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WORKS

OF

ANDREW A. FROST,

PROFESSOR OF PHYSICS,

UNIVERSITY OF CALIFORNIA,

BERKELEY, CALIF.

AND

LECTURES ON OBSERVATIONS

ON THE

PHYSICS OF THE

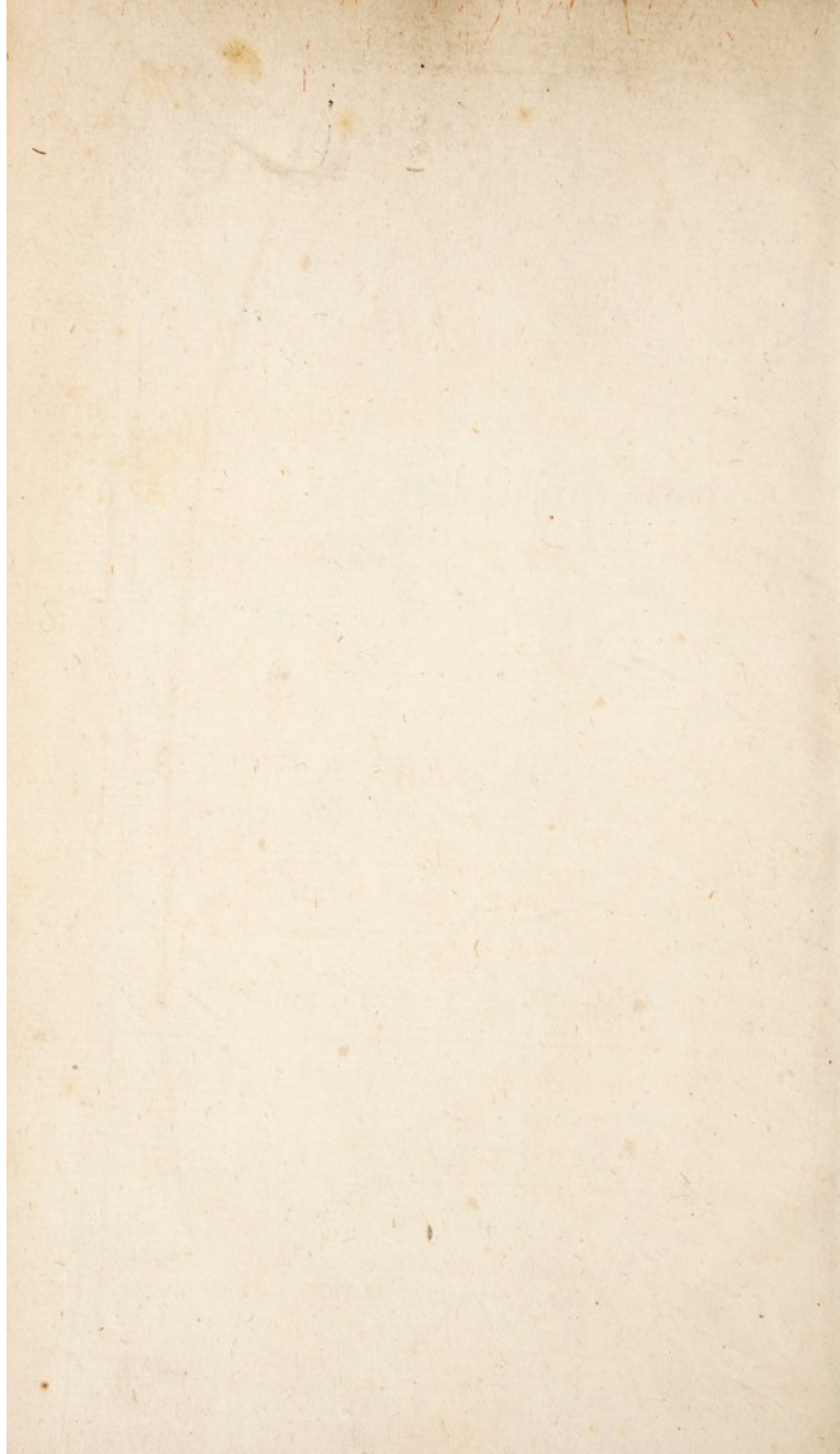
ATMOSPHERE,

AND

THE

PHYSICS OF THE

SEA.



THE WHOLE
WORKS

OF

Dr. *Archibald Pitcairn,*

Published by Himself.

Wherein are Discovered, The TRUE
FOUNDATION and PRINCIPLES

OF THE

ART of PHYSIC.

WITH

CASES and OBSERVATIONS
upon most *Distempers* and *Medicines*.

Done from the *Latin* Original

By GEORGE SEWELL, M. D.

AND

J. T. DESAGULIERS, L. L. D. and F. R. S.

With some Account of the AUTHOR.

The SECOND EDITION.

L O N D O N:

Printed for J. PEMBERTON in *Fleet-Street*, and W. and J. INNYS
at the *West-End* of *St Paul's*. M. DCC. XXVII.

THE WORKS
OF
W O R K S

Dr. Archibald Watson

Published by H. K. Lewis

Printed by W. G. and J. S. Taylor

Foundations and Principles

ART OF PHYSIC

CASES and



By George Watson M.D.

L.T. D. Watson M.D. and F.R.S.

Second Edition

London

Printed by W. G. and J. S. Taylor

1844



THE
Translator's PREFACