-

* Cruveilhier, Anat. Pathol. Vol. i. p. 230.

ous in the crowns of those of the lower jaw, which in some subjects are so much worn down as to expose the central osseous pith of the tooth. Though effected chiefly by attrition, it is much facilitated by the use of acid substances, and by those states of the stomach and alimentary canal which favour the formation of acid. Another form of the same destruction may take place in the corresponding sides of two teeth which are too closely implanted together. The mutual pressure exercised during the process of mastication appears to be the first cause of this. After it is once established, it destroys first the enamel, and then the bone of the tooth, causing caries in the latter, which become blue or black, and is gradually excavated into a hole.

The most frequent cause of disease of the teeth, however, is inflammation of their internal pulp. This, which is attended by intense pain, by progressively destroying the membrane, impairs the nutrition of the tooth, which becomes carious in the bony pith, while the enamel cracks, and is cast off in the form of concave scales or crusts. The bony part thus exposed proceeds still more rapidly to destruction. It becomes excavated, breaks down, and at length is expelled in fragments.

Inflammation of the membrane of the alveolar cavities also, by injuring the connecting vessels, may cause carious destruction of the teeth. But it is generally combined with more or less affection of the pulp. In the rachitic its destruction causes the developement of the teeth to be checked, rendering the individual toothless.

CHAPTER XIX.

SECTION I.

GRISTLE, CARTILAGE, *Cartilago*,—*Tissu Cartilagineux.*

THE cartilaginous system or tissue is found at least in three different situations of the human body; 1st, on the articular extremities of the moveable bones; 2d, in the connecting surfaces or margins of immoveable bones; 3d, in the parietes of certain cavities, the motions or uses of which require bodies of this elastic substance.

The organization of gristle is obscure and indistinct. On examination by the microscope, its structure is said to be uniform and homogeneous, like firm jelly, without fibres, plates, or cells. William Hunter, however, represents the articular cartilages as consisting of longitudinal and transverse fibres.* Herissant represents those of the ribs as composed of minute fibres mutually aggregated into bundles connected by short slips, and twisted in a spiral or serpentine direction.† By Lassone, the articular cartilages are said to consist of a multitude of minute threads mutually connected and placed at right angles to the plane of the bone, but so as to radiate from the centre to the circumference.‡ The general fact of fibrous

* Phil. Transact. Vol. xliii. No. 470.

† Mém. de l'Acad. Roy. 1748. P. 355.

‡ Mém. de l'Acad. Roy. 1752. P. 255.

structure is confirmed by Bichat, who says, that with a little attention it is possible to recognize longitudinal fibres, which are intersected by others in an oblique or transverse direction, but without determinate order. In its purest form no blood-vessels are seen in it, nor can they be demonstrated even by the finest injections. In the margins of those pieces of gristle, however, which are attached to the extremities of growing bones, blood-vessels of considerable size may often be seen, even without the aid of injection. In young subjects a net-work of arteries and veins, which is described by Hunter under the name of *circulus articuli vasculosus*, may be demonstrated all round the margin of the cartilage at the line between the epiphysis and it. They terminate so abruptly, however, that they cannot be traced into the substance of the latter. The most certain proofs, however, of the organic structure of this substance are the serous exudation which appears in the course of a few seconds on the cut surface of a piece of cartilage after a clean division by the knife; and that it becomes yellow during jaundice, and derives colour from substances found in the blood. Neither absorbents nor nerves have been found in it. The cellular texture said by Bichat to form the mould for the proper cartilaginous matter appears to be imaginary.

The articular cartilages adhere to the epiphyses by one surface, which consists of short perpendicular fibres placed parallel to each other, and

forming a structure like the pile of velvet. This is easily demonstrated by maceration first in nitric acid, and then in water. The free or smooth surface is covered by a thin fold of synovial membrane, which comes off in pieces during maceration. The existence of this, though recently denied by Gordon, was admitted by William Hunter, and may be demonstrated either by boiling, maceration, or the phenomena of inflammation, under which it is sensibly thickened. All other cartilages are enveloped, unless where they are attached to bones, by a fibrous membrane, which has been therefore named *perichondrium*. The existence of this may be demonstrated by dissection, and also by boiling, which makes it peel off in crisped flakes.

The chemical properties of cartilage have not been accurately examined. Boiling shows that it contains gelatine; but as a good deal of the matter is undissolved, it must be concluded also that it is under some modification, or united with some other principle, perhaps albumen. Immersion in nitric acid or boiling fluids induces crispation, and it dries hard and semitransparent like horn.

Section II.

Cartilage is subject to inflammation, which in the chronic form passes into ulceration or erosion,—an affection common in the articular cartilages of the thigh-bone and tibia.

In this state cartilage becomes reddish or vas-

cular, and flaccid, or soft and spongy, with a lardaceous appearance and distinct fibrous arrangement. It swells and acquires a size double or even four times larger than natural. In this state it does not become yellow, nor is dissolved by boiling. This is most common in the hip-joint. (Bichat.)

When inflammation continues some time, it produces erosion. The first trace of this consists in minute reddish perforations appearing at the synovial surface of the cartilage, and gradually extending and becoming deeper. At first they are circular; but as these perforations by extension coalesce, irregular abraded patches are produced, which at length become so deep as to expose the denuded bone. When this takes place, as the process advances, irregular excavations are hollowed in the epiphyses, which then present the state described at p. 574. This form of caries, which resembles in some respects *spina ventosa*, is, I conceive, the one to which Severinus alludes, and to which he wishes to restrict the epithet of *paedarthrocace*. I have seen it in adults, however; and it is most frequent in the knee-joint, in which I have seen it remove every trace of cartilage. In this process Hunter represents the transverse fibres as giving way first; but this distinction is too refined. The disease may terminate in bony *ankylosis*. It occurs also in the hip-joint and in the elbow-joint.

In the cartilages of the larynx inflammation

takes place either primarily or by extension from the perichondrium or the mucous membrane of the throat. When it takes place primarily, it is represented by Mr Porter as preceded by ossification. When it takes place secondarily, it may occasionally be traced to ordinary inflammation from exposure to cold, the poison of syphilis, or the unfavourable operation of mercury. In either case it produces a bad species of ulceration, with mortification of the cartilages, which are sometimes coughed up as dead sloughs. This constitutes one of the worst forms of laryngeal consumption, *(phthisis laryngea.*)*

In strumous subjects the cartilages of the nose are subject to a species of enlargement or thickening, accompanied with increased vascularity, and terminating in unfavourable ulceration. In some instances, tyromatous deposition in the tubercular form takes place, and renders the nostrils tumid, irregularly knobbed and painful. This, which also tends to very bad ulceration, is one of the forms of the disease described under the general name of *Noli me tangere.* That it originates in the cartilages I have observed more than once; and its ravages are seldom stopped till they are completely destroyed, leaving much deformity.

It has been supposed that cartilage does not readily granulate. But this must be a mistake; for when bones are removed from articular cavi-

* Observations on the Surgical Pathology of the Larynx and Trachea, &c. By W. H. Porter, A. M. &c. Dublin and London, 1826.

ties, granulations have been known to rise from the cartilaginous surface; and there is no doubt that wounds of cartilaginous tissue are frequently united by granulation.

Cartilage is also liable to ossification, as is seen in those of the larynx, of the ribs, &c. In these the osseous matter is disseminated in irregular points and patches. In diseases of the hip-joint, the cartilages of the thigh-bone and acetabulum become not only bony, but may be converted into a substance similar to ivory. (Bichat.)

A new formation of cartilage is frequently found in various tissues, but especially in the serous and synovial membranes, to which it is not uncommon to find cartilaginous bodies attached. Cartilaginous texture is also found in those sarcomatous tumours which eventually pass into insanable ulceration.

CHAPTER XX.

FIBRO-CARTILAGE,—*Cartilago Fibrosa,—Tissue Fibro-Cartilagineux,—Chondro-Desmoid Texture.*

INTERMEDIATE between the cartilaginous and the fibrous tissues, Bichat ranks that of the fibro-cartilages, which comprehends three subdivisions. 1*st*, The membranous fibro-cartilages, as those of the ears, nose, windpipe, eyelids, &c.; 2*d*, The inter-articular fibro-cartilages, as those found in the temporo-maxillary and femoro-tibial

articulations, the intervertebral substances, and the cartilaginous bodies uniting the bones of the pelvis; 3*d*, Certain portions of the periosteum, in which, when a tendinous sheath is formed, the peculiar nature of the fibrous system disappears, and is succeeded by a substance belonging to the order of fibro-cartilages.

Beclard follows Meckel in rejecting the first of these subdivisions, the individuals of which are quite similar to ordinary cartilage. Like it, they do not present the distinct fibrous structure, but are covered by perichondrium, the fibres of which have evidently caused them to be regarded as fibro-cartilages. On this principle Beclard gives the following view of the fibro-cartilages.

1*st*, Fibro-cartilages free at both surfaces; those in the form of *menisci*, which are placed between the articular surfaces of two bones; (*fibro-cartilagines inter-articulares.*) These are seen in the temporo-maxillary, sterno-clavicular, and femoro-tibial articulations, and occasionally in the acromio-clavicular and the ulno-carpal joints. These ligaments are attached either by their margins or their extremities, and are enveloped in a thin fold of synovial membrane. 2*d*, Fibro-cartilages attached by one surface. Of this description are those employed as pulleys or grooves for the easy motion of tendons; for instance, the chondro-desmoid eminences attached to the margin of the glenoid cavity for the long head of the *biceps*, and at the sinuosity of the ischium for the tendons of the *obturatores*. 3*d*,

Fibro-cartilages, which establish a connection between bones susceptible of little individual motion, as the intervertebral bodies; or which unite bones intended to remain fixed, unless under very peculiar circumstances, as those which form the junction of the pelvic bones. (*Symphysis pubis, sacro-iliac synchondrosis.*)

The peculiarities of these substances consist in their partaking in different proportions of the nature of cartilage and white fibrous tissue, and consequently, in possessing the toughness and resistance of the latter with the flexibility and elasticity of the former. The structure of the fibro-cartilaginous tissue is easily seen in the intervertebral bodies, or in the cartilages uniting the pelvic bones. In the former, white concentric layers, consisting of circular fibres placed in juxtaposition, constitute the outer part; while the interior contains a semifluid jelly. The concentric fibrous layers are cartilage in a fibrous shape. In the latter situation the fibrous structure is equally distinct; while the cartilaginous consistence shows the connection with that organic substance. A similar arrangement is remarked in the inter-articular cartilage of the temporo-maxillary articulation, and in the semilunar cartilages of the knee-joint. In all, the fibrous is said to predominate over the cartilaginous structure. Their physical properties are distensibility with elasticity. Though they are at all times subjected to considerable pressure, they speedily recover their former

size. Their chemical composition appears to be entirely unknown.

There is little doubt that the fibro-cartilages are liable to inflammation, either originally commencing in their own substance, or communicated to them from contiguous parts, especially synovial membrane, with which many of them are invested. Suppuration of that which forms the *symphysis pubis* was seen by a friend of Hunter, * and by Ludovici, in the person of a puerperal female. This was the effect of excessive stretching during labour. In other instances they are torn asunder, so as to cause diastasis, without suppuration. In one instance separation of this kind appears to have been congenital. Palletta and Brodie have described a variety of vertebral disease which always commences with, and sometimes consists in erosion of the intervertebral cartilages; and most surgeons have seen the semilunar cartilages of the knee-joint inflamed and eroded. The intervertebral fibro-cartilages have been found softened, swollen, and distended with fluid. Ossification is not uncommon, and in those of the sacro-iliac and pubal junctions *(symphyses)*, is remarked in adults, or those advanced in life so frequently, that it cannot be regarded as disease. In the vertebræ it is also observed, though less frequently. It has been seen most generally in the dorsal and lumbar vertebræ, which are thus indissolubly ankylosed.

The *accidental*, or new developement of the

* Med. Obs. and Inquiries, Vol. ii.

chondrodesmoid tissue, is not uncommon; and its appearance constitutes the anatomical character of the most usual form of scirrho-carcinoma. In this state irregular or amorphous masses of fibro-cartilage are developed in isolated points of the organs; and by their coalescence progressively invade or destroy the original texture of the part. In some instances a mass of cartilage is traversed irregularly by intersecting white or yellow fibrous bands. In others irregular nodules of cartilage are separated by ligamentous partitions. This deposition, which ever manifests a tendency to fatal disorganization, is most frequent in the female breast, in the womb, in the lacrymal and parotid glands, and in the intestinal canal of both sexes. In its progress to ulceration cavities are formed containing brownish jelly-like fluid; and as it approaches the surface, fungous growths and hemorrhage are frequent.

The organic substances which have been already described consist either of those which are ramified or distributed extensively through the animal body, or of those which are confined to definite situations. Those which are now to be examined are extended continuously over considerable spaces, and tissues or organs very different sometimes from each other. They are *envelopes* or *membranes*, and consist of skin, mucous membrane, serous membrane, synovial membrane, and compound membrane.

CHAPTER XXI.

SECTION I.

SKIN, *Cutis, Pellis.*—CUTANEOUS TISSUE,—DERMAL TISSUE; *la Peau, Tissu Dermoide;*—DIE HAUT, DAS FELL; FELL, old English; WITH ITS APPENDAGES, SCARF-SKIN OR CUTICLE, NAIL, HAIR,—*Tissu Epidermoide et Tissu Pileux.*

SKIN has been said to consist of three parts, true skin, (*cutis vera,*) mucous net, (*rete mucosum,*) and scarf-skin, or cuticle. Haller, Camper, and Blumenbach are inclined to deny the existence of the mucous net in the skin of the white, and to admit it in that of the negro only; and in point of fact, indeed, its existence has been demonstrated in the negro race only, and inferred by analogy to exist in the white. "When a blister has been applied to the skin of a negro," says Cruickshank, "if it has not been very stimulating, in twelve hours after a thin transparent grayish membrane is raised, under which we find a fluid. This membrane is the cuticle or scarf-skin. When this with the fluid is removed, the surface under these appears black; but if the blister had been very stimulating, another membrane, in which this black colour resides, would also have been raised with the cuticle. This is *rete mucosum,* which is itself double, consisting of another gray

transparent membrane, and of a black web very much resembling the *pigmentum nigrum* of the eye. When this membrane is removed, the surface of the true skin, as has been hitherto believed, comes in view, and is white like that of a European. The *rete mucosum* gives the colour to the skin; is black in the negro; white brown or yellowish in the European." *

Bichat denies the existence of a mucous coating or varnish *(corpus mucosum,)* such as Malpighi describes it, and regards the vascular surface of the corion as the only mucous net.

According to Chaussier, the skin consists of two parts only, the *derma* (δερμα) *cutis vera* or corion, and the epidermis, cuticle, or scarf-skin; the first embracing the organic elements of this tissue; the second being an inorganic substance prepared by the organic, and deposited on its surface. This opinion is adopted by Gordon, according to whom the skin consists of two substances placed above each other like layers or plates *(laminæ)*, the inner of which is the true skin, the outer the cuticle or scarf-skin. Beclard, on the contrary, thinks that a peculiar matter, which occasions the colour by which the several races are distinguished, is found between the outer surface of the corion and the cuticle; and that no fair race is destitute of it except the *albino*, the peculiar appear-

* Experiments on the Insensible Perspiration of the Human Body, showing its affinity to Respiration. By William Cruickshank. London, 1795, p. 3 and 4.

ance of whom he ascribes to the absence of the mucous net of the skin.

The *corion* of the human skin *(pellis, corium, derma, cutis vera)* seems to consist chiefly of very small dense fibres, not unlike those of the proper arterial coat, closely interwoven with each other, and more firmly compacted the nearer they are to its outer or cuticular surface. The inner surface of the corion is of a gray colour ; and in almost all parts of the body presents a number of depressions varying in size from $\frac{1}{12}$th to $\frac{1}{10}$th of an inch, and consequently forming spaces or intervals between them. These depressions, which correspond to eminences in the subjacent adipose tissue, have been termed *areolæ*. They are wanting in the corion of the back of the hand and foot only.

The outer or cuticular surface of the corion is quite smooth, of a pale or flesh-red tinge, and is much more vascular than its inner surface. It presents, further, a number of minute conical eminences *(papillæ,)* which, according to the recent observations of Gaultier* and Dutrochet †, are liberally supplied with blood-vessels *(bourgeons sanguins,)* and are the most vascular part of this membrane. In the ordinary state of circulation and temperature during life these eminences are on a level with the surrounding *corion ;* but when the surface is chilled this membrane shrinks, while

* Recherches sur l'org. de la peau, &c. Paris, 1809 and 1811.

† Observations sur la structure, &c. Journal de Phys. Mai 1819, and Observations sur la structure de la peau, Jour. Compl. Vol. v.—Note (O.)

the papillæ either continue unchanged, or shrink less proportionally, and give rise to the appearance described under the name of *goose skin; (cutis anserina.)* This surface was said by the older anatomists to present numerous openings, orifices, or pores; but according to Gordon, if we trust to mere observation, no openings of this kind can be recognized, either by the eye or the microscope, except those of the sebaceous follicles. The hairs, indeed, are found to issue from holes in the corion, but they fill them up completely.

In certain situations, for instance at the entrance of the external auditory hole, at the tip of the nose, on the margins of the eyelids, in the arm-pits, at the nipple, at the skin of the pubes, round the anus, and the female pudendum, are placed minute orifices, from which exudes an oleaginous fluid, which is quickly indurated. These openings lead into small sacs or cavities called follicles, *(folliculi)*, or sebaceous glands, *(glandulæ sebaceæ.)* Of these sacs the structure is simple. They appear to consist simply of hollow surfaces secreting an oleaginous fluid, which is progressively propelled to the orifice, where it soon undergoes that partial inspissation which gives it the sebaceous or suet-like aspect and consistence.

The corion is liberally supplied with blood-vessels, nerves, and absorbents. After a successful injection, its outer surface appears to consist of a uniform net-work of minute vessels, subdivided to an infinite degree of delicacy, and containing during life blood coloured and colourless. It can

scarcely be doubted that this vascular net-work *(rete vasculosum)* is the only texture corresponding to the *reticular body* of the older anatomists.

It is well known that this membrane when boiled sufficiently long is converted into a viscid glutinous liquor, which consists chiefly of gelatin, (Chaptal, Seguin, Hatchett, Vauquelin, &c.) and that glue is obtained in great quantity from it for the purposes of art. As, however, in these operations a portion of matter is left undissolved, and as glue is completely soluble in water, while skin resists it for an indefinite time, it may be concluded, that though the chief constituent of the corion is gelatin, it is under some peculiar modification not perfectly understood. The union of this organized gelatin with the vegetable principle denominated *tannin* forms leather, which is quite insoluble in water.

Cuticle or scarf-skin *(epidermis, cuticula)*, is a semitransparent, or rather translucent layer of thin light-coloured matter, extended continuously over the outer surface of the corion. Its thickness varies, being thinnest on those parts least exposed to pressure and friction, but thickest in the palms and soles. It is destitute of blood-vessels, nerves, and absorbents; and there is reason to believe, from observing the phenomena and process of its reproduction, that it is originally secreted in the form of a semifluid viscid matter by the outer surface of the corion; and that, as it is successively worn or removed by attrition, it is in like manner repaired by a constant process of

secretion or deposition. This semifluid viscid matter, which, in point of fact, is found between the outer surface of the corion and the firm cuticle, appears to be the substance mentioned by Malpighi, and so often spoken of as the mucous body or net *(corpus mucosum.)* It is certainly quite inorganic; and it is impossible to explain its production otherwise than by ascribing it to the outer or vascular surface of the corion.

Cuticle is rendered yellow, and finally dissolved by immersion in nitric acid. It is also dissolved by sulphuric acid, in the form of a deep brown pulp. These, and some other experiments performed by Hatchett, appear to show that it consists chiefly of albuminous matter somehow modified.

This description shows, that, if strict observation be trusted, the mucous net has no existence, at least in the European. In the Negro, Caffre, and Malay, however, a black membrane is said to be interposed between the corion and cuticle, and to be the cause of the dark complexion of these races. On this subject I refer to the description given by Cruickshank,* which is the best, the Essay of M. Gaultier already quoted, and the observations of Beclard. What is found in the skin of the mixed or half cast races, *i. e.* the offspring of an African and an European, or of a mulatto and European? and how is the transition between this colouring layer and its insensible diminution effected?

Nail is a substance very familiarly known. On

* Experiments, &c. p. 31.

its nature and structure we find many conjectures, but few or no facts in the writings of anatomists; and almost all that has been written is the result of analogical inference, rather than of direct observation. It is known that they drop off with the scarf-skin in the dead body; that they are destroyed or diseased by causes which act on the outer surface of the corion, and produce disease of the cuticle; and that, if forcibly torn out, the surface of the corion to which they were attached bleeds profusely and inflames. In other respects they are quite inorganic; but these facts appear to warrant the conclusion, that the root of the nail is connected with the organic substance of the corion, and that the whole substance is the result of a process of secretion quite similar to that by which the cuticle is formed.

According to the experiments of Hatchett, they consist of a substance which possesses the properties of coagulated albumen, with a very small trace of phosphate of lime.

The *root* of a hair is not only that part which is contained in the bulb, but the portion which is lodged in the skin. The *middle part* and the *point* are those which project beyond the surface of the skin. The *bulb* is a small sac fixed in the inner surface of the corion, in the contiguous filamentous tissue, and receiving the extremity or root of the hair implanted in it.

Every hair is cylindrical, tapering regularly from the root to the point, and solid, but containing its proper colouring matter in its substance.

The colour varies, but the root is always whitish and transparent, and softer than the rest; the fixed or adhering part of the root is almost fluid. When hair is decolorized, it becomes transparent and brittle, and presents a peculiar silvery-white colour; and as hairs of this kind are few or abundant, it gives the aspect of gray, hoary, or white hair.

The bulb, though visible in a hair plucked out by the root, is too small in human hair to be minutely examined; and Chirac, Gaultier, and Gordon, have therefore described its structure and appearances from the bulbs of the whiskers of large animals, the seal for example, in which it is much more distinct. According to researches of this kind, every bulb forms a sort of sac or follicle, which consists of two tunics, an inner one, tender, vascular, and embracing closely the root of the hair; and an outer, which is firmer and less vascular, and surrounds the inner one, while it adheres to the filamentous tissue and the inner surface of the corion. When the hair issues from the bulb, it passes through an appropriate canal of the corion, which is always more or less oblique, but which, as has been already said, it fills completely; and it afterwards passes in a similar manner through the scarf-skin. Nervous filaments have been traced into the bulbs of the whiskers of the seal by Rudolphi and the younger Andral. The bulb or follicle, in short, is organic, and forms by secretion the inorganic hair.

The structure of hair itself appears to be either so simple, or so incapable of being further eluci-

dated, that anatomists have not given any facts of consequence regarding it. Its outer surface is believed to be covered with imbricated scales, because in moving a single hair between the finger and thumb it follows one direction only.

Hair is believed to be utterly inorganic, though the phenomena of its growth, decoloration, and especially of the disease termed Polish plait, *(plica Polonica,)* have led various authors to regard it as possessed of some degree of vitality. These phenomena, however, may be explained by the occurrence of disease in the bulbs or generating follicles. Hair is insoluble in boiling water, but Vauquelin succeeded in dissolving it by the aid of Papin's digester. From the experiments of this chemist, and those of Hatchett, it may be inferred that hair consists of an animal matter, which appears to be a modification of albumen, a colouring oil, and some saline substances.*

Section II.

The cutaneous texture and appendages are liable to many forms of disease. Most of them, however, may be referred to some form of the inflammatory process, or to changes in texture either original or acquired.

1. *Inflammation* assumes in this texture a great variety of forms, which it is the province of pathological anatomy to distinguish accurately. This was first attempted by Cullen, whose *phlegmon* and *erythema* were intended to designate two forms of cutaneous inflammation, according as the vessels of the internal or external surface are the seat of morbid

* Annales de Chimie, 1806. Tome lviii. and Philosoph. Trans. 1800, Vol. xc. p. 327, *et seq.*

action. The distinction, though judicious, was overlooked; and those who confided in his practical instructions, without attending to the correctness of his pathology or the fidelity of his descriptions, transferred the seat of phlegmon from the skin, in which it was placed by Cullen, to the cellular tissue, where it has since remained. This error was abetted by J. Hunter and C. Smyth, whose distinctions of inflammation, according to the tissues in which it occurs, place rose in the skin, and *phlegmon* in the cellular membrane. These views were generally adopted till the appearance of Bichat, who attempted, after the example of Cullen, to distinguish cutaneous diseases according to their seat in the cutaneous tissue.* As this is obviously the most rational method, and though not much followed by practical authors, has received the approbation of such observers as Meckel and Beclard, it is best calculated for the order to be observed in the present treatise.

Cutaneous inflammation, though it eventually affect the substance, which, however, is not frequently, may be conveniently distinguished in the following manner. *First*, it may be seated in the exterior or cuticular surface of the corion; *secondly*, it may affect the *papillæ* or minute elevations of the corion; *thirdly*, it may affect the substance of the corion; *fourthly*, it may occur at the inner or attached surface of this membrane. If these circumstances be adopted as the basis of general division, subordinate characters may be derived from the mode in which the inflammatory process advances, and from the effects which it produces, in the following order:—

Diffuse or spreading inflammation.—I. Cutaneous inflammations seated in the outer or cuticular surface of the corion, (*cutis vera*, *derma*,) and generally spreading along it.

Measles,	Rubeola.
Rash fever, scarlet fever,	Scarlatina.
Nettle-rash,	Urticaria.
Rose-rash,	Roseola.
Common rash,	Erythema.

Effusive inflammation.—II. Cutaneous inflammation seated in the outer surface of the corion, producing a fluid which elevates and detaches the cuticle.

* Anatomie Generale, Tome iv. p. 721.

Rose, St Anthony's fire,	Erysipelas.
Bleb fever, bullose fever,	Pemphigus, febris bullosa.
Simple blebs,	Pompholyx.

Punctuate papular inflammation.—III. Cutaneous inflammations commencing in circumscribed or definite points of the corion, producing minute eminences.

Gum, gown, red gum, tooth gum,	Strophulus.
Sun-rash, prickly heat,	Lichen.
Itchy rash,	Prurigo.

Punctuate desquamating inflammation.—IV. Cutaneous inflammations of the outer surface of the corion, more or less circumscribed, affecting its secreting power, and producing exfoliation of the cuticle.

Scaly leprosy,	Lepra.
Scaly tetter,	Psoriasis.
Dandriff,	Pityriasis.
Fish-skin disease,	Ichthyosis.

Punctuate vesicular inflammation.—V. Cutaneous inflammations originally affecting the outer surface of the corion, circumscribed, definite, or punctuate, producing effusion of fluid first pellucid, afterwards slightly opaque, with elevation of cuticle, with or without further affection of the corial tissue.

Miliary rash,	Miliaria.
Shingles, vesicular ringworm, or fret,	Herpes.
Heat spots, or red-fret,	Eczema,
Limpet shell vesicle and scab,	Rupia.
Cow-pox vesicle,	Vaccinia.
Chicken-pox,	Varicella.

Punctuate phlegmonous or pustular inflammation.—VI. Cutaneous inflammations originally affecting the outer surface of the corion, afterwards its substance, and producing purulent matter more or less distinct.

Small-pox,	Variola.
Plague,	Pestis.
Malignant pustule, Persian fire,	Anthracion.
Itch,	Scabies.
Moist or running tetter,	Impetigo.
Scall or pustular ringworm,	Porrigo.
Great pox,	Ecthyma.

Punctuate chronic phlegmonous inflammation,—VII. Cutaneous inflammations originating in the substance of the corion, sometimes at the bulbs of the hair, and terminating in partial or imperfect suppuration, with formation of scales, crusts, &c. and more or less destruction of the corial tissue.

Boil,	Phyma, furunculus.
Carbuncle,	Anthrax Carbunculus.
Whelk,	Acne.
Scalp or chin whelk,	Sycosis.
Canker,	Lupus, noli me tangere.
White scall,	Vitiligo.
Yaws,	Framboesia, rubula.
Sivvens,	Sibbenia.

Punctuate phlegmono-tubercular inflammation, chronic.—VIII. Cutaneous inflammations, chronic, attended with general affection of the fibro-mucous tissues.

Arctoic leprosy, radesyge,	Lepra Norwegica.
Lombard evil, pellagra,	Pellagra.
Scherlievo, Falcadina,	Lepra Pedemontana.
Asturian itch or scab, Mal di Rosa,	Lepra Asturiensis.
Crim evil, Krimmische krankheit,	Lepra Taurica.
Arabian leprosy,	Elephantiasis.
Soft tubercle,	Molluscum.
Wart,	Verruca.

a. Cutaneous inflammations seated in the outer or cuticular surface of the corion, and generally spreading along it.—Inflammation of the outer surface of the corion may be diffuse and continuous, as in scarlet fever, diffuse and interrupted, as in common rash (*erythema,*) nettle-rash, and rose rash, or diffuse and of determinate figure, as in measles. The redness with which superficial cutaneous inflammation is attended varies. Though it disappears on pressure it returns immediately. In scarlet fever, though its tint is indicated by the name, it often has a shade of brown; in *erythema,* or simple rash, it is rarely so vivid as in other forms of cutaneous inflammation; in rose it has a tinge of yellow. In measles it assumes the shape of crescentic or lunular patches. In simple rash it terminates gradually in the sound skin; but in one variety of this rash (*erythema marginatum,*) and in rose it is marked by a distinctly circumscribed edge, or is said to be *marginate.* The swelling of superficial cutaneous inflammation is rather a general distension than obvious elevation. When it is obvious to the eye, or felt by the finger, and is at the same time confined to definite red patches, these are named wheals. A familiar instance of this occurs in the effect produced by the bite of several insects, the blow of a whip, or the stinging of nettles. Spontaneously it is seen in the disease named nettle-rash. In rose, elevation, extensive and continuous, conterminous with the redness, and like it bounded by a distinctly circumscribed edge, is uniformly observed.

Superficial cutaneous inflammation being seated in the extensive vascular net-work, (*rete vasculosum, reseau vasculaire,*) of the corion, always destroys to a greater or less extent its scarf-skin, which comes away in small portions or scales, sometimes in larger pieces, while a new but thinner and more transparent scarf-skin is formed. The process by which these changes are effected is termed desquamation, and is observed in measles, scarlet fever, nettle-rash, rose-rash, common rash, and rose when it does not proceed to the formation of blebs. As the process thus defined forms a good mode of distinguishing its varieties when seated in

the outer or cuticular corial surface, I adopt it on the present occasion.

According to the definition above given it comprehends the following diseases:—Measles, rash fever, scarlet fever, nettle-rash, rose-rash, common rash.

This must be regarded as the simplest form of cutaneous inflammation. It may indeed be doubted whether it can justly be termed inflammation; for though the capillaries of the cuticular surface of the corion are unnaturally distended with blood, and the usual functions of secretion and perspiration are suspended, it does not induce those consequences which succeed the inflammatory process in other tissues, or even in the same tissue, in a state of unequivocal inflammation. It may, however, be remarked, that in other respects the phenomena of the disorders referred to this head afford fair examples of inflammatory action. The skin is permanently red, either continuously or in patches, or in spots of definite figure, diffusely swelled, and unusually warm, or rather hot and dry. Its sensations are also deranged; for the parts are either painful, smarting, or itching, as in nettle-rash, rose-rash, and common rash; or the skin is generally tense and sore, as in measles and scarlet fever. In each of these diseases also, the capillaries of the outer or cuticular surface of the corion are inordinately distended with blood, which appears to move very slowly or stand entirely motionless in them. The skin of a person cut off during the progress of measles or scarlet fever is marked by innumerable minute vessels disposed in various modes, arborescent, asteroid, reticular, &c.; and in some instances minute specks of blood are effused on the corion or into its substance. In scarlet fever, confined chiefly to the skin, the outer surface of the corion of the face, neck, and trunk, is particularly injected; and towards the close of the disease this capillary injection is brownish or purple. The injection of the mucous surfaces shall be noticed afterwards. In nettle-rash this injection is in circumscribed patches, and accompanied with elevation, but disappears greatly after death. In erythe-

matous inflammation I have observed the cuticular surface of the corion of a scarlet red, and soft velvety texture, and distinctly traversed by numerous minute arborescent and asteroid patches, which, however, become much paler in a few days.

b. Cutaneous inflammations situate chiefly in the outer surface of the corion, producing sero-albuminous fluid, which elevates the scarf skin into pushes, blebs, or blisters, (Bullæ, Phlyctænæ,) *commencing in certain parts of the corion, but spreading continuously.*

The outer surface of the corion may be inflamed in such a manner as not to terminate in desquamation or resolution, but to pour forth a watery yellowish fluid, which detaches the cuticle and elevates it in the form of a bleb or blister. This is very well seen in the instance of scalding by boiling fluids, on the application of the blistering fly (*Meloe vesicatorius,*) or even in some cases of friction to parts naturally tender. In each of these cases, in a short time large watery elevations or bladders appear. The same process takes place spontaneously in rose, in common blebs, and in the bullose or bleb fever. The form of these blebs is not determinate; nor even are they always uniform in appearance. The action by which they are produced, though more violent in degree, is not different in kind from ordinary cutaneous inflammation. It is attended, nevertheless, with more swelling of the corion, more exquisite burning heat, and more searing or scalding pain, than the other forms of superficial cutaneous inflammation. The fluid secreted by this process is sero-albuminous. When the raised cuticle is divided a yellowish transparent watery fluid escapes; and when the cuticle is detached so as to expose the inflamed spot, the inflamed skin is found covered by a quantity of soft, cellular, gelatinous matter, of a yellow-white colour, somewhat tough, and similar to coagulable lymph. This substance is traversed by firm linear partitions, not uniform in number or direction, but forming interstices from which serous fluid, the same as that which escaped first, is discharged. The coagulable matter, which

is albuminous, at the same time contracts, and forming a covering to the corion, while the latter begins to secrete a new cuticle, is at length thrown off in the form of opaque patches. These facts show that the new secretion, though discharged fluid, afterwards separates into a serous and an albuminous portion, and is an imperfect or modified coagulable lymph; that both are the product of the inflammatory process; and that the latter is analogous to that producing albuminous exudation from serous membranes. This analogy has not escaped Bichat, who remarks, that vesications do not occur in the latter, solely because they want epidermis. To this head belongs the inflammation of cutaneous whitloe.

c. Cutaneous inflammation commencing in circumscribed or definite points of the outer surface of the corion, and producing minute eminences or pimples (papulæ,) *which disappear gradually or terminate in scarf, or minute exfoliations of the cuticle.*

When cutaneous inflammation appears in the form of innumerable minute points, which, without spreading or coalescing, remain in general distinct, it differs in nature from that which has been already considered as the spreading or diffuse inflammation. The simplest form under which this is observed to occur is that which consists of the minute pointed elevations named pimples (*papulæ,*) which may be described as small conical eminences, surrounded by a red circle, and sometimes attended with superficial redness of the neighbouring skin, but without definite figure. They are slow in progress, do not proceed to suppuration, and after remaining an uncertain time, subside gradually, occasioning a branny or scurfy exfoliation of the scarf-skin with which they are covered.

These seem to have been the circumstances which induced Dr Willan to consider pimples as arising from inflammation of the *papillæ* or conical eminences of the corion. I cannot say that personal observation has enabled me to determine whether this is at all times truly the case or not; and I therefore will not positively deny the accuracy of the opinion. On this point, however, I remark,—that I have

seen and daily see instances of *strophulus*, in which the papular eruption can neither in form nor distribution be traced to the cutaneous papillæ; that the eruption of *lichen* in adults appears in situations in which the papillæ are few, as regularly and abundantly as in those in which they are numerous; and that we meet with local examples of papular eruption in which it is difficult to suppose the disease to be an affection of the papillæ of one region of the skin only. For these reasons it may be justly doubted whether in all instances papular eruptions consist in inflammation of the papillæ.

Of the anatomical characters of pimples, little is accurately known. They are not diseases necessarily fatal; and when death takes place during their presence, their distinctive characters are either much changed, or entirely gone before the anatomist can inspect them. In some instances of strophulus in infants cut off by other diseases, I have seen the corion rough and slightly raised in irregular spots, which were the seat of closely-set pimples during life.

d. Cutaneous inflammation of the outer surface of the corion, more or less circumscribed, affecting its secreting power, and thus producing first, exfoliation of the scarf-skin, afterwards vitiated scarf-skin.

Though the scarf-skin *(cuticula, epidermis,)* and nails are incapable of injection, and are therefore believed to be inorganic, the former is remarked to be more sensible when thin and semitransparent, than when thick and opaque, which it may be in certain regions. It is also observed, that when it is removed by a blister, or the effect of a scald, the surface of the corion, when it ceases to discharge the sero-albuminous fluid already noticed, becomes covered by a thin pellicle of transparent membrane, so delicate, that it affords very little defence to the subjacent skin. This same transparent pellicle is observed in the skinning or cicatrization, as it is named, of cutaneous wounds. If, under these circumstances, the formation of this pellicle be observed, it will be found that it is deposited from the outer or cuticular surface of the corion, like a secreted substance in a viscid or semifluid

state, and afterwards becoming hard, dry, and semitransparent. When the first and thinnest pellicle is formed, the outer surface of the corion, which in the healthy state never suspends its secreting function, continues to deposit more of this semifluid, viscid matter, which in like manner, but more slowly, becomes firm; and as successive depositions continue to be formed beneath that last secreted, the cuticle in its perfect state consists of successive layers of matter secreted from the outer surface of the corion. It is not to be imagined, nevertheless, that they can be distinguished from each other. The secreting or depositing power of the corion is a process which is incessant and uninterrupted; and after the first secreted portions become firm, others subjacent undergo in like manner incessant deposition and induration.

While this process of repair is going on at the surface of the corion, a process of wearing or destruction is with the same rapidity in the healthy state going on at the outer or exposed surface of the cuticle. A piece of black or blue cloth rubbed gently over the skin becomes quickly whitened by minute portions of scarf-skin, which are thus detached from the firmer and more recent portions. A black silk stocking drawn on the leg for a very short time, even when the skin has been carefully washed with soap and water, comes off covered with numerous thin white amorphous scales, which are found to be minute portions of decayed cuticle, ready to be thrown off by the first slight friction. In like manner, the friction of dress, of washing, rubbing, &c. tends to remove the exposed portions of cuticle. These several facts show that this membrane is a substance secreted from the outer surface of the corion; that its production is successive and incessant process; and that it undergoes a constant wearing or detrition. As numerous facts show that it is an albuminous substance much indurated (Hatchett,) so it would appear that when this induration becomes extreme, as takes place in the exterior portions, their connection with the recent and softer portions is destroyed, and

detachment is the result. Such is the course of phenomena in the healthy state.

When the outer surface of the corion becomes inflamed or otherwise disordered, its secretion is no longer performed with the same perfection or regularity. The effect of this is seen in the vitiated state of the scarf-skin, which is no longer the uniform, continuous, firm, semitransparent membrane observed in health, but becomes broken, thickened, opaque, and divided iuto numerous scales. Of the various modes in which this secretion may be deranged, and of the varieties in cuticular disease to which it may give rise, too little is known to speak with precision of their individual forms. But it may be considered as certain, that every morbid state of the outer surface of the corion gives rise to certain unnatural conditions of the cuticle, and that every anormal state of the cuticle depends originally on a morbid state of the cuticular or secreting surface of the corion. In general, this morbid state consists in some degree of inflammation, or at least it is attended with some degree of this process though in the chronic form. In some instances, this chronic inflammation is obviously the immediate cause of the derangement of secretion; but in other instances, the disordered secretion continues after the inflammation subsides. The former is observed in the Greek leprosy (*Lepra,*) and the scaly tetter, (*Psoriasis,*) in both of which the formation of the morbid opaque scales is preceded and attended by a red inflamed state of the corion taking place in minute spots. It is less obvious in dandriff, (*Pityriasis,*) in which the surface of the corion, though dry, harsh, and rough, is not particularly red or vascular, and which, therefore, appears to exemplify the latter statement. The fish-skin eruption (*Ichthyosis,*) is in general so chronic, that it is difficult to say whether it is or is not attended with any degree of the inflammatory process; but when its commencement can be traced, it is generally possible to recognize marks of inflammation of the outer surface of the corion.

e. Cutaneous inflammation originally affecting the outer

surface of the corion, circumscribed, definite, or punctuate, producing effusion of fluid, first pellucid, afterwards slightly opaque, with elevation of cuticle, with or without further affection of the corial tissue.

Inflammation may be developed in many minute points of the corion simultaneously, and, continuing limited to these points without spreading, may terminate in each in the formation of a pellucid fluid, afterwards becoming more or less opaque. These may either be confined to the outer surface of the corion, without affecting its substance, or, beginning originally at the surface, may thence affect its substance.

The individual points appear first like a common rash, with general redness of the skin, sometimes like pimples or minute elevations, with a good deal of redness surrounding them. After some hours, a white pearly point appears at their summits, while the surrounding redness diminishes in breadth, so as to form a mere circle or hoop *(areola,)* which, if minutely examined, is found to consist of a zone of vessels, circumscribing the inflammatory process, and forming in their centre the fluid which gives the elevation the white appearance. After 12, 20, or 30 hours more, according to circumstances, the white pearly appearance extends, assumes a tint of yellow, and is depressed on the summit, indicating the advancement of the process of circumscribed inflammation. In the course of two or three days, there is detached a thin crust or scab, which consists of the cuticle of the part with the dried fluid adhering to it. Minute elevations of this description have been termed vesicles (*vesiculæ*), and the contained fluid *lymph* by Dr Willan. The fluid thus distinguished is not the same as the coagulable lymph of J. Hunter. It is nevertheless sero-albuminous, and appears to be quite similar to that which is secreted in the first stage of suppuration. The process by which it is secreted is confined to the vascular surface of the corion, and is not attended by ulceration of that surface in millet rash, shingles *(herpes)*, and the red-fret or mercurial eruption *(eczema.)* In chick-

en-pox it is sometimes attended by ulceration of the corial surface, sometimes not.

In the other two forms of vesicular inflammation, though the process commences at the surface of the corion, it finally affects the substance of that membrane.

In the limpet-shell vesicle *(rupia)*, inflammation of the punctuate or circumscribed character commences in one or more points of the outer surface of the corion, and causes the secretion of a thin clear fluid, which first elevates the cuticle into a broad flat vesicle, and soon becoming opaque, oozes through the broken cuticle, and is hardened into thin, superficial, but in general laminated scabs. These vesicles are surrounded by a red, hard, and painful margin or base, indicating slow inflammation of the corial tissue.

The progress of this form of cutaneous inflammation demonstrates clearly and satisfactorily the gradual transition of the morbid action from the surface to the substance of the corion. The inflammation, confined at first to a small spot by the usual zone or areola, causes merely sero-albuminous secretion, and consequent elevation of the cuticle. If at this time the cuticle be removed accidentally or intentionally, the subjacent surface of the corion is intensely red, soft, or velvety and pulpy, elevated, and extremely tender, while the surrounding ring or hoop of skin is hard, and equally elevated and red. From the softened inner portion the secretion of sero-albuminous fluid, generally of a reddish tint, continues; and the surface itself begins to become rough, and to lose its velvet aspect. This indicates incipient ulceration, which proceeds to affect the substance of the corion, until it is either much or wholly destroyed, generally in the form of an inverted cone; while the place of the destroyed skin is supplied by the sero-albuminous secretion, which hardens as it is formed, and seems thus to sink deeper and deeper into the skin. In the meanwhile, the surrounding portion of the skin is much indurated and inflamed, and seems to form a hard ring in the skin; and the whole process is attended with extreme pain, searing heat, and constitutional

distress. These phenomena are most distinctly seen in the *rupia prominens* and *escharotica*, and in a variety of the eruption, which I have witnessed in the persons of those who have been affected with the constitutional symptoms of syphilis, and who have for this been subjected to repeated courses of mercury; *(rupia cachectica.)*

Cow-pox (*vaccinia,*) whether in the teat of the cow, or the skin of the human subject, consists in local inflammation of the outer surface of the corion, which, by causing the secretion of a thin semitransparent fluid, elevates the cuticle into a vesicle. At the same time, the surrounding skin is red, sore and hard (*areola;*) and the inflammatory process denoted by these signs causes suppuration of the corion, with some destruction of its substance, or what is termed ulceration.

If the thin fluid secreted by the vaccine vesicle either in the teat of the cow, or in the skin of the human subject, be taken before it has become opaque or puriform, and applied to the surface of the human corion exposed by scratching, slight incision, or suitable abrasion of the cuticle, it is followed by local inflammation of the same characters as those of the original sore or vesicle, from which the morbid fluid is taken. The vaccine inflammation is naturally divided into two stages.

1. About the second or third day, or from fifty to seventy hours, after insertion of the fluid, the point of skin becomes red and slightly raised. This redness and elevation continue to increase till the cuticle is gradually elevated about the fifth or sixth day into a flat pearl-coloured spot or vesicle, which is found to derive its appearance from the secretion of thin semitransparent fluid, formed during the inflammatory process of the corion. The figure of this spot or vesicle varies according to the manner in which the vaccine fluid has been applied to the part. If it is by a longitudinal incision or scratch, as is commonly done, the shape of the vesicle is oval; if it has been by longitudinal and transverse ones of nearly equal size, or by simple puncture, then it is more or

less regularly circular ; and if the scratches have been numerous and irregular in direction, or if the fluid has been applied irregularly, the shape of the vesicle is also irregular. From its first appearance its upper surface is uneven, the margin being more elevated than the centre, and shining, firm, and distended, so as to project slightly beyond the plane of its base, or unaffected cuticle. This appearance it presents till the eighth day, when the surface is observed on the ninth to be even ; and in some instances the centre may be higher than the margin. At this time, when the vesicle is supposed to be fully formed, it is found to consist of many minute communicating cells, in which the fluid is contained. This cellular disposition is characteristic of the vaccine vesicle ; for it is found to occur under every variety of circumstances when the origin of the vesicle is genuine, and its progress uninterrupted.

2. The circumstance now remarked may be regarded as denoting the termination of the first and the commencement of the second stage. About the same time, the skin round the vesicle becomes hard, tense, and red, so as to form a ring or hoop, from one to two lines broad all round, and from a quarter to two inches in diameter, according to the size of the vesicle. This hard red hoop, which has been named *areola*, marks an augment or increase of inflammation in the substance of the corion, which continues with pain, tension, and hardness, in some instances with obvious swelling of the contiguous parts, till the end of the tenth or the beginning of the eleventh day. At the same time the fluid of the vesicle becomes opaque and thick like purulent matter, rendering the centre yellowish, and depriving it of its pearly distended aspect. On the eleventh and twelfth days, as the marginal redness fades, the surface of the vesicle becomes brown in the centre, and less clear on the margin ; the cuticle begins to separate ; and the fluid of the vesicle gradually thickens into a hard round scab or crust of a reddish or yellow brown colour, which afterwards becomes black, dry, and shrivelled, and is loosened, and drops off about the twentieth day after

the time when the vaccine fluid was first applied. It leaves a permanent uniform scar, distinguished by minute pits or depressions corresponding to the number of cells of which the vesicle consisted.

During the progress of the local inflammation some disorder of the constitution takes generally about the seventh or eighth day, in the form of loss of appetite or sickness, slight thirst and heat, and dryness of the skin. The pulse is almost never affected. The vaccine vesicle may also produce sundry cutaneous inflammations, very transitory, and of a secondary nature. Of these the vaccine rose-rash (*roseola vaccina*) is the most important and frequent.

It must not be understood that vaccine fluid when applied to the human body ever produces a general eruptive disease like itself over the person. This, indeed, was believed to be the case at first by Jenner, Pearson, Woodville, and perhaps some others. But more correct knowledge of the history of the disease shows that its action is confined to the identical spots to which it is applied ; that these, and these only, become the seat of genuine vaccine inflammation ; and that whatever eruptions or other morbid changes in the skin succeed, or have been said to succeed, the communication of cow-pock to the human body are not the result of its genuine or proper action. It is strictly and truly a local morbid process.

The history above given of the progress and characters of the vaccine vesicle, shows clearly that the application of the vaccine fluid, under proper conditions, is succeeded by a local inflammation of the corion, which observes a definite progress, divisible into two stages. In the first of these stages, which may be termed the *primary* or *immediate*, the inflammatory process is confined with great accuracy to the cuticular surface of the corion, and, diffusing itself very uniformly from the point of insertion at equal distances in every direction, terminates in effusion of lymph or sero-albuminous fluid, and elevation of the cuticle. During the first stage, which lasts about seven or eight days, the minute cells are

formed. They appear to consist in separate points of inflammation, at which the corial vessels discharge, as in other examples of the inflammatory process, sero-albuminous fluid, which is soon coagulated in a definite form. The coagulated portions form the partitions of the cells, within which the fluid part is contained. The appearance of the red ring *(areola)* which takes place about the eighth day, indicates the commencement of the *secondary* inflammation. This consists in the action being propagated to the substance of the corion, which is effected to some depth in the formation of puriform or purulent matter, and in destruction of part of its tissue. The subsequent phenomena and effects are easily understood.

It is a remarkable property of cow-pock inflammation, that it modifies considerably not only the variolous inflammation, but that produced by itself. The second application of the vaccine lymph in a person who has previously undergone this disease, produces a smaller vesicle of the same characters, but less intensely marked. If the application be made while the first is still in progress, and before its *areola* has appeared, it produces a vesicle which runs its course more rapidly than the original one, and terminates nearly at the same time with it. This constitutes the *test-pock* or vesicle of Mr Bryce.

Of chicken-pox as a cutaneous inflammation sometimes affecting the corial substance, I have already merely spoken. Like instances of the punctuate inflammation, though it commences at the surface of the corion with sero-albuminous secretion, it very often proceeds to suppuration, and occasionally affects the corial tissue. This is seen in the lenticular and more distinctly in the conoidal chicken-pox, in which the suppurated points are marked by depressions. The cutaneous punctuate inflammation of chicken-pox may be considered as the link which connects the vesicular and the pustular eruptions.

The facts now adduced show that it is impossible to draw a distinct line between the vesicle and the pustule, as was

attempted by Willan and Bateman. Looking only at the pathological process by which they are developed and advance to maturity, it is more natural to consider them as differing in degree only, and as gliding by imperceptible shades into each other, than as always capable of being accurately distinguished. What is a vesicle when first observed, may assume the appearance of a pustule on the following day; and the thin sero-albuminous fluid, by which they have been supposed to be distinguished, may be converted into purulent matter before the termination of the disease. As the terms, nevertheless, are useful as precise distinctions in nomenclature and description, and as they occasionally may be traced to a pathological difference, I retain them in the present observations.

f. Cutaneous inflammation originally affecting the outer surface of the corion, afterwards its substance, and producing purulent matter more or less perfect.

Inflammation of the minute circumscribed kind, though commencing originally on the surface, may speedily affect the substance of the corion, and in its progress may produce more or less loss of substance, with formation of purulent matter. The objects thus formed are named *pustules,* and are to be viewed as instances of genuine phlegmonous or rather purulent inflammation of the skin. Practical authors enumerate four forms under which this species of cutaneous inflammation may take place:—1st, the *psydracium;* 2d, the *achor;* 3d, the *favus;* and, 4th, the *phlyzacium.* To this number I feel it necessary to add the *phlyctidium.*

The *psydracium* may be viewed as the connecting link between the vesicle and pustule. It is small, often irregularly circumscribed, producing but slight elevation of the cuticle, and terminating in a laminated scab. It is attended with little or no redness of the surrounding skin *(areola),* does not affect the corion deeply, and rarely almost never leaves a hollow scar. Several of them often appear together, and becoming confluent after discharging the scanty puriform matter which they furnish, pour out a thin watery fluid, which on drying forms an irregular incrustation.

The *achor* differs not much from the psydracium. It appears in the form of a minute pointed elevation, of a yellow-colour, and succeeded by a thin brown or yellowish scab. It contains straw-coloured matter of the appearance and consistence of strained honey; it is surrounded with little inflammatory redness, and seems to affect the corion as little as the psydracium. In ordinary circumstances it leaves no scar.

The *favus* may be esteemed the next degree of inflammation of this tissue. It is larger and flatter than the last-mentioned pustule, not pointed, and contains a more viscid matter than the *achor*. It is surrounded by a slight-red, irregular, marginal ring, indicating a more considerable affection of the corial tissue. It is succeeded by a yellow, semi-transparent, and sometimes cellular scab, like honeycomb.

A form of pustule referable neither to these, nor to that which is to follow, I must here mention,—the *phlyctidium* or genuine small-pox pustule. It consists in a circular or annular spot of inflammation of the corion, encircled by a red ring or zone, which is observed to consist of the outer corial surface highly vascular and elevated. Within this suppuration takes place. Though the *phlyctidium* is observed spontaneously in the distinct small-pox, it is also produced artificially by friction of tartar-emetic ointment.

The *phlyzacium* is the most perfect example of the most violent degree of this form of cutaneous inflammation. It is described as a large pustule, raised on a hard circular base, of a lively red colour, and succeeded by a thick, hard, dark-coloured scab. It is generally slow in progress, and, commencing at once on the surface and in the substance of the corion, is attended with considerable surrounding inflammation; and the suppurative process which follows is always accompanied with more or less destruction of the corial tissue. It often leaves a hollow scar. The surrounding redness, hardness, and elevation; the slow progress and sometimes tedious suppuration; and lastly, the loss of corial substance, are the circumstances which indicate the peculiar seat of this form of cutaneous inflammation.

Into the pathological characters of the individual pustular inflammation, the limits of this treatise do not permit me to enter. On one or two of them, however, I shall offer a few remarks which may tend to illustrate the general nature of cutaneous pustular inflammation. I begin with small-pox as one of the most interesting.

From Dominico Cottugni we learn that it was the opinion of Astruc, that the poisonous matter of small-pox (*venenum variolarum*) affects particularly and exclusively the mucous body (*corpus mucosum*), which Malpighi describes between the skin and cuticle, and that it was the property of this poison to induce in it the peculiar variolous inflammation. This opinion appears to Cottugni to be correct, because it is confirmed by dissections made by him of the incipient and complete small-pox pustule. These dissections, Cottugni states, showed the incipient pustule to consist of the raised cuticle without affection of the substance of the corion ; that this elevation of the cuticle was occasioned by the intermediate mucous body (*corpus mucosum*) being expanded like jelly, without separation of parts or intervening cavity ; and that such separation and cavity could be perceived only when the pustule was completed. Variolous pustules, he then asserts, are of two kinds, the *umbilicate* or *depressed*, and the *vesicular* or *crystalline*. The umbilicate are those, the apex of which is, from the very beginning, flattened or truncated, and which are rather lenticular than conical, as most pustules, except the variolous, are. This shape they retain until in the course of inflammation they grow to their full size, which may equal or exceed that of a lentil either on the eighth or ninth days, or on the tenth and eleventh. The cause of this depressed figure is the navel (*umbilicus*) in the centre of the pock, which is at first like an indistinct point, but afterwards as the pock grows, becomes more elevated, with a flatter figure. From this central point or *navel* he represents all the actions of the pock, inflammation, suppuration, and drying or scabbing to proceed. For while it, as a seat of the poison, remains fixed, the surrounding part, not of skin, but

of mucous body, is raised into an inflammatory ring or mound, which prevents the morbid action from spreading. In the confluent small-pox this provision is not observed. No outer swelled or red ring is observed, and the mucous body of Malpighi is not in such circumstances affected with the just and laudable action of the disease. These results he ascribes to the spongy structure of the Malpighian membrane, which swells and secretes a lymphy fluid. In the crystalline small-pox, the fluid of which is almost pellucid, he asserts that the mucous body, instead of being converted into good matter, is filled with a caustic eroding humour, which seldom fails to leave deep scars. *

Though these crystalline pocks are nearly allied to his second kind, the vesicular, they must not be entirely confounded with them. They are utterly destitute of depression from their origin, are quite similar to minute blisters, and he conceives them to be generated in a similar manner, that is, by the inflammatory action operating like a scald, and detaching very rapidly from the mucous body the cuticle, so as to form vesicles or vesicular pustules. The purple-like pocks he explains in a similar manner. They are merely vesicular elevations of the cuticle, containing at first a watery fluid, but mixed afterwards with blood or bloody fluid exuding from the mucous body or vessels of the skin. They are generally mixed with petechial spots, the origin of which depends on the same cause.

In short, the doctrine of Cottugni is explicitly the following:—The natural and ordinary character of the small-pock is to produce in the mucous body (vascular web) of the skin a pit or depressed point, which is soon surrounded with an elevated circle, indicating inflammation of the corial surface. As this inflammatory process proceeds from the central pit or navel to the circumference, the elevated ring of mucous or vascular web is gradually converted into purulent matter, which necessarily renders the summit of the pock flatter and more

* Dominici Cottunnii Regii Anatomes Professoris de Sedibus Variolarum Syntagma. Vienna, 1771. lxxx. paragr.

extensive, while its centre remains depressed. The formation of purulent matter is indicated, he says, by the appearance of a whitish ring (*albidus annulus,*) which is at first at the vertex, but extends successively to the base of the pock. In this course, he says, it does not affect the corion (*cutis*) if the pocks be good; for before it reaches this membrane the purulent matter occupying the circumference of the pock either by bursting it escapes, or by the itching which it causes at length gets an outlet. Meanwhile the site of the pit or navel (*umbilicus*), which was previously sunk and hollow, not only attains the uniform convexity of the rest of the pustule, which renders it spherical instead of lenticular, but is raised into a top or apex, which first allows the contained matter to escape. This hardening forms a crust which covers the pustule during the subsequent process of drying (*persiccatio*), which now commences; when this is completed the crust or scab drops off, leaving the skin uninjured.

This is, according to Cottugni, the natural and most perfect process of variolous suppuration, from which all others are more or less deviations. Thus the umbilicate pocks may degenerate into the gangrenous, corruptive, crystalline, and warty; the vesicular deviate into the purple-like pox only.

The most doubtful point of this account of the variolous inflammation, is that which relates to the disease being entirely confined to the mucous body of Malpighi. The existence of this membrane is very doubtful, and if it cannot be demonstrated, the opinion of small-pox being confined to it is obviously inconclusive. If the term *outer surface of the corion* be substituted for mucous body, the whole description may be regarded as not far from the truth. The depressed pit or *navel* of which Cottugni speaks, corresponds with the central slough of John Hunter, to which I shall advert in its proper place. At present, the process of variolous inflammation, if divested of hypothetical language and opinions, may be stated in the following terms:—

The small-pox eruption consists of circumscribed points

of inflammation developed simultaneously in many spots of the corion. These inflamed spots (*phlyctidia*), always commence at the cuticular or outer surface, and in general penetrate to a depth which is greater or less in different circumstances. After no long time, each *phlyctidium* is surrounded with a hard red circle somewhat raised, which may be conceived to indicate the process of cutaneous inflammation. Hunter would say, and perhaps did say, that this inflammation is of the adhesive kind, and arises from lymph effused into that part of the corion which is red, hard, and swelled. I believe it cannot be in every instance shown that this hard swelling depends on effusion of lymph; and it may be doubted whether it arises from such effusion in the case of small-pox. *First*, hardness and swelling take place at a period of the eruption so early, that it appears unreasonable to ascribe them to effused lymph; *Secondly*, hardness and swelling accompany every example of circumscribed or definite inflammation; *Thirdly*, it is not easy to understand in what particular part the lymph could be effused, for the corion does not contain cells or cavities like the filamentous tissue, but the outer surface consists of a smooth dense membrane, abounding in minute blood-vessels. *Fourthly*, it is as easy and more natural to think that if effusion took place, it would do so into these minute vessels. In point of fact, the capillaries of the corion of the pustular redness and hardness are numerous and distended; and we believe that the truest conclusion is, that the redness, hardness, and swelling of each pock, consist in the unusual distension of the corial capillaries with blood.

Pustular inflammation of the skin naturally terminates in suppuration, which may be either with or without destruction of the corial tissue. In the variolous *phlyctidia*, when distinct, destruction of the skin is rare, but may occur. There is reason to infer that it takes place in consequence of a true process of ulceration.

According to the observation of John Hunter, there is another mode in which destruction of the corion, and a permanent scar may be effected. "The most certain character,"

that is the most certain pathological character " of the small pox," says this writer, " is the formation of a slough, or a part becoming dead by the variolous inflammation, a circumstance which hitherto, I believe, has not been taken notice of. This was very evident in the arms of those who were inoculated in the old way, where the wounds were considerable, and were dressed every day; which mode of treatment kept them from scabbing, by which means this process was easily observed; but in the present method of inoculation it is hardly observable. The sore being allowed to scab, the slough and scab unite and drop off together. The same indistinctness attends the eruptions on the skin; and in those patients who die of, or die while in the disease, where we have an opportunity of examining them while the part is distinct, this slough is very evident. This slough is the cause of the pit after all is cicatrized; for it is a real loss of substance of the surface of the *cutis*, and in proportion to this slough is the remaining depression."

" The chicken-pox comes the nearest in external appearance to the small-pox, but it does not commonly produce a slough. As there is generally no loss of substance in this case, there can be no pit. But it sometimes happens, although but rarely, that there is a pit in consequence of a chicken pock, then ulceration has taken place on the surface of the *cutis*, a common thing in sores."*

The circumstance of a slough at the bottom of each pock or inflamed point has been particularly insisted on by Joseph Adams, a most zealous admirer of the pathology of Hunter, and an active commentator on his principles. " We have before seen," says Adams, " that the peculiar property of some morbid poisons is to produce death in a part, whether the inflammation be violent or not. Of this kind is the small-pox, every individual pustule of which is found with a slough at the bottom, which may be removed with ease, after time has been allowed for its separation by suppuration. The

* Philosoph. Transactions, Vol. lxx. p. 133, Mr Hunter's account of a woman who had small-pox during pregnancy.

progress of the small-pox is therefore to form a number of sloughs under the skin, (on the cuticular or outer surface of the corion), and the danger depends on the number formed, and the violence which the constitution suffers from the first shock of that *stimulus* which excites it into this process. If the *stimulus* of the small-pox virus is moderate, its local action follows by adhesive inflammation and slough; after which, the parts and constitution have sustained the first shock, and the subsequent process of suppuration, to separate the slough, is accomplished with so much ease, that the constitution is rarely sensible of any general inconvenience. But the face having sustained the first shock, the actions on that part began with the greatest rapidity, and continue so throughout their whole progress; in consequence of which the pus has a higher tinge, and the progress of skinning beginning as soon as the slough begins to separate, this irregularity produces an inequality in the surface of the pustule. On the contrary, the actions being slower in other parts, the pustules acquire the property of common sloughs, and granulation follows suppuration for the restoration of the lost part."*

According to the observations of Cruickshank, this white slough is not situate in the corion, but in a vascular membrane exterior to it, and immediately beneath the cuticle. This anatomist macerated in water for a week several portions of small-pox skin, which he had previously injected, and kept for some time in spirits. "The spirits with which they had been impregnated made them resist the effects of this water longer. Cuticle and *rete mucosum* were already turned down, and upon the eighth or ninth day I found I could separate a vascular membrane from the *cutis*, in which were also situated the injected small-pox pustules. These last consisted of circles of long floating *villi* at the circumference, but of a white uninjected substance in the centre. This central part Mr Hunter had previously said was a slough formed by the irritation of the variolous matter."†

* Morbid Poisons, p. 364. † Experiments, &c. p. 41.

He subsequently comes to the conclusion, that on the surface of the skin (corion) lie five membranes, the outermost of which is cuticle, the next two-fold is *rete mucosum*, and the fourth is the first vascular membrane in which the small-pox pustules are chiefly seated.

From these facts and observations, as well as those which it has occurred to myself to make, the following conclusions may be drawn:—

The *phlyctidium* or pustule of small-pox consists of a cutaneous inflammation, which may produce,

1*st*, Secretion of puriform fluid without permanent injury or destruction of the corion. In lenticular chicken-pox, and distinct small-pox, there is no doubt that though suppuration takes place from the cuticular surface of the corion, it is not necessarily connected with destruction or ulceration of that membrane.

2*d*, Suppurative ulceration of the corion. In conoidal chicken-pox, in some instances of distinct small-pox, and in many instances of small-pox partially or wholly confluent, each pock goes on to ulceration of the corion. It does not appear that the pock slough described by Hunter is present in every case. It is admitted by Adams to be wanting in the vesicular small-pox, which appear after cow-pox, and in some other occasions.

3*d*, Death of numerous spots of the corion constituting sloughs. In some cases of distinct small-pox this has been observed; but it is most frequent in the confluent eruption. It then appears in the form of a white circular patch lying at the bottom of each pock.

4*th*, Along with sloughs at individual points, an extensive spreading redness of the skin rapidly terminating in sloughs of irregular shape and limits not unfrequently occurs in certain bad forms of variolous eruption.

Oriental plague I place among the examples of pustular cutaneous inflammation, because the carbuncle to which its poison gives rise, is, I conceive, an instance of punctuate inflammation of the corion. I am aware that Willan, and after

him Bateman, placed this disease among the order of tubercular eruptions. But this they have done, I am satisfied, without due consideration either of the characters of the pestilential carbuncle, or of those which they assign to the order of tubercles.

From careful comparison of the most authentic accounts of pestilential carbuncle, it commences as an inflamed spot in the corial surface and substance. The inflammation of the surface speedily induces sero-albuminous secretion and detachment of the cuticle, which is elevated in the form of bluish irregular blister; while beyond this the skin is of a fiery red colour, hard, and the seat of searing pain. The simultaneous inflammation of the corial substance speedily kills that membrane, which is then felt in the form of a hard black mass, surrounded by living but highly inflamed skin. This dead portion is afterwards, if the patient survive, detached in the form of a mortified slough. The carbuncle of oriental plague seems not to be quite similar to the ordinary carbuncle seen in this country.

Of the disease termed *malignant pustule* by the French and other foreign authors, (*Anthracion;* Nar al-Parsi; *Persian fire,*) we can scarcely speak from experience in this country, in which, so far as I am aware, the disease is unknown. From the description given by Enaux and Chaussier, Vicq-D'Azyr, Pinel, Ozanam, and others, it appears to consist in inflammation of the outer surface of the corion, speedily depriving that membrane of its vitality. It may commence in one or two modes; *first,* as a hard, red, burning, not elevated point, speedily causing bluish or reddish-blue fluid secretion, elevating the cuticle into a purple or pale blue blister, *(phlyctæna;) Second,* as a hard knotty substance slightly elevated into a doughy swelling, and causing detachment of the cuticle by similar effusion. In both cases the affected corion undergoes mortification partial or general, and is then detached as a foreign body. In some respects this resembles the ordinary carbuncle of this country. But it differs particularly in this, that the malignant pustule *(anthracion,)* is ascribed by the best au-

thorities to contagion, and very often is traced to epizootic contagion, or pestilence occurring among the lower animals.

The great pock, (*ecthyma,*) consists in an eruption of red, hard, sore pustules (*phlyzacia,*) distinct, seldom numerous, without primary fever, and not contagious. In the three species of ordinary (*E. vulgare*), infantile (*E. infantum*), and dingy pock, (*E. luridum*), the pustules are round or oval hard masses fixed in the substance of the skin, which is red, hard, and swelled, and terminating first in elevation and desquamation of the cuticle, and then in imperfect softening, discharging a serous and generally blood-coloured fluid, which concretes into a foul dark-brown or reddish scab, which at length drops off, leaving the subjacent skin reddish, and marked by a depressed scar, indicating the affection of the corial substance.

g. Cutaneous inflammations originating in the substance of the corion, sometimes at the bulbs of the hair, terminating in partial or imperfect suppuration, with formations of scales, crusts, and occasionally sloughs, and more or less destruction of the corial tissue.

The pathological reader may perceive that the last disease which came under consideration forms a preparatory step to those of the present order. The hard phlyzacious pustules by which it is distinguished denote a more complete affection of the corial substance than is known to take place in any previous cutaneous inflammation; while the slow, crude, and imperfect solution which they undergo, and the discharge of blood-coloured rather than purulent fluid, indicates a variety of the inflammatory process different from those already examined, and approaching to those now to follow. The transition, therefore, if not insensible, is at least natural, to a tribe of diseases of which the general character is inflammation of the corion, which modified in various ways gives rise to the varieties of disease referred to this kind. The principal modifying circumstances may be referred either to duration, to circumscription, or to difference in kind.

1. The influence of duration is observed in the compara-

tive difference of progress of the common boil, which is rapid, and that of the whelk (*acne*), canker (*lupus*), and yaws (*frambœsia*), which are slow and tedious. 2. The influence of circumscription or diffusion is evinced in those inflammations which are confined to a spot, and those which spread to some extent. In the whelk and boil the inflammatory process is restricted to a point; in carbuncle, on the other hand, it affects a great extent of the corion through its entire thickness. 3. Whether the inflammation of the corial substance be different in one disease from what it is in another, there are few means of ascertaining. Though various facts seem to indicate something of this nature, too little is known to justify positive conclusions.

The boil or bile (Die Beule; *Furunculus;* le Clou; il Ciccione;) may be adduced as an instance of acute inflammation of the corion confined to a certain spot. Pearson admits that its seat is the skin; but, by afterwards saying that it may occur in any part which abounds in cellular membrane, leaves the alternative either that skin contains this substance abundantly, or that boils may occur in many other tissues. Boyer, by placing its seat in the cellular tissue, confounds it with phlegmon. The opinion of Bichat differs from either, but partakes of both. This anatomist represents the corion to be penetrated by a great quantity of cellular tissue, which fills its *areolæ*, and is the exclusive and proper seat of the boil. The truth of this opinion depends on the idea attached to the term *cellular tissue*. If by this be meant the loose fatty matter with its intersecting threads, on which the inner surface of the corion rests, the opinion is erroneous; for this is the proper subcutaneous cellular tissue. To this doubtless the inflammatory action of boil may descend; but the phenomena and termination of the disease show that it consists at first of circumscribed inflammation of the corial substance, soon but slightly affecting the subjacent cellular tissue. The circumstances which indicate the corion as the seat of furuncular inflammation are,—the defined knotty tumour with which the complaint begins, the minute pustule to which

it gives rise, and the imperfect and tardy suppuration with formation of sloughs, and the perforated appearance of the skin.

Of the same nature are the inflammatory tumours termed Epinyctis and Terminthus mentioned by all authors almost from Celsus to Wiseman.

Though in this place I notice carbuncle as an example of spreading inflammation of the substance of the corion, yet the question of its precise seat is not free from ambiguity. Hunter believed it to begin in the skin, and going deeper to affect principally the cellular membrane, of which it caused mortification; and with this Pearson agrees. Boyer places it in the teguments and subcutaneous cellular tissue; while Monteggia, who repeats the fact that it destroys a considerable portion of the teguments and cellular substance down to the muscles, seems to regard it as a peculiar action affecting several tissues simultaneously and successively.

The statement of Hunter I was at one time disposed to regard as exhibiting a just view of the pathology of carbuncle, and to think that Willan laboured under a mistake in referring the seat of carbuncle to the skin. From observing the progress of several carbuncles from their origin to their termination, and from cutting them open more than once and examining their morbid relations as carefully as it is possible to do in the living body, I am satisfied that the opinion of Hunter is not correct, and that that of Willan is not altogether wrong. In several carbuncles which I have observed from the beginning, the inflammatory action commenced in the skin in the form of a hard knotty pustule; a circumstance which corresponds with the admission of Hunter. If cut open at this time, which may be done not only with safety, but with benefit, the corion is found to be thicker than natural, much redder, and more vascular; and these marks of inflammation pervade not only the substance of the corion to a considerable extent, but the subcutaneous cellular membrane in a slighter degree. This inflammation

of the cellular membrane spreads indeed along with that of the skin; but it also kills this tissue almost immediately, or at least speedily gives it the usual appearance of mortified matter. At the same time, the inflammation of the corion extending quickly, kills at least its exterior surface; and Hunter is inaccurate in saying that the skin does not die, but gives way by ulceration. Death of the corion is an early effect of carbuncular inflammation; and though it does not preclude the formation of ulcerated openings, it may take place without them. According to my own observation, death takes place most generally in patches of the corion, which may afterwards burst as it were by distension; ulceration takes place at points which have not been killed, and in general at the union of the dead and living skin.

There is no ground for believing that the subcutaneous cellular membrane is killed by the confinement of matter in its cells, as Hunter imagines. The ordinary mode in which this appears to take place is by the spreading inflammation of the corion, extending along its lower surface, and producing death, as it appears to do in diffuse inflammation, in which it spreads and does not readily cause suppuration.

Upon the whole, it may be concluded that the corion is the primary seat of disease in carbuncle, and that the affection of the cellular membrane, with which it is uniformly accompanied, is the effect of spreading inflammation of the corial tissue.

The whelk (*acne; ionthos; varus, vari,* Celsus;) consists of minute portions of corion, round, oval, or spheroidal, hard, circumscribed, and elevated. Of the four sorts enumerated by Bateman, three only, the simple (*A. simplex*), the inveterate (*A. indurata*), and the crimson (*A. rosacea*), can be considered as examples of inflammation of the substance of the corion. The black whelk (*Acne punctata*), doubtless arises from disease and obstruction of the mucous follicles, or sebaceous glands. Both the simple and indurated whelk may produce ulcerative destruction of the true skin, and leave a smooth depressed scar; and I have seen them by ex-

tending to the roots of the hairs render the skin entirely depilous.

The crimson whelk (*A. rosacea, gutta rosea ;* dartre pustuleuse couperose of Alibert,) is an affection rather complicated ; and I doubt whether it is justly classed with those now mentioned. It is doubtless an affection of the corial substance ; but it commences with redness and slight diffuse swelling of the skin of the nose and cheeks, not unlike that of *erythema marginatum.* This is followed by the appearance of two or three small seedy particles, very hard, but red and tending to suppurate, which they at length do partially at their summits, while the base remains hard, red, and firm. As the red appearance of the skin spreads the roughness increases, fresh particles of the same seedy consistence arise and undergo the same course ; and some coalescing form broad tubercular blotches of a crimson or livid colour, and irregular notched surface. The skin is not, however, in this state at all times permanently red. I have seen this affection in patches on the cheeks and nose so light coloured, that in the morning it could not be recognized ; but in the latter part of the day, after taking wine, and becoming warm, they assumed an intense red inclining to crimson. In the advanced stage, when numerous tubercles appear, and the surface is generally rough and red, the skin swells diffusely and becomes doughy, and is traversed by tortuous purple veins, the nose is enlarged, the nostrils become distended, their surface notched into lobular masses, the red hard bodies of the cheeks become large and coherent, and the whole countenance is converted into a crimson tumid mass, in which the original features are prodigiously deformed. These whelks do not often undergo suppuration, but are constantly casting the cuticle in the form of peelings, or scales, or crusts. When suppuration occurs it is liable to terminate in bad and intractable sores.

The chin and scalp whelk, (*Sycosis ; mentagra ;* dartre pustuleuse mentagre,) consists in chronic pustular inflam-

mation of the substance of the corion at the bulbs or conduits of the hairs. (Celsi, Lib. vi. 3.)

Under the head of canker, (*lupus, noli me tangere,* wolf of Wiseman and others, *dartre rongeante,* Pinel and Alibert,) may be noticed a disease consisting in hard elevated tubercles set in the corion, from which they appear to grow. The name of *noli me tangere* is applied by Wiseman to a "small round acuminated tubercle" without much pain, unless when "touched, rubbed, or otherwise exasperated by topics." Though most frequent on the face, it may occur on other parts. One of these, of a bluish colour, and looking like a *vein,* appears from the description to have been of the nature of erectile tissue.

One example of bluish spherical tubercle I have seen in the person of a woman of about 65 years of age, otherwise healthy. It was situate on the side of the nose near the middle of the nasal bone. It appeared first in the form of a small red prominence less than a pea, but gradually shot up from the skin, so as in the course of twenty months or two years from its commencement, to project at least one-third of an inch from the surrounding skin. It was then round or spherical, smooth, and even shining, and of a blue or light purple colour, which, on close examination, was derived from numerous minute vessels. It was connected to the skin by a neck, the base being narrower than the summit, but did not adhere to the bone. What was the ultimate fate of this person I did not learn; but no doubt can be entertained that if life were continued a sufficient time, the tubercle would terminate in destructive fungating ulceration.

I have seen also many cases of ragged ulceration of the countenance, and one or two in the incipient state before it spread to any extent. One mode in which this disease appears to commence is by the formation of a patch of hard red skin, slightly but diffusely swelled, and which is the seat of a hot, gnawing, smarting sensation. Though smooth on the surface, it is found by examination to be irregular,

or very soon becomes so by the formation of small hard round bodies (pustulo-tubercular) which after some time begin to be acuminated, and cast the cuticle in thin peelings. Occasionally they give rise to thin watery vesicles of no determinate shape, which either burst the cuticle and discharge their fluid, or appear to cause an insensible dewy oozing all over the surface. The most usual seat of this form of cutaneous inflammation is the side of the nose, one of the *alae*, or a small portion of the cheek. After subsisting in this form for some time, it may disappear spontaneously, the skin becoming of its natural colour, soft and without pain. More frequently, however, the cuticle continues to be cast off in peelings, vesicles and pustules continue to be formed, and one or other more red and painful than the rest is at length covered by a scab, which dropping off discloses a small sore with a smooth ungranulating surface, and a scanty, thin, bloody-coloured, puriform discharge, which generally forms a fresh crust or scab. This either spreads without showing any disposition to heal, or coalesces more or less completely with other sores which are generated in the same mode, and undergo the same process. After proceeding in this manner for weeks or months, a tendency to heal is manifested in some parts, while others continue to spread. The parts which heal are irregularly seamed and scarred. This form of disease appears to correspond with what Wiseman describes under the name of *Herpes Exedens*.

Another form of local pustulo-tubercular disease I have seen take place on the skin of the face, generally on the forehead, in the form of round hardish bodies, with flat summits, to the number of eight, ten, or twelve, disposed in a circular arrangement. The surface of the skin was red, glossy, and occasionally casting cuticular scales and shreds. These bodies were stated to be the seat of an uneasy sensation of heat rather than of pain. They had not advanced to ulceration. Upon removal by the knife, they became pale, white, and shrunk considerably. Internally they consisted of gray coloured substance, interspersed with a few blood-vessels,

not hard, so much as doughy, tough, and fibro-cartilaginous. They did not, nevertheless, present the characters of carcinoma, but seemed to consist in an inflammatory induration of the corial tissue.

On the anatomical characters of the white scall *(vitiligo)*, I possess no accurate information. I have often suspected that the appearances referred to this disease are in truth the effects of others more known.

Yaws *(frambœsia)*, consist in chronic inflammation of the corion taking place in circumscribed spots, attended partly with death of a portion of the corial substance, partly with growth of granular fungi,—the result of a peculiar morbid poison.

On the nature and characters of this disease much misconception has prevailed, chiefly from the erroneous notions to which its station, in the arrangement of Cullen, gave birth. These were first corrected in 1791 by Dr Jonathan Anderson Ludford, who showed that yaws is a true cutaneous inflammation, which, though more chronic, yet, like small-pox and other acute cutaneous eruptions, is preceded by febrile motions, and observes regular periods of accession, height, and decline.* The general accuracy of these facts has been confirmed by the testimony of Dr William Wright,† Dr Winterbottom,‡ Dr Joseph Adams,§ and Dr James Thomson,‖ who observed the phenomena of the disease in negroes or Europeans in the West Indies or elsewhere. Dr Dancer, who admits that they seldom make their appearance without previous indisposition, alone doubts the propriety of comparing them with small-pox and other eruptions.¶

* Tentamen Med. Inaug. de Frambœsia et Jon. Ludford Ed. 1791.

† *Apud* Adams on Morbid Poisons.

‡ Account of the Native Africans, &c. by T. M. Winterbottom, M. D. London, 1803, Vol. ii. c. viii.

§ Observations on Morbid Poisons, &c. by Jos. Adams, M. D. 2d Edit. London, 1807, chap. xvi.

‖ Observations and Experiments, &c. Med. and Surg. Journal, Vol. xv. 321, and xvii. 31.

¶ The Medical Assistant, &c. by Thomas Dancer, M. D. Kingston, 1801, chap. ix. p. 201.

It cannot be doubted that the appearance of yaws is invariably preceded by more or less indisposition—as languor, pains of the limbs like those of rheumatism, chillness or shivering succeeded by general heat and uneasiness, amounting in most cases to fever, and always more severe and distinct in children than in adults. The first trace of eruption is a white mealy scurf covering the whole cutaneous surface. A few days after small firm pimples may be seen on the forehead, face, neck, groin, and round the anus. These increase for six or ten days, when their tops are covered by a crust; and an opaque whitish fluid, which is ill formed matter, may be recognized. Thus converted into pustules, they gradually enlarge still covered by crusts, which are loose and irregular, until they attain the size of a sixpence or even of a shilling,—the largest being in general those which appeared first. If in this state the crust be removed, it exposes a foul sloughy sore, or, according to Adams, a rough whitish surface consisting partly of slough, partly of living animal matter. The pustules may also burst spontaneously, and discharge thick viscid matter, which hardens into a foul crust or scab on the surface. In the large pustules from this surface at length shoots up a red granulated excrescence composed of minute lobes, not unlike a wild rasp or mulberry, which is the proper yaw, and gives the disease its peculiar appearance and character. Its size varies according to that of the pustule from which it rises, from a pea to that of a mulberry of considerable dimensions. Its colour also varies according to that of the general health of the subject. In the healthy and robust it is red like a piece of flesh and prominent; in the weakly and puny it is pale and white like a piece of cauliflower, not elevated, and bleeds on the slightest touch. The yaw-fungus has little sensibility, and does not smart when capsicum-juice is applied, never suppurates perfectly, but discharges a sordid glutinous fluid, which dries into a scab round the edges of the excrescence and covers its upper part, if much elevated, with white sloughs. This glutinous fluid is the proper yawey matter, and communicates the disease by inoculation.

The time at which the fungous granulation rises is irregular. Thomson met with it so early as one month and so late as three after the first appearance of the eruption; and he concludes that its formation cannot be taken as a mark of the second stage of the disease, as was thought by Adams.* Each pustule, as it attains a certain size, undergoes the same process. After remaining some time the yaw gradually contracts, diminishes in height, and, as the pustule heals, is finally covered by skin. It leaves in general no mark except in those places in which inflammation has been violent, when a scar similar to that of cow-pock, but broader and more superficial, is left.

This description shows not only that yaws are an inflammatory disease of the skin, but that they are not, strictly speaking, an example of tubercular disease of that membrane, as in the arrangement of Willan is erroneously represented. The phenomena show that they consist in an inflammatory process of the corion commencing in minute points, and gradually spreading in extent and penetrating in depth, till it generates a peculiar morbid product, which, after undergoing certain changes, is at length spontaneously removed, and allows the sore to heal. Thomson justly remarks, that the disease is first papular, then pustular, and afterwards consists of yaw, though the latter is not constant, as the ulcer may heal without this substance; when it must be accounted pustular. At no period does it appear to be tubercular; for the yawey growth to which alone this term can be applied is rather an effect of the pustular or chronic corial inflammation modified by the proper yawey action. It may, in short, be inferred, that when the yawey action is sufficient without being excessive, it generates the proper fungous growths, under which the corion is either not materially injured or is regenerated; if the action be too violent, this growth is either destroyed or prevented from appearing; and in either case the corion is irreparably injured.

Sivvens, though a disease affecting not only the skin, but the fibro-mucous membranes, is entitled to notice in this place,

* Morbid Poisons, p. 201.

as causing cutaneous inflammation not dissimilar to that of yaws. Like most inflammations depending on the action of a morbid poison, when it affects the constitution it induces inflammation of the corion in the shape of pustules terminating in bad ulceration and sloughs,—of furuncular tubercles and ulcers,—and of pustular sores affording the raspberry granulating fungus. *

h. Cutaneous inflammations, chronic, affecting at once the surface and the substance of the corion, and attended with general affection of the fibro-mucous tissues.

Of the disorders which I refer to this head, several are so similar, that they are probably to be viewed as varieties of the same morbid action. Of this kind are the Radesyge, Spedalsked, Liktraa or northern leprosy, the Pellagra or Lombard evil, the Scherlievo of the same place in Italy, the Mal di Rosa of Asturia, and a cutaneous disorder prevalent in Crim Tartary. In whatever points these disorders differ, all of them agree in being preceded by distinct febrile commotion, in consisting of inflammation affecting the corion in definite points, and in causing at the same time more or less inflammation, punctuate or diffuse, of the mucous and fibro-mucous membranes of the nasal cavities, the throat, the Eustachian tube, and tympanal cavity.

In these diseases the affection of the corion is neither pustular nor tubercular, but consists in inflammation of its substance occurring in many minute points, and causing first an appearance like papulæ, or sometimes only an extensive diffuse redness and roughness of the skin; then desquamation of the cuticle; then pustulo-tubercular or minute hard eminences seldom suppurating completely, but sometimes causing, partly by sloughing, partly by ulceration of the corion, deep foul sores, destroying the corial texture and

* Gilchrist in Essays and Observations, Phys. and Lit. Vol. iii. Art. xi. Ed. 1771. Diss. Inaug. de Syphilitide Insontium, &c. Auct. A. Freer. Ed. 1776. Cases in Surgery, &c. by James Hill, surgeon. Ed. 1772. Observations on Morbid Poisons, &c. By Joseph Adams, M. D. London, 1807, Chap. xv. 2d. Ed.

the bulbs of the hair. This is particularly the case in the Radesyge, the form of disorder prevalent in Iceland, the Scandinavian peninsula, the Feroe Islands, and the peninsula of Jutland. In those prevalent in Italy, Asturia, and Crim Tartary, ulceration of the corion appears to be less frequent.

The limits of this treatise do not permit me to enter at large into the history of these diseases, which perhaps are not to be viewed as merely cutaneous affections; and I shall simply refer to the best sources for further information.*

To this head also may be referred some of the cutaneous eruptions which occur either among the secondary symptoms of syphilis, or in the persons of those who, for this disease, have been subjected to one or more courses of mercurial medicines. Though these eruptions may appear sometimes in the form of *papulæ*, sometimes as a variety of *rupia*, and sometimes as *ecthyma*, they are also not unfrequently of the chronic pustulo-tubercular nature, originally taking place in the corion, and causing more or less ulceration of that membrane. Their connection with inflammation of the mucous and fibro-mucous membranes is well known.

Upon elephantiasis so much accurate information has been of late years collected by Dr Adams, Mr Lawrence, and Dr Lee, that little difficulty can be experienced in settling its

* For Radesyge, Dissert. Inaug. de morbo cutaneo luem veneream consecutivam simulante, auctore C. F. Ahlander, Upsaliæ, 1806. Diss. Inaug, sistens obs. in exanthema arct. vulgo Radesyge, auctore Isaaco Vought. Gryphcæ, 1811. Geographische Nosologie von Fried. Schnurrer, M. D. p. 440. Morbus quem Radesyge vocant, &c. Commentatio Auctore Fred. Holst, M. D. Christianiæ, 1817. Ueber die Aussatzartige Krankheit Holsteins, &c. Von Ludwig Aug. Struve, M. D. 1820.—For Pellagra, S. Const. Tilii crat. de Pellagræ Pathologia, Viteberg, 1792. De Pellagra Obs. quas collegit Caiet. Strambio, 1784–89, Mediol. Franc. Frapolli Mediol. Animadvers. in Morbum vulgo Pellagra, Med. 1771. N. X. Jansen de Pellagra, Lug. 1787. Frank Delect. Tom. ix. p. 325. Holland in Medico-Chirurgical Transactions, Vol. vii.—For Mal de Rosa, Thiery Observations de Physique et Medecine, Tom. ii. Chap. vi.—For Scherlievo, Annali Universali de Medecina.—For Crim Tartary disease, the Travels of Falk, Gueldenstadt, and Pallas.

characters as a morbid state of the skin. The case described so well by the last of these observers, I had repeated opportunities of seeing; and the appearance of the skin could leave no doubt of the disease affecting the substance of the corion. The exact nature of this affection is perhaps less easily determined. By calling it a tubercular eruption after the manner of Dr Bateman, little exact information is communicated. Bichat states, that he has seen the corion manifestly disorganized in elephantiasis *, but says nothing of the anatomical characters of this disorganization. Pinel, Beclard, and Meckel, are equally silent on this subject. In short, though we have good descriptions of the external visible appearances of Arabian leprosy, an accurate description of its anatomical characters is still a desideratum.

The chronic soft tubercle *(molluscum diuturnum)*, is a rare disease; and I have seen only one example of it in the person of a man of 40, in whom these bodies were disseminated over the cutaneous surface of the face and scalp, the trunk, the upper extremities, the nates and thighs. Of two of the larger tumours which were removed from the *palpebræ*, the greater part was composed of firm, tough, whitish-gray matter of the consistence of condensed cellular texture, penetrated through its whole extent by numerous minute blood-vessels, but exhibiting in no other respect traces of organization. This substance, when macerated in water, was resolved into gelatinous, flocculent filaments, easily lacerable, and presenting no definite structure. Imbedded in this, and removable most easily by maceration, were several small bodies not larger than a pin head, like fat in appearance, of a regularly spheroidal shape, of a lemon-yellow colour, and specifically lighter than water. The matter of these bodies was unctuous. It communicated an oily stain to paper; it liquefied and became transparent at a temperature not exceeding 97° Fahrenheit, so that when attached to the body, it must have been fluid; it was insoluble in alcohol, ether, and water, but formed in the volatile oil of turpentine a colourless solution.

* Anat. Generale, Tome iv. p. 686.

When this was exposed to the temperature of the spirit-lamp, the greatest part of the volatile oil was evaporated, leaving a transparent, colourless, but viscid and semifluid substance, communicating to paper a stain becoming less deep, but not wholly removable by exposure to a high temperature. These results favour the idea that the matter of these bodies is oleaginous; but I was unable to observe any action of *aqua potassæ* or *aqua ammoniæ*, after repeated trials, both at the ordinary temperature of the atmosphere and when liquefied by a gentle heat. By the sulphuric acid it is hardened and blackened; by the nitric acid its yellow colour is rendered more intense. *

Whether the presence of these yellow adipocirous bodies is uniform in the *molluscum* I have had no subsequent means of ascertaining. If they are, it may be reasonably conjectured that their formation depends on some morbid or vitiated state of the sebaceous follicles.

Wart and corn are believed to depend on morbid accumulation of cuticle. The former, however, is vascular at its basis; and it may therefore be inferred that its production depends on morbid action of the surface of the corion at the particular point at which it appears.

2. *Dermatæmia. Dermatorrhagia.*—Hemorrhage of the skin appears under two forms; either that of a bloody or blood-coloured fluid oozing from certain regions, or of blood effused in the form of purple specks, spots, patches, or livid stripes on the surface of the corion below the scarf-skin. The former discharge is rare, and takes place chiefly as a supplementary evacuation to some natural one accidentally suppressed, as the menstrual discharge in females. The latter is of a different nature, and is both the effect and proof of a morbid state of the system.

Restricted in this manner, hemorrhage from the corion

* A good painting of the subject of this case was made by my late friend Staff-Surgeon Schetky, and by him deposited in the pathological collection of Chatham Hospital.

may take place in two modes; either when the corion only is affected, or when it is affected in common with many other membranes. The first case constitutes the simple purple disease (*purpura simplex*) of authors; of the second we have examples in the hemorrhagic purples (*purpura hemorrhagica*) or land-scurvy, and in the genuine sea-scurvy, (*scorbutus.*)

The anatomical characters of the disease consist in bright red or crimson spots, becoming in a day or two purple or livid, afterwards brown, and when about to disappear, assuming a yellow tint. They are occasionally attended with long livid stripes (*vibices*) or patches (*ecchymomata;*) and in some instances the cuticle is raised into vesicles or large purple blebs (*phlyctænæ,*) containing bloody or purple serous fluid. These spots consist of blood or bloody fluid, effused on the outer surface of the corion, which is soft or pulpy, velvety, and reddish, from injection of its vessels.

3. *Angiectasis.*—Anastomotic aneurism is frequent in the corion, and has been observed by J. Bell, Freer, Travers, and Wardrop. Though congenital, it must not be confounded with the *nævus maternus* or birth-spot (*l'envie,*) which appears to consist in a peculiar original malformation of the corion. A similar congenital defect is the white-spot (*leucosis, leucæthiopia,*) which consists in the absence of the polished vascular surface of the corion. Occasionally it takes place during life, and in minute spots is observed to follow diseases in which the cuticular surface of the corion has been destroyed by ulceration.

4. *Meliceris*, Cutaneous Wen, (see page 218.) The only encysted tumour which takes place in the skin consists in the immoderate enlargement of one or more of its mucous follicles, in consequence of obstruction of the excretory duct. When from any cause this takes place, the sebaceous matter, which in the healthy state is propelled to the surface and removed, accumulates in the interior of the follicle, which is thus inordinately distended, till by removing the obstruction the orifice is opened and the inspissated

matter eliminated. It almost invariably again accumulates unless care be taken to keep the excretory duct pervious,—an object which is most easily and certainly attained by frequent ablution. This mode of explaining the origin of the cutaneous folliculated tumour was understood by Morgagni,* Haller, Plenck,† and Monteggia,‡ and has been recently revived by Sir Astley Cooper.§

5. *Scirrho-carcinoma* of the skin is not uncommon. Though it may occur in any part of the cutaneous covering, it commences most frequently in situations where the corion is delicate and thinly covered. The skin of the face, especially of the eyelids, prolabium, and nose, is a frequent seat of this disorder; and next to these, perhaps, are to be placed the nipple of the female and the penis of the male, the corion of which are liable to be affected by this morbid structure. The scrotum is very often the seat of that peculiar carcinomatous destruction occurring in the persons of chimney sweepers. In all these cases the structure is much the same. In the situation of the corion is seen a tough firm substance of fibro-cartilaginous structure, the fibrous bands being generally arranged in a waving direction. In the most distinct example of the disease which I examined personally—a case of scirrho-carcinomatous degeneration of the whole skin of the penis, these fibrous bands were disposed transversely to the long direction of the part, and appeared to consist of a fibro-cartilaginous long band folded repeatedly on itself.

The reparation of the corion when destroyed has been maintained by many authors. Notwithstanding their assertions, however, this membrane is never, after its substance has been injured, restored to its original state. The breach is filled up by firm cellular tissue, the upper surface of which

* Adversaria Anatomica.

† "Sedes meliceridis," says Plenck, "in glandula subcutanea esse videtur. Quicquid ergo porum excretorium glandulæ subcutaneæ obdurat, contentum succum inspissat, vel ejus absorptionem impedit, meliceridem producere valet." Systema Tumorum, Cl. vii. p. 153. Viennæ, 1767.

‡ Istituzione Chirurgiche, Volume ii. § Surgical Essays, Part 2.

never acquires the organization of the outer surface of the corion. It is nevertheless capable of furnishing cuticle by which this new corion is covered. These facts may be verified in the cicatrization of burns and other injuries in which the corion has been destroyed. *

The nails, like the cuticle, may be diseased in consequence of a morbid state of the corial surface and vessels by which they are nourished. In one or two instances of strumous children, I have seen them fissured into several longitudinal portions, much thickened, and indurated like horn, and incurvated. In others of the fingers of the same individuals, they were small and imperfectly developed; and in some their place was supplied by a small portion of thick horny cuticle. Similar changes are sometimes induced by disease or by injury.

Of the hairs, the most extraordinary morbid state is the Polish plait (*plica Polonica;*) so named from being endemial in Poland, Lithuania, Hungary, and Transylvania, from the source of the Vistula to the Carpathian mountains. It occurs also in Prussia, Russia, Switzerland, and in some parts of the Low Countries. It is impossible to doubt that this anormal condition of the hairs depends on disease taking place in their bulbs or nutritious sacs. This is proved by the state of the skin from which the diseased hair grows, and by the unctuous, viscid, and blood-coloured fluid which the hairs in this state contain. We nevertheless possess no very precise information on the nature of this diseased state of the capillary bulbs; and in the absence of exact facts I abstain from offering conjectures.

The piliparous sacs lose their energy under certain morbid states of the system; for instance, fever, pulmonary consumption, and the constitutional symptoms of lues. The

* Ottonis Huhn Commentatio de Regeneratione, &c. 1787. P. 23, &c. Andreæ J. G. Murray, Commentatio de Redintegratione, 1787. P. 50. A Dissertation on the Process of Nature in the filling up of cavities, &c. By James Moore, Member, &c. London, 1789. Sect. ii. p. 54, &c.

hairs then drop out; and if at this time the bulbs be examined, the sacs are found to contain, according to Bichat, at least in persons who have passed through fever, the rudiment of new hairs. The shedding of the hairs which takes place in the decline of life, and the period of which varies remarkably in different individuals, Bichat represents as depending on a total death of the piliparous sacs.

Accidental and anormal developement of hairs is not uncommon. In the skin this appears in the shape of hairy moles and similar congenital marks.* Their occurrence in the stomach, intestines, and bladder, as noticed by a variety of authors, is also to be regarded as anormal. Lastly, the accidental developement of hairs is observed in encysted tumours, especially those of the ovaries, in which masses or balls of hair mixed with fat, oleaginous, or adipocirous matter, are not unfrequently found.† On the mode in which these hairs are formed nothing satisfactory is known.‡

CHAPTER XXII.

SECTION I.

MUCOUS MEMBRANE, VILLOUS MEMBRANE,—*Membrana mucosa, M. mucipara, M. villosa,* —TISSU MUQUEUX, Bichat.

THE organic tissue or membrane, to which the name of *mucous* or *villous* has been applied, consists of two great divisions, the gastro-pulmonary, and genito-urinary.

* Haller, Elementa Phys. † Bichat, tom. iv. p. 828.

‡ Meckel, Journ. Compl. T. iv. and Bricheteau, Journ. Compl. T. xv.

The first or gastro-pulmonary mucous surface comprehends that membranous surface which commences at the various orifices of the face at which it is contiguous with the skin ; and is continued through the lacrymal and nasal passages, and even the Eustachian tube, by the larynx on the one hand to the windpipe and bronchial membrane, and by the œsophagus on the other through the entire tract of the alimentary canal, at the opposite extremity of which it is again identified with the skin.

The distribution of the second division, or the genito-urinary mucous membrane, is slightly varied according to the differences of sex. In the male it is connected with the skin at the orifice of the urethra, from which it proceeds inwards toward the bladder ; sending previously small prolongations through ducts on each side of the *veru montanum*, from which it is believed to be continued through the *vasa deferentia*, to the *vasa efferentia* of the testicle. Continued over the inner surface of the urinary bladder, it is prolonged through the ureters to the pelvis and infundibula of the kidney. In the female, besides passing in this direction, it ascends into the womb, and passes through the Fallopian or uterine tubes, at the upper extremity of which it terminates in an abrupt opening into the sac of the peritonæum—the only instance in the whole body in which a mucous and serous surface communicate freely and directly.

These two orders of membranous tissue have each two surfaces, an attached or adherent, and a free one. The adherent surface is attached, 1*st*, to muscles, as in the tongue, most of the mouth and fauces, œsophagus, and whole alimentary canal, and the bladder; 2*d*, to fibrous membranes, as in the nasal cavities and part of the larynx, in which it is attached to periosteum or perichondrium, the palate, ureter, and pelvis of the kidney; 3*d*, to fibro-cartilages, as in the windpipe, *(trachea,)* and bronchial tubes.

The free surface is not uniform or similar throughout. The appearance of the pituitary or Schneiderian membrane is different from that of the stomach or intestines; the surface of the tongue and mouth is different from that of the trachea; and the free surface of the urethra is unlike that of the bladder. These variations depend on difference of structure, and are connected with a difference in properties; yet anatomists have improperly applied to the whole what was peculiar to certain parts only, and have thus created a system in which some truth is blended with much misrepresentation.

Mucous membrane consists, like skin, of a *corion* or *derma*, and an *epidermis* or *cuticle*.

The mucous corion is a firm dense gray substance, which forms the ground-work of the membrane in most regions of the body, but which is evidently represented by the fibrous system, *e. g.* the periosteum or perichondrium, in some other situa-

tions. It is most distinctly seen in the mouth and throat, and in various parts of the alimentary canal. In the first situation it is more vascular, less gray and dense than in the intestinal mucous membrane.

It possesses two surfaces, an inner, adherent to the submucous filamentous tissue, and an outer or proper mucous surface. In the stomach, the mucous corion is in the form of a soft but firm membranous substance, about $\frac{1}{6}$th or $\frac{1}{8}$th of a line thick, tough, of a dun-gray or fawn colour, (intermediate between Sienna-yellow and ochre-yellow; Syme,) slightly translucent, and sinking in water. The attached or inner surface is flocculent and tomentose and a shade lighter than the outer, which presents a sort of shag or velvet, consisting of very minute piles. This, when examined by a good lens at oblique light, appears to consist of an infinite number of very minute roundish bodies closely set, but separated by equally minute linear pits, and occasionally circular depressions. In the ileum it presents much the same characters; but the minute bodies of its shaggy surface are still larger and more distinct, and may be seen by the naked eye. In the windpipe, again, it is rather thinner and lighter coloured; and while its outer surface presents numerous minute pores, it is much smoother than in the alimentary canal, and entirely destitute of those minute bodies seen in the latter. It nowhere presents any appearance of fibres.

The mucous corion rests on a layer of filamen-

tous tissue, pretty firm and dense, and of a bluish white colour,—a character by which it is easily distinguished from the soft fawn-coloured mucous membrane. This submucous filamentous tissue is what is erroneously termed the nervous coat by Ruysch, Albinus, and some of the older anatomists. In certain parts the mucous corion is covered by a thin membrane, which has been named the epidermis or cuticle.

It is exceedingly difficult to demonstrate this membrane distinctly. It is very thin, quite transparent, and is perhaps most easily shown by boiling or scalding a portion of mucous membrane, and then peeling off with care the outer pellicle. This experiment succeeds best in the mucous membrane of the mouth and palate, in which, therefore, the existence of mucous epidermis cannot be doubted. The observations of Wepfer, Haller, and Nicholls, and especially of Bleuland,* are sufficient to prove its existence in the œsophagus. Bichat admits that, though it can be demonstrated at the cutaneous junctions of the mucous surfaces, it can no longer be shown to exist in the stomach, intestines, bladder, &c. Beclard renders this conclusion more precise, by showing experimentally that mucous epidermis cannot be traced in the œsophagus beyond the cardia; in the genito-urinary system beyond the neck of the womb, and that of the bladder.

* Jani Bleuland, M. D. Observationes Anatomico-Medicæ de sana et morbosa œsophagi structura. Lug. Bat. 1785.

The structure of mucous membrane varies in every situation and in every organ; and the first peculiarity which it is important to notice is the existence of minute piles or villosities in the gastro-enteric division. These bodies are best seen by detaching, inverting, and inflating a portion of ileum. When this is immersed in pure water, the observer may perceive, by means of its refracting power, an infinite number of minute prolongations, which are made to wave or move gently amidst the fluid; but even a very powerful magnifying glass does not render them so distinct as to determine whether they are round or flattened, whether they are solid or hollow, or whether they are obtuse or acuminated. The shape and structure of these villosities are indeed imperfectly known.

These piles, (*villi*, die zotten,) though seen by many anatomists, were first examined in 1721 by Helvetius, who represents them as cylindrical prominences in quadrupeds, but conical in the human subject.* Their intimate structure, however, Lieberkuhn undertook first by microscopical observation to demonstrate. According to this observer, each *villus* receives a minute branch of a lacteal, arterial branches, a vein and a nerve; and in each the lacteal branch is expanded into a minute sac or bladder (*ampullula, vesicula,*) like an egg, the capacity of which he estimates at $\frac{1}{5}$th of a cubic line, and in the apex of which may be seen by the microscope a minute opening.† Upon this sac

* Mém. de l'Acad. des Sciences, 1721.

† J. N. Lieberkuhn, M. D. &c. Diss. Anatom. de Fabrica

the arterial branches are ramified to great delicacy, and terminate in minute veins, which then unite into one trunk; while its inner surface he represents as spongy and cellular. The space between the *villi*, which do not touch each other, he further represents to be occupied by the open orifices of follicles, so numerous that he counted eighty of them, where were eighteen villi; and both, he asserts, are covered by a thin but tenacious membrane similar to epidermis.

Hewson, while he admits in each villus the ramification of minute arteries and veins, denies the saccular expansion, and infers that the lacteals are ramified in the same manner as the blood-vessels, and that the whole constitute a broad flat body,* the spongy appearance of which he ascribes to the mutual ramification of the latter. With this in general Cruickshank agrees; † while Sheldon, who found the villi not only round and cylindrical as Hewson, but bulbous as Lieberkuhn, and even sabre-shaped, rather confirms the statements of that anatomist. ‡ Mascagni and Soemmering agreeing in the general fact of vascular and lacteal structure, seem to represent the shape of the *villus* as that of a mushroom, consisting of a stalk and a *pileus*.

et Actione villorum Intestinorum Tenuium Hominis. Londini, 1782, § ii. iii. &c.

* Experimental Inquiries, part ii. p. 175, chapter xii.

† The Anatomy of the Absorbing Vessels, &c. p. 58.

‡ The History of the Absorbent System. p. 36 and 37.

Some of these discordant statements Hedwig attempts with equal ingenuity and industry to reconcile. The difference in shape he refers to differences in the animals examined; and in one class finds them cylindrical, (*e. g.* in man and the horse;) in another conical, (the dog;) in a third club-shaped, (the pheasant;) and in a fourth pointed or pyramidal, (*e. g.* the mouse.) The interior structure he also represents as spongy in all the animals which he examined; and invariably also he found at the apex the orifice of the duct, which, after the example of Lieberkuhn, he conceives constitutes the *ampullula*.*

These conclusions are not exactly confirmed by the researches of Rudolphi, who examined the *villi* in man and a considerable number of animals. This anatomist never found the orifice seen by Hedwig, notwithstanding every care taken to perceive it. He maintains that the *villi* are not alike in all parts of the intestinal canal of the same animal, as represented by Hedwig, but may be cylindrical in one part, club-shaped in another, and acuminated in a third. Admitting their vascular structure, which he thinks may be demonstrated, he regards the ampullular expansion as doubtful, and denies its cellular arrangement.†

* Disquisitio Ampullularum Lieberkuhnii Physico-Microscopica. Lipsiæ, 1797.

† Einige Beobachtungen über die Darmzotten von D. Karl A. Rudolphi in Reil. Archiv. iv. b. 1797. p. 63 and 340.

About the same time Bleuland, who had previously examined the intestinal mucous membrane, after successful injection of its capillaries, undertook to revive the leading circumstances of the description of Lieberkuhn. By examining microscopically well-injected portions of intestine, he shows that the *villi* are composed of a system of very minute arterial and venous capillaries, enclosing a lacteal which constitutes the *ampulla*, and in the interior of which a certain order of these capillaries terminates. He also revives the statement of the absorbing orifice at the extremity of each *villus*.* The rest of the observations of this author pertain rather to the distribution of the minute vessels, and shall be more particularly noticed under that head.

The observations of Beclard on these bodies are most perspicuous. According to this anatomist the intestinal *villi* appear neither conical, nor cylindrical, nor tubular, nor expanded at top, as described by several authors, but in the shape of leaflets or minute plates so closely set that they form an abundant tufted pile. Their shape varies according to the manner in which they are examined, and according to the part. Those of the pyloric half of the stomach and *duodenum* are broader than long, and form minute plates; those of the *jejunum* are long and narrow, constituting

* Jani Bleuland, M. D. &c. Vasculorum, in Intestinorum Tenuium Tunicis, &c. Descriptio Iconibus Illustrata. Trajecti ad Rhenum, 1797.

piles; at the end of the ileum they become laminar; and in the colon are scarcely prominent. They are semitranslucent; their surface is smooth; and neither openings at their surface, or cavity, or their interior, or vascular structure can be recognized.*

In most mucous membranes are found minute, oval, or spheroidal bodies, slightly elevated, and presenting an orifice leading to a blind or shut cavity. As they are believed to secrete a fluid analogous to or identical with mucus, they are named mucous glands; and from their shape and situation they are also denominated follicles (*folliculi*) and *cryptæ*. Though found in all the mucous membranes in more or less abundance, they have been most frequently examined in those of the alimentary canal, where they were first accurately described by Peyer and Brunner. (*Glandulæ Peyerianæ*. †) In this situation they are situate in the substance of the mucous corion. Their structure, so far as it can be examined, is simple. The orifice leads into a saccular cavity, the surface of which is smooth and uniform, and appears to secrete the fluid which oozes from them. This membranous sac appears to be lodged in a reddish-coloured, dense, anormal matter, which is probably filamentous tissue enveloping minute blood-vessels; but of the minute structure of which nothing is accurately known. In the state of

* Anatomie Generale, chap. iii. sect. 2de, p. 253.

† Peyer de Glandulis Intestinalium, apud Haller. Amstel. 1681. Brunner de Glandulis Duodeni. Francof. 1715.

health these bodies are so minute that it is very difficult to recognize them. I have seen them, nevertheless, in the tracheo-bronchial membrane by the eye and by a lens. When the membranes are inflamed they become larger and more distinct. In the bladder, the womb, the gall-bladder, and the seminal vesicles, they are not distinctly seen, and cannot be satisfactorily demonstrated. It is unnecessary, however, to follow the example of Bichat in trusting to analogy to prove their existence; for they are not necessary to the secretion of mucous fluid as he seems to imagine. Those in the urethra, first well described by William Cowper, are distinct examples of follicles in the genito-urinary surface. The sinuosities *(lacunæ)*, first accurately described, if not discovered by Morgagni, * though not exactly the same in conformation and structure, seem to be very slightly different.

In certain regions of the mucous membranes, more especially at their connections with the skin, are found minute conical eminences denominated *papillæ*. They are distinctly seen in the mucous membrane of the tongue, where they vary in size and shape, and in the body named *clitoris*. They are elevations belonging to the mucous corion, and they are liberally supplied by blood-vessels, the veins of which present an erectile arrangement, and with minute nervous filaments. Of the intimate structure of these bodies, however, little

* Adversaria Anatomica, iv. 8, 9, &c.

more is known. They are covered by a true epidermis.

In the stomach, duodenum, and ileum, this membrane is collected into folds or plaits, which have received in the former situation the name of *rugæ* or wrinkles, and in the latter the name of *plicæ* or folds, and *valvulæ conniventes* or winking valves. In the vagina also are transverse *rugæ*, which in like manner are folds or duplicatures of its mucous membrane. Those of the œsophagus are longitudinal, and have been described by Bleuland. In the tracheo-bronchial membrane, and in the membranous and spongy portions of the urethra, we find them in the shape of minute plaits or wrinkles in the long direction of their respective tubes, but rarely of much length. These folds or plaits are quite peculiar to the mucous membranes ; and the object of them appears to be to increase the extent of surface, and to allow the membrane to undergo considerable occasional distension.

In certain points, where a communication is observed between the general mucous surface and the cavities or recesses of particular regions, anatomists have not demonstrated a mucous membrane, but have inferred its existence as a continuation of the general surface. In the tympanal cavity to which the Eustachian tube leads, the existence of a mucous or fibro-mucous membrane is rather presumed from analogy than proved by actual observation. We know that, where the biliary and pancreatic ducts enter the duo-

denum, and for a considerable space towards the liver, the interior appearance is that of a fine mucous surface provided with *lacunæ* and villosities; but it is impossible to say at what point of the hepatic duct, or of the smaller canals of which it is formed, the mucous membrane terminates. The tracheal membrane, when traced to the bronchial divisions, presents no arrangement, either of *papillæ*, piles, or villosities; and nothing is perceived except a smooth uniform surface, of a colour between gray, dun, and red or purple, which is moistened with a viscid semi-transparent fluid, and which is as like the peritonæum as the intestinal mucous membrane. Lastly, the situation where the existence of the mucous system, though believed, is most uncertain, is in the interior of the *vasa deferentia*, and where they take their origin from the *vasa efferentia* of the *testis*. Regarding the organization of these tubes, no sensible evidence can be obtained, and whatever is stated concerning it is the result of analogical inference.

Though these membranes have been designated by the general name of *mucous*, it is not to be understood that the action of their surface is in every situation the same. It is not easy to limit the signification of the term *mucus*; for it appears that this fluid varies in the nasal passages, in the trachea and bronchial membrane, in the œsophagus, stomach, and intestines, and in the urinary bladder and ureters. But it may be stated as a certain fact, that many parts of the

two mucous surfaces never in the healthy state secrete any modification of this animal matter; and in others the membrane is almost always moistened by a different fluid. The mucous or villous membrane of the eyelids is never in the healthy state occupied with mucus, but is uniformly moistened with the tears; the membrane of the mouth and throat is moistened with saliva only; the urethra presents a peculiar viscid fluid, which seems to exude from many minute vessels opening along its surface, as in the *lacunæ*, but which is widely different from mucus. All those parts, in short, which are not in perpetual, but only occasional, contact with foreign or secreted substances, seem to present no mucus in the healthy state; whereas the surfaces of the stomach, intestines, gall-bladder, and urinary bladder, are constantly covered with a quantity, more or less considerable, of this animal secretion.

The chemical properties of mucous membranes are completely unknown. The analysis of the fluid secreted by them has been executed by Fourcroy, Berzelius, and others, but is foreign to the subject of this work.

The mucous membranes are most liberally supplied with blood by vessels which are both large and numerous. This is proved not only by the phenomena of injections, but by the red colour of which many of their divisions are the seat. This coloration, as well as the injectibility, is not indeed uniform; for in certain regions mucous surfaces are pale or light blue; in others their redness is considerable.

Thus, in those regions in which the mucous membranes coalesce with the periosteum, forming fibro-mucous membranes, *e. g.* in the facial sinuses, the tympanal cavity and the mastoid cells, the colour is pale-blue, or approaching to light-lilac. In the bladder, in the large intestines, in the excretory ducts, in general, though pale, this colouring becomes more vivid. In the pulmonic mucous membrane it is a slate-blue, verging to pale pink. In the stomach, duodenum, small intestines, and the vagina, it becomes still more marked. In the uterus it varies according to the period or the intervals of menstruation.

If these vessels be examined in the gastro-enteric mucous membrane, in which they are probably most numerous, they are found to consist of an extensive net-work of capillaries divided to an infinite degree of minuteness, mutually intersecting and spreading over the upper or outer surface of the mucous corion. This vascular net-work, though demonstrated by Ruysch, Albinus, Haller, and Bichat, has been very beautifully represented in the delineations of Bleuland, who thinks he has traced their minute ramifications into the *villi*, as above stated. These minute vessels are derived from larger ones, which creep through the submucous cellular tissue, and which are observed to penetrate the mucous corion to be finally distributed at its exterior surface. The substance of this membrane itself appears to receive few or no vessels. It is well known that the vessels which supply the mucous surfaces enter by the serous

surfaces at which they are in the form of considerable trunks. Having penetrated the serous membranes, they divide in the subserous cellular tissue into branches, the size of which is considerable, and here they form those numerous anastomotic communications which constitute the arches so distinctly seen in the ileum. From the convexity of these arches in general are sent off the small vessels, which are then fitted, after passing through the muscular layer and the submucous tissue, to enter the mucous corion.

The capillary terminations, then, of these arteries, and their corresponding veins, constitute the physical cause of the coloration of the mucous membranes. This coloration, however, is not at all times of the same intensity in the same membrane, and varies chiefly according to the state of the organ which the membrane covers. The coloration of the gastro-enteric mucous membrane undergoes even within the limits of health many variations. Thus, according to the absence or presence of such foreign substances as are taken at meals, the mucous membrane is pale, or presents various shades of redness. At the period of menstruation the uterine mucous membrane becomes red and injected. Pressure on any of the venous vessels renders the mucous membrane blue, purple, or livid, as is seen in *prolapsus*, and more distinctly in *asphyxia*, in which all the mucous membranes assume a livid tint. (Bichat.) The varieties of red colour observed in the gastric mucous membrane by Dr Yellowly are to be ascrib-

ed partly to the latter cause, partly to the vascular redness which the presence of foreign bodies occasions.* The pulmonary division of this membrane is of an ash-gray or dun colour, inclining to pale-blue or light red. These colours vary, nevertheless, according to the facility or the difficulty with which the blood moves through the pulmonary capillary system. It is also freely supplied with blood-vessels derived chiefly from the bronchial arteries. These vessels, after accompanying the bronchial tubes and their successive subdivisions, divide into minute branches which penetrate the mucous corion, which here is white, dense, and fibrous, and after anastomosing with the capillaries of the pulmonary artery and veins, form a minute delicate net-work on the outer surface of the pulmonary mucous membrane. According to Reisseissen, to whom we are indebted for a careful examination of these vessels, a successful injection of them from the bronchial arteries, renders the whole mucous membrane of the *bronchi* entirely red to the unassisted eye. †

The termination of arteries at the mucous surfaces has at all times occupied the attention of anatomists and physiologists; but it is unfortunately not a matter of sensible demonstration.

* Observations on the vascular appearance in the Human Stomach, which is frequently mistaken for inflammation of that organ. By John Yellowly, M. D. &c. Medico-Chirurg. Trans. Vol. iv. p. 371.

† Franz Daniel Reisseissen, ueber die Bau der Lungen, u. s. w. Berlin, 1822.

The thin serous or sero-mucous fluid with which they are at all times moistened, has led every author almost, and among the rest Haller and Bichat, to infer the existence of arteries with open mouths, or what are termed exhalant vessels. If this be entirely denied, the pathologist, as well as the physiological inquirer, is deprived of a convenient source of explaining many vital phenomena. It has been admitted, nevertheless, more on analogical than direct proofs. The injections of Bleuland are the only experiments after those of Kawe Boerhaave, which, so far as I am acquainted, tend to confirm the conclusion.* These experiments, nevertheless, require to be repeated and extended.

That lymphatics are distributed to mucous membranes is a point well established. Cruickshank saw the lymphatics proceeding from the pulmonic mucous membrane loaded with blood in persons and animals dying of hæmoptoe. Their existence in the gastro-enteric mucous membrane has been long established.

The mucous surfaces are also freely supplied by nervous twigs and filaments, derived in general from the nerves of automatic life. It is a mistaken view, nevertheless, to ascribe the sensibility

* Experimentum Anatomicum, quo Arteriolarum Lymphaticarum existentia probabiliter adstruitur, &c. a Jano Bleuland, M. D. Lug. Bat. 1784. Item; Jani Bleuland, M. D. &c. Vasculorum Intestinorum tenuium Tunicis subtilioris Anatomes Opera Detegendorum Descriptio Iconibus illustrata. Trajecti, 1797.

and other properties of the mucous surfaces to these filaments. These mucous membranes possess intrinsically certain vital properties independently of the nervous filaments with which they are supplied; and the principal use of these filaments appears to be to regulate these properties, especially that of secretion.

The progressive developement of mucous membrane, and especially of its *villi*, has been studied by Meckel in the intestinal tube. This anatomist states, that in the beginning of the third month he first recognized them distinctly in the form of long plaits (Längenfalten) thickly set on the inner surface of the intestine, and scarcely indented on their free edge. The number and depth of these folds, and their indentations, are gradually increased, till in the end of the fourth month, sometimes sooner, in place of the simple long plaits, the observer may distinguish an irregular multitude of minute elevations, which become proportionally larger at a later period of fœtal existence. He therefore infers that the *villi* are formed by the gradual indentation and decomposition (Zerfällung) of simple longitudinal plaits. *

The connection between the mucous membranes and the skin, I have elsewhere stated, was first well demonstrated by Bonn, who traces their mutual approximation and reciprocal transition into each other, and represents the former as an interior production of the latter enveloping the in-

* Deutches Archiv für die Physiologie von J. F. Meckel, 3ter Band. Halle und Berlin, 1817. P. 68.

ternal as the skin incloses the external organs. * This view has been adopted by Meckel and Beclard, to whom I refer for the proofs of its accuracy. I cannot conclude the subject, however, without observing that one of the most conclusive arguments in its favour is derived from the circumstances of the developement of the intestinal canal during the first months of uterine life. The history of this curious process, which has been so happily investigated by Wolff and Oken, † and so well traced by Meckel, shows that at this period the gastro-enteric mucous membrane, which is previously formed by the vitellar membrane of the ovum, and the *allantois* or vesical membrane, which afterwards forms the genito-urinary mucous surface, are in direct communication on the median line, and afterwards at the navel with the skin or exterior integument. ‡ The detailed history of this process belongs, however, rather to special than to general anatomy; and I notice it here as the strongest proof which occurs to me of the connection between the skin and the mucous membranes, and as an anatomical fact which furnishes the solution of some curious congenital malformations, and of various morbid processes, which affect simultaneously, successively, or occasionally, both orders of membranes.

* Specimen Anatomico-Medicum Inaug. &c. Continuationibus Membranarum, &c. &c. In Sandifort Thes. Vol. ii. p. 265. Rotterod. 1769.

† Jenaische Zeitung, S. 207, 208.

‡ Deutches Archiv für die Physiologie, Dritter B. Halle und Berlin, 1817.

Section II.

The morbid states of the mucous membranes are numerous and important, and constitute a large proportion of the diseases which daily come under the notice of the physician. Generally speaking, these morbid states may be referred to the following heads: inflammation and its effects, sero-albuminous effusion, suppuration and ulceration, hemorrhage, induration and thickening producing contraction or stricture, new growths, and malformation.

1. The inflammatory process in this tissue gives rise to a considerable number of diseases which long usage has distinguished according to the region, the mucous membrane of which is diseased. These affections, which agree in general characters, and vary only in certain points depending on situation and local peculiarity, may be conveniently arranged according as they take place, *a.* in the cephalic or facial mucous membrane; *b.* in the tracheo-bronchial mucous membrane; *c.* in the gastro-enteric membrane; and *d.* in the genito-urinary mucous membrane.

a.	Cephalic division.	Eyelids and eye,	Ophthalmia.	
		Nasal duct,	Epiphora.	
		Nasal passages,	Coryza.	Ozæna.
		Tympanal cavity,	Tympania.	Otorrhœa.
b.	Tracheal division.	Throat,		
		Larynx,	Laryngia.	Cynanche laryngea.
		Trachea,		Croup; catarrh.
		Bronchial membrane,	Bronchia.	Bronchitis, catarrh.
c.	Alimentary division.	Œsophagus,	Œsophagia.	Inflammation of œsophagus.
		Stomach,	Gasteria.	
		Ileum,	Enteria.	
		Colon,	Colonia.	Dysenteria.
d.	Genito-Urinary division.	Ureter,	Ureteria.	
		Bladder,	Cystidia.	Catarrhus vesicæ.
		Urethra,	Urethria.	Gonorrhœa, clap, &c.
		Womb and vagina,	Metria.	Leucorrhœa, &c.

In these several divisions of the mucous surfaces the anatomical characters of inflammation are much the same. The process takes place under two varieties, the spreading or diffuse, which extends over the surface of the membrane; and the punctuate or circumscribed, which affects many points at the same time. The membrane becomes red, in-

jected, traversed by minute red points and vessels, sometimes arborescent or asteroid, sometimes punctular or in minute points, occasionally in linear streaks, and not unfrequently in red patches; the surface becomes swelled and villous or pulpy; and the proper secretions of the part are altered into sero-albuminous fluid, puriform mucus, or actual purulent matter. In situations in which there is epidermis, as in the mouth and gullet, this is elevated into minute vesicles and blisters forming *aphthæ;* or the membrane is cast off in the form of exfoliated patches. In the gastro-enteric membrane the *villi* are removed, and the surface is rendered plane like that of the rectum or bladder. The inflammation may terminate in the formation of ulcers; or in induration and permanent thickening of the mucous tissue by effusion of lymph beneath it, and into its substance. The follicles are at the same time liable to become enlarged and vascular, and occasionally proceed to ulceration; but this is more frequent in the chronic form of the process. The minute peculiarities will be more conveniently noticed under the respective heads.

a. Cephalic mucous membrane. α. Ophthalmia serosa et puriformis.—The ophthalmic mucous membrane (*conjunctiva*) may become the seat of inflammation, with secretion of sero-albuminous fluid, puriform fluid, or purulent matter. In the former case, in which the natural fluid appears simply to be much augmented, the inflammation is confined chiefly to the ocular conjunctiva, which is reddened and elevated, forming in severe cases round the cornea a prominent ring or excrescence, which appears to start from the eyelids—a state denominated by the ancient surgeons chasm or gaping (*chemosis*), because a small opening corresponding to the cornea is left in the centre of the swelled membrane. This severe form of the disease occasionally terminates in suppuration, ulceration, or sloughing.

Of the second form, two varieties are mentioned, the purulent ophthalmy of infants, and the purulent ophthalmy which affects epidemically large bodies of men in close intercourse with each other. In both cases, the mucous surface of the

eye and eyelids is very red, swollen, villous, and pulpy, and puckered into folds by the violent action of the muscles; while the cornea is generally completely concealed by more or less chemosis, and the eyelids are everted. After continuing in this state for eight or ten days discharging much puriform yellow fluid, it may terminate in infants in resolution, but more generally produces specks or opacity of the cornea, ulceration, pustules, or chronic inflammation and thickening of the cornea, rendering that tunic opaque. In adults, proceeding much in the same manner, its effects are generally more serious. If it do not at an earlier period of the disease cause opacity, the cornea may be ruptured partially or generally, so as to allow the escape of the humours. The membranous inflammation becoming in all cases also chronic, the surface of the conjunctiva becomes irregular by numerous minute hardish eminences or granulations, and this originally an effect, becomes afterwards a cause of further inflammation.

The puriform ophthalmy originating from the gonorrhœal poison, though differing in its cause, is the same in its pathological effects.

A pustular form of ophthalmy is sometimes observed. It consists in the appearance of minute eminences of the sclerotic mucous membrane near the circumference of the cornea. These bodies, which may be considered either as aphthæ or pustules, are conoidal, and surrounded by a cluster of vessels which run into them either all round in a circular area, or from one side, most commonly the temporal. When they are situate a line or two from the margin of the cornea, they are broad and flattened. This disease seldom under proper treatment advances to suppuration or ulceration; and I have seen it disappear in thirty hours after being first seen. It seems in some instances to consist in a punctuate deposition of lymph, in others to be a peculiar concentration of blood-vessels. It is not impossible for it, however, to proceed to suppuration and form a minute abscess of the *conjunctiva*. When these pustular eminences appear in the corneal mucous membrane, they generally pass into ulcers.

In some instances, with abatement of pain, diminution of swelling, and alleviation of other symptoms, the vessels appear much distended and distinct, though tortuous, the membrane is thickened in patches or continuously, and sero-albuminous fluid is deposited in spots or along the course of the vessels. These appearances mark the transition of the disease into the chronic form. Their persistence too often leaves the superficial speck *(nebula)*, the triangular web *(pterygium)*, or the opaque spot *(leucoma.)*

β. Watery Eye; Epiphora.—The mucous membrane of the eye and eyelids communicates with that of the nostrils by the narrow tube termed lacrymal duct. A minute capillary opening at the nasal extremity of each eyelid, termed *lacrymal (punctum lacrymale)*, forms the upper or palpebral end of this canal; and its inferior or nasal extremity is a considerable opening in the lower nasal passage, between the lower spongy bone. This canal is lined by a fibro-mucous membrane, the free surface of which is moistened by a thin semi-transparent, glairy fluid, not like the mucus of the nasal or tracheal membrane, but merely viscid enough to facilitate the descent of the tears, and to maintain a free communication between the eyelids and nostrils. This membrane may be inflamed in any part of its course, especially at the palpebral extremity; and the swelling attendant on this process in a canal so narrow produces a temporary obstruction to the transmission of the tears,—constituting the simple and acute form of the *watery* eye or *epiphora*. In ordinary circumstances this terminates in resolution, and the canal again becomes pervious in a few days. In more severe cases, however, either in consequence of thickening of the fibro-mucous membrane, or the effusion of albuminous fluid, the obstruction is more permanent; and if not seasonably removed, may induce secondary inflammation of the parietes of the canal, and ulceration and false openings; *(fistulæ.)* In all cases the inflammatory process may affect the subjacent periosteum of the lacrymal, nasal, and superior maxillary bones, and induce caries in one or more of them. With or without this

latter complication, the disease constitutes lacrymal *fistula*. In either mode it is sometimes the result of syphilis, and very often where mercury has been given for the treatment of that disease.

Similar disease of the lacrymal duct may take place in consequence of previous chronic inflammation of the eyelids and Meibomian glands.

The mucous membrane of the nasal passages is inflamed in *Coryza*,—an affection forming the preliminary part of catarrh. A secondary *coryza* occurs in nasal polypus; and *ozæna*, which consists in chronic suppurative inflammation of the nasal membrane lining the nasal and covering the spongy bones, is always preceded by similar inflammation. The same process is not unfrequent in the fibro-mucous membrane of the maxillary sinus, in which it generally proceeds to suppuration, forming abscess of that cavity.

γ. *Otitis*.—The membrane of the external auditory passage is, strictly speaking, neither skin nor mucous membrane, but a texture intermediate between both. In its morbid relations it is, however, more closely connected with the latter, and is often the seat of inflammation, producing a yellow puriform discharge (*otorrhœa*) from the outer surface of the tympanal membrane, and the membrane lining the ear-hole. The membrane is then red, soft, villous, and highly tender. The average duration of this disease is from fifteen days to three weeks, after which the fluid discharged becomes thicker, and in colour, consistence, and odour, resembles caseous matter. The ceruminous glands are disordered during its presence; but as it recedes their secretion becomes abundant.

δ. *Tympania*.—Though the membrane of the tympanal cavity and the Eustachian tube presents a smooth uniform surface, moistened by a thin watery fluid possessing little resemblance to mucus, yet, as continuous with the naso-guttural membrane, and as similar to that of the facial sinuses, it may be placed in pathological properties in this situation. Bichat indeed corrects the error of those anatomists who

represent the membrane of the tympanal cavity as periosteum; but in his anxiety to maintain its mucous he overlooks its fibrous character. Its adherent surface cannot be distinguished from the periosteum of the bones to which it adheres. When removed and dried it is thin, crisp, and semitransparent. During the inflammatory process it becomes red, thick, soft, and actually villous; and it secretes first serous, afterwards yellow puriform fluid, which cannot be distinguished from genuine purulent matter, though without ulceration.* In this disease an opening takes place in the membrane, which becomes fungous, or is eventually destroyed; the tympanal bones are discharged; and not unfrequently the inflammatory process spreading into the mastoid cells, fills these cavities with matter more or less viscid. In such circumstances it may affect the periosteal surface and cause caries of the bones, which are then found denuded and rough. Not unfrequently it causes inflammation of the *dura mater* and cerebral membranes.

ε. *Thrush; Aphthæ.*—The mucous membrane of the mouth and throat is liable to this form of inflammation, which depends on the presence of epidermis in this region. It is then elevated into whitish or ash-coloured vesicles or blisters, sometimes round or oval, sometimes irregular. The contained fluid is separated into two parts, one albuminous, forming the rudiment of new epidermis, the other serous, which escapes while the old epidermis is cast in the form of scab or slough.

The mucous membrane of the throat and soft palate is affected by diffuse redness, swelling, and other marks of inflammation during the sore throat of scarlet fever. That of quinsy is more frequently seated in the submucous cellular tissue.

b. Inflammation of the tracheo-bronchial membrane may be distinguished as the process is developed, 1*st*, in the larynx;

* "Le cadavre d'un homme exposé à ces écoulemens pendant sa vie, m'a présenté une épaisseur et une rougeur remarquables de la membrane du tympan, mais sans nulle trace d'erosion." Anat. Generale, tome iii. p. 430.

2*d*, in the windpipe or proper tracheal membrane; 3*d*, in the bronchial or pulmonic membrane. Though these inflammations possess certain common characters, each is attended by peculiarities which require attention.

α. *Laryngia, Laryngitis. Cynanche Laryngea.*—Though this disease appears not to have been unknown to Cullen and some previous authors, we are indebted to Dr Baillie, Dr Farre, Dr Percival, Mr Lawrence, and Mr Howship, for a more accurate account of its pathology than we previously possessed. It may be stated as a well established fact, that the symptoms of this disease arise from inflammation circumscribed to a definite region of the larynx. Though the whole laryngeal membrane, from the *epiglottis* to the tracheal rings, is red and swelled, the particular point at which this morbid action is most injurious is that part of the mucous membrane which covers the arytenoid cartilages, and forms the chink called *glottis*. Though this part of the laryngeal membrane may not be more swelled than any other, a moderate degree of swelling soon diminishes the aperture so much that inspiration is rendered difficult or impossible, and the danger of suffocation becomes urgent. It must nevertheless be observed, that in many instances the margins of the glottis are occupied by an oedematous or puffy swelling, similar to that which occasionally affects the eyelids, prepuce, and female *labia*,—from sero-albuminous infiltration of the submucous filamentous tissue, and the effect of which is to diminish, or in some instances to obliterate, the aperture which regulates the admission of air into the trachea. The redness and swelling of the laryngeal membrane is occasionally more conspicuous at its posterior part than elsewhere; and the epiglottis is sometimes swelled and thickened with injection of its membrane; but whatever variations the disease presents, its effect on the membrane of the glottis is uniform; and this aperture is either much contracted or completely obliterated.

With redness and swelling, the laryngeal membrane is generally occupied by thick viscid mucus, which contributes by adhering to the margins of the glottis to obstruct

the aperture. It is most abundant in the recesses called *sacculi*, where it assumes the appearance of purulent fluid. In some rare instances suppuration takes place with breach of surface; and purulent abscesses have been found between the thyroid or arytenoid cartilages, and their investing membrane. Reddening of the tracheal membrane is a complication. Inflammation confined chiefly to the membrane of the epiglottis is described by Sir E. Home;* and this with the arytenoid affection, Dr M. Hall shows is the effect of the accidental attempt to swallow boiling water. †

Of laryngeal inflammation three terminations may be enumerated; 1*st*, resolution, which takes place some time between the 36th and 60th hour; 2*d*, fatal suffocation, which may take place any time after the 30th hour; and, 3*d*, a chronic state with suppuration or ulceration of some part of the organ, which may be apprehended if the disease continues without proving fatal for four revolutions of 24 hours.

The latter result is most usual after attacks so lenient as not to suffocate, but too severe to be completely resolved. The membrane then continues injected, thickened, and corrugated, rendering the individual hoarse and incapable of laryngeal speech. In one or more points ulceration takes place generally in oval patches, which spread and become deep, affecting the submucous tissue or the perichondrium. The ulcers which were previously an effect, become now a cause of inflammation, and obstinately resisting all tendency to heal, continue to spread with chronic inflammation, and give rise to more or less wasting with hectic fever. This constitutes the disease described under the name of laryngeal consumption; *(phthisis laryngea.)* (Cayol.)

In some instances suppuration of the submucous filamentous tissue takes place previous to ulceration of the membrane; and though, by affecting the perichondrium on the one side, and the laryngeal mucous membrane on the other, it may cause the same chronic process as that now described, it is generally a milder and more sanable disease.

* Transactions of a Society, Vol. iii. † Medico-Chirurg. Trans. Vol. xi.

In others it spreads to the cartilages, and by inducing ulceration or death of these bodies, causes an insanable disease speedily fatal. In Mr Dyson's case, in which the epiglottis and upper part of the trachea were ulcerated, the *os hyoides* became carious, and was exfoliated dead. *

In persons cut off by tubercular consumption, minute ulcers of the laryngeal and tracheal membrane are not unfrequent. They vary in size, and are irregular in shape; but in general they appear in the form of angular or oval spots, from which the mucous membrane has been entirely removed. In the larynx of a young woman before me, I count five of these eroded spots affecting the oval shape, none of more extent than a square line, and one patch evidently formed by the coalescence of two, as large as the section of a split pea; and in the tracheal membrane of the same subject, at the bronchial bifurcations, large patches of the same description are visible. In the latter situation, indeed, this destruction is more common and more extensive than in any other point.

The most frequent seat of ulcers of the larynx, according to Louis, is the junction of the vocal chords; then the vocal chords themselves; and lastly, the base of the arytenoid cartilages, the upper part of the larynx and the *sacculi*. In the trachea these ulcers occupy chiefly the posterior part. The bronchial membrane is, according to the same authority, less frequently ulcerated; but when not so, it is almost invariably reddened.

β. Croup (*Bronchiasis albuminosa*) may be defined to be inflammation of the tracheo-bronchial mucous membrane, terminating in sero-albuminous exudation. The points deserving attention in the pathology of this disease, are, 1*st*, the fact of inflammation; 2*d*, the extent of the process; and, 3*dly*, its effects. The inflamed state of the tracheo-bronchial membrane is established beyond doubt. Home observed that it was redder than natural when the concrete covering

* Mem. Med. Society, Vol. iv.

is detached; Rumsey recognized manifest traces of inflammation; in Cheyne's cases the vessels of the membrane were large, distinct, and sometimes numerous, (9th.) The same was seen by Albers, Jurine, and Bretonneau. In short, whether the membranous exudation be present or absent, the tracheo-bronchial membrane is always more or less red, bloodshot, villous, and swollen; and puriform fluid oozes from the bronchial tubes.

This inflammation is seated in the tracheo-bronchial membrane solely. It begins immediately below the cricoid cartilage, and extends along the tubes into the *bronchi* and bronchial membrane. It is rarely observed to affect the laryngeal membrane; and when it does so, this is to be viewed as a complication not essential to genuine croup.

The effect of this inflammation is to produce from the surface of the membrane a fluid or semifluid secretion, which soon undergoes coagulation after exposure to the air. In the upper part of the trachea this substance is firm and in the form of a tubular membrane moulded on the canal; below and in the bronchial divisions it is less firm; in the tubes it is completely fluid. * (Home, Cheyne, Bretonneau.) The nature of this morbid exudation has been a matter of ambiguity. Home, who remarked that the tubular membrane when complete is tough and thick, might be soaked in water for days without dissolving, that it does not adhere to the windpipe, as there is always fluid matter beneath it, and that beyond it, the windpipe, bronchial tubes, and pulmonic vesicles, are covered by pus or purulent mucus, thought it of the nature of thickened mucus. In one case Rumsey calls it viscid mucus or phlegm; in others he likens it to the buffy coat. Field regards it as coagulable lymph; Cheyne, with some confusion, compares it to the exudation of the inflamed pleura or peritonæum, and accounts it thickened puriform fluid; while by Pinel and most of the recent authorities, it

* "We can even demonstrate," says Cheyne, "the adventitious membrane degenerating into the puriform fluid, and again gaining consistence in different parts of the same membrane."

is identified with albuminous exudation. According to the investigation of its chemical properties by Schwilgué, Maunoir and Peschier, and Jurine, it appears to contain albumen in various proportions, and to owe its tenacity and firmness to this principle. Bretonneau, in particular, endeavoured to establish a distinction between the tracheo-bronchial exudation, the albuminous concretions of serous membranes, and the buffy coat, but without success. * It may be inferred, therefore, that this substance, without being either wholly coagulable lymph, or thickened mucus, or dried purulent matter, is a morbid product secreted from the tracheo-bronchial mucous surface, in a semifluid form, and undergoing, in consequence of the presence of albuminous or albuminogelatinous matter, coagulation, as it is more freely exposed to air.

Death is produced in this disease chiefly by the albuminous fluid in the bronchial tubes and vesicles excluding the air from the pulmonary membrane.

Bronchiasis albuminosa adultorum. Polypose inflammation of the trachea. Not very dissimilar is that morbid state of the tracheo-bronchial membrane, in which a membranous concretion, moulded on the tube, is, from time to time, brought up by coughing either in fragments or entire. Instances of this disease, which is not common, were first observed by T. Bartholine,† N. Tulpius,‡ Clark, § Lyster, Bussiere, || Samber, ¶ F. Nicholls,** and more recently by Warren, †† Baillie, and Laennec.

The mode of their formation is not established without ambiguity. In many instances they are the result of a modification of the inflammatory process. In some, however, in which they are connected with bronchial or pulmonary

* Des Inflammations du Tissu Muqueux, et en particulier de la Diphtherite, &c. Paris, 1826. P. 293.

† Centur. iii. Hist. 98.

‡ Obs. Lib. ii. Obs. 7.

§ Phil. Trans. No. 235, p. 779 and 780.

|| Ibid. No. 263, p. 545.

¶ Phil. Trans. No. 398, p. 262.

** Ib. No. 419, p. 123.

†† Transactions of College of Physicians, Vol. i. p. 407.

hemorrhage, they appear to be formed by the coagulation of blood not discharged at the time of hemorrhage.

γ. Bronchial inflammation, acute and chronic. Bronchiasis puriformis; Bronchitis.—The pathology of this disease, though understood by Morgagni, De Haen, and Stoll, has been more fully illustrated by the researches of Chevalier, Badham, Abercrombie, Hastings, and Laennec. Dissections of persons cut off in different stages of the disease show that the bronchial membrane is much reddened and injected, villous or pulpy, and thickened or swelled. As the disease proceeds, it discharges viscid puriform mucus, or muco-purulent fluid, which fills the air-cells or vesicles, and prevents the lungs from collapsing when the chest is opened. The tracheal membrane may be reddened or traversed by arborescent red lines; and though the bronchial membrane is in general entire, in some instances small ulcerated breaches are observed in various parts. In the chronic form, the membrane, though red and villous, is rarely so much swelled as in the acute disease; but minute ulcers or patches of ulceration are more common.

The effect of this process in the bronchial membrane is to augment the quantity and change the quality of the fluid secreted in the natural state. At the commencement of the process, the bluish, semitransparent, and particled mucus of health is mixed with mucilaginous, semitransparent, and grayish fluid, not unlike white of egg, which is secreted in considerable quantity. As the process advances, it becomes thicker, more viscid and opaque, and sinks in water; and when fully established, this viscid mucus is either mingled with, or converted into yellowish opaque fluid, which cannot be distinguished from purulent matter, and which is generally more or less streaked with blood. These changes may be effected without breach of continuity or ulceration of the membrane. This fact, which was first established by De Haen,* has since been fully confirmed by Willan,† Bad-

* Rationis Medendi, i. xi. p. 60. † Reports, 1796, 20th March.

ham,* George Pearson,† and Hastings.‡ It is attended with hectic fever and wasting.

Though ulcers, however, are not essential to chronic inflammation of the bronchial membrane, they may occur, and are most common in the lungs of those whose occupation exposes them to inhalation of irritating mechanical powders. Such, for example, has dissection shown to be the state of the bronchial membrane in stone-cutters,§ glass-grinders, needle-grinders, and leather-dressers.

Pustular Inflammation.—On the nature of a form of ulcer considerably different we have less certain information. In several cases of bronchial disease, the membrane becomes the seat of numerous minute eminences, which, as they may be traced through the stages of inflammation, suppuration, and ulceration, may be regarded as pustules of the pulmonic mucous membrane. The ulcers thus formed are in general round or oval, rarely irregular, with margin slightly raised, and surrounded by a red circle *(areola,)* more or less distinct. The matter expectorated consists of purulent fluid, streaked with blood, and mingled with a considerable proportion of dense mucus. The analogy between this and certain ulcers of the intestinal mucous membrane is obvious. It gives rise to wasting and hectic fever.

Induration, Consolidation.—When chronic inflammation subsists long, the inflammatory action extends to the submucous filamentous tissue, which unites the bronchial tubes and vessels to the serous membrane of the lungs—the parenchymatous or cellular tissue of the older anatomists. Of this the first effect is redness, with vascular injection of the submucous tissue (*infarctio.*) As the morbid state of the blood-vessels continues or increases, sero-albuminous fluid is effused into its interstices; the part loses its natural softness and

* Observations on the Inflammatory Affections of the Mucous Membrane of the Bronchiæ, &c. pp. 48—76

† Phil. Trans. 1809, Part ii. p. 315—321.

‡ Treatise on Inflammation of the Mucous Membrane, &c.

§ Johnstone of Worcester, Mem. Med. Society.

elasticity; and as the process extends the lung loses the spongy lightness which depends on permeability of its vesicles. In a lung in which the chronic inflammation of the submucous tissue has subsisted for some time, the following phenomena are recognized:—1*st*, On opening the chest and admitting the air, though there are no adhesions, the lung collapses imperfectly or not at all; 2*d*, The pulmonic tissue surrounding a portion of inflamed membrane becomes hard and dense, and floats deep or sinks in water; 3*d*, Deprived of its elasticity and compressibility, it cannot be inflated, does not crepitate, and resembles a portion of solid flesh. In such circumstances bronchial inflammation is complicated with *pneumonia*.

A variety of chronic bronchial inflammation, important from its close resemblance to consumption, is that occasioned by the presence of foreign bodies which have dropped accidentally into the windpipe. Of this species of disease three cases are recorded; one by Dr Lettsom of the foil of a button having dropped into the trachea of a boy;* another by Dr Mervin Nooth of a leaden shot which slipped in to his own windpipe without his consciousness, while swallowing a glass of wine; † and a third by Mr Howship of an inch nail which had fallen into that tube. ‡ In each of these cases the usual symptoms of chronic, bronchial, and even of pulmonary inflammation were induced; and purulent expectoration with occasional hemoptysis, and hectic and great wasting, threatened certain death. In each, however, after a lapse of years, the foreign body was rejected by coughing when least expected, and recovery eventually took place. Though this favourable issue prevents the pathologist from ascertaining with certainty the exact nature and extent of the lesion, it is not, I conceive, unreasonable to infer, that the bronchial membrane certainly, and probably the pulmonic tissue, were maintain-

* Memoirs of the Life and Writings of the late J. C. Lettsom, M. D. &c. By T. J. Pettigrew, F. L. S. &c. London, 1817. Vol. iii. p. 82. Art. xiii.

† Transactions of a Society, &c. Vol. iii. p. 1.

‡ Practical Observations in Surgery and Morbid Anatomy, &c. p. 222.

ed in a state of chronic inflammation during the presence of the foreign body.

Bronchial inflammation takes place secondarily in hooping-cough, measles, and even scarlet fever. In measles I have seen the membrane red, injected, villous, and secreting puriform fluid copiously—the usual symptoms of pulmonary consumption having preceded the fatal event. In scarlet fever not only the pulmonic but the facial mucous membrane is inflamed; and in some severe and fatal cases I have traced the capillary injection along the gastro-enteric division, and in the genito-urinary from the neck of the bladder to the pelvis of the kidney. This general affection of the mucous system explains the fatality as well as many of the symptoms of scarlet fever. Inflammation of the tracheo-bronchial membrane is an occasional consequence of inhaling accidentally certain of the noxious gases.

Redness and punctular injection of the tracheo-bronchial membrane, with more or less secretion of viscid mucus, was seen in hydrophobic subjects by Beddoes, Babington, Oldknow, Rush, Satterley, Brandreth, and Trolliet, the last of whom labours to prove that the rabid poison affects particularly this membrane. Much of this effect is doubtless to be ascribed to the violence of the anormal motions of the respiratory muscles; and it is still undetermined how far the appearances now mentioned are primary and essential, or secondary and accessary.

c. In the gastro-enteric mucous surface inflammation may take place either generally or partially. *α*. In the œsophageal mucous membrane inflammation seldom appears, unless as part of the same process affecting the stomach and bowels more or less generally. This is particularly the case in inflammation of the gastric mucous membrane, with which a similar state of the œsophageal is almost invariably connected. The surface is red, injected, and more or less villous, and thickened; and the œsophageal epidermis is occasionally elevated into apththa or blebs, leaving, when these are removed, an excoriated or abraded surface. In the chronic

form it may affect the mucous glands, and produce ulceration. Irregular patches of the latter I have seen in subjects in whom the colic membrane was extensively covered by ulcers. The cases described by Dr F. Simmons and Dr Gartshore appear to have affected the submucous tissue.

β. The gastric mucous membrane may be inflamed generally or partially. When a limited portion of the villous membrane is inflamed, the disease is seldom violent. The mucous membrane of the inflamed part shows an unusual number of minute vessels, but is rarely much crowded. In some instances, however, it is red or scarlet, with vessels disposed in arborescent, punctular, or striated fashion; and not unfrequently spots or patches of extravasated blood are recognized. At the same time, the substance of the mucous coat is thicker than natural, of pulpy softness, and when attempted to be detached, is readily lacerated.

The gastric mucous membrane is liable, nevertheless, to a more general inflammatory process, in which its surface presents a light rose-coloured blush diffused all over, and secretes mucous or muco-purulent fluid copiously. The mucous membrane is also pulpy and softened, but not remarkably thickened. This state of the gastric membrane, though occurring spontaneously, may be produced by repletion or improper articles of food, and by several of the acrid poisonous substances. Of this form of *gasteria* a good delineation is given by Dr Armstrong in the 2d pl. of his 1st Fasciculus.

Gasteria psilotica ; Psilosis.—In the persons of those who have long pined under various chronic diseases, the gastric mucous membrane is liable to a form of disease in which some part of it becomes pale white, bluish, rose-coloured, or gray, continuously or in long narrow stripes, or irregular patches more or less thickly set. The spaces so coloured are simply depressed beneath the level of the adjoining membrane, not ulcerated, soft and thin, and converted into a glairy semitransparent pulp. According to M. Louis, to whom the pathologist is indebted for the correct description of this change, when in narrow stripes it is distributed

nearly uniformly over the whole surface of the stomach; when continuous it occupies the large extremity of the organ, is rarely confined to the great *cul de sac*, and in some instances appears at once at the cardiac and pyloric orifices. The vessels of the submucous tissue, which is generally sound, are large, distinct, and empty.* From the few instances in which I have seen this change myself, I should say that it consists in removal of the *villi* by some process analogous to inflammatory absorption. It is certain that in the affected patches these processes are greatly less distinct, and often totally gone. I may add that this is one at least of the forms of the change which John Hunter describes as *digestion* of the stomach †; and also one of these described by Dr Yellowly, ‡ the greater part of which, it is to be observed, occurred in persons cut off by pulmonary consumption. To this head probably are to be referred such cases as that recorded by Mr Douglas, who found the villous coat obliterated except near the pylorus, and the muscular absorbed. § The theory of its production is further exceedingly obscure; and I abstain from conjecture.

In similar subjects, but more especially in the phthisical, the gastric membrane is liable to become occupied by minute roundish eminences, not unlike granulations separated by superficial furrows, with occasional points of ulceration round or oblong form, from one to several lines in diameter. The colour of the membrane is at the same time reddish, or reddish gray, always thickened, and generally softened, and covered with much viscid mucous. This granular state of the mucous membrane is most frequent in the large curvature, and the parts adjoining to the anterior and posterior surfaces, at the pyloric extremity, the small curvature, and the great *cul de sac*, the whole extent of which, however, is rarely affected. || The granular eminences appear to be

* Mémoires ou Recherches Anatomico-Pathologiques. Paris, 1826.

† Observations on certain parts of the Animal Economy, p. 226, 231.

‡ Medico-Chir. Trans. Vol. iv. p. 271, 5 out of 20.

§ Mem. Med. Soc. Vol. iv. p. 395.

|| Louis in Medico-Chir. Trans. Vol. iv.

swellings of the mucous glands, which are most abundant in the situations in which it is seen.

Gasteria Diuturna.—Chronic inflammation of the gastric mucous membrane is much more frequent than is imagined. The process is in general confined to one or two small spots, which are slightly red, often brown or reddish brown, rough, villous, and firmer than natural. Of these appearances the most constant is the rough villous aspect and firm consistence, which are at once recognized by drawing the finger over the part. The inflammation does not spread, but gradually penetrates to the submucous filamentous tissue which is exposed, and the formation of an ulcer or ulcers, such as are described by Morgagni, * Portal †, Baillie ‡, Louis, § Annesley, || and Armstrong. ¶ The most usual appearance of these ulcers is that of depressed breaches in the continuity of the mucous membrane, with a rough, brown coloured surface, variable in size, but generally small, affecting an irregularly round or oval shape, sometimes angular, and with edges smooth, but sharp and accurately marked. This character, which is that of a piece of the membrane completely cut or scooped out, is certainly derived from the peculiar properties of the mucous corion, which seems in ulceration to undergo a gradual process of absorption. When the first minute perceptible point of ulceration is formed, the edges are destroyed or absorbed in the same gradual manner, and thus the ulcer is enlarged. The edges are in general some shade of crimson or reddish brown, owing to injected capillaries of the corion; but in other instances the colour does not differ from that of the adjoining surface.

Ulceration affecting the mucous follicles of the stomach is somewhat different. The surface of the swelled follicle begins to be perforated by innumerable minute reddish points,

* Epist. xxix. 14, 15, 20. † Anatomie Medicale, Tome v. p. 198.

‡ Morbid Anatomy, p. 141, 142. § Louis ibid.

|| Researches into the Causes, Nature, and Treatment, &c. Vol. i. p. 251.

¶ The Morbid Anatomy of the Bowels, Liver, and Stomach, Fasciculus 2. Plate 6th, p. 52.

which gradually coalesce, and when this is completed, a reddish brown ragged surface is formed.

Ulceration very often proceeds by successive destruction of the submucous, muscular, and peritonæal coats to perforation, which consists in the occurrence of a ragged opening, through which the contents of the organ escape, and give rise to secondary peritonæal inflammation, which is invariably fatal. This accident, examples of which are recorded by Morgagni, Lieutaud, Carmichael Smyth, * Gerard, † Crampton, ‡ Travers, || Louis, and Dr Abercrombie, may take place at any part of the stomach, but appears to be most frequent in the space between the great and small arches, but nearer to the former. In some rare instances, in which adhesion is formed between an adjoining organ and the edges of the aperture, the contents of the stomach are prevented from escaping, and life may be continued till the progress of ulceration destroys a part where this temporary barrier cannot have place.

The most important point to be known is, that these ulcers may cicatrize. Independent of the uncertain cases recorded by Atkinson and Reil, we have an authentic and unequivocal example in the person of the late M. Beclard. This able anatomist laboured at one period of his life under obstinate symptoms of gastric disease, the nature of which, though uncertain, seemed to partake of chronic inflammation. The symptoms did not give way without frequent local bloodletting, counter-irritation, and the most rigid regimen. After death, there was found in the small curvature, about 4 lines from the *cardia*, a cicatrized ulcer, the size of a 20 sols piece, with a depressed surface, the middle of which was traversed by a solid cellular band, on each side of which were two *lacunæ* formed by peritonæum. The margins were neither red nor swollen; and the rest of the stomach was sound. §

* Med. Commun. Vol. ii. p. 467.

† Des Perforations Spontanées de l'Estomac. Paris, 1803.

‡ Trans. of the Association, Vol. i. || Med. Chir. Trans. Vol. vii.

§ De la Membrane Muqueuse Gastro-Intestinale, &c. p. 558. Par C. Billard.

Besides the ulcerative perforation now mentioned, another variety has been described by Jaeger of Wirtemberg, Zeller of Tubingen, Cruveilhier of Paris, and Dr John Gairdner of this place, as occurring in the stomach and bowels of infants generally at the breast. From the elaborate examination of this subject by the latter author, it appears that these perforations are probably not the result of previous ulceration, but are effected by some solvent power of the fluids after death; that, nevertheless, the parts so eroded and perforated appear to undergo a previous change of structure, in consequence of which they are less able to resist the solvent power.*

Before I conclude this subject, I may remark, that in some instances the mucous follicles appear to become enlarged in consequence of chronic inflammation, without affection of the gastric membrane. A very good instance of this change is recorded by Haller, who found in the pyloric end of the stomach of a woman of 64, ten or twelve hemispherical bodies like *papillæ*, with black or perforated summits, and cavities full of purulent matter. Though the size of these bodies was variable, the diameter of some was three lines, in others a full inch.†

A particular cause of gastric mucous ulceration has been supposed to exist in certain substances belonging to the class of corrosive poisons. That in many instances these substances induce inflammation, ulceration, and erosion of the gastric tissues, cannot be denied; and this is true, particularly of the concentrated mineral acids, as is shown in the cases and experiments of Tartra, Orfila, and Brodie. Though it is true, however, that these substances produce in many instances inflammation, and in several corrosion, it is not established that they cause ulceration. It is very doubtful even if arsenic itself, to which this property has been often ascribed, ever induces ulceration; for in a large proportion of cases in which particles of the solid oxide have been found in the stomach no ulceration has been recognized.

* Medico-Chirurgical Transactions of Edinburgh, Vol. i. p. 311.

† Opuscula Pathologica Observat. xxvii.

The reason of this I conceive to be, that death is effected by the severity of the general operation of the agent before there is time for ulceration. The further examination of this point, however, belongs to toxicology.

In many cases of canine madness the œsophageal and gastric membrane has been found reddened and covered with viscid mucus ; (Morgagni, Baillie, Babington, Ferriar, Marcet, Powel, Pinkard, &c.) and several authors have here been inclined to ascribe the symptoms of that disease to œsophageal and gastric inflammation. Admitting, however, that appearances of this kind are sufficient to constitute spreading or diffuse inflammation of the mucous surface, it does not follow that this is the cause of the hydrophobic symptoms. The œsophageal and gastric redness is not constant ; and its presence and degree, which are secondary, depend rather on the violent spasmodic motions of the muscles of deglutition and the diaphragm, than on positive or primary inflammation.

The affection of the gastric mucous membrane occurring in fever, as remarked by Roederer, and Wagler, Sarcone, Pinel, and others, shall be noticed afterwards.

γ. *Enteria.*—Inflammation of the iliac mucous membrane is greatly more frequent than it has been represented by authors. Whatever be the influence of authority to the contrary, it may be shown that the frequent fluid alvine discharges, to which physicians give the name of *diarrhœa*, are in the greater number of cases to be referred to inflammation of the mucous surface of the intestines, spreading over a considerable extent, and rarely penetrating to the submucous filamentous tissue.

Though it was originally maintained by Glisson on the evidence of dissection, that in diarrhœa the intestinal mucous membrane is inflamed, and a similar idea was entertained by Baglivi and other Italian physicians, the facts on which this opinion rests appear to have been overlooked amidst the zeal and ingenuity with which the hypothesis of *inordinate motion* (*motus abnormis*) of the school of Hoffmann and Cullen was defended. Next to the instance recorded by Morgagni in

his own person, and others mentioned in his 31st epistle, in the Reports of Ludovic Bang for 1782 and 1787, may be found distinct traces of the opinion, that intestinal inflammation gives rise to diarrhœa.* Much about the same time, (1788,) Carmichael Smyth conjectured, "that in diarrhœas, from catching cold, the villous or interior coat of the stomach and intestines is sometimes slightly inflamed." † This conjecture was afterwards confirmed by the researches of Baillie, ‡ Pinel, § Hildenbrand, ‖ Broussais, ¶ Petit and Serres, ** Abercrombie, Andral, Latham, †† and lastly Billard. The proofs collected by these authors it is unnecessary to examine minutely. They establish indisputably the inference, that the red or rose tint of mere injection of the mucous membrane is adequate to produce all the symptoms of diarrhœa passing into dysentery. The state of the intestinal membrane, as discovered by necroscopy, may vary according to the extent of the disease, or the kind of the inflammatory process.

1. The simplest form is that in which the mucous surface is light reddish, or rose-coloured over a large extent,—an appearance which depends on superficial injection of the villous membrane. The *villi* are red, and more or less gorged with blood. This state, besides producing copious mucous or sero-gelatinous discharges, is very often the pathological cause of intesti-

* Selecta Diarii Nosocomii Regii Hafniensis, Auctore Frederico Ludovico Bang, Vol i. p. 47, Vol. ii. and 233, 314, 360, 361.

† Medical Communications, Vol. ii. p. 210.

‡ "It does not always happen," says Baillie, "when a person has died from fatal purging, that there are ulcers in the intestines. In two cases which I have opened of persons who died from this complaint, the small intestines were inflamed, so as to present the appearance of distinct vessels, the small branches of arteries curling most beautifully at the outer surface of the intestine filled with florid blood, and the *villous coat being slightly red.*"—Dissections, &c. p. 218.

§ Medecine Clinique et Nosographie Philosophique, Tom. ii.

‖ Ratio Medendi in Instit. Clinico. ¶ Phlegmasies Chroniques.

** Traité de la Fievre Entero-Mesenterique.

†† An Account of the Disease lately prevalent at the General Penitentiary. By P. M. Latham, M. D. &c. Lond. 1825.

nal hemorrhage. In some instances it is shaded from a light rose to blood-colour or wine-coloured crimson. *2d*, The intestinal membrane may be marked by redness disposed in various forms, arborescent, asteroid, or punctular, or in slender linear streaks. These appearances may occur independent of inflammation, as an effect of transudation, or stagnation during the last hours of existence or after death, and should therefore be distinguished from the same forms of redness in connection with the inflammatory process, when they indicate a slight or incipient form of it. 3. A common form is in red or brown patches, irregular in size and shape, with sensible elevation above the surrounding membrane, forming a sort of puffy swelling, the surface of which is rough and irregular, and, though not hard, void of its natural feel. Though these patches may occur in any part of the small or large intestine, they are most common at the termination of the ileum and the beginning of the colon. From petechial and ecchymotic blotches, with which they are liable to be confounded, they may be distinguished by the blood being observed, in pieces of intestine held up to the light, to be still contained within vessels. (Latham.) These red patches are exceedingly prone to proceed to ulceration, which takes place in one or more points near their centre, and by extension and coalition produce in no long time a breach in the continuity of the mucous corion equal in size to the original patch. This is the form of disease described by MM. Petit and Serres under the name Entero-mesenteric fever, and which there is reason to believe is occasionally epidemic in Paris.* Of the same nature is the disease which was prevalent in the Millbank Penitentiary during 1822 and 1823. According to the luminous and accurate description of Dr Latham, the patches which most frequently were circular, and not exceeding the diameter of a pea, were dispersed at intervals through the whole tract of the intestines. When larger and more irregular, they appear to have been the result of the coalescence of several small patches. The transition to ulceration in this

* Traité de la Fievre Entero-mesenterique, p. 139.

instance consisted in the reddened mucous membrane becoming elevated, rough, and unequal to the touch, and in erosion taking place at several points. * 4. A considerable extent of the membrane may be diffusely red or reddish brown, or with a general rose-coloured ground may present red or brown patches of a more intense tint. The membrane is at the same time soft, friable, pulpy, and often thickened; the mucous glands are enlarged and reddish; and the membrane is covered more or less extensively by thick, semi-opaque viscid mucus of a reddish or wine-coloured tint. This form of the disease is also said to proceed to ulceration. When it does so, the process takes place not only in spots and patches of the mucous membrane, but in the follicles, which are converted into a number of oval reddish-brown ulcers. 5. Part of the intestinal mucous membrane may present numerous vesicular or pustular elevations, not unlike thrush vesicles (*aphthæ*), which may terminate in the formation of abraded spots or minute ulcers. Excoriation and abrasion is mentioned by various authors; but I think none of them distinguish between this and ulceration, of which I regard it as the incipient stage. Abrasion consists, properly speaking, in the removal of epidermis; but as the existence of this in the gastro-enteric membrane is still problematical, it may be doubted whether there is other abrasion than what I now admit. 6. In certain forms of intestinal inflammation, the morbid process appears in the shape of spheroidal or conoidal circumscribed eminences, which are red, fungous, and irregular, and form a conspicuous prominence of the mucous membrane. These bodies which thus resemble pustules, and are surrounded by a red hoop (*areola*), are represented by MM. Bretonneau and Trousseau to consist in inflammation of the mucous follicles of Peyer and Brunner. According to the former of these observers especially, this follicular inflammation, passing occasionally to ulceration, is a most frequent form of intestinal disease not only primary, but occurring in the course

* An Account of the Disease, &c. p. 48.

of fevers. Its most constant and frequent locality is the 3, 6, or 10 last inches of the ileum; and when it affects the colon it is near the ileo-cœcal valve, being on both sides of this point much more confluent than at greater distances. This form of intestinal inflammation M. Bretonneau denominates *dothinenteria* (*δοθινη pustula*, and *εντερον intestinum*.) *

Any one of these forms of morbid condition may produce all the phenomena of diarrhœa or even dysentery. The most uniform and remarkable effect, however, is after the first discharges of feculent matter to cause abundant excretion of viscid mucous matter, which, though fluid when discharged, undergoes a species of coagulation not unlike jelly. This may be easily recognized, even when mixed with feculent matter. It is free from the peculiar offensive odour of the latter; and it appears to contain a proportion of albuminous or gelatinous matter, or both.

Ulceration of the mucous follicles is very common after the disease in any of the above forms has subsisted long. This was seen in those of the duodenum by Brunner, in those of the ileum by Lecat, Prost, Petit, and Serres, Bretonneau, and Trousseau, Billard, and Dr Bright. This form of ulceration is invariably more complicated and more difficult of cure than simple ulceration of the villous membrane.

Perforation. — Though any part of the small intestine from the *duodenum* to the *cæcum* may be the seat of ulcers, they are most numerous and largest in the lower part of the ileum. In this part of the tube the ulcerative process may advance so far as to affect the submucous tissue, the muscular layer, and the subserous tissue, upon which the peritonæum generally gives way, and laceration or perforation takes place. That the peritonæum is removed by absorption, or rather gives way when no longer supported by the collateral tissues, may be inferred from the fact observed by M. Louis, to whom we are indebted for the best and fullest account of this accident;—that the margin of the ulcers in which perforation takes place is sharp and clean; that the mucous and

* Archives Generales, tome x. 1826. P. 67 and 169.

submucous tissue are destroyed nearly to the same extent; and that the muscular is less, and the peritonæum scarcely at all destroyed.

The effect of perforation is, as in the case of the stomach, 1*st*, escape of the intestinal contents to a greater or less extent; 2*d*, the developement of peritoneal inflammation, with albuminous deposition on the peritonæum. The period which elapses between the commencement of ulceration and the completion of erosion varies in different cases. According to the observations of Louis, already quoted, it may be inferred that in a space varying from 12 to 25 days, the ulcer or ulcers may effect destruction of the intestinal tunics. The occurrence of the final laceration of the peritoneal coat may be conjectured by the patient experiencing all at once in the belly intense tearing pain, aggravated by pressure, speedily followed by shrinking of the features, vomiting, &c. which continuing with almost incessant severity from 20 to 54 hours, denote intense peritoneal inflammation terminating in death. In one case, which, however, must be regarded as an exception, life was continued for seven days after the appearance of symptoms of perforation.

Enteria mollescens.—Under this head may be placed a change observed by Louis in the ileum of many persons cut off by phthisis and other chronic diseases. It consists in the mucous membrane becoming exceedingly soft, almost like mucus or jelly, sometimes thicker than natural, and sometimes redder. In the instances in which I have observed this change in phthisical subjects, the intestinal *villi* were less distinct than natural. But whether this arose from removal of these bodies or from the pulpy swelling of the mucous corion, or from absolute disorganization, I have not been able to determine. It is rarely continuous, and occurs chiefly in large patches, which occupy, however, the whole circumference of the bowel.

Chronic ulceration.—To this head I refer a form of disease of which I have seen several instances in children labouring under symptoms of mesenteric wasting; *(tabes.)* I

have no doubt that it commences in inflammation of the mucous membrane; but as it was found in the cases to which I allude in the form of ulcerated patches, I prefer, for the sake of obvious and easy distinction, to designate it as above. In the best marked instance in which I have seen it, and the preparation of which is before me, it occurred in the form of three large bands near the lower end of the ileum, extending transversely round the entire circumference of the bowel. The broadest of these bands is about two inches, the narrowest about eight lines. Over the whole of these spaces is the mucous membrane completely removed by the ulcerative process, leaving an irregular surface, partly granulating, partly ulcerated in the mucous tissue. The margins are sharp, clean, and accurately cut, almost as if they had been divided by a knife, and slightly turned up, so as to leave an excavated furrow beneath the mucous membrane which forms the margins. The colour of the bottom of these ulcerated patches, when recent, was reddish brown, and the contiguous mucous membrane was red, verging to pale rose colour and peach-blossom. This, however, has disappeared, and at present it is much the same tint as the healthy part of the mucous surface. The mucous membrane is a good deal thickened, and rather firmer than in the sound part of the tube. At each of these ulcerated bands the submucous and subserous filamentous tissue is thickened, but indurated and contracted, so as to diminish considerably the calibre of the canal. In the first patch, which is about twelve inches from the ileo-cœcal valve, this thickening consists of a firm knot like a bean, at the mesenteric side of the bowel, and the intestine is contracted to about half its usual capacity. In the second, about five inches from the ileo-cœcal valve, this indurated knot at the mesenteric attachment of the bowel is equally well marked, and has had, if possible, greater influence in contracting and diminishing the canal of the bowel. The ulcerated surface is very irregular by soft spongy eminences, separated by means of linear furrows. The third occupies the end of the ileum and beginning of the colon,

and has entirely destroyed, with the mucous membrane of both bowels, the ileo-cœcal valve. The destroyed part here presents a surface consisting in very minute round granules; and in the beginning of the colon are one or two large irregular granulations. The same inflammatory induration of the submucous and subserous filamentous tissue has here operated in diminishing the capacity of the bowel; and, indeed, previous to being cut open, it seemed almost impervious. The inflammatory process here had produced peritoneal inflammation, and false membrane connecting the *ileum, caput cœcum,* and part of the colon together. The vermiform process is unaffected. Opposite to each were enlarged mesenteric glands, and especially at the last mentioned one was a cluster of large knotty masses.

Though I describe the ultimate effects of this destructive process, I have no doubt, from what I have seen of other cases in earlier stages, that it is the result of chronic inflammation of the intestinal mucous membrane. I had an opportunity of observing the progress of the disease for more than two years, during which the case was more or less under my care; and during that period it was possible to recognize occasional attacks of inflammation. The other symptoms were occasional pain of the belly, never severe, unless at the period of the above attacks, and diarrhœa alternating with constipation, afterwards incessant and uncontrollable diarrhœa, wasting, and hectic fever;—in short, all the symptoms imputed to mesenteric decline; *(tabes mesenterica.)* This process, therefore, or chronic inflammation of the intestinal mucous membrane, with or without ulceration, I regard as one of the pathological causes of mesenteric *tabes.* The enlargement of the glands, in which this disorder has been very generally believed since the time of Wharton, Baglivi, and Richard Russell to consist, is merely secondary, and is a consecutive effect of the irritation exercised at the organic extremities of the lymphatics and lacteals. This view of the relation between enlarged mesenteric glands and intestinal inflammation, though already stated by Broussais, has not, however,

been established by that author on authentic proofs. Enlargement of these glands is indeed, I have elsewhere said, a common effect of irritation at the organic extremities of their lymphatics.

δ. Colonia. Dysentery. Colonitis.—The opinion that dysentery depends on inflammation of the bowels is very ancient; but the authority of Cullen succeeded for a time in throwing doubt and obscurity on a doctrine, in favour of which various positive and unequivocal facts have since been collected. The state of the intestines in this disease has been described by Pringle, Baker, Donald Monro, Hunter, and Baillie, Cheyne, and O'Brien; and their accounts, with some trifling exceptions, in general correspond. In four dissections made by Pringle in the Flanders campaign of 1744, the villous coat of the colon was red or vascular, and abraded or ulcerated; the lower end of the colon, and generally the *rectum*, was in a state termed mortification; the ligamentous bands are said to be relaxed, half corrupted, or entirely obliterated; and the colon, sometimes the ileum and stomach, much distended by air. * In the inspections recorded by Baker of the London epidemic of 1762, the villous membrane of the rectum, colon, cœcum, and occasionally part of the ileum, was more or less reddened, velvety-granular, and occupied by numerous minute bodies like small-pox pustules, but harder and solid when divided, and fungous eminences. In one case four or five perforations had taken place in the transverse arch of the colon. † In persons cut off by old dysentery, Monro represents the villous membrane of the rectum and colon as inflamed with livid spots in the arch of the latter; and in one seized by violent pains of the bowels two days before death the ileum reddened. ‡ From a subsequent account by the same author, it appears that the colic mucous membrane as high as the valve, was occupied by livid or black spots of

* Observations on the Diseases of the Army, by Sir John Pringle, M. D. London, 1768. Chap. 6.

† De Catarrho et de Dysenteria Londinensi epidemicis utrisque, anno 1762, Libellus. Auct. G. Baker. Coll. R. &c. Lond. 1764.

‡ An account of the Diseases, &c. By Donald Monro, M. D. Lond. 1764.

various size, occasioned by black blood in the submucous filamentous tissue; and that in the centre of each spot there was more or less erosion of the villous membrane. Though no black spots or erosions were seen in the mucous membrane of the ileum, in one or two minute red spots, and slight traces of inflammation were recognized. * The general accuracy of these statements is briefly confirmed by F. L. Bang in the following terms. "Perlustrata interna facie intestini cœci atque coli, vidimus tunicam villosam alibi adhærentem, et alibi derasam, ibidemque tunicam vasculosam lividam quasi sanguine plenam, mesenterium rubescens vasis distinctis plenissimum." †

Dr John Hunter, on the contrary, who states that he never saw abrasion or mortification of the villous coat, is inclined to think, that in the dissections mentioned by Pringle, the black colour arising from extravasated blood was mistaken for gangrene. Though it is impossible to doubt that this mistake has been often committed in describing the necroscopic changes of the gastro-enteric membrane, it must not be forgotten that inflammation occasionally terminates in mortification, and that instances of this are not unusual in the tropical form of the disease especially. The general fact of inflammation is further confirmed by Maximilian Stoll, who describes the cœcum, colon, especially its transverse arch, and rectum, in persons cut off by acute dysentery, as swelled, thickened, hard, and fleshy, of a leaden or dull red colour, the mucous membrane of a foul or dingy red tint with blood, or of a deep rank green tinge removable neither by water nor the sponge,—an appearance indicating the commencement of elementary decomposition. ‡

The necrological appearances of tropical dysentery have been described more or less fully by Sir W. Farquhar, Dr Ballingall, Mr Bampfield, Mr Annesley, whose several testimonies tend to establish the general conclusion, that this disease consists in inflammation of the colic mucous membrane,

* Essays and Observations, Physical and Literary, Vol. iii. article 25.

† Selecta Diarii Nosocomii Hafniensis, Tom. ii. 1786. P. 223.

‡ Ratio Medendi, Partis iii. Vol. iii. Sectionis 4.

spreading in general, not always or necessarily, with ulceration, but advancing to this process when not suitably or promptly opposed, and occasionally ending in death of portions of the mucous membrane. Of this inflammation the chief peculiarities are, 1*st*, that it is confined with considerable accuracy to the colon or large intestine, and the ileum being but rarely affected, and only at its lower or colic extremity; 2*d*, that this inflammatory action spreads continuously from the ileo-cœcal valve along the mucous membrane of the *cæcum*, right branch of the colon, transverse arch and sigmoid flexure, at various rates, and with various effects, but at all times with that of producing frequent copious discharges of mucous, muco-purulent, and blood-coloured stools; 3*d*, that this process may continue for some time without producing ulceration of the mucous corion, or inflammation of the sub-mucous tissue; that these phenomena may take place, nevertheless, in certain circumstances, at an early period; and that in others they occur towards the conclusion of the disease; and 4*th*, that though this inflammatory process in general commences with disorder of the circulation, and increased number of the cardiac pulse, it may commence without this, and almost always goes on when once established, without the pulse being much quickened, till the inflammatory process either affects the sub-mucous tissue, or, which is nearly the same thing, begins to effect mortification of the mucous tissue.

The formation of numerous ulcers in the tract of the colon may be said to indicate the chronic form of the disorder. This, from the statements of Ballingall, Bampfield, and Annesley, appears to be more common in the tropical variety of the disorder than in that observed in more temperate climates. The same change, however, was seen by Morgagni, Lieutaud, Baillie, Cooke, and others, in the dysenteric affections of the latter description. In one instance of a man of 65, who had for several weeks laboured under chronic purging, and whose body I inspected for my friend Mr Caird, I found the colic mucous membrane occupied by numerous ulcers, irregular in shape, and varying in size from the area of a split pea to that of a sixpence, and even of

a shilling. The lower end of the ileum presented a few small patches of ulceration scarcely penetrating the mucous corion. In the cœcum, on the other hand, they were deeper, and had not only penetrated this membrane, but were destroying the submucous tissue. In the ascending portion and transverse arch they had effected equal destruction, and in one or two the peritonæum only was left. The bottom or surface of these ulcers varied according to the stage of destruction. In the least advanced, in which the mucous tissue was not entirely destroyed, the surface of the ulcer was a sort of pale-red or gray-brown colour. When the surface was formed by exposed submucous tissue it was more ashen-coloured, but with red streaks depending on blood-vessels. The muscular layer gave it a red or brown tint; and where the peritonæum was exposed, it was thickened, reddened, and in general coated by a layer of lymph on its free surface. The edges of these ulcers, if formed of mucous tissue, were generally well-marked, sometimes thickened, and occasionally slightly turned upwards from destruction of the submucous filamentous layer. Seldom were they red; and their most prevailing tint was light or ash-coloured brown. The colic mucous membrane was generally traversed by blood-vessels at variable distances from each other. The *villi* were obliterated and indistinct. The valvular folds also were destroyed, and the cellular arrangement of the bowel could no longer be recognized.

It is not unimportant to know that these ulcers of the intestinal mucous membrane may, under certain circumstances, undergo a process of reparation. The steps of this process, which was originally observed by Dr Donald Monro, have been well described by Petit and Serres in their account of the entero-mesenteric disease of Paris, and by Dr Latham in that of the epidemic of Millbank Penitentiary. From the observations of these authors it results, that the first step towards repair consists in the loose margin of ulcerated mucous membrane becoming fastened down to the muscular layer or the peritoneal coat respectively, by deposition of lymph all round. This lymphy deposition forms an elevated promi-

nent ring, inclosing a depressed space corresponding to the centre of the sore, and which about the same time acquires a reticular appearance from intersecting filaments of lymph, among which may be seen minute red vessels. As the process advances, these filaments, by acquiring solidity and strength, seem to draw the mucous membrane forming the edges to the centre of the ulcer, while the elevated ring becomes flattened. At length, the lymphy deposition being covered by a thin pellicle newly formed completes the cicatrix. When the ulcerated spots are examined in this state, the ragged edges of mucous membrane are found to be mutually approximated; and the peritonæum at the same time to be puckered or drawn together, appearing as if a small portion of the intestine had been taken by the forceps and tied by a ligature. This shows that the process of repair consists not in the mucous corion being reproduced, but in the opposite margins of its breach making as it were an effort to approach by means of the lymphy exudation from the peritonæum, which was thus necessarily contracted.

ε. *Pustulo-tubercular eminences.*—I am not aware that the circumstances on which the formation of hard pustules or tubercles of the colic mucous membrane depends, have been investigated or determined. Is this membrane liable to a peculiar pustular or pustulo-tubercular inflammation? That they do not occur in all forms of colic inflammation is proved by the fact, that they were not seen in the camp dysentery of 1743, and but rarely in the tropical dysentery of the east; while they were observed in every case of the London dysentery. Dr John Hunter, who saw them in all the dysenteric inspections which he performed in Jamaica, describes them as true *pustules*, though they contain no purulent matter; and represents them as seated beneath the villous coat or the submucous tissue. Each pustule, though at first small, round, and reddish, not more than the one-tenth of an inch in diameter, gradually enlarges till it attains the diameter of one-fourth of an inch, becoming at the same time paler. In this stage a minute crack or fissure appears at the top, and gradually enlarges, when the contents of the pustule are

found to be cheese-like substance. As the opening enlarges, the edges become prominent, the base grows rough, and matter sometimes tinged with blood oozes from it. This is the progress of one pustule or tubercle; but they are generally in clusters, and may coalesce and form an unequal ulcerated surface, with a hard thickened base. *

Of much the same nature are the granulations of the intestinal mucous membrane, described in the persons of the phthisical by Louis. According to this observer these granulations are of two sorts, the *semicartilaginous* and the *tubercular*. The former, which in the cases inspected were most frequent and most numerous, were distributed equally round the bowel; and though dispersed occasionally through its whole length with intervals of two or three square inches, they were generally largest and most numerous towards the cœcum. They were not seen in the colon. Generally after attaining the size of a pea, the mucous membrane at top became thick, soft, and gave way; and the destructive process thus begun advanced, forming an ulcer with hard, white, opaque edges. The tubercular granulations, which were less frequent, were never seen near the duodenum, and always most numerous near the cœcum, occupied indiscriminately any point of the bowel. They terminated by softening in minute ulcers. It does not appear that the ulcers thus formed are ever cicatrized. †

When cicatrization either of the simple or the tubercular ulcer does not take place, or takes place imperfectly, yet without causing immediate death, it gives rise to the symptoms denominated *lientery* (λειεντερια, slippery bowels); and its natural termination is dropsy, abdominal and general.

By these ulcers the colon is occasionally perforated with the same effects as other parts of the canal. Haller records an instance in which an ulcer of the transverse arch, by gradual absorption, perforated the coats of the stomach; ‡ and Low-

* Observations on the Diseases of the Army in Jamaica, &c. By John Hunter, M. D. F. R. S. &c. Lond. 1784. Chap. 4, Sect. 2. p. 230, 231.

† Recherches Anatomico-Pathologiques sur la Phthisie. Paris, 1825.

‡ Opuscula Patholog.

dell mentions one in which an ulcer of the sigmoid flexure effected an opening into the urinary bladder. *

ζ. *Inflammatory induration.*—Another effect of inflammation common to the gastro-enteric mucous membrane with others, is more or less permanent thickening of its substance, or that of the submucous tissue, inducing contraction of the capacity of the canal. This takes place in the œsophagus, in the cystic and common bile ducts, and in the intestines, small and great. In the œsophagus it constitutes one of the most manageable forms of stricture of that tube, in so far as the swelling, under proper management, occasionally disappears. (Grashuis, Bleuland, Monro, Howship.) Its most usual seat is in the neighbourhood of the cricoid cartilage, and occasionally at the *cardia*. A good example of the former is delineated by Dr Armstrong. In the common biliary duct I have seen this inflammatory thickening give rise to jaundice; and I suspect this, and not spasm of the tube, is the most frequent cause of biliary obstruction. In the ileum this contraction is perhaps less frequent than in the colon. Yet in the case above-mentioned the diameter of the bowel was very much diminished, chiefly by inflammation of the submucous and subserous filamentous tissue; and Dr Charles Combe records an interesting example of thickening of the lower end of the ileum, in which the capacity of the bowel was diminished to the size of a turkey's quill. † In the colon this inflammatory induration is more frequent. It takes place chiefly in the sigmoid flexure, and in the connection with the rectum. Of the former instances are recorded by Haase, Christian Wincker, Laubius, Portal, and Baillie, and delineated by Mr Annesley; and indeed it is no uncommon consequence of tropical dysentery. Of its occurrence in the latter situation Willan records an excellent example; and I may add, that I have seen several cases of it in persons who have returned to this country after severe or long continued dysentery.

η. In some rare instances more or less of the intestinal mucous membrane has become completely dead, and been dis-

* M m Med. Society. † Transact. Coll. Phys. Vol. iv. p. 16.

charged like a foreign body. Of this mode of exfoliation of the mucous membrane of the ileum, occasionally with the muscular and peritoneal tunics, good examples are recorded by Monro second from Cullen, * Mr William Dougall, † Dr T. Sanden, ‡ and Mr John Bower. § Dr Baillie records a case in which a large portion of the colic membrane was voided; || and Mr J. M. Bowman mentions one in which a portion of the colon and cœcum with attached mesocolon are said to have been discharged. ¶

θ. An effect of inflammation of the gastro-enteric membrane, as well as the tracheo-bronchial, is albuminous or sero-albuminous exudation. This was observed by M. Bretonneau in the œsophagus; by Baillie, Andral, Howship, Godman, and Villermé, in the stomach; and by a considerable number of authors in the colon. In all cases the formation of these membranous substances has been preceded and accompanied by marks of inflammatory action. In the cases of M. Bretonneau they were connected with tracheal and œsophageal inflammation.** In that of Howship it was the consequence of swallowing boiling water;†† in the cases of Andral it occurred in connection with fever; ‡‡ and in those of Godman §§ and Villermé |||| it was connected with chronic inflammation of the gastric mucous membrane. In the intestinal canal it is invariably the consequence of some degree of inflammatory action.

ι. Febrile Gastro-enteria.—Gastro-enteric inflammation has been considered above chiefly as a primary and idiopathic disorder. It is, however, not unfrequently observed as a concurrent symptom or effect of many disorders reputed pri-

* Essays, Physical and Literary, Vol. ii. p. 395.
† Medical Comment. Vol. ix. p. 278.
‡ Annals of Med. Vol. vi. p. 296. § Ib. Vol. vii. p. 346.
|| Transactions of a Society, &c. Vol. ii. p. 144.
¶ Med. and Surg. Journal, Vol. ix. p. 492.
** Des Phlegmasies des Membranes Muqueuses.
†† Practical Remarks on Indigestion, &c. London, 1825.
‡‡ Clinique Medicale, &c. Paris, 1823.
§§ The Philadelphia Journal. 1825.
|||| Archives Generales, tome xiv. 1827. P. 614.

marily febrile. This was observed long ago in ague and remittent fevers by Baglivi, Sarcone, Roederer, and Wagler, Stoll, Selle, and others, and more recently by Pinel, Broussais, Petit, and Serres, Andral, Bretonneau, and Trousseau. In continued fever it has also been seen by Andral, Bretonneau, and Trousseau, and by Cheyne, Reid, O'Brien, and Dr Bright in this country. From the facts collected by these observers it results, that the action of fever has a peculiar tendency to affect the mucous surfaces in general, and especially the tracheo-bronchial and gastro-enteric membranes. In the former it may produce the anatomical characters of unequivocal bronchial inflammation, proceeding not unfrequently to the first stage of peripneumony. Of the latter it affects more or less intensely different regions. In some it affects the gastric, in others the duodenal, in others the ileal, and in a few the colic mucous membrane. In most instances the membrane is reddened and vascular, thickened, and occasionally softened. (Andral.) In many it assumes the form of red or brown patches, with or without ulceration. In many the mucous membrane is occupied by white conical elevations half a line or a line high, as broad as a lentil at base, but with depressed summits like the pustules of small pox. These are rare in the jejunum and colon, but are frequent in the two lower fifths of the ileum. (Andral.) In the colon this punctuate inflammation appears in the form of broad conical bodies, elevated, with pointed tops, of a cherry-red colour, and injection of the surrounding membrane. In a large proportion of cases, according to Bretonneau and Trousseau, the mucous follicles are enlarged, reddened, softened, and not unfrequently the seat of ulcers. Upon this statement, however, some doubt is thrown by Andral, who maintains, that, though these bodies are highly vascular, and pour forth an augmented secretion when the mucous membrane is inflamed, yet their affording the commencement of intestinal ulcers is not an invariable circumstance. Though the frequency of ulceration of the lower extremity of the ileum is proportional to the number of follicles, ulceration is exceedingly rare in the duodenum, in which they are more numerous, larger, and

more apparent than in any other part of the gastro-enteric membrane. From the recent observations of Dr Bright, nevertheless, no doubt can be entertained of the fact, that inflammation and sloughing of the mucous follicles is a frequent cause of ulcers.

The comparative frequency of ulcers in different regions of the gastro-enteric surface during fever may be understood from the following table, in which Andral gives the result of 71 necroscopic inspections.

	Cases.		Cases.
Ulcers of the Stomach in	10	Cœcum,	15
Duodenum,	1	Ascending colon,	4
Jejunum,	9	Transverse arch,	11
Lower part of the ileum,	38	Descending colon,	3
		Rectum, -	1

According to this statement, which is on the whole accurate, ulcers are most frequent in the lower end of the ileum, nearly in the proportion of one-half of the cases, next to this in the cœcum in about one-fifth of the cases, then in the transverse arch, in the stomach, and in the jejunum. In the ascending and descending colon, they are not very common, and in the duodenum and rectum extremely rare. Their progress and effects are the same as when taking place idiopathically.

In some instances of fever, Andral remarked that portions of the intestinal mucous corion appeared to be suddenly struck by mortification, forming a species of mucous carbuncle *(anthracion,)* and like that requiring to be thrown off by a long process of ulceration. The eschars thus discharged left ulcers extensive and irregular.

Variolous inflammation.—It has been an opinion not uncommon, that the variolous poison produces in the mucous surfaces, and especially along the tract of the gastro-enteric mucous membrane pustules, similar to those of the skin ; and sundry instances of *papillæ,* pustules, and similar bodies in the stomach or intestines, recorded by Lieutaud, have been supposed to give countenance to this idea. Upon this point,

however, facts are something discordant. 1. In Mr Heaviside's museum is a preparation demonstrating the appearance of numerous genuine pustules of the mucous membrane of the pharynx, and half way down the œsophagus.* In one subject, in like manner, Wrisberg counted 14 distinct pustules on the palatine arch, on the posterior and inferior part of the *velum* more than 12, and many in the neighbourhood of the *epiglottis*, and in the upper part of the pharynx, but observed general redness only in the rest of the œsophagus. In another subject he observed on the mucous surface of the larynx and trachea, a crop of singular warty eminences, varying in size from a lentil to a grain of hemp seed, round or oblong in shape. These bodies Wrisberg states he took care to distinguish from inflamed mucous follicles.† Sir Gilbert Blane, to the same effect, records an instance of fatal confluent small-pox, in which the whole mucous surface of the œsophagus, stomach, duodenum, and intestines, to the rectum, was found beset with small round ulcerated spots. These were most crowded in the duodenum, and in the colon. They were dark-coloured in the centre like cutaneous pustules. In the same subject, the mucous membrane of the *trachea* and *bronchia* was occupied with similar ulcerated spots.‡ 2. Notwithstanding these facts, however, which are accurately stated, it is not absolutely certain that genuine *phlyctidia* have even been seen in the stomach or intestinal membrane. The papillæ and pustule-like eruptions which are supposed by some to be of this nature are evidently enlargements of the mucous follicles. 3. The variolous poison certainly produces inflammation of the gastro-enteric mucous membrane; but this consists in diffuse redness and injection, or red-brown patches, or both, generally with some affection of the mucous

* Howship, Observations, p. 253.

† Henrici Augusti Wrisbergii, D. M. &c. Commentationum, Medici, Physiolog. &c. Argumenti. Vol. i. Gottingæ, 1800. P. 52, &c.

‡ Some Facts and Observations, &c. by Gilbert Blane, M. D. Transactions of a Society, Vol. iii. p. 425.

follicles.* In one or two instances of fatal confluent small-pox, I have seen the gastric mucous membrane deep-red, much loaded with vessels, and patches of extravasated blood, and similar appearances with bloody mucus in various parts of the ileum. In the same subjects, the tracheo-bronchial membrane was of a deep-brown colour, and highly vascular. These phenomena explain the severity and fatality of this disease.

d. The genito-urinary mucous membrane in both sexes is the seat of sundry forms of the inflammatory process.

α. The urethral membrane, though forming a part of this surface, possesses, nevertheless, certain anatomical and sensible peculiarities. Smooth, and even polished, moistened by a thin transparent fluid, it is formed into the sinuosities named *lacunæ*, which, like the follicles of other membranes, secrete a fluid of a peculiar odour, which, united with that of the general membrane, serves to lubricate the surface. Examined from its opening to its cystic extremity, it presents divisions which may be enumerated in the following order, the spongy, the bulbous, the membranous, and the prostatic or vesical portions, according to the parts of the canal to which the membrane is attached. This membrane may be the seat of inflammation of two sorts;—one circumscribed and unsuppurative, the other spreading, and accompanied with secretion of puriform or purulent matter, more or less abundant.

Urethria simplex.—Common inflammation of the urethra consists in redness, swelling, and pain of a certain part of the canal, which thus is rendered very narrow, or even may undergo temporary and partial obliteration. This affection is attended with painful tension of part or the whole of the

* "The pharynx and œsophagus were certainly much inflamed, as was the stomach, and more or less the whole of the intestines; but after the most diligent search, no trace whatever of the pustular action was found either in the pharynx, œsophagus, stomach, or intestines." Howship, Observations. See also *Cotunnii syntagma*, &c. xliii. xlix.

penis, suppression of urine, sometimes priapism, and constitutional disturbance proceeding at once from local irritation, and the distress occasioned by difficulty of voiding the urine, or by its total suppression. This form of urethral inflammation should be distinguished from stricture, with which it is too often confounded. Instead of spreading along the membrane, it has a tendency to pass to the submucous tissue, and thicken it. It is probable that it may occur in any part of the canal; but its most ordinary site is the membranous portion. If properly treated, it terminates in resolution with a gleety discharge, in effusion of lymph or suppuration, not unfrequently with fistulous openings.

Urethria puriformis; Gonorrhœa; Medorrhœa.—That the fluid of gonorrhœa is of inflammatory origin is proved by the swelling of the urethral orifice, the pain and tenderness of the canal, and the sore or scalding sensation *(ardor urinæ)* occasioned by the transit of the urine over it. At an early period of the art, when pathological knowledge was defective or erroneous, this discharge from the urethra was believed to consist of seminal fluid, and to issue from the organs by which that fluid is secreted. Afterwards, when medical practitioners understood the nature of the discharge as distinct from seminal fluid, it was believed to be purulent matter issuing from ulcers in the canal. This opinion, which indeed was more rational, was nevertheless completely disproved, first by Morgagni, * and afterwards by John Hunter, † who showed by dissection of persons whose death had occurred while they were labouring under urethral discharge, that though minute ulcers may occasionally be found in the canal, they are totally unconnected with the discharge, which in the greater number of cases is secreted by the urethral membrane in a state of inflammation. According to the most accurate observations several regions of the urethral mucous membrane may without ulceration or erosion furnish puriform secretion.

* Adversaria Anatom. Epistola xliv. 1, 2.

† Treatise on the Venereal Disease, Part ii. Chap. 1.

The first of these is the hollow named navicular *fossa*, about 1, 1½, or 2 inches from the orifice, or the anterior end of the spongy portion of the membrane. This region abounds with the *canaliculi*, to which Morgagni traced the secretion; and in the dissections of John Hunter it was uniformly found redder, and more vascular or blood-shot than usual, and the *lacunæ* often filled with matter. *Secondly*, in cases in which the inflammation is more extensive, the membranous part of the canal, Cowper's glands and their ducts, are involved in the morbid process. This, however, is exceedingly rare, according to Littre, Morgagni, and Baillie. The first, after inspecting forty cases of urethral inflammation, found in one case only the glands of Cowper morbid. Morgagni met with one or two instances only; and John Hunter remarks, that if the matter of clap were secreted and deposited either beyond or in the bulb, it would be incessantly ejected by the muscles, as occurs in regard to the urine and seminal fluid. In cases yet more extensive, the prostatic part of the urethra has been known to be inflamed; and in very violent forms of clap, the inflammation has been found to extend to the bladder itself. It thus appears that no portion of the canal, from its orifice to the neck of the bladder, is exempt from inflammation; and every part of the membrane between these two points has been found more or less reddened, slightly villous, vascular, and more or less swelled, so as to diminish sensibly the calibre of the canal. It is observed by Dr Baillie, that the inflammation may pass from the mucous to the submucous membrane, and the surrounding tissue of the spongy body, which thus becomes larger and harder, in consequence of loaded vessels and effused lymph, than in the natural state. It is not improbable that this morbid state of the spongy body, by irritating the *ischio-cavernosi* muscles, and exciting them to action, gives rise to the painful affection denominated *chordée*.

The glands of Cowper have been seen indurated and like tubercles, in consequence of inflammation; occasionally their

ducts are rendered impervious, and in some instances ulcers take place. And in some instances the effect of this process is to obliterate both the longitudinal folds and the *canaliculi* of Morgagni. Ulceration, to which Morgagni himself had recourse, is not requisite to explain this occurrence, which may be affected by inflammatory thickening of their membrane. When the inflammation terminates in effusion of lymph into the submucous tissue, the swelling induces that contraction of the canal which constitutes stricture.

β. Cystidia. Cystirrhœa.—The cystic mucous membrane, like the urethral, is liable to inflammation either over its whole extent or at a single spot. The part most frequently affected is the neck of the bladder and the space termed cystic triangle (*la trigone vesicale*); a circumstance which has been ascribed to one of two causes. The first is, that the neck is most usually affected by mechanical obstructions to the passage of the urine, and is therefore most likely to be the first seat of the irritation which connects injury and inflammatory action. The other is, that its contiguity to the urethra renders it liable to be first affected by inflammation of that canal when disposed to spread, or when, in consequence of bad treatment, chronicity or other causes, urethral becomes an exciting cause of cystic inflammation.

From either of these causes, inflammation may be developed in the cystic mucous surface near the neck of the bladder, and may thence be propagated over a considerable extent of the membrane, which then becomes marked by red points, villous, highly vascular, and diffusely swelled, with occasional spots of extravasated blood. In general, the character of this inflammation is to spread; and in ordinary cases it does so without affecting the submucous or other tissues. Instances, however, occur in which it passes successively to the submucous filamentous tissue, to the muscular, and thence to the peritoneal coat. In the spreading form the inflammation is attended with secretion of thick mucous or puriform fluid, which falls to the bottom of the urine.

It may terminate in resolution, in suppuration, in destruc-

tion of the coats or ulceration; or lastly, it may pass into the chronic state. The manner in which the two first terminations are effected is in every respect similar to these processes, as they take place in other mucous surfaces.

The third, or ulceration of the mucous and other tissues of the bladder, is not uncommon, and may occur under two forms. In the first, which is most common, it may be superficial, and remove the whole mucous membrane so as to expose the muscular layer as if it had been neatly dissected. In the second, which is more usual, the ulcerative process advances in minute patches from the mucous to the submucous and muscular tissues, and in some instances to the subserous and peritoneal membrane. This process differs from the other in this respect, that lymph is irregularly deposited, that there is considerable swelling, and sometimes a true abcess is formed. More frequently, however, small portions of the mucous membrane are detached in isolated points by ulceration; and though the subjacent tissues are exposed, there is no regular cavity or abscess, but merely an ulcerated depression, which secretes purulent matter. (Walter.) In more severe cases, in which the suppurative or ulcerative process penetrates the different coats, communications are formed between the bladder and the neighbouring parts. The most ordinary of these modes of communication are the general peritoneal cavities, or the rectum, in both sexes, and the vagina in the female. In the first case, besides other symptoms, the urine gives rise to fatal peritoneal inflammation; in the second and third, its escape by unnatural passages induces much local irritation and general distress, and eventually may terminate in death. Sloughing of the cystic mucous membrane has been known to occur, but is not common.

Cystidia Diuturna. The termination of *cystidia* in the chronic form is most frequent in those who have laboured under repeated attacks of acute cystic inflammation; those who have had urethral or prostatic inflammation, or other disease of these parts; those having urethral stricture; those liable to sabulous or lithic concretions, or wherever there is

a permanent cause of irritation. It is hence common in persons whose health is impaired, or who are advanced in life. The cystic membrane becomes not only reddish but brown, villous, flocculent, and considerably thickened. In some instances it becomes granular and unusually hard. This change was repeatedly seen by Hoffmann, Morgagni,* Lieutaud, Portal, and others; and it is important to remark, that it never continues long without causing inordinate thickening of the muscular layer, and occasionally irregular contraction of its constituent fibres, so as to form *sacculi*, or cavities on the organ. In most instances it secretes puriform mucus, (Hoffmann, Chopart,) but without destruction of the mucous membrane. The former author relates an instance in which the usual effects took place, while upon inspection the cystic tissues were found thickened and condensed, and the vessels of the mucous membrane large, numerous, and loaded, yet without trace of ulceration. This disorder is said to have been the cause of death to Voltaire, Buffon, D'Alembert, and Spallanzani.† On the other hand, the mucous membrane may be entirely removed as in the acute form, by a process of ulceration or sloughing. In the case of Professor Barthez of Montpellier, recorded by M. Double,‡ the cavity of the organ, which contained a mulberry calculus nine lines in diameter, was diminished and filled with purulent matter; its walls were black and sphacelated; of mucous membrane not a trace was left; and the muscular coat was thickened. § From a similar action results the villous, fungating, and granular state of the bladder observed by Ruysch, Walter, Baillie, and others. ||

The effects of this process is to alter considerably the ordinary secretion of the cystic mucous membrane. The cystic mucus in the healthy state is a thin fluid, easily miscible with the urine, and so trifling in quantity, at least in the

* Epist xlii.

† Brera Storia della Malattia di P. Spallanzani.

‡ Hist. Anatom. Med. Obs. 1224, 1266, 1270, 1272, 1274.

§ Journal General de Medecine. Nov. 1806.

|| F. A. Walter, Einige Krankheiten der Nieren und Harnblase untersucht u. s. w. Berlin, 1800. P. 31.

urine discharged, that it is rarely observed. What is called *cloudy* urine, generally contains a little more of this mucous matter than usual. In the inflamed state it appears in the form of thick, opaque, viscid fluid, which falls to the bottom of the vessel, and in very severe cases it is puriform, or purulent fluid, opaque and milky, but not ropy, and is occasionally reddish or streaked with blood. To account for the origin of this morbid secretion, Fanton conceived that follicles or mucous glands of the cystic membrane became inflamed, and increased their natural action.* The existence of such bodies in this membrane is nevertheless questionable; and it is unnecessary to look for any other tissue save the mucous surface to explain the origin of the discharge. The other effects of this disease are weight, uneasiness, and sometimes tension in the hypogastric region; heat in voiding the urine; uneasy parched condition of the skin of the legs and feet, with burning of the soles; thirst, quick pulse, impaired appetite, and general wasting. The constitutional disturbance and wasting generally prove fatal directly, or by inducing some fatal disease.

Membranous substances have been observed to be discharged from the bladder by Willis, Ruysch, Boerhaave, and Morgagni. According to the account of the inspections, these are stated to be portions of the mucous membrane of the bladder. Though I feel difficulty in denying the testimony of observers so competent, I feel equal difficulty in admitting this exfoliation, which indeed is analogous to the exfoliations of the intestinal mucous membrane. It is equally possible, and not altogether improbable, that these membranous substances were albuminous concretions from the inflamed cystic membrane.

γ. The utero-vaginal mucous membrane of the female is not less important as a seat of morbid action.

The labio-vaginal mucous membrane is often the seat of gonorrhœal inflammation, which seems to produce in it much the same effects as in the male urethra. In severe cases the *nymphæ* swell so much that they make, with the external *la-*

* Dissert. Anatom. 1745.

bia, one shapeless mass. The vaginal membrane I have seen the seat of a thick yellow puriform discharge, which was positively asserted to be unconnected with gonorrhœal infection. This, however, requires further confirmation. In all cases the membrane becomes so much swelled that the *rugæ* are to a certain extent obliterated. The *lacunæ* are stated to be the chief source of the discharge when thick and puriform.

The uterine mucous membrane is liable to various forms of the inflammatory process, most of which, however, may be referred to three heads,—the spreading sero-mucous or puriform, the limited or suppurative, and the albuminous.

Of the spreading inflammation there are two varieties, one with transparent mucous discharge, the other with opaque or white mucous discharge.

In the first case, in which a transparent, gelatinous, hard coagulable fluid issues from the vagina, the uterine mucous membrane is in a state of chronic congestion, and the organ itself becomes slightly enlarged. This discharge, which issues from the mucous surface of the womb, and, according to Leake, from the same vessels which are subservient to menstruation, constitutes a large proportion of the cases regarded as *fluor albus*. It takes place as a symptom of prolapse of the womb, bladder, or vagina, of inversion of the womb, of cancer, polypus, and even warty growths of the organ.*

In the second form, though the disease may affect the mucous surface in general, its more particular seat is the cervix of the womb and its mucous glands. It was observed originally by Morgagni,† and afterwards by Leake, that in certain forms of *fluor albus* incident to young females of 8 or 10 years old, the discharge proceeds from the mucous glands of the womb. By observing pain and tenderness uniformly in this part, Mr C. M. Clarke confirms the accuracy of this observation. It causes an opaque perfectly white fluid, resembling a mixture of starch and water made in the cold, or thin

* Observations on those Diseases of Females which are attended by Discharges, &c. &c. by Charles Mansfield Clarke. Part i. Lond. 1814, and Part. ii. Lond. 1821.

† Epist. xlvii. 14, 15, 18.

cream, easily washed from the finger, and diffusible in water, which it renders turbid, sometimes tenacious, like melted glue, to issue from the vagina.

3. When the mucous membrane of the womb or vagina is inflamed, it may secrete puriform or purulent fluid, which is not unfrequently retained within the cavity of the organ. Collections of purulent matter in the former have been recorded by Lieutaud, * Portal, † Dr Clarke, ‡ and others. Of these collections the peculiarity is that they are not discharged as they are formed,—a circumstance which is in general to be ascribed to obstruction of the uterine orifice by lymph. This, it is to be remarked, is accidental, and does not establish an essential or specific difference between such purulent collections and those discharges which take place from the orifice of the organ. It is nevertheless to be remarked, that these collections partake in a more conspicuous degree of the characters of genuine active inflammation of the uterine mucous surface.

Puriform inflammation of the utero-vaginal mucous membrane is to be distinguished from abscess of the *labia*, or *nymphæ*, from suppuration of the submucous vaginal tissue, which I have seen take place under circumstances that might lead them to be confounded with each other, from gonorrhœal inflammation, from corroding ulcer of the mouth of the womb, and from cancer of the womb or of the rectum.

The second general form of uterine mucous inflammation is that in which the product of the process is an albuminous membranous concretion. Morgagni records a good instance of redness of the uterine mucous membrane, part of which was at the same time lined by a preternatural membranous substance. It has been further long known, that many females discharge periodically shreds and portions of membranous matter of various size and shape, and some so large that they form almost complete moulds of the inner uterine surface. These facts, which were observed by William Hunter, Leake, Denman, and Hulme, are well known to accoucheurs

* Hist. Anatom. Med. † Anatomie Medicale, Tom. v. p. 519.

‡ Transactions of a Society, Vol. iii. p. 560.

and those conversant with the management of female disorders. It may be stated as a well established fact, that these membranous productions are analogous to those which I have above shown are secreted by other mucous surfaces; and that their formation is connected with an inflammatory state of the uterine mucous membrane. Independent of the fact, that their formation is attended with pain of the uterine region and disturbed function, in some favourable instances in which inspection has taken place, the transition from fluid to solid state has been traced, and the congested state of the uterine vessels demonstrated. In sundry instances, nevertheless, these membranous productions are formed by that action of the vessels which constitutes menstruation, and they are formed chiefly at the menstrual periods. In all cases, their formation implies a state of the uterus incompatible with impregnation; and sterility is the accompaniment of this disease.

It has been observed by Baillie, that the vagina is liable to a violent form of inflammation, which, by producing effusion of lymph, causes mutual adhesion of the sides of the canal.* By Howship, this is ascribed to excoriation between the *labia* causing at an early age effusion of lymph, so as to resemble *aphthæ;* and he mentions an instance in a child of two months, in which lymph had been secreted, and had become vascular, leaving a minute aperture for the urine at the inferior angle of the vagina.† If these two forms of inflammation be different, the latter is probably of the same nature as that now to be mentioned.

Sloughing inflammation of mucous surfaces.—To this head I refer two varieties of disease met with, particularly at the communication of the two great mucous surfaces with the skin.

The first is the disease originally described by Hoffmann and Van Swieten under the name of *cancrum oris,* the water-canker of Dr Robert Hamilton of Lynn Regis,‡ and more

* Morbid Anatomy, Chap. xxii. p. 415.

† Practical Observations, &c. Chap vi. p. 360.

‡ Apud On the Marsh Remittent Fever, &c. Lond. 1801.

recently by Dr M. Hall,* and Dr Thomas Cuming.† In this disease the mucous membrane of the mouth, cheek, or gums, becomes hot, swelled, of a dark-red colour, and eventually black, hard, and dead. The mortified portion begins then to be thrown off; but in the meantime the original inflammatory process advances; and combined with that necessary for ejecting the sloughs, is accompanied with extreme pain, and much constitutional disturbance. Though this disorder has been thought to originate in the skin, in which it appears when presented to the practitioner, it may always be traced to the mucous membrane of the mouth; a fact which is properly verified by the observation of Dr Cuming.‡

The second variety of this disease is seen in the pudendum of young girls, in whom the labial or vulvular membrane is liable to a species of diffuse inflammation which almost invariably terminates in mortification of the mucous corion, which is then cast in the form of slough. According to the observations of Mr Kinder Wood, to whom we are indebted for the most distinct account of this disorder yet published, the labial mucous membrane becomes of a dark red colour, swelled, and covered by numerous watery vesicles or *aphthæ*, the cuticle of which dropping off discloses deep foul ulcers, surrounded with much redness, and secreting thin offensive matter. Similar aphthæ also appear on the skin of the *mons veneris*, *perinæum*, and adjoining parts.§ Though the disease is often fatal by the severity of the constitutional disorder, in some instances, after the sloughs are cast, effusion of lymph and granulation may take place, and, unless much care is taken in dressing, great part of the vaginal orifice and the labia are united permanently, leaving only a small orifice for the escape of the urine. In this manner the vagina is not unfrequently closed so as to simulate congenital imperforation. It appears from the account of Mr Wood,

* Medical and Surgical Journal, Vol. xv.

† Dublin Hospital Reports, Vol. iv. p. 330.

‡ Ibid. p. 335.

§ History of a very fatal affection of the pudenda of female children, by Kinder Wood, Esq. Med. Chir. Trans. vol. vii. p. 85, &c.

that this inflammation is confined chiefly to the *labia*, the *nymphæ*, the *clitoris*, and *hymen*; and it does not seem to affect the vagina.

2. *Hæmorrhage.*—In the mucous membranes hemorrhage is frequent; and though none of them can be said to be exempt from it, it is most common in the Schneiderian or nasal membrane, in the pulmonic, intestinal, and uterine mucous surfaces. In the hemorrhagic form of land-scurvy (*purpura hæmorrhagica*), with the bloody spots on the outer surface of the corion of simple *purpura*, are combined spots and hemorrhage from almost all the mucous surfaces. Of the hemorrhages of the mucous membranes the following table may be given:—

Nasal passages,	*Epistaxis.*	
Mouth,	*Stomacace.*	
Bronchial membrane,	*Hæmoptysis,*	*Pneumonorrhagia.*
Stomach,	*Hæmatemesis,*	*Gastrorrhagia.*
Ileum and colon,	*Melæna; Dysentery,*	*Enterorrhagia.*
Rectum,	*Hæmorrhois,*	*Proctorrhagia.*
Bladder,	*Hæmaturia.*	*Cystirrhagia.*
Urethra,		*Urethrorrhagia.*
Womb.		*Menorrhagia.*

In these several regions of the mucous surfaces, the pathology of hemorrhage, which has been already partially considered,* is much the same. The discharge of blood or bloody fluid from any of the mucous membranes is not so much a disease of itself as one of the effects of some degree or variety of the inflammatory process. Thus blood is discharged from the bronchial membrane during bronchial inflammation; from the gastric mucous membrane during vascular congestion of the stomach; from the intestinal during the congestion of dysentery; and from that of the rectum during the vascular state attendant on *hemorrhois*. In these circumstances, the blood, whether pure or mingled, as it often is with mucous, muco-purulent or puriform fluid, oozes from the mucous membranes without destruction of tissue, or rupture of vessels, or, in the language of the physiologist, is exhaled. "I have often opened," says Bichat, "persons who

* See p. 207 and 209.

have died during hemorrhage, and have examined the bronchial, gastric, intestinal, and uterine surfaces, yet have not perceived the slightest trace of erosion, notwithstanding the precaution of washing them with care, allowing them to macerate, and afterwards submitting them to examination by means of a lens." * In this manner, therefore, are to be explained those slight hemorrhages which take place in pulmonary catarrh (*hæmoptoe*), about the termination of peripneumony, and in young females after the accidental suppression of the menstrual discharge.

From these the more copious and irresistible hemorrhages from mucous surfaces differ chiefly in a previous serious lesion of the mucous or submucous tissue. This lesion consists in vascular injection more or less extensive of the mucous corion, and injection occasionally very complete, and amounting to extravasation, of the submucous tissue, which is thus rendered red-brown, hard, and void of its natural elasticity. Of the former instances are seen in the gastro-enteric mucous membrane during *hæmatemesis*, *melæna*, and bloody flux; and the latter may be observed in the lungs during *hæmoptysis*, and in the rectum in *hæmorrhois*. These principles are so well established by numerous facts, that it is unnecessary to strengthen them by any elaborate induction. I shall merely adduce the phenomena of a few of the hemorrhagic diseases in illustration of the general doctrine that hemorrhage is an exhalation from parts, the capillaries of which are previously inordinately distended.

The Gastro-enteric Membrane. Hæmatemesis and Melæna. —On the pathology of this disorder, so much misunderstood by the ancients, it is unnecessary to dwell. Correct views were first given by Hoffmann, who, from the fact of finding in dead bodies the mesenteric vessels and those of the ileum much distended with black blood, and the stomach filled with the same, taught that the bloody discharge, whether from the upper or the lower end of the canal, proceeds not immediately from the vessels of the stomach, or from blood extravasated into its cavity, but also from the vessels of the

* Anatomie Generale, tome i. p. 563, 565.

small intestines, especially those of the ileum. * This inference is confirmed by several dissections of Valsalva and Morgagni, † who in hematemesis and intestinal hemorrhage found the gastro-enteric mucous membrane always entire, and its vessels more or less injected.

From an extensive collection of cases, Portal derives conclusions still more distinct. This anatomist shows, 1*st*, that the black matter discharged by vomit and by stool, or by vomiting only, is genuine blood, which is seen to ooze after death from the blood-vessels of the stomach and intestines; 2*d*, that this oozing or transudation takes place from the gastric, duodenal, and mesenteric arterial extremities into the cavity of the stomach or intestines, separately or at once, more frequently into the stomach only, in consequence of certain arterial branches receiving more blood than the corresponding veins return; and, 3*dly*, though compression of the branches of the portal vein may cause this extravasation, the blood is not effused from the *vasa brevia*, in which it flows in an opposite direction. ‡

Similar are the views of Abernethy, who states that in the bodies of several persons who died under attacks of this disease, he found "the villous coat of the alimentary canal *highly inflamed, swollen, and pulpy*. Bloody specks were observed in various parts; and sphacelation had actually taken place in one instance. The liver was healthy in some cases and diseased in others." He concludes, therefore, that the diseases termed *hæmatemesis* and *melæna* arise from "violent disorder, and consequent diseased secretion of the external coat of the bowels; and that the blood discharged does not flow from any single vessel, but from the various points of the diseased surface." § From the same source originates the cocoa-coloured fluid observed by Baillie in fatal cases of *haematemesis*. ||

* Medecinæ Rationalis Systematicæ, pars ii. sect. i. chap. iii. § 17.

† Epist. xxix. 10; xxxi. 23; xxxvi. 11.

‡ Mémoires sur la Nature et le Traitement de Plusieurs Maladies, Par Antoine Portal, Tom. ii. Paris, 1800. P. 108.

§ On the Constitutional Origin and Treatment, &c. p. 30. London, 1811.

|| Lectures and Observations on Medicine.

It may therefore be inferred, that the blood discharged in this disease issues from the loaded capillary vessels of the gastric, duodenal, and ileal mucous membrane without breach of surface; and as it is anatomically impossible to distinguish these vessels into arteries and veins, the dispute whether the blood issues from the one or other order is frivolous. The blood may acquire its dark colour from two causes; 1*st*, admixture with the gastric juice in the stomach and duodenum; and, 2*d*, from the action of the carbonic acid, sulphuretted hydrogen, and other substances of acid properties contained in the intestinal canal.

Hæmoptysis; Pneumonorrhagia; Pulmonary Hemorrhage; Pulmonary Apoplexy.—For the first accurate description of the anatomical characters of pulmonary hemorrhage, we are indebted to the researches of the elaborate Stark, who ascertained the following facts. The air vesicles in some parts of the lungs are filled with blood or bloody serum; the parts do not collapse on opening the chest, but are firm, dark or light red in colour, and can neither be compressed nor distended by the usual inflation. When cut into, thick blood or bloody matter issues from the cut surfaces; and portions of the diseased parts, after being macerated in water, still sink as before maceration. He further showed, by blowing air into the blood-vessels and air-tubes of the sound and diseased portions respectively, that in the latter air passes from the branches of the pulmonary artery and veins into the bronchial tubes; in other words, that the capillary vessels of the lungs communicate freely with the bronchial tubes and air-cells. *

The general accuracy of this description has since been verified by the researches of Laennec, who has indeed rendered the pathological anatomy of this disorder more precise than formerly. From these, it results that a portion of the pulmonic tissue becomes uniformly hard, of a dark red colour, and impermeable to air. The indurated spot is always partial, from one to four cubic inches in extent, cir-

* The Works of the late William Stark, M. D. &c. London, 1788, p. 34

cumscribed with sound or pale-coloured lung, and looks not unlike a clot of venous blood; circumstances by which it is to be distinguished from pneumonic induration, which terminates gradually in sound lung.* These changes, which consist in extreme injection of the pulmonic capillaries, and in effusion of blood into the submucous filamentous tissue, and into the pulmonic vesicles, are confined, however, chiefly to the severe forms of pulmonary hemorrhage. They are the effects of previous injection of the capillaries, which is to be considered as the uniform cause of hemorrhage.

Much the same changes are observed in the rectum and its submucous tissue in hemorrhoidal disease. This is proved by the testimony of Latta,† Benjamin Bell,‡ Callisen,§ Monteggia,|| Delpech,¶ Chaussier, Larroque, and Calvert.** This disorder is to be distinguished from varix of the veins of the bowels.

I conclude this subject with a few remarks on hemorrhage from the uterine mucous membrane in the state of impregnation. It is generally supposed that hemorrhage taking place at this period is the effect of abortion; and Denman and some other authors employ a good deal of not very intelligible argument to prove the proposition. It may, however, be demonstrated, that hemorrhage, or, to speak more to the fact, the anormal state of the uterine capillaries, which leads to hemorrhage, is the *cause* of abortion; and that almost no instance of abortion takes place without previous hemorrhagic distension of the uterine or utero-placental capillaries. By Denman himself it is remarked, that "when abortion is about to happen, there is usually between this (the *decidua reflexa*) and the outer membrane of the *ovum*, an effusion of blood, which often insinuates itself through the

* Traité de l'Auscultation Mediate, &c.

† A Practical System of Surgery, Vol. ii. Chap. iv. p. 34.

‡ A System of Surgery, Vol. vi. 7. Edit. Chap. xxxiv. p. 324.

§ Systema Chirurgiæ Hodierniæ, Vol. ii. Edit. 4to. p. 126.

|| Istituzione Chirurgiche, Vol. viii. Chap. xv. 389.

¶ Precis Elementaire, &c. Tome iiime Sect. viii. chap. 1. § ii. p. 262.

** A Practical Treatise on Hemorrhoids, &c. London, 1824. P. 23, 24.

cellular membrane of the placenta, and between the membranes, giving externally to the whole *ovum* a tumid and unequal appearance, not unlike a lump of coagulated blood, for which it has been frequently mistaken, and then it is popularly called a false conception." * I have had occasion to observe the phenomena of several abortions with some care; and in every one I have traced them to some degree of hemorrhage taking place from the uterine or utero-placental vessels. The blood which Denman remarks is found insinuated through the cellular membrane of the placenta is derived from the vessels of that body. It is not, therefore, the premature effort of the *uterus* to contract that constitutes abortion; but the inordinate distension of its vessels, which terminates in hemorrhage, and the occurrence of which then excites the uterus to premature contraction. The vessels of the uterus and placenta, naturally full of blood, may, from a variety of causes operating on the mother, become unusually distended, and discharge blood as in other hemorrhagic injections. This exudation taking place either at the uterine surface, or in the substance of the placenta, or in both at once, speedily detaches the placenta from the womb; the usual supply of blood is interrupted; and the fœtus perishes in consequence. In this sense only can the remark of Leake be well-founded. "Whatever may be the cause of abortion, the effect is produced by a separation of the after-burden from the womb, and consequently, the child, being deprived of nourishment, must soon perish and be expelled." † The difficulty here refers to the remote causes, which may be different in different cases. The pathological cause is invariably the same.

Febrile gastro-enteric hemorrhage.—That the black or coffee-ground vomit, (*vomito prieto,*) and dark-coloured, tar-like, or molasses-like stools, which take place in bad remittents, malignant agues, and yellow fever, consist in hemorrhage from the gastro-enteric mucous membrane, is established by the researches of Physick, Dr John Hunter, Ban-

* Principles of Midwifery, Vol. ii. p. 280.

† Vol. i. p. 149.

croft, Jackson, and many other authors. In all cases in which subjects dead of these diseases, under these symptoms, have been inspected, the same kind of coffee-ground matter has been found in the stomach and intestines, but without breach of the mucous surface. The matter, however, has been traced almost in its formation, in the circumstance of dark blood oozing insensibly from the capillaries of the mucous membrane. Its colour is necessarily rendered more intense by the fluids of the gastro-enteric surface. This peculiar exudation may be regarded as the result of disorganization of the mucous capillaries, in consequence of previous congestion during the febrile action. Not confined, however, to the gastro-enteric mucous surface, it occurs in the tracheo-bronchial and genito-urinary. It is observed also occasionally in other tissues from the same cause. In short, febrile action either consists in, or is the cause of, capillary disorganization in most of the textures.

The process of hemorrhagic injection, like that of inflammation, may terminate in suppuration, with or without breach of surface, in induration, and thickening, dependent on chronic inflammation.

3. *Inflammatory Stricture.*—To thickening as an effect of the inflammatory process, I have already had frequent occasion to allude. This takes place to a small extent in the mucous corion, and to a much greater degree in the submucous filamentous tissue, in which it depends partly on the increased number of vessels, partly on the effusion of lymph, which causes the mutual cohesion of its component filaments. When this is considerable, and takes place in a membrane lining a canal, it contracts its capacity, and forms what is named stricture; *(constrictio)*; *(arctatio)*. Though this may occur in any part of the mucous system, it is most common in the lacrymal canal, the Eustachian tube, the œsophagus, near its upper or lower extremity, the rectum or lower part of the colon, and in the male urethra. The constriction, in such circumstances, depends not unfrequently on the presence of some remaining degree of inflammation; and if this subside, the constriction may also partially dimi-

nish.* To its entire disappearance, however, the absorption of the effused lymph is essentially necessary; and in all probability this is never completely effected. In the intestinal canal especially, this induration may be so great that the tissue of the tube becomes hard and firm like parchment or cartilage, and at the same time much thicker than natural. The calibre of the canal then becomes so much contracted that nothing passes through it; and life is terminated, partly by inanition and deficient nutrition, partly by irritation. I have already alluded to partial contractions recorded by various authors, from Haase, Wincker, and Laubius to Dr Combe and Willan. The most perfect example of total contraction with which I am acquainted is recorded by M. Tartra in his Essay on Poisoning by Nitric Acid. In an individual who died three months after swallowing this poison, the alimentary canal was reduced to so small volume, that it might have been held in the hollow of the hand. Its coats were shrivelled, crisp, and indurated; and its calibre through its whole length did not exceed that of a common quill. † Under such circumstances, all the intestinal tissues suffer successively and simultaneously the effects of the inflammatory process; and the contraction is augmented by the violent and excessive stimulus which it applies to the muscular layer.

That a similar change takes place in the mucous and submucous tissues of the bladder is shown by the observations of Guarinonius, Bonetus, Camerarius, Targioni, Morgagni,‡ Dr Barry, § Dr Gilchrist, || Desault, ¶ Baillie, ** Fr. Aug. Walter, †† Charles Bell, ‡‡ Forster, §§ and other authors,

* Home. Howship, Practical Observations, p. 254.

† Essai sur l'empoisonnement, &c.

‡ Epist. iv. 13, 19. x. 13. xxii. 4. xxxix. 33. xl. 22. xli. 13. xlii. 20, 33, 34. xliii. 24. xliv. 15. xlviii. 32. xlix. 18.

§ Edinburgh Med. Essays, Vol. i. p. 266.

|| Essays, Physical and Literary, Vol. iii. ¶ Journal de Chirurgie.

** Engravings, &c. 7th Fascicul. pl. 1. fig. 2d.

†† Einige Krankheiten der Nieren und Harnblase u. s. w. p. 31. Tafel. ix.

‡‡ Engravings, &c. §§ Med. Chir. Trans. Vol. i. art. 9.

who found the mucous coat thickened and indurated like cartilage, and the cavity much contracted. It is at the same time generally sacculated.

Another form of inflammatory thickening causing diminished area of mucous canals is that which takes place in chronic enlargement of the mucous glands. The best example of this is observed in the enlargement of the mucous follicles of the cardia, which is no uncommon cause of stricture of the cardiac orifice of the œsophagus. This inflammation is very difficult of resolution, and too often terminates in ulceration of the membrane and the glands.

4. *Adhesion.*—It was asserted by Bichat and others that mucous membrane does not effuse lymph or contract adhesions. The accuracy of this conclusion, which evidently arose from opinions too generalized on the properties of this tissue, the nature of lymph, and the final causes or rather purposes of morbid action, is questionable; and the inference requires limitation. Independent of the well known experiment of John Hunter, who, by the use of a very irritating injection, produced a secretion of coagulable lymph in the vagina of an ass;—I have already shown that each of the mucous surfaces, under certain states and forms of inflammatory action, may effuse a fluid containing a large proportion of albumen, and which, neither in chemical properties nor pathological relations, can be distinguished from the albuminous exudation of serous membranes. The question of adhesion, however, depends not so much upon the fact of albuminous exudation as upon the anatomical disposition of the cavity or canal, whether it be sufficiently small to favour the mutual approximation of opposite and corresponding surfaces. Thus in the gastro-intestinal membrane, which is in general capacious and distended, either incessantly or frequently with foreign bodies, mutual approximation is too imperfect to admit of adhesion. Yet by some observers this is asserted to have happened. In situations, on the contrary, in which mucous surfaces line narrow tubes, as the lacrymal duct, the Eustachian tube, the urethra, and perhaps the Fallopian tubes, obliteration of the canal by adhesion of its sides is

more frequent. It is certain that the surgeon has not unfrequently occasion to observe corresponding points of narrow canals as the urethra adhering apparently by concretion of its sides. * I have even had occasion to advert above to a mode in which the vaginal mucous membrane may contract adhesions, and present the similitude of congenial imperforation. The assertion of Bichat regarding the inaptitude of mucous surfaces to adhere requires, therefore, some limitation. Certain facts lead me to infer, that one of the conditions necessary to the albuminous exudation and the subsequent concretion of mutual surfaces consists in the destruction of the mucous epidermis by abrasion or ulceration.

5. *Polypus.*—Under this name various morbid growths are mentioned by authors. It is represented as a disease peculiar to the mucous tissue, and is generally observed to take place in those regions at which it is not very remote from the skin. It occurs particularly in the nose, throat, Eustachian tube, the external ear-hole, and in the neck of the womb. In the stomach and bladder it is less frequent, and it very rarely occurs in the intestinal tube. It appears under one of three forms.

1. It may take place in the form of a soft ash-gray or bluish production, glistening on the surface, translucent, spongy, and compressible, and attached to the membrane by one or more narrow necks, which render it pendulous. This, which is what is termed by practical authors the *benign polypus,* is proper to the mucous tissue, of which it appears often to be merely a relaxed production or growth. It is much under the influence of atmospheric pressure, increasing in size, and causing much uneasiness while the weather is moist and the mercurial column is low. In clear dry weather, on the contrary, and when the height of the barometer indicates vigorous atmospheric pressure, it shrinks and contracts so much that the patient seems to forget its existence. This form of polypus is frequent in the nasal mucous membrane, in which it causes much uneasiness during its distended

* Smith Ward, Mem. Med. Society, Vol. iii. p. 536. Maclure, Med. and Surg. Journal.

state. It may grow also from the fibro-mucous membrane of the frontal, sphenoidal, and maxillary sinuses.* When removed it presents, with a few blood-vessels, a flocculent tomentose structure, which is well seen by immersion in water, in which it generally floats. It occurs also in the throat; and I removed one of the same description some years ago from the external auditory hole. Ruysch observed them growing in the maxillary sinus, and proceeding through the passage below the spongy bone into the nostril,—a fact which I find verified by an observation of M. Giles.† The same sort of tumour is occasionally found in the vagina; and it is a remarkable proof of the general tendency to the formation of these productions, that in some individuals I have seen them occur at the same time in the nasal and vaginal mucous membrane. The formation of this variety of polypus is ascribed by Morgagni to anormal developement of the mucous glands; ‡ a theory in which he is followed by Plenck. §

2. The name of polypus is also given to a firm fleshy incompressible mass, oval, spheroidal or pyriform, opaque, dark red or purple in colour, sometimes with narrow, sometimes with broad and multifid basis. This form of polypus, which is not influenced by the weather, is observed to occur in the pharyngeal or œsophageal mucous membrane, (Monro); in that of the stomach, (Morgagni, ‖ Monro, ¶ Granville;**) in the intestines, in the colon, and rectum, (Rhodius, Fanton, Portal, Monro.) In the case of M. Paulo, recorded by Portal, two fleshy concretions as large as the fist were voided during life; and after death, which was preceded by hectic and wasting, in the ascending and transverse colon were found four polypous tumours, each as large as a nut, and two smaller ones attached to the mucous membrane. ††

* G. F. Gruner de Polypis in cavo Navium obviis.

† Phil. Trans. No. 226. p. 472. ‡ Epist. xvi. 36.

§ "Causa polypi proxima est papillæ pituitariæ excrescentia seu vegetatio morbosa." Systema Tumorum, Classis iii. p. 173.

‖ Epist. xiv. 17, 18. ¶ Morbid Anatomy, p. 189, pl. vi.

** Med. Rep. Aug. 1817. †† Anatomie Medicale, Tome v. p. 213.

A good example of polypus of the rectum is recorded by Dr Monro *tertius*. * In the bladder they are mentioned by Warner, Baillie, and Walter. Instances of uterine polypus, (*cercosis*, Plenck,) are recorded by Mauriceau, Lamotte, Morgagni, Lieutaud, Levret, Sabatier, Baudelocque, Denman, and Clarke. From these it results, that though polypus occasionally originates from the mucous membrane of the *fundus*, it more frequently grows from the inside of the neck, or from the *os tincæ* itself. Upon the nature or the mode of developement of this variety of polypus nothing satisfactory is known. It appears to consist in deposition of matter entirely new, either in the mucous corion, or in the submucous filamentous tissue. The tumour is almost invariably covered by a thin pellicle similar to mucous membrane, but much more vascular. It appears, on the whole, to be much of the nature of vascular sarcoma occurring in other textures. It is generally vascular, often traversed by varicose veins, is liable to frequent hemorrhage, and occasionally degenerates into destructive ulceration. It ought not, however, to be confounded with cancer.

3. The name of polypus is also given to a broad, sometimes flat, hard tumour, taking place in the nasal mucous membrane, and peculiar apparently to this region. It is generally of a reddish or brown colour, harder even than the fleshy polypus, smooth on the surface, and presenting the appearance of mucous membrane. From several examples of this disease which I have had an opportunity of examining, I infer that it depends on some anormal developement of the fibro-mucous covering of the spongy or nasal bones. It affects not the mucous membrane only, but the subjacent periosteum, and adheres firmly to the bones, fragments of which are not unfrequently rent off in the attempt to extract this polypus. It has a tendency to induce inflammation and caries of the bones, but does not appear to possess much malignant tendency of itself. Upon the whole, this variety, though commonly denominated polypus, is in truth a tumour of the periosteum partaking of the polypous character.

* Morbid Anatomy of the Gullet, p. 192.

6. *Tyromatous* deposition, commonly denominated tubercular, is not uncommon in the mucous tissue. It occurs chiefly in the alimentary canal, and in the uterus in the persons of the strumous. Its characters in the former situation are well described by Dr Monro *tertius.** In the uterus it has been observed by several.

7. *Scirrho-carcinoma* is a frequent organic change in mucous tissue. It occurs under three forms,—fibro-cartilaginous deposition, tubercular deposition, and lardaceous degeneration.

Though it may affect any of the regions of these surfaces, it is more frequent in certain points than in others. Thus it occurs very often in the œsophagus, in the cardia, in the pyloric end of the stomach, in the sigmoid flexure of the colon, in the rectum, and in the uterus, occasionally in the larynx and trachea. In the œsophagus and stomach it has been seen by many observers, among others, by Morgagni, Bleuland, Palletta, Baillie, Chardel, Monro, Howship, Armstrong; in the pylorus it has also been seen by many; (Morgagni, Baillie, Pinel, Holmes, Louis, &c.) and the rectum is perhaps the most frequent seat of scirrho-carcinoma of any of the internal parts. In all these situations the anatomical characters of the disease are much the same. In the mucous corion, or at its attached surface, is formed a deposition of white or gray fibro-cartilaginous substance, the fibrous bands running transversely to the direction of the bowel. This deposition is firm, of ligamentous consistence, and undergoes a self-destroying process in the interior. In general, however, the mucous pellicle forming its free surface undergoes ulceration; or contraction of the canal takes place to such an extent as to interfere with the functions of the organ, and terminate life.

Tubercular induration is another form in which scirrhus may affect the mucous tissue. A portion becomes occupied by irregular nodulated masses, consisting of hard spheroidal bodies not unlike cartilage, sometimes softer like flesh inter-

* Morbid Anatomy, p. 217.

spersed with cartilaginous points. This is observed in the œsophagus (Bonetus, Bleuland, Palletta, Mr David Hay, &c.) in the cardiac and pyloric orifices of the stomach and in the rectum. In the latter it forms many of the examples of scirrho-contraction of that organ. This affection appears to consist in peculiar chronic induration with degeneration of the mucous follicles, in situations abounding in which it most usually occurs. It is observed to attack very often the neck of the uterus. It is totally distinct from the tyromatous deposition of strumous habits, with which it has been occasionally confounded by some observers. The tyromatous deposition occurs chiefly in the young, and has been seen even in infants. Tubercular induration is a disease of middle age and declining years. For some judicious observations on the developement and distinctions of these two varieties of cancer, I refer to the writings of Bayle and Cruveilhier, and a recent work of Scarpa. *

A third form in which cancerous disease attacks the mucous tissues is that of lardaceous degeneration. In certain regions, indeed, this is so rare that it is never seen. For example, though not very frequent in the gastro-enteric mucous membrane, it has been observed in the œsophagus and rectum. It is not known in the tracheo-bronchial membrane. In the uterus, however, it is very common; and I have seen several instances in which the neck and part of the body of this organ was converted into a ceromatous and apparently inorganic mass. The decomposition of this morbid deposition is peculiar. It terminates not in ulceration, but in a species of softening and pulpy disorganization or liquefaction, rendering the decomposing surface doughy or pasty like soft lard, traversed by marks of erosion similar to those produced by the gnawing of animals.

8. *Warty excrescences* are occasionally found in mucous membranes. They consist of hard eminences often fissured, sometimes sessile with broad base, occasionally peduncular, and occasionally pass into bad ulceration. They are most fre-

* Opusculi di Chirurgia di Antonio Scarpa, &c. vol. i. Pavia, 1825.

quent in the pharyngeal and œsophageal, and in the cystic and uterine membrane.

9. *Fungous growths* or excrescences are mentioned as occasionally found in the mucous tissues; but little accurate information is given regarding them. They are frequent in the bladder of the male (Lecat, Sandifort, Baillie, Walter, &c.) and the uterus of the female, but appear to be more rare in other regions. It is probable that these excrescences named fungous, are in truth the products of an advanced stage of some organic change either already noticed or to be noticed. In the uterus, for instance, authors mention the occurrence of reddish tumours not unlike masses of clotted blood, which are manifestly either *molæ, or fungus hæmatodes,* or some of the products of cancerous ulceration. In other instances, as in the bladder, these fungous growths actually issue from the mucous membrane in a morbid state, sometimes the effect of chronic inflammation, or are the result of enlarged prostate. Upon the whole, accurate facts are wanting on this head.

10. Though *hydatids* are enumerated by some authors among the morbid products of mucous surfaces, it is not easy to understand, without violation of certain pathological principles supposed to be well-established, the reason of their developement in these situations. Thus, hydatids have been stated to be coughed up from the lungs, to be voided from the intestines, and to have escaped from the uterus. In the case of the lungs, they are formed originally in the pleura, or pulmonic tissue, from which they find their way to the bronchial membrane; or they may escape from the liver through the diaphragm; (Dr Foart Simmons, Dr Monro.) In the case of the intestines, they are also in all probability formed in the liver or the peritonæum, and thence proceed by ulceration into the intestinal cavity. The uterus, in short, is the only cavity with mucous surface, in which inspection shows that they have been found. * Tyson, nevertheless, states that he found them in the bladder. †

* Morgagni, Epist. xlviii. 13, 14. Portal, Anatomie Medicale, Tome v. p. 527, 528.

† Phil. Trans. No. 188.

11. Deposition of bony matter in certain of the mucous surfaces is mentioned by various authorities. Thus Metzger records an instance of ossification of the œsophagus;* Walter one of bony deposition in the inner surface of the pharynx;† De Haen mentions an osseous degeneration of the stomach;‡ Short § and others mention similar deposits in the colon and rectum; and Hody, || Lettsom, ¶ Baillie, Odier, and Mackie** mention examples of the same occurrence in the uterus. The history of the mode of developement of this deposition is not exactly known; and it is not quite certain whether the ossification originates invariably in the mucous corion. This indeed appears to have taken place in the instance mentioned by Walter, and in such cases of uterine ossification as that recorded by Dr Caldwell. †† In instances of osseous deposition in the alimentary canal, it is justly suspected by Dr Monro then to originate in the muscular fibres.

12. Further, in certain regions of the mucous tissue are found morbid growths which are proper to these regions, and to be found in no other part of the mucous membranes. Thus the milt-like tumour described by Dr Monro has been found chiefly in the stomach and bowels; and the fleshy tubercle of William Hunter and Dr Clark, and the cauliflower excrescence of the latter, are found only in the womb.

The former variety of tumour, for an accurate description of which we are indebted to Dr Monro *tertius*, resembles in structure and consistence the milt of fishes, is of a pale red colour, with an irregular surface, and is covered by a thin but vascular membrane, adheres slightly to the organ from which it grows by a number of small vascular processes penetrating the mucous corion, which is unnaturally thick, and presents a honey-comb appearance. The portion of intestine to which such tumour is attached presents marks of vascular injection. The substance of the tumour, though

* Adversaria Medica, p. 176 and 177.
† Catologi Mus. No. 1536.
‡ Rat. Med. Tom. iv. cap. i.
§ Ed. Med. Essays, Vol. iv. 353.
|| Phil. Trans. No. 440.
¶ Mem. Med. Society, Vol. v.
** Med. and Phys. Journal.
†† Med. and Surg. Journ. Vol. ii. 22.

miscible with water, which it renders turbid, is indurated by immersion in alcohol,—a circumstance from which it may be inferred to contain a proportion of albuminous matter. It emits a fetid offensive smell, and communicates the same to the organ from which it grows. It is chiefly a disease of advanced life,—a circumstance by which, with others, it may be distinguished from hematoid fungus.

The fleshy or sarcoid tubercle of the uterus, though apparently not unknown to Morgagni, was first observed by William Hunter, and has since been distinctly described by Dr John Clarke, Dr Baillie, * and Mr C. M. Clarke.† According to the accounts of these observers, it appears in the form of one or more tumours of hard whitish substance, sometimes as firm as cartilage, projecting from the mucous surface of the organ, but occasionally growing between the peritonæal coat and muscular layer. In size they vary from that of a pea to masses of several pounds; and in shape, though generally spheroidal, they are sometimes irregular. They cause a copious mucous discharge and much local irritation, but without much affecting the constitution.

The cauliflower excrescence was also first accurately described by Dr John Clarke; ‡ and his description has been since verified by his brother Mr C. Mansfield Clarke. From the observations of these authors, it results that the cauliflower excrescence arises always from some part of the *os uteri*. When first recognized it forms an irregular prominence, with a broad base and a granulated surface. As the tumour increases in size, the granulated structure of its surface becomes more distinct, and begins to be parted into numerous elongated granules, which give it the appearance of a cauliflower when it begins to run to seed. In most instances these granules are friable and brittle, and break off, if rudely handled, in the form of minute white fragments; and indeed such fragments are occasionally or periodically

* Morbid Anatomy, chap. xix. p. 374.

† Observations on the Diseases of Females, part i. chap. xviii. p. 243.

‡ Transactions of a Society, Vol. iii. p. 298.

discharged with the urine and other fluids. Its surface, which is of a bright flesh colour, is covered by a thin delicate membrane, from which oozes abundantly a sero-albuminous fluid, which mats the linen like starch, and occasionally blood flows copiously. In married women who have had children its growth is rapid; in those not exposed to sexual intercourse it is slow. The attempts made to inject this growth have been unsuccessful. The injection escapes from its surface rapidly; and it shrinks so much after death, that it is impossible to recognize any thing but a small loose flocculent membranous prolongation of the part to which it is attached. These circumstances, with its hemorrhagic character, lead Mr Clarke to regard it as an assemblage of minute arteries similar to the placental structure. It is probably a variety of erectile tissue. *

13. *Displacements.*—The mucous membranes, partly in consequence of their loose connection in many instances with subjacent tissues, partly in consequence of inordinate action in the muscular fibres of their proper organs, sometimes in consequence of inflammation, are liable to various unnatural changes of situation. Thus the eyelids are liable to eversion, the *rectum*, the *vagina*, and the *uterus* to *prolapsus*, the uterus to inversion, the intestinal canal to invagination and hernial protrusion.

14. Lastly, *Malformations* are frequently observed in the mucous system; but it is often difficult to distinguish between those which are proper, and those which are common to it with collateral and subjacent tissues. Occasionally, for instance, parts of the mucous system in common with the other constituent tissues of an organ are wanting. Thus part of the alimentary canal may be deficient, and the urinary bladder or the rectum has been known to be wanting. In other instances, part of the mucous tissue of one organ may be so incomplete, that a direct communication with another is established. Thus the *velum* may be fissured, and the palate may communicate directly with the nasal pas-

* Observations on those Diseases of Females, &c. Part ii.

sages; the vagina may open into the rectum, the bladder in the hypogastric region, or communicate directly with the rectum; or the urethra may open into the perinæum. The mechanism of malformations of this description is to be explained by the history of the developement of the mucous system during the early months of fœtal existence. The researches of Wolff, Oken, J. F. Meckel, and Tiedemann, show that a slight interruption given to the process of developement at this period, while the cutaneous and mucous surfaces are in direct continuation upon the mesial plane, is sufficient to continue through life a peculiarity of structure, which belongs only to the embryo during formation. The sacs of the *ileum* and bladder, called *diverticula*, appear to depend on deficiency of the muscular layer, in consequence of which the mucous corion is protruded through the defective space. (Morgagni; Palletta.)

In other instances, deviations from the normal arrangement consist in unnatural unions of mucous surfaces, rendering the canals which they line impervious, and constituting varieties of imperforations. Thus the pyloric orifice of the stomach has been found closed,* the rectum imperforate, and the vagina imperforate. These, in all probability, are to be ascribed to deficiency of mucous membrane, in consequence of which the contiguous parts contract adhesion.

In other instances again, malformations are the result of disease. Of this description are the enlarged or distended state of the pulmonic vesicles, produced by several being burst into one large cavity; the central contraction of the stomach; the sacculated state of the urinary bladder; the dilatations of the alimentary canal, in consequence of the lodgement of foreign bodies or concretions; and those of the gall-bladder or gall-ducts, in consequence of the presence of gall-stones. Another variety of the same description of malformation consists in the fistulous openings occasionally effected between the mucous membranes and the cutaneous surface by the process of progressive ulceration. To this head belong the *fistulæ* of the stomach, of which so many

* Case by Mr Crooks, Edin. Med. Chirur. Transactions, Vol. ii. p. 589.

examples are now recorded; the *fistulæ* which result from the ulceration caused by the discharge of gall-stones; artificial anus so frequent after intestinal inflammation, and especially that which attends strangulated hernia; urinary fistulæ, whether taking place from the bladder in the hypogastrium or rectum, or from the urethra; and destruction of the recto-vaginal septum in females, either by laceration or ulceration. These fistulæ are covered by a smooth callous membrane so similar in its properties to mucous texture that John Hunter, Meckel, and some other authors think it not an extravagant or gratuitous hypothesis to regard them as examples of the anormal developement of mucous texture.

CHAPTER XXIII.

Section I.

Serous Membrane, Transparent Membrane;—*Membrana pellucida,—M. serosa;—Tissu Sereux.*

The pleura and peritonæum are the best examples of the tissue, which has been named *serous*, from the fluid with which it is moistened, and which may be termed *transparent* or *diaphanous* as its distinctive character.

The distribution or mechanical arrangement of these membranes is peculiar, and though not well understood by anatomists till Douglas, by his description of the peritonæum, rendered it clearer, may now be said by the labours of Hunter, Carmichael Smyth, and Bichat, to be quite intelligible. In this, nevertheless, there are certain peculiarities which may perplex the beginner, and prevent him from obtaining at first a clear idea

of the distribution and configuration of the pellucid membranes. Thus they have neither beginning nor termination; they have neither orifice nor egredient canal; and they are not continuous with any other membrane or texture.

Every serous membrane consists of a hollow sac everywhere closed, and to the cavity or interior surface of which there is no natural entrance; a circumstance from which they have been denominated *shut sacs, (sacci occlusi; sacs sans ouverture.)* In every serous membrane one part is inverted or inflected, or reflected, as is commonly said, within the other, so that the inner surface of the former part is applied with more or less accuracy to the inner or like surface of the latter. This mode of disposition has suggested to anatomists the homely and trite, but not inappropriate comparison of a serous membrane to a night-cap, one-half of which is folded or doubled within the other, so that while one-half of the inner surface is applied to the remaining half, no communication exists between the inner and the outer surface. Every serous membrane, in short, is a single sac, one-half of which is doubled within the other.

In every serous membrane the outer surface of the unreflected portion is applied over the walls of the region which the serous membrane lines, while the outer surface of the inflected portion is applied over the organ or organs contained in that region. From this arrangement it results that each organ

covered by serous membrane is not contained in that membrane, but is on its exterior surface, and that of every organ so situate one part at least, viz. that at which its vessels and nerves enter, is always uncovered. Thus the lungs are on the outer surface of the *pleura;* the heart is on the outside of the *pericardium;* the stomach, intestines, liver, spleen, and pancreas, are on the outside of the *peritonæum;* and the testicles are on the outside of the *peridydimis.* In the same manner the lungs, though invested by pleura before and behind, at their apex and their base, are uncovered at their roots, or the points where the bronchial tubes and great blood-vessels enter their substance; the heart is uncovered by pericardium at the upper part of the auricular cavities; and the intestinal canal is uncovered along the whole of that longitudinal but tortuous line by which the mesentery is attached, and at which its proper vessels and nerves are transmitted.

To comprehend the arrangement of the pellucid membranes still more distinctly, it is expedient, by an effort of abstraction, to trace the course of any one of them, having previously thrown out of the question the necessary means by which their interior or free surface is exposed. In this mental process also it is requisite to remember that there is no initial point save what is arbitrarily made. If, for example, the course of the *pleura* be traced, the membrane presents no natural mark or boundary from which the anatomist is to commence his demonstration; and he must fix artificially on

any point which he finds most convenient for the purpose. Commencing with this understanding, from the circumference of the spot termed *root* of the lungs, the membrane may be traced first along the internal surface of the chest formed by the ribs and intercostal muscles, forwards to the sternum, upwards to the first rib and *apex* of the thoracic cavity, and downwards to the diaphragmatic insertions, and over the surface of that muscle, and the outer surface of the pericardium again to the circumference of the root or connection of the lungs. From this point again it may be traced over the surface and between the lobes of these organs, both of which, as already stated, are thus situate on the outside of the pleura. The course first described is that of the *unreflected* or *exterior* division of the pleura. The second, or that over the organ covered, is the course of the *inflected* or *doubled* portion of the membrane, which is thus necessarily smaller, and less extensive than the former.

The arrangement thus sketched, which may be easily shown to be applicable to all the serous membranes, demonstrates their twofold character of lining the walls of a cavity and covering the organs contained. From an idea of this property the older anatomists applied to them the epithet of *membranæ succingentes.*

In tracing the course of the serous membranes, the anatomist observes, that they present productions which float with more or less freedom in the cavity formed by the free surface, and which may

be generally shown to consist of two folds of the single membrane produced beyond the inclosed organ, but still maintaining the unity of the membrane. Of these prolongations, the most distinct examples are the *epiploon* and the *appendices epiploicæ* of the peritonæum. Less manifest instances are the adipose folds of the pleura near the mediastinum, and the bladder-like appearance at the base of the heart, within the pericardium. The synovial fringes in the interior of the synovial membranes, which belong to a subsequent head, are nevertheless of the same general character. Between the folds of these productions there is invariably more or less adipose substance, which indeed is observed in some quantity in various parts of the filamentous tissue on the outer surface of the serous membranes in general.

Every serous membrane I have above represented as a hollow sac everywhere continuous, and the outer surface of which has no communication with the inner. To this character the only exception is the peritonæum in the female, which is perforated at two points, corresponding to the upper extremity or orifice of the Fallopian or oviferous tubes. This has been already mentioned as the only spot at which the mucous and serous surfaces communicate directly with each other.

Every serous membrane may be described as consisting of a very thin, colourless, transparent web or pellicle, through which the tissue of the subjacent organ or parts may be easily recognized; and every serous membrane presents two

surfaces, an attached or adherent, and a free or unadherent.

The attached surface, which is also termed its *outer* one, is that by which it is connected to the tissue or organ which it covers; it is somewhat irregular, flocculent or tomentose, and is evidently connected by fine filamentous tissue. The degree of attachment is very variable in different membranes, and in different points of the same membrane. In general serous membranes adhere much less firmly to the walls of cavities than to the surface of the contained organs. Thus the abdominal peritonæum and the costal pleura are more easily removed than the intestinal peritonæum and the pulmonic pleura. The peritonæum adheres feebly to the bladder, to the liver, and to the pancreas, more intimately to the different regions of the intestinal tube, and seems to be almost identified with the substances of the female organs of generation. From the interior of the capsular pericardium and from the vaginal coat it is almost impossible to detach the serous pellicle. The former, however, I shall have occasion to show, is peculiar in having between the serous surface and the fibrous membrane no filamentous tissue, upon the abundance or deficiency of which the degree of adhesion depends.

The free or unadherent surface, which has been also named *inner*, is very smooth or polished and uniform, moistened with a watery fluid, from which it derives in some degree its shining ap-

pearance, and completely destitute of fibres or any other trace of organic structure. From this smooth polished aspect, which is a peculiar attribute of the free surface of serous membrane, all the organs covered by it derive their glistening appearance. Thus the exterior surface of the lungs derives its appearance from the pleura, the heart from the pericardium, the liver and intestinal canal from the peritonæum. A successful injection of size or turpentine, coloured with vermilion, brings into view so many capillary blood-vessels in this membrane, that it might be supposed at first sight to consist entirely of minute arteries and veins. Farther, by proper management, lymphatics may be injected in it with quicksilver to a degree equally minute and delicate. From these experiments, therefore, it may be concluded, that serous membrane is chiefly composed of minute arteries and veins conveying colourless fluids, and of vessels connected with the general trunks of the lymphatic system. Whether it contain anything else but vessels of this kind, or has a proper substance or tissue, remains to be ascertained. Though nerves are often seen passing along their outer or attached surface to the neighbouring tissues, none have hitherto been traced either into the pleura or peritonæum.

By most of the older anatomists, and among others by Haller, serous membrane is considered as of the nature of filamentous tissue or cellular membrane, more or less closely condensed, (*tela cellulosa*

stipata ;) * and this view is adopted and maintained by Bordeu, † Bichat, ‡ Meckel, § and Beclard, || the last of whom, however, thinks they partake of ligamentous characters. Macerated they become soft, thick, and pulpy ; and are finally resolved into flocculent filamentous matter. In the course of decomposition in the dead subject they first lose their glistening aspect, then become covered by a foul dirty coating of viscid matter, which appears to exude from their surface ; and eventually they are dissolved into shreds. Immersion in boiling water renders them thick, firm, and somewhat crisp. When dried they become thin, clear, and transparent, and, if preserved from humidity or the attacks of animals, may remain long unchanged. The experiments of Hatchett, Fourcroy, and Vauquelin, show that they contain gelatin and a little albumen ; but no precise information on their chemical composition has yet been given.

The principal character of the serous membranes is that of isolating the organs which they cover, and to the structure of which they are foreign or adventitious, and forming shut cavities, in which there is an incessant process of exhalation and absorption. In some instances they evidently contribute to facilitate the mutual motions

* Elem. Physiolog. Lib. iv. sect. i. § i. xvi. Lib. xxii.

† Recherches sur le Tissu Muqueux, sect. i. § i.

‡ Anat. Generale, Tome iv. p. 573. § Handbuch, B. i.

|| Elemens d'Anat. Gen. p. 228.

of contiguous and corresponding parts and surfaces. From their free surfaces is secreted a fluid containing a very small portion of albumen, (Hewson, * Bostock, †) which is greatly augmented during the state of disease.

The mode of developement of the pellucid membranes is not very well ascertained. The investigations regarding organogenesy by Oken, Meckel, and Tiedemann, to which I have occasion so frequently to allude, disclose facts which induce Meckel to hazard the opinion that some of them are not at all times shut sacs. I have some reason to doubt, however, whether the fact which he adduces for this purpose necessarily implies the open condition of the pericardium and the peritonæum. In the case of the former the developement of the heart proceeds from the basis generally, without affecting the integrity of the investing membrane. In the case of the latter there is more reason to believe, that at the navel at least the peritonæum is either open, or is continuous with the vitellar membrane.

In the fœtus the serous membranes are so thin, that they are much more transparent than in the adult. In small animals also, they are more transparent than in large, and in cold-blooded animals than in the mammiferous. Of some also the disposition varies at different periods. Thus the descent of

* Experimental Inquiries, ii. chap. vii.

† Nicholson's Journal, Vol. xiv. p. 147, and Medico-Chirurg. Tr. Vol. iv.

the testicle,—a process which has been so well explained by Albinus, Haller, Wrisberg, and Langenbeck, is necessarily attended with a remarkable change in the arrangement of that portion of peritonæum which the gland impels before it.

The above description applies chiefly to the general characters and properties of serous membranes. I have yet, however, to advert to certain forms of this tissue, which, though similar in general characters, present too many peculiarities to be justly identified with them. The first which I notice as least different is the *pericardium*, or capsule of the heart; the second is the arachnoid membrane, which shall be examined with the cerebral envelopes.

The capsule of the heart *(pericardium)* consists of two portions or layers, an outer or proper capsular, and an inner or lining division. The outer or proper capsular part of the pericardium possesses the characters of a fibrous membrane, of some density and considerable strength. When properly washed, its colour is gray or grayish-white, and it appears to consist of very minute fibrous threads, which are arranged without any definite order. These fibres are most distinct at its lower margin, where it is connected to the circumference of the tendinous part of the diaphragm. In the young subject it is generally thin and translucent; in adult age or advanced life it is thicker and more opaque. This part of the pericardium is a mere investing membrane, which bounds

the region containing the heart, but which extends no further. It embraces the origins of the large vessels above, adheres to the margins of the tendinous centre below, and is on each side connected with the pleura.

When the pericardium is slit open, its inner surface has the appearance of a transparent or serous membrane, through which the fibres of the outer or capsular part may be seen, and which has the usual glistening aspect of such membranes. It is difficult, however, to insulate it from the outer layer, unless by boiling, when it may be peeled off in minute shreds.

Like the transparent membranes, this inner layer has neither beginning nor end, neither origin nor termination. After lining the inner surface of the proper capsule, it may be traced from the angle at which this capsule adheres to the large arteries and veins, over the auricles, and finally, over the outer surface of the ventricles to the apex of the heart.

In this whole course, it preserves the characters of a thin transparent membrane, with a free surface and an attached one. The free surface is perfectly smooth, glistening, and moistened with a watery fluid. The attached surface adheres, on the one hand, to the inner surface of the capsule, and on the other, to the outer surface of the heart, by means of fine filamentous tissue.

Injection shows that the pericardium consists chiefly of minute arteries and veins. The sub-

stance of the capsular part is probably a modification of the white fibrous system; but it requires to be more carefully examined. No nerves have been traced into any part of this membrane, nor is it quite certain that it contains lymphatics.

The cerebral membranes are not uniform in nature, and cannot be conveniently referred to any head save that of compound membranes. The *dura mater* is fibrous; the *pia mater* is supposed to be celluloso-vascular; and Bichat has laboured to demonstrate that the arachnoid is a serous membrane,—a view which is adopted by Meckel and Beclard, but rejected by Gordon. By configuration and disposition, I believe it is more easily referable to this than to any other class; and I therefore introduce its anatomical history in this place.

The brain has been said to be surrounded by three membranous envelopes, the hard membrane (*meninx dura, dura mater*), the web-like membrane (*tunica arachnoidea*), and the soft or thin membrane, (*meninx tenuis, pia mater.*) There is perhaps no great or just objection to this arrangement, which has been adopted by almost all writers. But it simplifies the subject, without impairing the truth of what is observed, to refer them to two only; one of which, the hard membrane (*meninx dura,* μηνιγξ σκληρη, *dura mater*), is common to the brain with the inner surface of the scull; the other, the thin membrane (*meninx tenuis,* μηνιγξ λεπτη, *pia mater*), is proper to the brain only. They may be

distinguished, therefore, by the terms *common membrane of the brain* and *proper membrane of the brain*. The arachnoid, again, is a pellucid web common to the two cerebral membranes.

The first of these, the common or hard cerebral membrane (*meninx dura*, *dura mater*), presents two surfaces, an outer or cranial, and an inner or cerebral. The outer surface is irregular, filamentous, and vascular; and the substance of which it consists is distinctly fibrous. The fibres, however, do not follow any uniform direction, but are interwoven irregularly. Maceration causes this membrane to swell and become separated into fibrous threads. It is well known that it is liberally supplied with blood-vessels, and that it is connected by these to the inner surface of the scull. No nerves or absorbents have been discovered in it. This outer or cranial surface of the *dura mater* is manifestly of the nature of periosteum. Its vessels may be traced into the inner table; it contributes to the formation of the cranial bones in the fœtus; and various facts show that it contributes to their nutrition during life.

The inner or cerebral surface of this membrane is very smooth, uniformly polished, and shining; and when examined in water, it appears to be formed by a very thin, transparent membrane, through which the cranial or outer surface and the fibrous structure of the hard membrane may easily be recognized. This pellucid inner membrane, which is termed by Baillie the *inner lamina*,

I shall afterwards show is the exterior division of the arachnoid membrane.

The *dura mater* is an extensive membrane, and lines not only the interior surface of the scull, but that of the whole vertebral column. Here indeed it undergoes some modification. The inner surface of each vertebra has a proper periosteum continuous with the periosteum of the outer surface; and from this issues a quantity of filamentous tissue, which penetrates directly a membranous canal, evidently of fibrous structure, (*theca vertebralis*) tough and firm, but more delicate than the cranial *dura mater*. The *dura mater* in its course forms sundry prolongations; for instance, the large crescentic one named the *falx*, the horizontal one termed *tentorium*, and the small crescentic one named *falx minor* or *cerebelli*.

The thin, soft, or immediate and proper cerebral membrane, (*pia mater*, *meninx tenuis*,) presents in like manner two surfaces, a smooth or cranial, which is exterior, a filamentous or cerebral, which is interior and central.

The outer or smooth surface of the thin membrane, (*pia mater*) has a glistening appearance; and if examined attentively, it is found to be formed by a very thin transparent membrane, exactly similar to that which forms the cerebral surface of the *dura mater*. It is possible to recognize through it the subjacent cerebral part of the membrane, its vessels, and the appearance of the brain itself. This surface has been named in the

ordinary works the web-like membrane, *(tunica arachnoidea.)* It is believed to be a separate membrane from the *pia mater*; but that which forms the inner or cerebral surface of the *dura mater*, has a claim equally strong to this distinction.

The inner or cerebral surface of the proper or soft membrane, I have already said, is filamentous, flocculent, and somewhat rough. It indeed presents a surface which sends out many angular processes of animal substance, which is filamentous and loose in appearance, and which evidently, by numerous minute vessels, arteries, and veins, communicates with the convoluted surface of the brain. These processes, which are the *Tomenta* of the ancient anatomists, correspond to the furrows of the convoluted surface in which they are lodged. In detaching the membrane from this part of the brain, numerous vessels are observed to be drawn out of its substance; and when the membrane is injected these vessels may be seen distinctly filled, and communicating with the gray matter of the convoluted surface. The veins of this membrane may be traced to the sinuses in those large longitudinal vessels which are lodged in folds of the hard membrane.

After suitable injection, it is difficult to perceive any thing but arteries and veins in the proper cerebral membrane. Neither nerves nor absorbents have yet been recognized in it. Bichat considers that it contains a notable quantity of cellular tissue. This, however, is denied by

Gordon, who could not recognize such tissue. The difference, however, consists merely in name. The *pia mater*, indeed, possesses no cellular tissue like the subcutaneous, the submucous, or the subserous. If, however, a portion of the arachnoid be peeled from it by careful management of the forceps and blowpipe, there is found a quantity of loose filamentous or flocculent matter, which evidently unites this tissue to the finer web of the former. It is further remarkable that Dr Gordon himself admits that the inner surface (he should have said the outer or attached,) of the arachnoid membrane is more or less *thready* or *flocculent*, according to its connection with the *pia mater*, without seeming to be aware that this thready appearance is occasioned by filamentous tissue. Lastly, the existence of this tissue between the *pia mater* and arachnoid is unequivocally demonstrated by the phenomena of serous infiltration.

The distribution and configuration of the *pia mater* is peculiar; and correct knowledge of these is requisite in order to understand its pathological relations. The *pia mater*, or proper membrane of the brain, consists of two parts, an outer, covering the *convoluted* surface of the brain, and an inner or central, entering the cavities formed by the inner, central, or figurate surface, and spread over this surface in the form of what has been termed the vascular or choroid web; *(plexus choroides; tela choroidea.)* The arrangement of the first or exterior division of the cerebral mem-

brane is well known. Its flocculent-vascular, or tomentose surface, is applied closely and immediately to every part of the convoluted surface, both eminences and depressions *(gyri et sulci)*; to every part of the foliated surface of the cerebellum in like manner; and finally, though in a more delicate form, to the surface of the spinal chord, transmitting those vessels which enter and issue from the substance of each part.

The continuity of the *pia mater* or exterior division of the proper cerebral membrane, with the choroid plexus or interior division, may be demonstrated in the following manner. *First*, the *pia mater* may be traced behind and below the posterior extremity of the mesolobe or middle band, (σωμα τιλλοειδες, *corpus callosum*, der balken,) where it is continuous with the transverse web called *velum interpositum*, and which may be regarded in this order of examination as the first part of the central division. *Secondly*, from this point, the situation of the *velum interpositum*, it may be traced forwards on both sides of the mesial plane into the lateral ventricles, spread over the surface of the optic *thalamus* and striated eminence in the form of the vascular web called choroid *plexus*, the right half of which communicates with the left by means of a similar slip of vascular membrane lying beneath the vault *(fornix)*, and behind the anterior pillars of that body at the spot termed *Foramen Monroianum*. *Thirdly*, it may be traced over the geniculate bodies or posterior

eminences of each thalamus into the posterior-inferior *cornu*, or sinuosity of the lateral ventricle, where it covers the *great hippocampus*. *Fourthly*, it may be traced at the angle between the *cerebellum* and *medulla oblongata*, or what is named the bottom of the fourth ventricle, where it forms a very minute choroid plexus seldom noticed by anatomists, but not less distinct, and which may be traced up the fourth ventricle to be connected with the *velum interpositum* in the middle ventricle, and with the lateral portions of the hippocampus on each side. Each choroid plexus, or, to speak more accurately, each of the divisions of the choroid plexus now enumerated, may be shown to be mutually connected, and to form parts of one general membrane, which again constitutes the inner or central division of the great membrane of which the *pia mater* forms the exterior. Each division of the choroid plexus, in like manner, is connected, by means of minute blood-vessels, to the portion of the figurate cerebral surface on which it rests, and it appears to perform the same function of sustaining vessels as the *pia mater* does to the convoluted surface.

The membranous nature and appearance of the choroid plexus may be demonstrated by immersing it in clear water, when, by a little management of the probe and forceps, it may be spread out exactly like the *pia mater*, which it closely resembles. It presents the appearance of a thin semitransparent web, one surface of which is

smooth, the other somewhat flocculent, and the substance of which appears with and without a glass to be traversed by numerous minute vessels. The transparent web, which forms the basis or ground-work of this membrane, possesses the characters of very close filamentous tissue; and it may be regarded as a filamento-vascular web. Its smooth surface, which is also the free one, is manifestly a continuation of the arachnoid membrane. Like that it is smooth, polished, thin as the finest silver paper, and it may be raised from the more filamento-vascular basis of the membrane to which it adheres.

I am now, by describing the characters and distribution of this membrane, to show how far it resembles, and how far it is unlike, the perfect serous membrane.

The fine inner lamina from which the cerebral surface of the *dura mater* derives its glistening aspect, I have already stated, is to be regarded as the outer or cranial division of the arachnoid membrane. This is to be proved, first, by its anatomical characters, and, secondly, by its distribution and transit.

The inner or free surface of the *dura mater* presents, it has been already said, all the characters of the free surface of the *pia mater*, except one,—the facility with which the thin pellicle, which gives it these characters, can be detached. This, however, is derived from the want of filamentous tissue intermediate between the fibrous

layer of the *dura mater* and the pellucid membrane ; and the latter is thus so intimately united with the former, that it is difficult, if not impossible, by the ordinary means, to detach them. This, however, is no more a reason for regarding this pellucid pellicle as the same as the *dura mater*, than the intimate adhesion of the capsular pericardium to its fibrous coat, or of the peritonæum to the female ovaries, is for regarding the membranes as part of these organs. Immersion in boiling water and maceration produce on this surface of the *dura mater* the same effects as on the free surface of the *pia mater*. Lastly, the phenomena of morbid processes indicate that these surfaces are in all respects similar ; and if the thin pellicle on the free surface of the *pia mater* is entitled to separate existence, that on the free surface of the *dura mater* is equally so.

The continuity of these two divisions, demonstrated by their configuration, affords proofs of the same description. This is most easily accomplished by tracing the *dura mater* from those points at which it adheres to the inner surface of the cranium, to those at which the several nerves issue from that cavity by the cranial holes. If the optic nerves be attentively examined at the spot where they enter the optic *foramina*, the *dura mater*, which covers the bone around these holes, is found to go a very short distance into them, to stop suddenly, and be reflected backwards, in anatomical language, to cover the ner-

vous trunks, and to extend along the *pia mater*. This reflected portion is in truth the arachnoid membrane which lines the *dura mater*, passing from it along the nervous chords to form the free surface of the *pia mater*. In like manner, if the third pair or oculo-muscular, or fifth or tergeminal nerves, be examined at the openings at which they perforate the scull, the *dura mater* is found adhering firmly round their several margins to the bone by its outer or attached surface, while its inner free surface turns back on the nervous chords, and is thence continued over the *pia mater*. In short, the continuity of this thin transparent membrane from the *dura mater* to the *pia mater* may be traced at each of the nervous trunks as they issue from the brain through the cranial apertures.

Another proof of a similar description is derived from examining the free or lower margins of the *falx major* and *minor*, and of the horizontal portion of the *dura mater*, *(tentorium cerebelli)*. First, at the upper or convex margin of the great *falx*, where the veins pass from the *pia mater* to the longitudinal *sinus*, it is not difficult to trace the arachnoid membrane from the *pia mater* along their coats, to that portion of the *dura mater* which forms the sinus, and conversely, from the falx along the veins to the free surface of the *pia mater*. In the second place, the lower, or concave margin of the falx, is connected at the bottom of the middle fissure between the hemispheres to the *pia mater*

on each side by thin transparent filamentous membrane, which is in truth the arachnoid passing from the falciform process of the *dura mater* to the free surface of the *pia mater*, covering the commutual surfaces of the hemispheres; and the same may be seen at the lower margin of the small or cerebellic falciform process. In the third place, at the inner margin of the transverse portion or tentorium, the transparent pellicle of the *dura mater* may be traced passing to the *pia mater* of the brain above, and of the *cerebellum* below. The same arrangement may be demonstrated in the vertebral cavity, in which it further covers the serrated membrane, *(ligamentum denticulatum.)* In short, while the *dura mater* is proper to the inner surface of the scull, and the *pia mater* to the surfaces of the brain, the arachnoid membrane is common to both, and invests not only the free surface of the *pia mater*, as is usually stated, but the inner surface of the *dura mater*.

The arachnoid has a still more extended distribution. After covering the free or inner surface of the *pia mater*, it follows the course of that membrane into the central surface of the brain, and covers the upper or unadherent surface of the several divisions of the choroid plexus. This is demonstrated by the same process by which the continuity of the plexus with the *pia mater* is established.

From the foregoing description it results that the arachnoid membrane possesses in arrange-

ment and distribution a great resemblance to the serous membranes. It differs, nevertheless, in its extreme tenuity, in the closeness with which it adheres to the collateral tissues, and, as will afterwards appear, in its slight disposition to albuminous exudation. It appears to contain in its structure less filamentous tissue than the pure serous membranes.

I have elsewhere, in treating of the developement of the brain, had occasion to speak of the cerebral membranes. The *pia mater* in the twofold form now described exists at an early period of the ovum, before the formation of the brain is commenced. It is then recognized in the form of a very vascular membrane, somewhat confused, but still sufficiently distinct to show, that in the centre of each half, the cerebral matter afterwards to constitute the hemispheres is deposited from the vessels of its central or attached surface. At this period the arachnoid pellicle cannot be distinguished. It is only when a considerable part of each hemisphere is formed that the free surface of the *pia mater* can be shown to be covered by arachnoid membrane. This may be stated in general terms to be between the end of the fifth and the middle of the seventh month. The free surface of the *dura mater* begins to be perceptible about the same time.

The *tunica albuginea* of the testicle may be here mentioned as a membrane composed of fibrous tissue, embracing the gland, and a very thin pel-

lucid layer outside, without intermediate filamentous tissue,—a peculiarity in which it resembles the female ovary.

Section II.

The serous membranes are the seat of a considerable number of morbid processes, which, according as they take place in one membrane or another, give rise to several of those diseases which it is the province of nosology to distinguish and of medicine to treat. Most of these processes may be referred to inflammation or its effects, dropsy, hemorrhage, new growths, and morbid deposits.

1. Inflammation occurs in serous membrane under at least two forms, acute and chronic. The anatomical characters of the process vary according to its acute or chronic character, and according to the physiological peculiarities of the affected membrane. These characters it is perhaps most convenient to examine as they appear in the pleura, pericardium, and peritonæum, in which they assume their most perfect form.

When inflammation commences in a serous or diaphanous membrane, the first change which is observed to take place in it, is diminution or loss of its transparent and glistening appearance. * It becomes opaque, dull, and in some instances dry. This change is very well seen, not only in the pleura, pericardium, and peritonæum, but in the arachnoid membrane, in which it is distinct when other traces of the process cannot be recognized. It is from this circumstance that dulness of the arachnoid denotes, with great certainty, serous effusion in the cerebral cavities.

* "When inflammation," says Hunter, "takes place in parts that have a degree of transparency, that transparency is lessened. This is probably best seen in membranes, such as those membranes which line cavities or cover bodies in those cavities, such as the *pia mater*, where in a natural state we may observe the blood-vessels to be very distinct."—4to. P. 281.

At the same time, red vessels may appear either in isolated spots or over a considerable extent. They are generally arborescent or parted into minute ramifications. Sometimes they consist of minute red lines, radiating from a point like stars; and in other instances they form a confused net-work of red vessels, interspersed with bloody points and spots, amounting occasionally to extravasation. These vessels which, though placed in the substance of the membranes, gradually approach the surface as the process advances, are not newly developed, but appear to be the colourless capillaries of the sound state of the membranes injected with red blood. These changes, which may be regarded as the essence of the first stage of inflammation in serous membranes, are best observed in the pleura, pericardium, and peritonæum. In these they are sometimes so intense and general as to give the membranes a red mottled appearance, and prevent the observer from distinguishing the subjacent tissue.

After existing for some time, varying in different circumstances (from 6 to 20 hours in the *pleura* and *peritonæum*,) these changes are followed by others, which may be regarded as their effects. The first and most important of these is the formation of a new fluid at the free or unadherent surface of the membrane. The nature of this fluid varies according to the stage, and perhaps the kind of inflammation. I shall describe, first, that which takes place in the commencement of the acute form.

The capillary injection of the inflammatory process is scarcely well established when it begins to cause a semitransparent fluid to ooze in small quantity from the affected points of the surface of these membranes. In this state the characters of the fluid can scarcely be determined. In a more advanced stage of the process, when it is abundant, it is a straw-coloured, homogeneous, semitransparent fluid, which, as it is effused, undergoes spontaneous coagulation. This consists in part of the fluid assuming a solid form in the shape of a semifluid jelly-like layer of variable thickness, with a rough honey-comb sur-

face exteriorly, where it is in contact with the membranes, and interiorly, with thready filaments mutually interlacing, and more or less consistent. A thin fluid portion at the same time is found in the interstices of these filaments, and oozes from the surface of the coagulated part. These facts are easily demonstrated by examining the effused matter while still recent, and while the process of coagulation is going on, but not completed. It is then a soft, spongy, translucent matter, of a straw-yellow colour, and pulpy gelatinous consistence. When removed from the membrane its surface is rough and irregular, like honey-comb, and marked by blood spots more or less numerous, which are occasioned by the forcible rupture of the minute vessels of the membrane passing into the new product; while serous fluid trickles from it, and falls to the most dependent part of the cavity. When cut or torn in minute pieces this serous fluid oozes abundantly from the sections; and the observer may then remark the filamentous and cellular disposition of the solid coagulated portions. The filaments varying in size cross each other mutually, so as to form partitions and intermediate cells, but without regular order.

The matter thus effused is what was named by Hunter *coagulating or coagulable lymph,* in consequence of its property of spontaneous coagulation. It is often mentioned among some of the older anatomists as masses of liquid fat found between the serous membranes; and even Dr Cleghorn speaks of it in this manner. Its property of coagulation depends chiefly on the proportion of albumen which it contains. If a mass of coagulable lymph in its recent, straw-coloured, and translucent state, be immersed in alcohol, it instantly becomes shrivelled, indurated, of a white colour, and perfectly opaque; and the same changes result from immersion in dilute acids or in boiling fluids. It also becomes much tougher and firmer. From this circumstance it has been denominated by the foreign authors *albuminous exudation.* Of its soft state, when recently effused, it is of the utmost importance for the physician to be aware, in consequence of the fact which I have now verified several times,

that in the pleura it communicates to the ear the same stethoscopic and percussive phenomena which arise from the presence of fluid.

After its first coagulation this substance undergoes other changes which are highly important in a pathological relation. As the diaphanous membranes are at all times mutually applied, a very common effect of this effused substance and its coagulation is to connect the corresponding points more or less firmly. The process by which this is accomplished was understood by Hunter and Baillie, and may be stated in the following terms. As the lymph is effused and separated into clot or coagulable part and fluid, the former is observed to be soon penetrated by minute red vessels, which may be demonstrated by injection, and the existence of which is also proved by the fact above-mentioned, that the surface of a piece of detached lymph is marked by numerous blood-spots, occasioned by the rupture of the elongated capillaries of the inflamed membrane. These vessels may be traced from the latter into the extravasated substance, in which they are observed to ramify. Red spots, like effused blood, also appear through the substance of the lymph, and in the course of a few hours these are discovered to be new vessels. As this process, which constitutes the organization of the lymph, advances, the penetrating vessels become more numerous, and the lymph becomes more firmly attached to the inflamed surface of the membrane. At the same time the fluid part of the exudation is absorbed, and the albuminous portion becoming firmer and something opaque, the soft, pulpy, gelatinous, translucent, straw-coloured substance is gradually converted into a firm, white, opaque body, uniting more or less exactly the corresponding surfaces of the membrane. The new vessels of its interior substance at the same time contract, and ultimately convey only colourless fluid. The substance thus rendered organic and the seat of an incessant process of exhalation and absorption, is termed *membrane of adhesion* (*concretio, concrementum,*) or false membrane. The process by which it is formed is termed *union by adhesion,* or simply *adhesion.*

These phenomena are most commonly observed in the *pleura, pericardium,* and *peritonæum,* in each of which they are modified according to the local peculiarities of the membrane.

In the pleura it appears in the form of a broad layer, variable in thickness, extending between the convex surface of the pulmonic and the concave surface of the costal pleura; or it may occur in the spaces between the lobes; (interlobular pleurisy of Laennec); or it may be stretched between the pleura of the inferior concave surface of the lung and that of the thoracic or convex surface of the diaphragm. When the lung is affected by tubercles or tubercular excavations, it often occurs in the form of short membranous slips, and very generally as a membranous capsule covering the apex of the lung, and connecting it to the thoracic pleura.

In the pericardium the constant motion of the heart modifies the appearance of the albuminous exudation. As this motion prevents during coagulation the exact apposition of the surfaces of the capsular and cardiac divisions of the membrane, the most prominent parts, or those which least change relation only adhere. This forms the irregular laminated processes mentioned by Baillie as giving the appearance of lace-work; and if the capsule be separated from the heart in this stage of the process, it gives the result noticed by Laennec, who compares it to the appearance produced by the sudden separation of two pieces of slab united by a thick layer of butter. At a later period this disunion will afford the calf-stomach surface (*caillebottée; bonnet de veau*),* which may be regarded as the link connecting the organizable state of the deposition with that in which it forms an adherent tissue.

In the peritonæum it takes place chiefly along the line of one portion of ileum with another, and between the prominent points of these and the omentum, or the muscular portion of the membrane. In some instances every fold almost of ileum is connected with some other, and the whole are

* Laennec, Observ. 1, 2, 3, 4, and Art. ii. Obs. 4.

matted together by long triangular prisms of lymph, generally opaque, of a lemon-yellow colour, and of a pulpy or gelatiniform consistence.

Albuminous exudation or lymph is much less frequently found between the surfaces of the arachnoid membrane. That it is actually secreted by this membrane, however, is well established. Dr Stark records three cases in which coagulated lymph was found between the *dura* and *pia mater*, and round the membranous coverings of the *medulla oblongata* and spinal chord.* One example of this exudation is delineated by Baillie ; † and Hooper represents three, in which he traces its progress from simple inflammation to organized membrane. ‡ Instances of albuminous exudation on the surface of the arachnoid are also mentioned by Tacheron, Andral, and Dr Abercrombie. § In the body of a woman who died with symptoms of intense coma, I found a thin but distinct albuminous deposit on the free surface of the arachnoid, extending from the optic commissure to the posterior margin of the annular protuberance. It was less firm and more translucent than in the pleura or peritonæum, but presented in other respects the usual properties. Similar depositions have been remarked in various regions of the arachnoid by Parent-Duchatelet, Martinet, Bayle, and others.

Bailie and most other observers notice, besides coagulating lymph or albuminous exudation, a serous fluid, limpid, yellowish, reddish, or brownish, according to circumstances. Though this fluid has been supposed to be derived immediately from the blood, there is no doubt that it is the serous or watery portion of the morbid exudation, from the surface and insterstices of which it may be seen trickling. The red or brown tint it derives from blood issuing from the new formed capillaries opened by laceration of the lymph from the membrane. Shreds of lymph are at the same time found

* The Works of the late William Stark, M. D. Lond. 1788. Part iv. p. 69.

† Plate iv. Fascic. x. ‡ Plates i. and ii.

§ Pathological and Practical Researches, &c. p. 51—56—60.

floating in it. This is most generally seen in the pleura and pericardium.

I have already stated that the exudation of inflamed serous membrane owes its coagulability to the presence of albuminous matter; and indeed upon the proportion of this ingredient the process of coagulation depends. In certain instances, in which the inflammatory process is believed to be less genuine and energetic, this principle is so scanty that coagulation is partial and imperfect; and instead of a uniform layer of lymph between the mutual surfaces, each presents a series of loose shreds and patches, with a considerable quantity of reddish or whitish semi-opaque fluid in the dependent part of the cavity. This constitutes the link between the albuminous and the purulent, sero-purulent, or serous products of inflammation in these membranes.

Examined more minutely we find that the fluid varies in its proportion of albumen in different membranes, and according to the form of the inflammatory process. These variations may be referred generally to two heads, puriform and serous secretions.

The varieties of puriform secretion may be classed under the heads of sero-purulent, puriform, and purulent.

The sero-purulent is often connected with the albuminous, from which it is separated during the process of coagulation. It consists chiefly of serous fluid with minute granules of albuminous matter, which subside to the bottom and leave the supernatant liquor like whey or chalk-water. It always contains flakes of lymph. It takes place in pleuritic and peritonæal inflammation, acute and chronic, and is generally found in the dependent part of the cavity, *e. g.* in the posterior part of the chest, and in the lumbar and hypogastric *fossæ* in the peritonæum.

The puriform fluid of serous membranes consists of serous fluid, with an opaque and thicker matter not coagulable in mass blended with it more equably than in the last case. The granular matter is less abundant or entirely wanting; and the opaque milky fluid is not so easily separable as in the sero-purulent fluid. Though it is often asso-

ciated with the albuminous, and contains flakes of lymph, yet, as little lymph is found on the surface of the membranes, and as the quantity of the latter is often in the inverse ratio of the quantity of puriform fluid, it may be regarded as less nearly allied to the pure albuminous inflammation than the sero-purulent. Both are to be regarded as abortive efforts to effect albuminous exudation.

The puriform secretion occurs in all the serous membranes, but is most frequent in the peritonæum. It is in particular very common in that form of peritonæal inflammation which occurs in the persons of women in childbed; and Hunter, who was aware of the fact, states it as an instance of the combination of the adhesive with the suppurative inflammation,—a circumstance to which he ascribes the unfavourable issue of such cases. * It is occasionally the combination, and sometimes the substitution of the suppurative for the adhesive process. This is amply confirmed by the necroscopic appearances of peritonæal inflammation in puerperal females, in which every shade of morbid effusion is seen, from albuminous lymph, with separation of proper serous fluid, to puriform or purulent collection.

Genuine purulent fluid, as it is represented by pathological authors,—a white, or cream-coloured, opaque, and homogeneous fluid,—is another product of inflammation of serous membranes. Though always combined with more or less albuminous exudation, which is found in loose irregular patches on the membrane, and in the form of shreds and flakes in the fluid, it is more uniform in composition than the puriform, being destitute of the granular matter, and not separating when allowed to rest into thin and solid matter. It occurs in chronic pleurisy, (*empyema,*) in pericardial inflammation as an affect of the acute, and in *peritonitis,* acute, subacute, and chronic, especially the puerperal.

* "This mixing of the suppurative with the adhesive, or the hurrying on of the suppurative, I have frequently seen in the abdomen of women who have been attacked with the peritonæal inflammation after child-birth, and which, from these circumstances, became the cause of their death."—On the blood, &c.

It was at one time believed that genuine purulent matter could not be formed in these membranes, unless as an effect of the preliminary process of ulceration. Instances of purulent collections in the chest without ulceration of the pleura, and of purulent matter in the abdomen without breach in the peritonæum, might have led pathological writers to the inference, that suppuration may occur in a serous membrane without ulceration, and that secretion of purulent matter is one of the effects of simple inflammation of serous tissue. The truth of this fact, however, appears not to have been established before the time of William and John Hunter, the last of whom notices it as a point not previously ascertained. Speaking of the transition or gradual change from coagulable lymph to purulent fluid, he infers "that suppuration takes place in serous surfaces without a breach of solids or dissolution of parts," mentions it as a circumstance "not commonly allowed," and considers this suppuration as the effect of a more advanced stage of the process than that which gives rise to effusion of lymph, and union by adhesion. Of this fact, he informs us, he first became aware in 1749 and 1750, when, in the inspection of a young subject, the left side of the chest was found to contain a considerable quantity of purulent matter without breach of the pleura or surface of the lungs; and, at the same time, it was regarded by Dr Hunter and Mr Samuel Sharpe as a new fact. * It has since been often observed both in the pleura and peritonæum; and as such is mentioned by William Hunter, † Baillie, Black, and Willan.

* Treatise on Inflammation, &c. p. 379. *Note.*

† "Another kind of *pus* is that which is formed without any apparent breach or dissolution of the solids, and therefore is only a sort of inspissated *serum*, or an inflammatory exudation. We occasionally meet with collections of this kind in all the natural internal cavities of the body. I have seen it in great quantity in the cavity of the abdomen or of the *peritonæum*, in that of the thorax or of the *pleura*, and in the *pericardium*, where there was no visible suppuration, ulceration, or dissolution of the solids, or any part of the surface all round. This kind of *pus* is generally thinner than that of an abscess; and the containing surface is more or less covered with

The purulent fluid in this case and many others is secreted partly from the surface of the inflamed membrane, partly from the organized layer of lymph, partly from both. In the first case, the puriform or purulent fluid is secreted directly by the capillaries of the inflamed membrane. In the second, it is derived from those of the organized false membranes, which assume the suppurative action. In the third, both sets of vessels are concerned. These facts are demonstrated in instances of chronic pleurisy, and of chronic inflammation of the *peritonæum*.

A second effect of inflammation of the diaphanous membranes is effusion or secretion of fluid in the subserous filamentous tissue. When the arachnoid membrane is inflamed the delicate filamentous tissue which connects it to the *pia mater* is almost invariably distended with serous fluid, more or less transparent. This change makes the arachnoid membrane look as if it were raised or detached from the *pia mater* by the interposition of a transparent or slightly opaque gelatinous matter uniformly spread between them. If a puncture or incision, however, be made, a small portion only trickles from it, being that which is exposed to the immediate incision. The fluid of the contiguous parts does not escape,—a circumstance which with inspection shows that it is contained in the interstices formed by the mutual crossing of the filaments of the subserous tissue. In this manner and in the same situation albuminous fluid may be effused, especially at the base of the brain. In pleurisy this effusion is less common, unless the pulmonic tissue is at the same time inflamed,—a peculiarity which appears to depend on the intimate union between the pleura and lungs. In in-

a glutinous concretion, or slough of the same colour as the fluid, in some parts adhering very loosely, in others so firmly, that it can hardly be rubbed off; but still the surface covered by these sloughs is without ulceration or loss of substance."—Medical Observations and Inquiries, Vol. ii. p. 61.

Baillie, Morbid Anatomy, *passim*.

Black, Clinical and Pathological Reports. Newry, 1819.

Willan, Reports on the Diseases of London, 1797. P. 186. 8vo Edition.

flammation of the pericardium it takes place beneath the cardiac fold of the membrane, and occasionally assumes the form of minute abscesses in the subserous tissue and on the surface of the cardiac fibres. In inflammation of the peritonæum it is more common; and careful inspection may detect effusion below the intestinal, and more distinctly in some instances below the muscular peritonæum. In this situation, indeed, may be found patches and minute deposits of purulent fluid, not only in the ordinary forms of peritonæal inflammation, but in that which takes place in the persons of puerperal women.

A third change mentioned as a consequence of inflammation in serous membranes is inordinate thickness and some degree of pulpiness. * The occurrence of thickening is contradicted by Laennec, who denies that inflammation produces thickening of the *pleura*, and contends that observers have been misled by morbid deposits on its surface, or the formation of new membranes. Without doubting the discernment or candour of this pathologist, I must remark, that, as Baillie expressly mentions thickening as a consequence of inflammation in the *pleura, peritonæum*, and mesentery, and as this is confirmed in regard to the *peritonæum* by the testimony of Pemberton † and Black, ‡ the question resolves itself into one of individual observation. If, in some instances of acute inflammation of serous surfaces, thickening is not recognized, there are few in which the chronic form of the process affects the pleura, pericardium, and peritonæum, without more or less thickening of the membrane. The appearance of this, indeed, may arise from effusion into the subserous filamentous tissue; but in cases of chronic inflammation the membrane itself appears to be not only thicker, but harder and firmer than natural. Does this change depend on effusion of lymph into its component tissue, or developement of vessels which are loaded with various fluids? In chronic peritonitis I have observed the attached surface

* Baillie's Morbid Anatomy, p. 54, 127, and 200, in reference to the mesentery.

† On the Abdominal Viscera. ‡ Clinical and Pathological Reports, &c.

of the membrane manifestly loaded with extravasated matter in the interstices of the filamentous tissue. What are the cases in which the serous membranes become pulpy or softer than natural, while they are also thickened? On these points accurate information is still wanting.

The next effect of the inflammatory process in serous membranes is destruction of their tissue by ulceration. Though this may happen in the acute form of the disease, it is not common. But after it has subsisted for some time, one or more points of the membrane begin to be affected by the ulcerative process, which at once spreads superficially, and penetrates its substance. The manner in which this takes place is invariably by the inflammatory process affecting the subserous tissue, and causing there suppuration in a circumscribed point. The serous membrane being no longer supported at this point, gives way sometimes in round irregular patches, sometimes in ragged linear fissures. This process is not equally common in all the serous membranes. It is most usual in the pleura, pulmonic and costal, and in the muscular peritonæum.

By some pathologists, and, if I do not misunderstand him, by Hunter, ulceration is ascribed to pressure exercised by purulent matter; and thus, indeed, this author explains the tendency which collections of matter betray to proceed towards the surface. The pressure of such agents, doubtless, operates as an irritating cause, and may therefore produce what Hunter terms *ulcerative inflammation*. In several examples, however, ulceration may occur as a direct effect of the inflammatory process, without the formation of matter sufficient by pressure to cause destruction of the tissue; and in such circumstances I have in general traced it to previous suppuration of the subserous tissue, as already mentioned. In cases of empyema and chronic peritonitis, especially the puerperal form in which this ulceration is not unfrequent, both causes may be in operation. But even in the interesting case of peritonæal inflammation given by Hunter to illustrate the nature of what he terms the relaxing process, it is impossible to doubt, that, before the muscular peritonæum

was detached in the shreds and fragments in which it was found on inspection, inflammation and suppuration of the subserous filamentous tissue had taken place. * In short, from the cases recorded, and from several which I have examined personally, I infer that ulceration of the serous tissue is always preceded by inflammation and suppuration of the subserous; that the attachment of the former being thus destroyed, its vitality is impaired, and its cohesion thereby weakened; and that it gives way rather in the manner of laceration than genuine ulceration.

Observation has not yet determined whether gangrene be an effect of inflammation of the serous tissue. That it is occasionally involved in this process I infer from seeing the *pleura* in gangrene of the lungs, and the *peritonæum* in that of the bowels, soft, black, or greenish, shreddy, and lacerable. But it is still uncertain whether primary inflammation of a serous tissue exclusively may terminate in mortification of that membrane. With this process ulceration with bloody effusion or blood-coloured patches must not be confounded. Bichat states, that in numerous bodies which he inspected, he met with gangrene of the *peritonæum* only; and that he never witnessed an instance of this change either in the arachnoid membrane, in the *pleura*, in the *pericardium*, or in the *peridídymis*.†

The second general head of secretions, or those termed *serous*, have been long received as the distinctive character of the disorders named dropsies; (*Hydropes.*)

To the influence of inflammation or capillary injection in causing effusion, extravasation, or secretion of *serum*, I have already in part alluded. In no texture is this more conspicuous than in the serous or transparent. The mechanism of this process it is perhaps not very easy to explain satisfactorily, unless by referring it to the same principles to which I have already referred, the ordinary albuminous and purulent exudations. I shall attempt, however, to state as briefly

* Treatise on the Blood, &c. Part ii. Chap. vi. Sect. vi. p. 461. 4to.

† Anat. Generale, tome iii, p. 517.

as possible the ascertained facts which tend to establish the general conclusion,—that inordinate accumulation of serous fluid from the free surface of the diaphanous membranes is a frequent result of a process of capillary congestion, or even of inflammation.

I have already stated that the serous membranes in general are understood to be the seat of a process of incessant exhalation and resorption. This may be regarded as demonstrated in the case of the *pleura*, *pericardium*, *peritonæum*, and *peridídymis*, by the experiments of Haller, Bichat, and others; and of the arachnoid the same is presumed from analogy. The fluid thus secreted, though in the healthy state very scanty, is distinctly albuminous. This may be regarded as demonstrated by the rude experiments even of Hewson and Bichat. The difficulty in the healthy state of obtaining a quantity sufficient for analysis led Berzelius to examine that of *hydrocephalus*, which he supposes makes a nearer approach to the normal condition than the others; and of this he found 1000 parts to contain 1.66 of albuminous matter, with salts of potass and soda, and some animal matter combined with lactate of soda. * This result is confirmed by the researches of Bostock and Marcet, which show that, though some muco-extractive matter is present, albumen forms the chief part of the solid contents of the serum of the blood and the fluids of the serous membranes. Lastly, Marcet, who examined all the dropsical fluids, found that they contain coagulable matter; but that those of the pleura, pericardium, and peritonæum, contain much more than the arachnoid, and that of hydrocele most of all. †

The inordinate augmentation of these fluids varies in degree, from a few ounces to several pints; and it varies according to the site of the membrane from which it is effused. Thus the fluid secreted by the arachnoid membrane may not amount to above half an ounce, or at most to two or three

* General Views of the Composition of Animal Fluids. By J. Berzelius, M. D. &c. Med. Chir. Transactions, Vol. iii. 251.

† Medico-Chirurg. Trans. Vol. ii. p. 381.

ounces, which is to be regarded as a great quantity. In some recorded instances it is said rather vaguely to amount to six. The fluid secreted by the pericardium may not be above one ounce, rarely exceeds two or three, and in a few instances only amounts to six, eight, or ten. In the pleura, on the contrary, it may amount to three, four, or five pints or quarts; and in the peritonæum has been known to amount to several gallons.

The quality of this fluid varies. That of the arachnoid is limpid and colourless, like clear water, with a slight saline taste, and contains traces of albumen. In the pericardium it is light-coloured and semitransparent. In the pleura it may be straw-yellow and semitransparent, but is more frequently reddish, or brown and something opaque. In the peritonæum it is semitransparent, yellow, or greenish, sometimes with various shades of red or even brownish, like chocolate or coffee. In each of the three last cases it is invariably combined with albuminous matter.

The hypothesis of Cullen, who ascribes this inordinate accumulation to any cause which increases exhalation or diminishes absorption, though plausible, is too general, and does not comprehend all the facts of the case. One of the most uniform and powerful agents in augmenting exhalation from serous surfaces is that state of the capillaries in which they are injected, distended in such a manner as to constitute congestion or even inflammation. The influence of this cause appears to have been first well understood by Cruickshank,*

* "The second species of dropsy is very common, and is that which arises in consequence of previous inflammation of a cavity; and may take place in any habit of body. If an inflammation arise in a cavity it may terminate in a number of different ways; one of these is by increased secretion of fluid of surfaces. A man receives a blow on the testicle, inflammation takes place, and the consequence is frequently a hydrocele or dropsy of the *tunica vaginalis*. A child's brain inflames, and this inflammation ends at last in *hydrocephalus*, or collection of water in the brain. Pleurisy frequently terminates in hydrothorax, or collection of water in the chest. I have often taken away forty or sixty pints of water, which had accumulated in the cavity of the abdomen in the few days the peritoneal inflammation had last-

Baillie,* and Parry,† nor had escaped the observation of Pemberton.‡ Its reality, however, was first investigated and formally maintained by Grapengiesser of Gottingen,§ by Rush of Philadelphia,‖ and has recently been the subject of much research and inquiry by Wells,¶ Blackall,** Crampton,†† and Ayre. The results of the inquiries thus instituted may be stated in the following manner.

Though accumulation of fluid in the cavities of serous membranes depends on increased exhalation from the vessels of these membranes, that exhalation is not to be regarded merely as an increased form of the natural action, but is a process of morbid secretion, depending on a state of the blood-vessels, either identical with, or analogous to inflammation. The vessels of the membranes are numerous, enlarged, and in general injected. When they are not so, the stage of injection has passed, and been succeeded by that of exhalation. The presence of albuminous flakes in the effused fluid furnishes proofs of the same description. The membranes are more or less opaque, and dull, and covered by shreds and patches of lymph in various spots; and fluid is effused into the subserous tissue. Thus, in several instances of dropsical infiltration, with effusion into the cavity of the pleura, I have found that membrane not only vascular, but coloured of a red-brown tint, opaque, void of its glistening

ed, during the usual species of childbed fever. This is to be considered as the substituting a less dangerous disease for another. Peritoneal inflammation kills often in three days; but acute may last twenty years."—Anatomy of the Absorbing Vessels.

* Morbid Anatomy, p. 57. 4th Edit. Lond. 1812.

† Collections from the unpublished Medical writings, &c. p. 205, 207, 208.

‡ Abdominal Viscera, p. 12. "Sometimes a resolution of the inflammation takes place from the throwing out of a fluid, when ascites is produced."

§ De Hydrope.

‖ Medical Inquiries and Observations. By B. Rush, M. D. Philad. 1805. Vol. ii. p. 159.

¶ Transactions of a Society, Vol. iii. p. 167, 183, and 194.

** Observations on the Nature and Cure of Dropsies.

†† Clinical Report on Dropsies. Transactions of Association, Vol. ii.

aspect, and covered by patches of albuminous exudation. The same is observed in ascites. One of the most decided examples is afforded by the inspection of Sir James Craig, so well described by Dr Somerville.* The peritonæum was found covered by lymph in various points, and lymphy flakes were found abundantly in the fluid. On the same point, the dissections of Dr Crampton in the Transactions of the Dublin Association afford unequivocal and satisfactory evidence.

In the case of the cerebral membranes it is not quite so easy to obtain evidence. The arachnoid is averse, if I may use the term, to albuminous exudation; and though this occurs occasionally, serous effusion is greatly more frequent. The inflammatory origin of this effusion, however, is proved by several circumstances.

1st, The *pia mater* and choroid *plexus* are more or less, sometimes highly vascular. The arachnoid is always dry, opaque, dull, and elevated by infiltration into the subjacent tissue. In some instances this infiltrated fluid contains albuminous matter; and in some patches of lymph are deposited on the free surface of the arachnoid membrane. In one of the most distinct cases of this disease which fell under my personal observation, I found the free surface of the cerebral arachnoid adhering to that of the falciform process in the great fissure between the hemispheres by well marked filaments of albuminous exudation.

2d, In the case of violence inflicted on the head, which it is well known has a tendency to induce inflammation, when that inflammation proves fatal, almost invariably we find effusion from the membranes, in some cases to a great extent. In proof of this, I prefer referring to the cases of other observers than to such as I have inspected. In the fatal cases recorded by Pott and Dease the most uniform appearance is water in the ventricles, which evidently proceeds from the choroid plexus, or inner division of the cerebral membrane. In the numerous and well described cases of Schmucher also, this effusion is always one of the

* Medico-Chir. Tr. Vol. v. p. 340, &c.

changes recorded; and vascularity of the *pia* mater, and dulness of the arachnoid, with subarachnoid infiltration, are frequently remarked. Similar results may be derived from the cases given by Dr Thomson, and from those of Dr Hennen. In short, it may be inferred that traumatic inflammation of the cerebral membranes always induces more or less serous effusion. It is scarcely necessary to remark, that this explains a fact observed by most practical physicians, that *hydrocephalus* is very often ascribed to blows or falls on the head, the tendency of which to induce congestion of the vessels cannot be denied.

3d, To the same purpose it may be said, that the effusion resulting from the operation of the process of fever, whether intermittent, remittent, or continuous, demonstrates the influence of vascular congestion in inducing it. Thus in ague, meningeal effusion is not uncommon; in remittent it is frequent; and in continued fever it is perhaps the most usual cause of the fatal termination of the disease. The extensive body of evidence collected on this point of late years by writers on remittent and yellow fever, and on the ordinary continued fever of this country, renders it unnecessary to dwell longer on this point.

In favour of the same inference, the connection so often remarked between dropsy and hemorrhage might be adduced. My limits, however, do not permit me to add more.

The principal pathological facts regarding the process of inflammation in serous membrane have been so fully stated, that it is superfluous to dwell on the individual diseases. I shall merely, after enumerating them, make a few remarks on some peculiarities presented by the chronic forms of these disorders. They may be arranged in the following order, showing their transition into dropsies.

Acute form.	Chronic form.	Dropsical form.
Cerebral envelopes,	*Meningitis; Arachnitis*,	Hydrencephalus.
Pleura, *Pleuritis*,	*Empyema*,	Hydrothorax.
Pericardium, *Pericarditis*,	*Pyocardia*,	Hydrocardia.
Peritonæum, *Peritonitis*,	Chronic peritonitis,	Ascites.
Peridídymis, *Orchitis*,	*Empyocele*,	Hydrocele.

Visceral divisions of the peritonæum.

Gastric peritonæum,	*Gastritis.*
Intestinal peritonæum,	*Enteritis.*
Colic peritonæum,	*Colitis.*
Mesenteric peritonæum,	*Mesenteritis.*
Omentum,	*Epiploitis.*
Cystic peritonæum,	*Cystitis.*
Hepatic peritonæum,	*Hepatitis.*
Splenic peritonæum,	*Lienitis.*
Uterine peritonæum,	*Hysteritis.*

Chronic pleurisy *(empyema)* is remarkable for the effects which it produces. *First,* the great accumulation of fluid forces the lung towards the mediastinum and spine, and compresses it into so small bulk that it appears to be destroyed. Inspection shows, however, that it is merely compressed. Its vessels are crushed together; its bronchial tubes and vesicles closed; and the whole organ is rendered unfit for respiration. This is the condition mentioned by Broussais under the name of atrophied lung.* *Second,* suppurative destruction may take place in the pulmonic pleura and corresponding part of the lung, and lay open one or more bronchial tubes, causing pulmonary *fistula* and *pneumothorax.* Sero-purulent or purulent fluid is then discharged by coughing in a forcible and continuous stream. Of this kind are many cases of pulmonary abscess reported to be cured. *Thirdly,* suppurative destruction may take place in one or more points of the costal pleura, and discharge a considerable quantity of puriform fluid through openings between the ribs, which are occasionally carious.† When these two modes of opening are combined, pneumothorax and emphysema take place.‡ *Fourthly,* The inordinate accumulation of fluid in the left sac of the pleura may be so great as to

* Phlegmasies Chroniques, Cases 19, 20, 24, 25, 27, 28, 30.

† Miscell. Curios. Dec. iii. An. v. Obs. 49. Mem. Med. Society, Vol. iii. p. 127. Kirkland, Med. Surgery, Vol. ii. p. 178. Withering's Remarks on Dropsy, &c. Works, Vol. ii. p. 304, § 35.

‡ Treyer, in Annals of Thomann, Vol. i. Dr Duncan, in Trans. Med. Chir. Society, Edin. Vol. i. and Contributions to Morbid Anatomy, No. iv. Empyema and Hydrothorax, in Med. Surg. Journal, Vol. xxviii. p. 302.

thrust the heart to the sternum, and eventually into the side of the chest, in which its pulsations are then felt.* This change I have witnessed twice in chronic pleurisy.

Chronic peritonæal inflammation is distinguished by three circumstances:—1*st*, Purulent or sero-purulent fluid may be secreted in one or more distinct sacs, formed by the union and secretion of effused lymph. This, which was early noticed by Morgagni, (Epist. xxxiv. 221,) is verified by J. Hunter,† and more recently by Baillie, Black,‡ Mr Cooke, and others.

2*d*, Purulent fluid may be secreted by the whole inflamed membrane without breach of surface. This proposition I should scarcely have thought requisite, after what has been said above, to state formally, did not the valuable remark of John Hunter, that "the cavity of the abdomen acquires all the properties of an abscess," appear to be forgotten by Dr Black of Newry, who, in recording a case in which the "abdomen contained more than two quarts of thin purulent fluid of a turbid appearance," seems to think it extraordinary that the matter was secreted by inflamed surfaces. In other respects the case is a good confirmation of the general principle now stated. I may add, that in several cases of peritonitis lasting for several weeks, which have come under my own observation, I have seen many folds of small intestine connected by lymphy exudation, and a considerable quantity of genuine purulent fluid bathing the adhering masses, and filling the hollows of the lumbar, iliac, and hypogastric regions. The omentum is sometimes glued down at its corners to a fold of ileum; in other instances it is drawn up and shrivelled into a roundish or cylindrical mass.

* Morgagni, Epist. xx. 6. Barry, p. 405, 406. Abercrombie, in Med. Chir. Transactions.

† "Inflammation attacks the external coat of an intestine. The first stage of this inflammation produces adhesions between it and the peritonæum lining the abdominal muscles. If the inflammation does not stop at this stage, an abscess is formed in the middle of these adhesions."—Treatise on the Blood.

‡ Clinical and Pathological Reports, p. 133, 176.

3d, Ulceration may take place at one or more points of the muscular or intestinal peritonæum, by a process, the mechanism of which has been already explained. The first is most common, and may be so extensive and complete as to destroy the whole membrane on the fore part of the abdomen, and expose the transverse and straight muscles as distinctly as if they were cleanly dissected, and leave the tendons of the lateral muscles in rags, partly gone, partly in the form of slough. At the same time, the intestines are covered with a coat of lymph, which is believed by Hunter to prevent the matter from irritating, and producing ulcerative inflammation of the bowels, and from diffusing itself over the abdominal cavity. * Its chief use is to prevent inflammation of the subserous tissue.

The rarity of the latter, which is well established, is ascribed by Hunter to the indisposition to ulceration manifested by the intestinal peritonæum. † It is the express testimony of Baillie, that he "did not recollect to have seen one instance in which the ulcer had begun on the outer or peritonæal surface of the intestines, and had spread inwards." To show that this termination, though uncommon, is not unknown, I mention, that of 16 cases of chronic peritonæal inflammation reported by Broussais, in one only did perforation of the intestines take place; ‡ and that in the case of Willan above alluded to, the colon was superficially ulcerated in several places.

In the sero-purulent and purulent collections, which are the result of peritonæal inflammation in puerperal females, after it has passed the acute stage, a peculiar mode of termination is not unfrequently observed in an opening taking place spontaneously generally at the navel, and allowing the

* On the Blood, &c. Part ii. Chap. vi. Sect. vi. p. 461, and Sect. ix. p. 467.

† "If the disposition for ulceration was equal on every side of the abscess, it must open into the intestine, which is seldom the case, although it sometimes does." P. 236.

‡ Phlegmasies Chroniques, Section ii. Chap. iv. Obs. lv. p. 480.

issue of a large quantity of fluid. This opening is effected first by distension, the pressure of the matter separating the *recti,* and enlarging the umbilical aperture afterwards by laceration, while the peritonæum detached from the supporting tissues, and sustained only by the skin, at length gives way, and forms an opening. Examples of this are recorded by Hulme, * Leake, † Denman, ‡ Mr John Burns, § Gordon, || Armstrong, ¶ and Hey. ** Gordon and Denman mention cases in which matter was discharged by the urethra with favourable issue. The fluid of ascites in females has a peculiar exit, by which not unfrequently it escapes, the Fallopian tubes.

Puerperal Peritonitis.—That the disease termed puerperal fever consists in peritonæal inflammation of one or other of the forms above-mentioned, is established by the observation of the best authors, and by daily experience. In every case in which the symptoms of the disease appear during life, we find in the peritonæum more or fewer of the marks of the inflammatory process above described. This variety of peritoneal inflammation, nevertheless, is peculiar in commencing almost invariably in some part of the peritonæum investing the organs of reproduction. Thus the first, the most abundant, and the most invariable traces of inflammatory action, are found either in the uterine, or the ovarian peritonæum, or in that of the Fallopian tubes, especially at their fimbriated extremities, or all three at once. The most usual appearances which I have remarked in a large proportion of cases, are opaque, dull, and lustreless aspect of the uterine and ovarian peritonæum ; blood-spots or vascular injection, especially of the ovarian peritonæum ; albuminous exudation of the uterine and ovarian peritonæum, often agglutinating the latter to that of the oviferous tubes ; and seropurulent or purulent fluid, with albuminous shreds, in the hypogastric, iliac, and occasionally the lumbar *fossæ*, and

* On the Puerperal Fever. † On Child-bed Fever.

‡ Introduction, &c. Fever. § Elements, &c.

|| Treatise on the Epidemic Puerperal Fever, 5th and 6th Cases.

¶ Facts and Observations, p. 158. ** On Puerperal Fever.

purulent or albuminous exudation between the bladder and uterus, and the uterus and rectum. In one of the latest cases of this disease which I had occasion to inspect, and the morbid parts of which I preserve, the peritonæal covering of each ovary was inclosed in a layer of albuminous exudation. In this the fimbriated extremities of the oviferous tubes were imbedded; and in that of the right side the adhesion was tolerably firm. The usual blood-spots indicating organization were distinct. Between the uterus and rectum was an extensive albuminous exudation, forming a cyst containing purulent fluid; and a smaller one of the same kind was found between the uterine and vesical peritonæum. In more severe cases the inflammatory process spreads over the intestinal peritonæum, and produces its usual effects. Suppuration not unfrequently takes place in the veins of the womb; but whether it be a necessary or accidental complication I cannot say. I have seen it in about four or five among 18 or 20 cases. The commencement of this disease in the uterine and ovarian peritonæum is not wonderful, when the extraordinary distension of that membrane during the latter months of pregnancy is considered. Denman remarks that there are not wanting instances in which it has been evidently forming before delivery, or during labour; Joseph Clarke states that he saw reason to date the commencement of several cases from before delivery, and refers to two in which this conclusion was justified by the speedy extinction of life after labour, and the appearances on inspection, (44); and Hey refers to two cases, one fatal, in which symptoms appeared previous to delivery. These inferences I have now had occasion to verify more than once; and not many weeks ago I had occasion to detract in two days fifty ounces of blood with corresponding antiphlogistic measures, to check incipient symptoms of peritonæal inflammation in a lady during the latter part of pregnancy.

Tabes mesenterica; Marasmus.—A species of chronic *peritonitis,* giving rise in children to the symptoms of this disease, is described by Dr George Gregory. Its anatomical characters are much the same as in the ordinary instances of

peritonæal inflammation; but it also tends to induce thickening of the peritonæum, secretion of matter termed *scrofulous, (albuminous? tyromatous?)* and finally ulceration of the peritonæum. In consequence of this ulceration, the mucous and peritonæal surfaces of the bowel communicate directly, so that instead of forming a continuous canal, as in the normal condition, they constitute a mass of tubes communicating freely with each other, and with thickened and ulcerated peritonæum, by numerous openings. From the early symptoms combined with these changes, Dr Gregory considers this disorder as primarily commencing in the peritonæum.* With this view I am disposed to agree; but must observe, that not only the symptoms, but even the appearances of peritonæal inflammation may be explained, by supposing the ulcerative process to originate in the mucous membrane, and proceed to the peritonæal, in which the effusion of the contents of the tube necessarily produce inflammatory exudation. For a case illustrating this mode of progress, I refer to Howship, p. 264.

Meningitis and *Arachnitis.*—These two affections are generally combined,—in other words, inflammation of the *pia mater* is generally accompanied with that of the arachnoid membrane. It assumes acute, subacute, and chronic forms.

The acute and subacute forms constitute the disease described by practical authors under the name of *water* of the head, *water* of the brain, *hydrocephalus*, and *hydrencephalus*. This inference, which was originally advanced by Quin, and adopted by Rush and Garnet, was first verified by Cheyne, and has been since amply confirmed by the inspections of Golis, the inquiries of Dr Blackall, of Dr Ayre, Dr Abercrombie, the dissections and researches of Parent-Duchatelet, Martinet, and Senff. The proofs collected by these authors, it is unnecessary, after the general remarks already submitted, to detail. From the account also of the distribution of the proper cerebral membrane, it is easy to explain the necroscopic phenomena of hydrocephalic brains. The

* Observations on the scrofulous inflammation of the Peritonæum, &c. Med.-Chir. Transact. Vol. xi. p. 258.

natural result of this distribution is, that when the membrane is inflamed, and its vessels in consequence secrete watery fluid, while that from the outer division is deposited beneath the arachnoid coat, that of the inner trickles from the membrane, on the figurate surface of the brain, or in the ventricles, in which its effects are in proportion to its quantity. If small, it produces little change on the parts of the brain. If copious, it raises the vault, pushes out the walls of the ventricles, enlarges their capacity and dimensions, breaks down the median *septum*, forming a large communicating aperture, and may ultimately extend the substance of the organ, and render it so thin as to give it the appearance of a mere bag, containing a considerable quantity of water.

In some instances fluid is not found in the ventricles. The *pia mater* and *plexus*, however, are highly injected, the arachnoid is opaque, dull, and dry-looking, and the subarachnoid tissue is infiltrated. This demonstrates that the symptoms of the disease depend not on the effusion, but on the previous vascular injection.

In addition to these proofs derived from inspection, that the fluid proceeds not from the brain but its membranes, it may be added, that in the fœtal state, previous to the formation of brain fluid, may be derived from the congested vascular membrane. The new action thus established gives a sudden check to the normal action of the vessels; and as the formation of the brain is thus interrupted, the individual is born anencephalous. The same process taking place in the vertebral portion of the membrane during the early months of fœtal life, causing at once serous effusion, interruption to the growth of the chord, and arresting that of the spinal plates, and their mutual union constitutes *spina bifida*.

The influence of acute *meningitis* in deranging the mental faculties, though questioned by Bayle, appears to me undoubted, for the following reasons:—

1*st*, In some few cases of the disease taking place in adults, and in which its nature was confirmed by accurate inspection, I have remarked the same confusion of thought, incapacity of judgment, and incoherence of speech as in the ma-

niacal. In general, in this delirium gay and pleasurable ideas predominate. In the most distinct of these cases, to which I have already alluded, the nature of the disease was unequivocally demonstrated, not only by the fluid of the ventricles, but by the vascularity of the *pia mater* and plexus, subarachnoid infiltration, dulness of the arachnoid, and albuminous exudation from the free surface of that membrane. 2*d*, In several cases of the disease occurring in infants, without proving immediately fatal, I have traced to this cause a degree of idiocy which was supposed to be congenital. Upon inquiry, it always appeared that the infant had undergone soon after birth an anomalous and little understood disorder, after which, hearing and sight seemed much impaired, and the vivacity of the infantile age was not observed. Inspection at a subsequent period demonstrated the nature of the affection.

Symptomatic meningeal inflammation, I have formerly said, takes place in fever continued, intermittent, and remittent, after injuries of the head, and occasionally in other diseases.

From the appearances of a considerable number of cases of the ordinary continued fever of this country, which since the beginning of 1817 I have inspected personally, or have seen inspected, I infer that subacute congestion of the cerebral membranes is one of the most frequent phenomena of that disease, and one which very often contributes to its fatal termination. I have elsewhere attempted to show, however, that this is not the cause of fever; and though the cause of many of its symptoms, especially the confused thought and incoherent speech, that it is one only of an extensive and general morbid state of the capillary system induced by the action of fever. It may nevertheless occasionally amount to inflammation.

Delirium in the Phthisical not an instance of Metastasis. —Subacute meningeal inflammation I have seen take place in the phthisical during the last days or weeks of existence. Upon examining the brains of persons of this description who have had delirium for some time before death, the *pia*

mater and *choroid plexus* are more or less sometimes highly injected; the arachnoid is dull, opaque, and lustreless; the subarachnoid tissue is infiltrated, especially in the vicinity of the vessels; and serum is effused in the ventricles. In an extreme case of this nature, which occurred under the care of Dr Renton, and in which the patient had *delirium* amounting to *mania* for three weeks previous to death, I found, among other lesions, the whole *pia mater* most extensively injected, and its minute vessels of a scarlet red colour, while the large vessels were filled with dark blood. The scarlet-coloured capillaries were distinct and abundant at the convoluted surface, and in particular at the base of the brain, and in the portion which covers the outer surface of the *hippocampus major*. The arachnoid was dull, opaque, and elevated by subserous infiltration. At the inner margins of the hemisphere, in the neighbourhood of the falx, the arachnoid of the *pia mater* adhered to that of the *dura mater* with albuminous effusion; and pisiform or lenticular eminences like those described by Greding and others were found proceeding from the *pia mater*. The choroid plexus was also injected; and serum to the amount of about an ounce or ten drachms was found in the ventricles. The substance of the convoluted or gray matter of the brain was extensively traversed by reddish vessels, in which the blood was still fluid.

Chronic Meningeal inflammation. The pathological causes of insanity.—However general be the opinion that mental derangement may exist independent of anatomical change in the state of the brain or its coverings, in the writings of various authors we find ample proof of two facts; that mental derangement is always connected with some change in the organization of these parts; that most anormal changes give rise, sooner or later, to confusion of thought, incoherent ideas, and insane actions; and that deranged intellect is one only of several symptoms which may occur in consequence. Already, when enumerating the morbid changes incident to the brain, I have alluded occasionally to several of those which may induce insanity. I am now to advert to a state of the

cerebral membranes, which there is every reason to believe is a very uniform cause of that malady.

The elaborate inspections of Greding, to whom I have had occasion formerly to allude, afford the first traces of comprehensive views on the anormal states of the brain and its coverings, in the persons of the maniacal and epileptico-maniacal insane. According to the researches of this physician, the *pia mater* and arachnoid membrane are rarely sound in those affected with insanity. In 120 cases inspected, though in a few (5) the *pia mater* is stated to be pale, in more (9) it was reddish; and in a number still greater its vessels were injected with dark blood. The exterior surface was in 29 cases white, thick, and mucous; sometimes dry and lardaceous, like the buffy coat of inflamed blood near the vertex, along the mesial margins of the hemispheres. In 29 cases this alteration extended more generally over the membrane. In 9 it was observed over the convex and plane surfaces of the hemispheres; and in 6 it extended round the *cerebellum* and *medulla oblongata*. The white, thick, opaque appearance Greding ascribes to subarachnoid effusion; the dry lardaceous to albuminous exudation. In 37 cases he found minute, pisiform, or lenticular eminences, like a mustard-seed, a hemp-seed, or a pea, soft or hard, disseminated over the membrane; in 27 cases, more copious and thickly set; and in 14 cases accumulated abundantly. These bodies, which are to be distinguished from the *glandules* of Pacchioni, by situation, soft consistence, and milky colour, appear to be a product of the inflammatory process. I have occasionally seen them in subjects in whom the traces of chronic inflammation were distinct. *

Similar changes in the cerebral membranes were recognized by Joseph Wenzel of Mayence,† and Chiarugi of Florence. The latter especially, among 59 necroscopic in-

* Melancholico-Maniaco et Epilepticorum quorundam in Ptochotropheo Waldheimensi demortuorum sectiones tradit J. E. Greding, Continuatio 2da. Apud Ludwig Adversaria, Vol. ii. Part iii. p. 449.

† Observations sur le Cervelet et sur les diverses parties du cerveau dans les Epileptiques, par Jos. Wenzel, D. M. &c. Traduit par M. Breton. Paris, 1811.

spections of insane persons, found in 54 more or less thickening of the membranes, serous infiltration of the subarachnoid tissue, with or without injection of the capillaries, and serous fluid to greater or less amount in the ventricles. *

Much the same results may be derived from the necroscopic reports of Haslam and Marshall. Of 37 cases of insane persons examined by the former, whatever was the state of the brain, the membranes were unsound in all except one (the 33d); and in this "considerable determination of blood to the brain shows that the capillaries of the *pia mater* were inordinately loaded. In 23 of these cases the *pia mater* was injected and loaded with blood, more or less reddened or disordered in its capillary system. In 24 cases, the arachnoid membrane was opaque; in some instances of milky opacity; in several thickened; and in one-half at least with infiltration into the subarachnoid tissue. Of these 24, 13 belong to the first class in presenting traces of injection of the *pia mater*. In 21 cases, serous fluid varying in amount from two tea-spoonsful to four, six, or eight ounces was found in the ventricles; and of these also 10 corresponded with the first class in presenting traces of meningeal inflammation more or less intense. The presence of this fluid in the cerebral cavities, I have already shown, indicates previous vascular congestion of the choroid plexus; and though this membrane was not in all instances much or evidently affected, yet, since in several it was vascular, thickened, vesicular, or indurated, the appearance of fluid in the cavities is as unequivocal a mark of previous inflammation as if it had been reddened, injected, or penetrated by extravasated blood. The opacity, both macular and diffuse, Dr Haslam regards as marks of inflammation; and the subarachnoid infiltration is of the same nature. In several cases, (5, 7, 8, 14, 15, 18,) the injection had proceeded to extravasated patches. In one case, in which the patient died hemiplegic, the right lateral ventricle was distended with dark-coloured blood which had issued from the choroid plexus; and in one in which the

* Della Pazzia in genere e in specie, con una centuria d'Osservazioni. 3 Vol. 8vo. Firenze, 1794.

patient dropped down lifeless in a moment much blood was extravasated between the cerebral membranes.*

The cases dissected by Dr Marshall about the same time, but published some years after, furnish similar results. Of 22 cases of insane persons whose brains were inspected by this anatomist, in 21 serous fluid, varying in amount from 1, 2, or 4, to 12 ounces, was found in the cerebral cavities; and in 17 of these 21 cases similar effusion was found in the subarachnoid tissue occasionally to the extent of elevating the arachnoid membrane in minute vesicles or cysts, (cases 6, 8, 9, 18, 22.) Though the *pia mater* is said to have been injected in four cases only, and the arachnoid to have been opaque in two, it results from the fluid effused into the ventricles or between the membranes, from the vascularity of the substance of the brain, and from the facility with which the *pia mater* was detached from the convoluted surface, that the capillaries of the latter membrane were in a morbid state.† It is further to be remarked, that in nine of these cases were the arteries of the brain opaque, thickened, steatomatous, or ossified,—a condition highly favourable for deranging the capillary circulation of the membranes or the inclosed organ.

These results are important in enumerating the most uniform morbid appearances found in the cerebral membranes of the maniacal. Their chief value, however, consists in the verification which they have since received from the researches of Neumann of Berlin, and Bayle and Calmeil of Paris. From the inquiries of the second of these authors especially, it appears almost established that a state of chronic inflammation of the cerebral membranes is invariably the cause of insanity. My limits do not permit me to detail the whole of the proofs in which this inference is founded; nor is it necessary, after collating the dissections of Greding, Chiarugi, Haslam, and Marshall. A short statement of the principal

* Observations on Madness and Melancholy, &c. by John Haslam, 2d edition. London, 1809.

† The Morbid Anatomy of the Brain in Mania and Hydrophobia, &c. &c. collected from the Papers of the late Andrew Marshall, M. D. 1815.

morbid changes recognized by M. Bayle will be sufficient to show how far the inference is justified by facts.

1*st*, The most constant anatomical character of this state of the cerebral membranes is injection, more or less intense and extensive, of the cellular vascular web of the *pia mater*. The vessels are loaded; the membrane is red or scarlet; and blood trickles from all parts on removing it from the brain. In other instances, its interstices are distended with serous fluid, which gives it a pale gray colour, and increases its volume and thickness. The arachnoid is reddish scarcely once in 16 or 20 cases.

2*d*, The arachnoid becomes opaque and thickened, especially in the convex centre of the hemispheres, at their mesial margin, and on their mutual surface. This thickness, which may be so great as to approach that of the *pleura*, the *pericardium*, the *dura mater*, or macerated parchment, M. Bayle ascribes not to albuminous deposition on its surface, but to developement of vessels, and extravasation of matter in its substance.

3*d*, The meningeal injection very generally terminates in serous effusion, either from the free surface of the arachnoid membrane into the subarachnoid tissue, or from the arachnoid of the choroid plexus, constituting effusion into the ventricles.

4*th*, *Albuminous exudation* occurred in $\frac{1}{6}$th of the subjects at the free surface of the arachnoid of the *dura mater*, covering its whole extent, confined to the convexity of one or both hemispheres, to the falx, or to the occipital region,—applied, but not adhering to the cerebral arachnoid.

5*th*, Adhesions of the two surfaces of the arachnoid occurred not more than 8 or 10 times in 100 instances. They are most common in the great fissure, and once or twice were observed in the ventricles. In one case, in which the disease was complicated, M. Bayle found the two folds of the arachnoid intimately united by the interposition of an albuminous patch.

6*th*, The membranes adhered to the convoluted surface with unusual firmness, so as to carry portions of brain in

one-half of the cases. This took place in spaces varying in size from a lentile or a bean to a five-franc piece or more. The connection of this change with inflammation is denoted by the vascularity and anormal thickness of the membranes at the adhering points.

7*th*, The pisiform granulations of Greding were found in not more than $\frac{1}{10}$th of the subjects; a degree of rarity probably dependent on the circumstance that they are in general a product of long-continued inflammation.

8*th*, Bloody extravasation in the arachnoid cavity, which belongs to a subsequent head, was found in about $\frac{1}{8}$th of the cases.

From these and similar facts, and from the cases of M. Calmeil, it results that the cerebral membranes, more especially the tomentose and vascular surface of the proper membrane, (*pia mater* and *choroid plexus,*) are liable to assume a peculiar state of chronic inflammation, affecting more or less sometimes very considerably the convoluted and cerebral surfaces of the brain. Of this morbid change the first effects are more or less weight, uneasiness, and pain of the head; sometimes partial convulsive motions; sometimes tetanic motions or involuntary contractions, *vertigo,* double vision, spectral *delirium,* and occasionally sudden loss of sensation and motion. In other instances, it induces gradually deficient memory, disordered intellect, and some affection of the muscles of speech. *Finally,* it induces palsy, fatuity, and stupor or coma, terminating fatally.

Palsy occurring under these circumstances in the insane is distinguished by peculiar characters. At first the motions of the tongue are constrained; the efforts to speak are unavailing; articulation is impracticable; and the individual struggles and stammers to express his desires like a person under the influence of intoxication. As this becomes intense he is observed to totter, stagger, or reel in walking, and is aware that he cannot direct the muscles of the limbs to move as he wills. At this time the derangement verges to fatuity. At a more advanced period, not only is speech obliterated

or converted into inarticulate muttering, but the patient is unable to maintain himself erect; and whenever he wills to make any motion, neither arms nor legs are obedient to his desires. This morbid action of the cerebral membranes, in short, impairs, but does not annihilate the motions of all the voluntary muscles. It induces a general but incomplete loss of power.

The senses are at the same time impaired but not obliterated. The paralytic madman distinguishes light from darkness; he hears a loud sound made at the ears; and he is sensible of pungent odours. But if the skin be touched with two bodies, the one hot and the other cold, he distinguishes no difference. Taste and general sensation are equally obtuse. In this state death is not remote. The duration of the affection varies according to the slowness or rapidity of the meningo-encephalic disorder, from which the palsy arises. Some paralytic maniacs live eight months, a year, eighteen months, and others continue two or three years, rarely longer. The average duration of life, after the commencement of paralytic symptoms indicates affection of the cerebral surface, is about thirteen months.

2. *Hemorrhage.*—Discharges of blood from the serous membranes have not attracted so much attention as those of the mucous surfaces. They are nevertheless not uncommon; and though the inaccessible situation of the serous surfaces has made their hemorrhages be overlooked or confounded with other diseases, they constitute a form of morbid action too important to be omitted. They occur in all the serous membranes, are preceded by injection, and take place by exhalation, and may be arranged in the following order.

Cerebral membranes,	*Meningæmia.*	
Pleura,	*Pleuræmia,*	*Hæmathorax.*
Pericardium,	*Hæmacardia.*	
Peritonæum,	*Hæmenteria.*	
Perididymis,	*Hæmatorchis.*	

Meningæmia.—The nature of the subject compels me re-

luctantly to begin with hemorrhage of the tomentose or vascular surface of the *pia mater*. In this variety of meningeal hemorrhage, which has been greatly overlooked, the vessels of the attached surface of the *pia mater* become inordinately injected and effuse blood, which is deposited in the convoluted surface generally, and occasionally in the ventricles. Omitting some obscure accounts of this affection in the older collections, the first good example is given by Morgagni from Valsalva, who found in the body of a man of 58 much coagulated blood between the *pia mater* and the convoluted surface of the right hemisphere. (Epist. ii. 19.) Two similar cases Morgagni inspected himself. (Epist. iii. 2 and 4.) The best instances of this hemorrhage, however, is given by Mr Howship in his 11th case. It occurred in a young woman of 22, who for two years had laboured under rheumatic ailments, and at length, after paralytic and vertiginous symptoms, died lethargic. Upon inspection the *pia mater* was found vascular and red ; its vessels increased in number and size ; and blood was diffusely extravasated all under the *pia mater*.—" The extravasated fluid had formed superficial coagula, corresponding to the *sulci* between the convolutions."—" It had taken place very universally, and the effusion seemed to have arisen not only from the capillary arteries upon the external surface of the *pia mater*, but also from those processes of the membrane which dip between the convolutions forming the *tomentum cerebri*. Several of these deep-seated coagula were divided by the knife in the course of the dissection." *

Slighter examples of partial extravasation on the convoluted surface I have seen myself, and mentioned some years ago, † when I did not well understand the source of the hemorrhage. Dr Abercrombie records two instances communicated by Dr Hunter and Dr Barlow, in which the extravasation, he states, was from the superficial vessels of the

* Practical Observations on Surgery and Morbid Anatomy, &c. Lond. 1816. Section ii. Case xiv. see also cases xviii. and xx.

† On the Pathological Anatomy of the Brain and its Membranes, Med. and Surg. Journal, Vol. xviii. p. 487.

brain. * He does not specify, however, whether the blood was beneath the *pia mater* or above it. If it was above, it belongs to the following head.

Hemorrhage from the free surface of the arachnoid membrane is more common. It may take place either from that which lines the *dura mater,* and covers the *pia mater,* when it is found between these two membranes; or from the arachnoid of the choroid plexus, when it is found in the ventricles. Of the former, a good instance is given by Haslam, who found this the cause of sudden death in the person of a maniac. The same change was found by Bayle in about $\frac{1}{8}$th of the cases of persons cut off by symptoms of chronic meningitis. The cases of Drs Hunter and Barlow are already mentioned. Effusion from the interior arachnoid is more frequent; and cases may be found in the writings of most collectors. Of this nature are the following. The case of the chamberlain of the monastery of Rheinau, near Schaffhausen, recorded by Wepfer; † several described by Morgagni, *e. g.* the case of Cardinal Sanvitali; and those in the 13th, 15th, 17th, 19th, and 22d sections of his second epistle; the cases of Antonio Tita, Pietro Facciolati, and the Danish ambassador in his third epistle, and one or two in the sixtieth; the case related by Veratti in the Bologna Memoirs; ‡ the case by De Haen, called rupture of the choroid plexus; § the 48th of Rochoux; ‖ the 4th, 8th, and 12th cases of Cheyne; ¶ one or two cases by Merat; ** and the 20th and 21st cases of Serres. †† In all these cases, blood or bloody fluid was found in the ventricles; and since it was not connected, as in the ordinary instances of this with rupture or injury of the cerebral substance, and consequently had not penetrated, as I have formerly shown, from the sub-

* Researches, Pathological and Practical.

† Historia Apoplecticorum.

‡ Comment. Bonon. Tom. ii. Chap. i. § Rat. Med. Pars iv. cap. v. p. 189.

‖ Recherches sur l'Apoplexie.

¶ Cases of Apoplexy and Lethargy. Lond. 1812.

** Memoires de la Societé Medicale d'Émulation, Tome vii. p. 61.

†† Annuaire Medico-Chirurgicale, &c.

stance of the hemispheres, it is inferred that it must have issued from the plexus. There is no reason to suppose that the vessels of this web are ruptured in this form of hemorrhage. The fluid is rarely pure blood, generally sanguinolent; but even if ever pure, the observations of Bichat, Merat, and Serres, show that it may ooze by exhalation from the plexus. It constitutes the meningeal apoplexy of Serres.

It is further an interesting confirmation of this view, that hemorrhage of the same nature may take place from the arachnoid of the membranes of the spinal chord, and give rise to similar symptoms, though modified by the situation of the effusion. Of this variety of arachnoid hemorrhage, an instance is quoted by Sauvages from Duverney, under the title of *asphyxia spinalis;* but the best examples are those recorded by M. Chevalier in the 3d volume of the Medico-Chirurgical Transactions, and that by Sir A. Cooper in his work on Dislocation. In these cases blood coagulated and fluid was found in the spinal canal between the membranes, and the vessels of the membranes were inordinately loaded.

Pleuræmia; hæmathorax.—On this form of hemorrhage, instances of which are recorded by Morgagni and Lieutaud, which has been well described by Merat and Laennec, it is unnecessary to say more. Merat informs us that this hemorrhage proved fatal to Professor Mahon. *

Hæmacardia, or hemorrhage from the pericardium, has been not less overlooked than the other bloody discharges of the serous membranes. In the few instances which have been recorded, it has generally been ascribed to laceration or rupture of the auricles, venous sinuses, or organs of the large vessels, allowing the blood contained to escape and distend the pericardium. In the instances to which I now advert, the most minute and diligent search was inadequate to detect either rupture, laceration, or minute orifices by which blood could escape; and it must therefore be inferred, that it issues from the membrane by the process of exhalation.

Of this singular hemorrhage, four distinct and authentic

* Journal de Medecine, Tome ix. p. 132.

cases are recorded. In the first, by Dr Alston, three pounds of coagulated blood and bloody serum were taken from the pericardium. When the inner surface of the pericardium, and the external surface of the heart were carefully cleansed by sponges, no aperture of any of the large vessels could be discovered; "but on pressing the heart bloody serum oozed from many small orifices on its surface, and principally near its basis." * The second case, by Dr Thomson of Worcester, is similar in the quantity and kind of blood effused, and in the impossibility of tracing it to rupture or open vessel. † In the third case, by Mr Joseph Hooper, about five pints of fluid blood, perfectly free from *coagula*, were found in the pericardium, in which no vestige of rupture could, after the most careful examination, be found. ‡ Lastly, in a case by Merat, two ounces of pure blood were found in the pericardium of a man of 53, who had laboured under organic lesion of the heart and consecutive dropsy. §

Baillie, to whom these effusions were known, was aware of the difficulty of explaining them, and conjectures that the blood may have oozed by transudation, or escaped from the extremities of the minute vessels, which he supposes may be inordinately relaxed. || The last supposition, it may be remarked, virtually admits exhalation.

Hæmenteria; Peritonæmia.—Peritonæal hemorrhage is not uncommon. It occurs under two forms, the sanguinolent and the sanguine. A valuable instance of this hemorrhage, mentioned by Morgagni, ¶ is that of Laelio Laelii, a medical student, a native of his own town of Imola, in whose abdomen was found about 1½ pound of fluid blood, with black spots of the peritonæum. The best examples, however, are those recorded by Merat. In the first, there were three pints of bloody serum in the cavity, with evident marks of peritonæal inflammation. In a second, there were between two

* Medical Essays and Observations, Vol. vi. p. 111. Art. lvi.

† Medical Observations and Inquiries, Vol. iv. p. 330, Art. xxvi.

‡ Memoirs of the Medical Society, Vol. i. p. 238, Art. xviii.

§ Mémoires de la Societé Medicale d'Emulation, Vol. vii. p. 63.

|| Morbid Anatomy. ¶ Epist. xxxv. 2. Case of Laelio Laelii.

and three pints, and the membrane was covered with numerous granulations. In a third case, in which death took place 47 days after the first symptoms, upon inspection there were found about twenty pints, of a fluid, first sanguinolent, then like pure blood, and lastly some clots. The marks of inflammation were so intense as to leave few traces of the original form of the abdominal viscera. *

Hæmatorchis.—Of hemorrhage from the vaginal coat, Bichat states that he met with two instances only; and Merat acknowledges that he has not yet seen them. On some occasions this hemorrhage lays the foundation of the bloody tumour *(hæmatoma,)* occasionally found in the vaginal coat.

From the facts recorded it results that these hemorrhages, like those of the mucous tissue, are the result of exhalation. Bichat states, that after scrupulous examination of the inner surface of the *pleura, pericardium,* and *peritonæum,* under these hemorrhages, he found the surface entire, and the vessels unbroken. There is every reason to believe that they are in all cases preceded by congestion of the capillaries; for most of those which are hitherto accurately recorded were connected with marks of inflammation, and some with organic lesion.

I have yet to observe, that the serous membranes are liable to become simultaneously the seat of hemorrhage in land-scurvy and in sea-scurvy. In the former disease, these membranes have been found occupied not only by petechial spots and dark or livid blotches, but with considerable effusion of fluid blood. Of this, the cases of Dr Duncan Junior and Mr William Wood are the best examples. In extreme cases of scurvy the same extravasation takes place.

3. Of anormal accumulation of serous fluid in the serous membranes I have nothing to add to what is already said in the chapter on the exhalants. These accumulations may almost invariably be traced to disease of the contained organs.

4. Air is not unfrequently effused into cavities formed

* Mémoires de la Societé Medicale d'Emulation, Tom. vii. p. 65.

by serous tissue. Besides the form of *pneumothorax*, which results from fistulous opening of the lung, another may take place from laceration or wound of the lung. In the peritonæum it is the result either of inflammation, of gangrene and decomposition of serum, of ulcerative perforation, or of organic disease producing the same effect.

5. Tubercular deposition is said to be frequent in the serous membranes. The exact nature of the deposition, however, is not well defined. The tubercular diseases occurring in serous membranes are of two sorts, the genuine *tyromatous*, or that in which tyromatous matter is deposited, in irregular or amorphous masses in the membrane,—and the *cenchroid* or miliary, in which minute lenticular bodies hard as cartilage, but transparent, are developed in these membranes.

6. The tyromatous deposition occurs in these membranes, but most frequently in the peritonæum, in which it was originally observed by Morgagni, Lieutaud, and Baillie, afterwards well described by Dr Baron, and more recently observed by Dr Moncrieff. They are small round bodies of caseous consistence, and generally softened in the centre. They cause inflammation of the membrane. In the pleura tubercles are noticed by Morgagni, Lieutaud, and Baillie. To this head, perhaps, we may refer a variety of *tyromatous* tumour of the pleura observed by Mr Howship. It consisted in a great number of bulbous processes variable in shape and size, but, apparently from the description, oblong, spheroidal, and attached by narrow stalks or peduncles. The substance of these bodies, which was semitransparent and very firm, of a dull-yellow colour, partly fluid and partly solid, is ascribed by Mr Howship to effusion of lymph. The opacity and increase of density resulting from immersion in alcohol showed that they contained albuminous matter. *

In the membranes of the brain they seem to be also not uncommon, though their origin from the arachnoid is not quite established.

* Practical Observations on Surgery and Morbid Anatomy, p. 204.

Tubercles or tyromatous depositions in the tubercular form are often found in the *pia mater*, and especially its cerebral prolongations. They occur not only in the exterior division of the membrane, but in that which penetrates the ventricles; and from this circumstance it often happens that tyromatous bodies, which are found in the cerebral substance, have originated in the membranes. Thus of the figures given by Baillie in the 7th pl. of his 10th fasciculus, two tubercular bodies are found actually attached to the choroid plexus; one found in the lower part of the fourth ventricle; and that represented by Dr Hooper in the same situation (12th pl.) appears to have had the same origin; and those said to be found in the brain were very probably originally formed at the filamentous surface of the *pia mater*, between which and the bodies, in most instances, vascular connections are distinct and immediate.

The cenchroid tubercles are very frequent in serous tissue. In the pleura they were seen by Wrisberg, Baillie, Bayle, Laennec, and Andral; in the peritonæum by Scoutetten.

These miliary or cartilaginous tubercles are not unfrequently found to occupy all the serous membranes at once, more especially in the bodies of the lower animals. Thus I have often seen them in the pleura, pericardium, and peritonæum in the sheep; and in a specimen of the Paca dissected by my friend Dr Grant, every serous membrane was thickly set with them. They occur chiefly in men and animals long excluded from air and exercise. In the early stage they do not exercise much influence on the state of these membranes. But at a more advanced period they cause inordinate exhalation, opacity, dulness, and other marks of morbid circulation of the tissue. The opinion of Laennec, that miliary tubercles are the incipient form of the tyromatous tubercle, is in reference to the serous membranes destitute of proof. The miliary eminences of these membranes have not yet been shown to pass into the tyromatous.

7. *Chondroma.—Cartilaginous degeneration* is not uncommon in the serous tissue. It appears in the form of patches vary-

ing in size and shape, attached to the free surface of the membranes. By some authors this is regarded as a preliminary step to ossification. But this is not established.

8. *Ossification.*—In no texture, perhaps, is osseous deposition more frequent than in the serous. It occurs in every one of these membranes without exception. In the arachnoid it is not unfrequently seen in the form of osseous plates at the inner surface of the *dura mater*, and the free surface of the *pia mater*. In the pleura and pericardium it is exceedingly common, instances of it being noticed by most authors, and numerous specimens of it contained in museums. In the pleura it is most common in the costal division, large portions of which are sometimes found converted into broad flat patches of bone. The instances of ossification of the diaphragm are of the same nature. In the pericardium it is probably most frequent in the cardiac division, and constitutes those cases vaguely denominated *ossified hearts*. In the peritonæum it is less frequent; but is remarked in particular portions of this membrane. Thus it is common in the muscular, diaphragmatic, splenic, and uterine peritonæum, less frequent in the hepatic and colic, and scarcely seen in the ileal. These patches, though hard, firm, and apparently solid like bone, never present the organization peculiar to that substance. Its presence is generally connected with traces of inflammation or at least injection of the membrane; and Rayer has lately, in an elaborate essay, attempted to prove that osseous deposition is a result of that process.* Indeed, many circumstances render it highly probable that chronic inflammation of serous tissue causes effusion of lymph, which is eventually converted into osseous matter. One of the most satisfactory proofs of this principle is, that osseous induration of the peritonæum is very common in hernial protrusions of the intestine, in which the membrane is subjected to slow inflammation; and that the vaginal coat of the testicle is often cartilaginous, or even bony in cases of old hydrocele.

* Archives Generales, Tom. vii.

9. *Hygroma.*—The serous cyst is not uncommon in the diaphanous membranes. It appears, however, from various observations, to be most frequent in the attached surface, or in the subserous tissue.

10. *Hydatids.*—These globular sacs are believed to be almost proper to the serous membranes. It is certain that in these they are more frequently observed than elsewhere. Thus they are found attached to the pleura, to the pericardium, to the peritonæum, and to the vaginal coat; and in some rare cases they have been seen in the choroid plexus. Thus Fischer found the *tænia hydatigena* of Pallas, or the *cysticercus pyriformis* of Zeder, attached to this membrane by a peduncle, and vesicular bodies, supposed to be of the same *genus,* attached to the arachnoid surface of the *dura mater.* The writings of Bonetus, Morgagni, and other collectors, contain frequent examples of pulmonary hydatids, several of which were originally hydatids of the *pleura,* and several of the subserous tissue. In the peritonæum they are still more frequent; and Dr Monro *tertius* gives a valuable collection of cases, in which these bodies were found connected with various regions of that membrane. Though the *cysticercus* or solitary hydatid is occasionally found, those more usually seen in this membrane are the *cænuri* and *echinococci,* or the gregarious form of the animal. Of this description, I saw some years ago a very good example. In the body of a man of about 45, who died with the usual symptoms of dropsy, two globular cysts, one as large as a child's head, were found attached to the hepatic peritonæum. In each of these were contained an immense number of globular cysts containing transparent fluid, about half an inch or eight lines in diameter, and surrounded in like manner by a transparent fluid. Two similar cysts, each containing many small ones, were found attached to part of the ileum. These bodies caused during life irregular prominent tumours of the belly. Hydatids are also common in the vaginal coat.

11. *Fungus Hæmatodes* is observed to take place in this tissue. One example, in which it originated in the hepatic

peritonæum, and thence proceeded to affect the greater part of the abdominal cavity, and afterwards presented at the groin, where it destroyed the bones of the pelvis, and the upper end of the thigh-bone, some years ago fell under my observation. The tumour had attained an enormous size, and consisted chiefly of cerebriform matter contained in several cysts, and in some instances softened into a dark-coloured pulpy semifluid mass.

12. Scirrhous induration is said to take place in serous tissue. There is no doubt that it often affects this tissue from the contiguous ones, especially the mucous and submucous; but it is not ascertained that it originates in the serous membrane. It is not necessary to confound under this name various indurations, which seem to be the result of the inflammatory process, or the lardaceous state observed in the omentum and mesentery in old dysenteries, which by some have been represented as examples of this morbid degeneration.

13. *Accidental Developement.*—No tissue perhaps is so liable to be accidentally repeated as the serous. The cysts already mentioned are generally regarded as examples of this repetition; and, indeed, they possess all the characters of serous tissue. These cysts are found in many parts of the body; but they are very common in the female ovary, in which they often constitute the anatomical character of dropsy of that organ. They are also seen in the testicle of the male. The mode of their developement is not well ascertained. The hypothesis of dilatation or expansion by mechanical compression was successfully refuted by Bichat; but the one which he attempts to establish in its place has not been generally adopted. The minute clustered bodies denominated by Laennec *acephalo-cysts,* and the animal nature of which, though admitted by that author, is denied by Cuvier and Rudolphi, belong to the same head; and their formation is equally little understood.

14. Before concluding this chapter, I must notice certain morbid states incident to the fibro-serous membranes.

The *dura mater,* as a compound membrane, partaking at once of the structure of periosteum and arachnoid, is liable

to affections which bear this twofold character. Its outer or cranial lamina is liable to all the morbid processes incident to periosteum. Its inner or arachnoid, it has been already shown, is liable to those peculiar to this membranous pellicle.

I have already shown that the latter surface of the *dura mater* is occasionally covered by albuminous exudation, the result of the inflammatory process. This same substance is occasionally deposited between its laminæ, and causes thickening and some induration.

Tyromatous deposition in round nodules also occurs in this membrane, and has been well represented by Dr Hooper in his 6th and 7th engravings. They possess all the characters of the usual tyromatous matter, and consist of whitish or gray opaque substance of the consistence of cheese, of different degrees of firmness, inclosed in a vascular capsule. Generally they grow from the arachnoid surface of the membrane, but sometimes they seem to arise from its substance.

The *dura mater* often becomes the seat of a firm tumour, which as it grows produces absorption of the cranial bones. In the excellent collection of cases by M. Louis, we find that it invariably proceeded to bad ulceration; but that death in general took place in consequence of interruption to the functions of the brain.

In the testicle I have seen a peculiar disease which I refer to the *albuginea* and its serous covering. The testicle seems much enlarged and irregular; but shortly ulceration takes place, and discloses an extensive mass of dead matter evidently exterior to the gland. The sloughing process alternating with ulceration and granulation proceeds till the whole exterior coat of the testicle is expelled. This process, which occurred in a scrofulous subject, and never showed any tendency to malignant ulceration, I ascribe to death of the fibro-serous covering of the testicle.

Cartilaginous and bony matter of different degrees of firmness and perfection are often observed in the cerebral membranes, more especially the *dura mater*. Of this change manifold instances are given by Bonetus, Morgagni, Lieutaud, Sandifort, and other collectors; and they are delineated by Baillie

and Hooper. These cases are vaguely mentioned under the general title of ossification of the brain; but few of them are entitled to this character, for all of these originate in the membranes. The only authentic instance apparently of bony matter found in the substance of the brain unconnected with the membranes, is that delineated by Dr Hooper in his 12th engraving. The description, nevertheless, is not sufficiently minute to justify positive assertion.

CHAPTER XXIV.

SECTION I.

SYNOVIAL MEMBRANE;—*Membrana Synovialis;—Bursæ Mucosæ.*

BICHAT enumerates several circumstances in which he conceives that serous and synovial membrane differ from each other. Gordon, who doubts how far the distinctions are well founded as the basis of anatomical arrangement, admits, however, the following peculiarities.

Synovial membrane resembles serous membrane in so far as it is a thin, transparent substance, having one smooth free surface turned towards certain cavities of the body, and another connected by delicate cellular substance to the sides of these cavities, or to the parts contained in them. But it differs from serous membrane in the following circumstances. 1*st*, It possesses little vascularity in the healthy state; no blood-vessels are almost ever seen in it after death, nor can they be made to receive the finest injection; 2*d*, Its lymphatics are quite incapable of demonstration;

3*d*, Very delicate fibres, like those of cellular substance, or like the finest filaments of tendon, are distinctly seen in it after slight maceration; 4*th*, It is considerably less strong than serous membrane. On these grounds, therefore, synovial membrane is to be anatomically distinguished from serous membrane.

The synovial membrane, as described above, is found not only in each of the moveable articulations, but in those sheaths in which tendons are lodged, and in which they undergo a considerable extent of motion, and in certain situations in the subcutaneous filamentous tissue.

The distribution of the synovial membranes is much the same in all these situations. They are known to line the ligamentous apparatus of each joint, capsular and funicular; and they are also continued over the cartilaginous extremities of the bones of which the articulation consists. This continuation, which was originally maintained by Nesbitt, Bonn, and William Hunter, and was demonstrated by various facts by Bichat, has been lately questioned by Gordon and Magendie, the former of whom especially thinks it unsusceptible of anatomical proof. The cartilaginous synovial membrane is certainly not so easily demonstrable as the capsular, for the same reason which I have already assigned regarding the difficulty of isolating the arachnoid of the *dura mater*, the capsular pericardium, the ovarian peritonæum, and the serous covering of the *tunica albuginea*,—the want of filamentous tissue.

The presence of synovial membrane in the articular cartilage is nevertheless established by sundry facts. 1*st*, If a portion of articular cartilage be divided obliquely, and examined by a good glass, it is not difficult to recognize at one extremity of the section a thin pellicle, differing widely in aspect, colour, and structure, from the bluish-white appearance of the cartilage. 2*d*, If the free surface of the cartilage be scraped gently, it is possible to detach thin shavings, which are also distinct from cartilage in their appearance. 3*d*, The free surface of the cartilage is totally different from the attached surface, or from a section of its substance, and derives its peculiar smooth polished appearance from a very thin transparent pellicle uniformly spread over it. 4*th*, If articular cartilage be immersed in boiling water, this thin pellicle becomes opaque, while the cartilage is little changed. 5*th*, Immersion in nitric or muriatic acid, which detaches the cartilage from the bone, gives this surface a cracked appearance, which is not seen in the attached surface, and which is probably to be ascribed to irregular contraction of two different animal substances. 6*th*, The existence of this cartilaginous synovial membrane is demonstrated by the morbid process with which the tissue is liable to be affected. Upon the whole, therefore, I believe little doubt can be entertained, that the representation of their course, as given originally by Nesbitt, Bonn, and Hunter, is well founded

The same views may be applied to the synovial linings of the tendinous sheaths, which are equally to be viewed as shut sacs.

Attached to the free surface of each synovial membrane is a peculiar fringe-like substance, which was long supposed to be an apparatus of glands (glands of Havers) for secreting synovial fluid. It is now known that these fringes are merely puckered folds of synovial membrane, and that, although synovia is abundantly secreted by them, this depends merely on the great extent of surface which their puckered arrangement necessarily presents. This arrangement is easily demonstrated by immersing an articulation containing the fringed processes in clear water, when they are unfolded and made to float, and show their connections, figure, and terminations. They are analogous to the free processes of serous membranes, and like them are double, and contain adipose matter.

The synovial sheaths (*bursæ mucosæ*,) are very numerous, and are generally found in every tendon which is exposed to frequent or extensive motion.

Though the fluid prepared by these membranes has been examined by Margueron, Fourcroy, John Davy, Orfila, and other chemists, it cannot be said that very accurate results have been yet given of its chemical composition. It is said to contain water, albumen, incoagulable matter, regarded as mucilaginous gelatine, a ropy matter, and salts of soda, lime, and some uric acid.

Section II.

The diseases of synovial membrane are important.

1. Inflammation is an occurrence not unfrequent in the synovial tissue, and produces effects in many respects similar to those which are observed in the serous. Every example of diseased joint, there is reason to believe, commences with inflammation, acute or chronic, of the synovial membrane. Of this process the anatomical characters are injection of the membrane, which sometimes becomes very red with numerous vessels, and occasionally traversed by crimson or brown spots and patches; dulness of its surface; opacity; thickening to a considerable extent, and some degree of pulpiness. The effects of the process are effusion of fluid, sometimes serous, sometimes ichorous or vitiated *synovia*, more especially tinged with blood, occasionally sero-albuminous fluid, which undergoes partial coagulation, and leaves the cavity distended with a thin sero-purulent liquid. In other instances, complete purulent matter, with curdy or albuminous flakes, are the result of synovial inflammation.

If it fail to terminate in resolution, the fluid effusion in the synovial sac constitutes the simplest of those multiform affections known under the name of white swelling, (*hydarthrus.*) When this is not abundant the fluid part is absorbed, and the coagulable matter may contract adhesion to the free surface of the membrane. This is the origin of that species of *ankylosis*, sometimes general and complete, sometimes partial and imperfect, in which the articular synovial membrane is found united by *bridles* or ligaments of false membrane.

When sero-purulent or purulent matter is effused into a synovial cavity, especially where the inflammation fails to be resolved or passes into the chronic state, ulceration of the capsule and the interligamentous tissue is liable to take place; and the ichorous or sero-purulent fluid is discharged by one or more openings in the skin.

In more advanced and chronic states the synovial membrane often becomes thick, pulpy, and vascular, granular or villous on its surface, and is at length destroyed by ulcera-

tion. In some joints this process is an immediate effect of inflammation, the synovial covering being gradually perforated in numerous points at which the subjacent cartilage is exposed, and then undergoes erosion. Though this process may occur in any joint, the researches of Mr Brodie show that it is most frequent in the knee, in which the destruction it occasions is often very great. A disease of this kind I have several times seen remove every particle of cartilage from the articulating extremities, and expose the cancellated structure of the bone. This process is attended with extreme pain and suffering to the patient, more particularly aggravated during the night. The same process takes place in the elbow-joint; but here it often forms fistulous abscesses of the extra-capsular cellular tissue. In the articular processes of the vertebræ, I have seen it often give rise to disease of these bones, and finally terminate in ankylosis, with destruction of the processes and considerable lateral curvature of the spine.

Inflammation of the articular synovial sacs affects not only the cartilages and bones, but the ligaments, capsular and funicular. Its transition to these textures, which is easy and direct, induces thickening and induration of the ligament, in consequence of effusion of lymph between its fibres and interstices. After some time the action extends to the extra-articular filamentous tissue, which is then injected by jelly-like fluid, sometimes colourless or pale red, at other times reddish or brown. At the same time, this filamentous tissue acquires a granular character, and some induration. These several changes, which give rise to swelling round the joint more or less diffuse, constitute one of the most frequent forms of white-swelling. Suppuration may take place, as in the last instance, followed by fistulous openings.

In the synovial sheaths of tendons inflammation produces effects not dissimilar. The most marked instances of this process is observed in synovial or thecal whitloe, *paronychia thecalis*, in which inflammation of the synovial membrane, I have elsewhere shown, from the anatomical peculiarities of these sacs, not only causes death of the contained tendon, but, by passing to the periosteum, may induce caries of the

phalanges. In other parts of the body these sheaths are not very liable to inflame, unless in consequence of external injury. From this cause I once witnessed severe inflammation terminating in effusion of purulent fluid in the synovial sheath between the tendon of the *glutæus maximus* and the head of the trochanter. After incision, however, it terminated favourably, without appearing to impair the motions of the tendon.

Ganglia.—A milder form of inflammation is occasionally seen in these sheaths, terminating in effusion of semitransparent, viscid, glairy fluid, like white of egg. This effusion causes an oblong prominent hemispheroidal swelling, tense, elastic, and communicating a sense of fluctuation, which has been long distinguished by the names of *hygroma* and *ganglion*, according to the degree in which it takes place. As I restrict the former appellation to the serous cyst, there is no occasion for using two names to varieties of an affection the same in anatomical characters. Ganglion is subcutaneous or tendinous, according to its situation in the subcutaneous or tendinous synovial sacs.

During gout the synovial sacs, both articular and tendinous, are the seat of an inflammatory process which terminates in the secretion of synovial fluid loaded with urate of soda.

2. Hemorrhage of the synovial membranes is not very common, but has nevertheless been observed. M. Pitet, in particular, saw in the knee-joint a collection of blood, which he thinks was exhaled from the articular synovial membrane. * When this effusion does takes place it is an effect of previous injection of the capillaries of the sac. I have often thought that some of the bloody abscesses met with occasionally in the cellular tissue, and in the neighbourhood of tendons, depended on synovial sacs in which hemorrhage had followed chronic inflammation. This probably is the origin of the 17th case of Palletta, in which a bloody tumour containing pure blood was found in the left ham. † The incision of these tumours is always followed by exten-

* Bulletin de la Société de Med. p. 222.

† Exercitationes Pathologicæ, p. 207.

sive and malignant, often fatal inflammation of the interior surface of the cyst.

3. *Tyroma.*—Synovial membrane is said to be liable to tubercular deposition. No doubt can be entertained of the frequency of albuminous deposits; and I believe tubercles have been seen in the coxo-femoral synovial membrane in disease of that joint. This, however, I have not had an opportunity of verifying.

4. *Cartilage.*—In some instances cartilaginous bodies are observed to adhere by a narrow peduncle to the free surface of the synovial membranes. This, though most frequently observed in the femoro-tibial articulation, is certainly not peculiar to it. These bodies may be either generated by morbid action of the synovial tissue, or may be portions of cartilage or fibro-cartilage broken accidentally from some part of the articular apparatus, and suffered again to contract adhesion to the synovial membrane by the inflammation which their presence induces.

5. *Hematoid fungus*, or cerebriform degeneration, is a disease which often originates in the interior of joints. The circumstances under which this commences renders it difficult to ascertain the texture primarily affected. It is nevertheless most probable that it is chiefly the synovial membrane in which this tumour commences. In the cases of the disease which have been inspected before much destruction has taken place, the articular extremities of one or both bones have presented large fungous spongy masses of matter like brain, and well supplied with blood-vessels; and it has been impracticable to recognize any trace of synovial membrane or cartilage. The analogy between the serous and synovial sacs in this respect is obvious.

6. *Scirrho-carcinoma* appears not to originate in this tissue, but certainly affects it from collateral tissues. Some authors have, indeed, with singular vagueness, spoken of certain forms of white swelling or *fungus articuli*, as being a sort of cancerous disease. This, however, is only one of many errors which originate in the practice of applying a vague general epithet to many different morbid states.

NOTES.

Note A.—P. 62.

THE reader may wish to see the views of this anatomist stated in his own language.

" In questa maniera presso a poco vengono ad essere costituite le membrane, che formano le celle della pinguedine. In tutte queste parti vasi sanguigni si trovano ovunque continuati e non possono depositar nelle celle l'umor più sotti le, se non che per i pori delle lor tuniche. I vasi assorbenti che nascono da queste celle, son quelli i quali assorbiscono di mano in mano l'umore, che vi si separa, e con questo, e con quello, che viene, e proviene da altre parti, elaboran la linfa destinata al nutrimento del corpo animale. Riguardo alle celle destinate a contener la pinguedine essi assorbiscono l'umor piu sottile, e rendon perfetta la separazione di quella materia oleoso-grassosa, che va sotto il nome di pinguedine, adipe, o grasso, e si accumula più o meno a tenore delle diverse età degli animali, secondo la quantità del nutrimentó, del riposo, degli esercizi, accumulandosi nella quiete, consumendosi nell esercizio e nelle malattie.—Prodromo della Grande Anotomia, seconda opera postuma di Paolo Mascagni. Firenze, 1819. P. 76. Capitolo ii.

Note C. and D.—P. 90 and 93.

The opinion that cartilaginous and osseous induration of the semilunar and mitral valves depends on chronic inflammation, derives great probability from some circumstances observed in the origin and progress of these changes. One of the strongest arguments in its favour is the fact, that in the serous membranes the formation of cartilaginous and osseous patches is often preceded by distinct marks of inflammation. Though we cannot prove absolute identity between these textures and the inner cardiac membrane, yet as they are very similar in many of their properties, there is reason to believe that in this also they resemble each other. The opinion is maintained by M. Rayer in an elaborate

paper in the *Archives Generales*; but a greater number of positive facts and direct evidence is requisite to determine the point.

Note H.—P. 222.

The chemical history of steatomatous and lipomatous tumours is imperfectly known. Many years ago Dr Bostock analyzed a stearoid tumour without obtaining any precise result. The effects of the agents employed indicated the presence of neither fat, jelly, nor adipocire; nor was any change accomplished by potass. From its general intractability, however, and the effects produced by sulphuric acid, he infers that it is composed chiefly of carbonaceous matter. —Edin. Med. Journal, Vol. ii. p. 14 and 17.

Ignorant of these results, I attempted some years ago to examine the chemical nature of the matter contained in a steatomatous cyst. This matter was of a lemon yellow colour, not absolutely opaque, yet not translucent, and like fat, for it communicated a stain to paper, and liquefied on exposure to heat. Though it was perfectly soluble in oil of turpentine, I found that no method which I could devise could make it unite with *potassa*. From the experiments of Chevreul, it is not improbable that they contain cetine or adipocire. But it must be admitted, that precise information is still wanting.

Note I.—P. 229.

The direct communication of the lymphatics with the veins, though recently advanced as a new doctrine, was observed in 1771 by John Fred. Meckel.

"Non raro mihi in repletione vasorum lymphaticorum mercurii ope occurrit, liquidum hoc penetrabilissimum absque extravasatione ex vasis lymphaticis in venas sanguiferas transiisse. Hinc cavam venam inferiorem, ex injectione in vasa lymphatica, mercurio plenam inveni, nulla interim, ne guttula quidem mercurii per thoracicum ductum, prope insertionem suam ligato, in venam cavam superiorem effusa. Viam qua sibi fluidum hoc in venam aperturam ex lymphatico, ductu fecerat, diu ignorabam. Insertum, in venæ portarum ramum gastricum, lymphaticum vasculum observave-

ram, cujus communicationis in epistola mea de vasis lymphaticis jam ante plures annos mentionem feci. Simili causæ repletionem venæ cavæ per vas lymphaticum, incognitum mihi, tribuebam. Sed viam per venas resorbentes ex glandulis conglobatis in truncos venarum superesse, nuperiores demum observationes me docuerunt. Glandulam nempe lumbarem semiscirrhosam, per ductum lymphaticum ex pelvi trans arteriam iliacam adscendentem, mercurio replevi. Intravit mercurius in glandulam, ejusque dimidiam partem, inferiorem nempe, pelvi propriorem replevit. Resistentia in glandula insignis, columnam mercurii in tubulo injectionis octodecim pollicum sustinebat, nec viam in vas glandulæ lymphaticæ excretorium, mercurius pandere sibi valebat. Pressione itaque digiti denique mercurium in ductus glandulæ minores, per vas lymphaticum glandulæ insertum adegi. Sensi diminutionem fluentis, et fugam ex vase glandulam intrante, attentus expectabam majorum ex glandula sursum exporrectorum ductuum lymphaticorum intumescentiam, sed spe mea frustratus, eleganti spectaculo, minutissimos mercurii globulos, in venam ex glandula ad venam cavam inferiorem euntem elapsos, hujus ramulos ad truncum usque expandentes vidi. Per venam hanc, trunco venæ cavæ in superficie sua anteriori sub exitu spermaticæ dextræ insertam, mercurius omnis, per vas lymphaticum ad glandulam advectus, et via quidem magis aperta sola ponderis mercurii pressione, facili demum negotio in venæ cavæ truncum transiit, ut brevi tempore magna liquidi hujus copia truncum venæ cavæ intraverit, trunculis lymphaticis superioribus ex glandula exeuntibus, plane vacuis."—J. F. Meckel, Nova Experimenta et Observationes de finibus venarum ac vasorum lymphaticorum, &c. § i. p. 4.

Note K.—P. 422.

I have said that palsy occurs generally in the side opposite to that in which the lesion of the brain is found, because in some cases it has been observed in the same side.

Though this singular phenomenon early attracted the attention of pathologists, it cannot be said that the circum-

stances under which it takes place or does not take place are determined. The fact was early demonstrated by Molinelli; and much inquiry and experiment was made by Pourfour de Petit, Saucerotte, and others, members of the Academy of Surgery; and has since been the subject of occasional inquiry to several from Morgagni to Dr Anderson and Dr Yellowly. The mutual interlacement of the cerebral chords between the restiform bodies has been supposed at various times, from Mistichelli and Pourfour de Petit, adequate to explain it. To this the principal objection is the fact, that palsy of the opposite side, though frequent, is not an invariable result of injury of the brain.

Note L.—P. 486.

I have elsewhere said that this interruption of normal action of vessels depends on a sudden change somehow affected in them, in consequence of which they no longer continue the nutritious process. The proof that the imperfect developement of the arterial system is only a collateral effect, is found in the fact, that the developement of these vessels is always equal and sometimes superior to the progress of the anormal action and its effects.

Note M.—P. 514.

This subject it was my intention to illustrate with several cases which have come under my own observation. As these, however, are similar to all other cases with which the practical surgeon is familiar, I defer the details of them for the present.

Note N.—P. 569.

I have already adverted to the late period at which surgeons began to have a just idea of the process of necrosis. As a counterpart of this it is worthy of remark, that the notions of *spina ventosa* were so vague and unsettled among the older surgeons, that many instances of disease of bones which belong to the head of *necrosis* were denominated *spina ventosa*. The whole of the cases which Amyand delineates in the Philosophical Transactions as *spina ventosa* are really ex-

amples of *necrosis*; and it is manifest, from the language of surgeons at that time, and for many subsequent years, that this mistake was general. The truth is, that the distinctive nature of *necrosis* was not understood till the researches of David and Troja directed the attention of surgeons to the subject; and it was left to Wiedmann to fix the exact meaning of the term. The denomination of *spina ventosa* is still very vaguely used. I have attempted to fix it in the text; and I think, if the conditions which I specify be observed, it will be at least more easy to understand it exactly. It is important to observe that the very same process which causes *necrosis* in the compact osseous texture of the *diaphyses* may produce *spina ventosa* in the looser cancellated structure of the *epiphyses;* and that the difference depends chiefly on the anatomical arrangement and configuration of the filamento-vascular medullary tissue. *Spina ventosa* ought on no account to be confounded with cancer of bone.

Note O.—P. 598.

I do not state the details of Gaultier and Dutrochet in the text, because they still require confirmation. Their minute distinctions of the outer surface of the skin are in a great degree anticipated by Cruickshank. The description of this anatomist, though not very distinct, deserves to be known.

"Was I to describe the different membranes which lie on the surface of the true skin, I should now say they were five, each of which I conceive is a cuticle, or an incipient cuticle.

"The three first are evidently cuticles, and the two last, most probably, are forming into cuticle, and, like the second and third, are to succeed the first, which is perpetually falling off in small portions like scales,—the only circumstance which seems to favour *Lewenhoek's* doctrine, that the cuticle is formed of scales.

"If I am still not perfectly understood respecting these five membranes, I repeat that cuticle, commonly so called, makes the first; the *rete mucosum* is double, and makes the second and third; the first vascular membrane in which the small-pox pustules are chiefly seated makes the

fourth; and the membrane which may be separated some days after the separation of the last, by continuing the maceration, and which shows the pores still larger, makes the fifth. These two last membranes, I fancy, might easily be detected in the skins of those who die of the measles, scarlet-fever, or other eruptive diseases, as well as in the small-pox skin; for I conceive that these eruptive diseases do not create, but demonstrate these membranes, in consequence of the great determination of blood in these cases to the skin."—Experiments, &c. p. 43.

According to M. Gaultier, the mucous body of the negro skin consists of four parts; 1*st*, a series of minute vascular bundles, to which M. Gaultier applies the name of "bourgeons sanguins," and which are really the termination of vessels ramified on the papillæ; 2*d*, the deep whitish layer, consisting of white vessels, and indicated in an oblique section of the negro skin, by a white line between the surface of the corion and a darker undulating line; 3*d*, the coloured layer, named by M. Gaultier *gemmules*,—the true colouring matter of the skin,—indicated by the undulating line already noticed; 4*th*, the superficial white layer, consisting of serous vessels as the first, indicated by a white line between the dark undulating line and the cuticle.

The vascular eminences (bourgeons sanguins) of M. Gaultier, are the termination of the cutaneous papillæ; and this induces M. Dutrochet to give the following view of the constituent parts of the cutaneous tissue. 1*st*, the derma, or corion, the true skin of the ancient anatomists; 2*d*, the papillæ, or minute elevations of this membrane; 3*d*, the epidermal membrane of the papillæ, which is the deep whitish layer of M. Gaultier; 4*th*, a coloured layer, the proper colouring matter of the skin; 5*th*, a horny layer, which corresponds to the superficial whitish layer of Gaultier; and, 6*th*, the epidermis, or cuticle.

THE END.

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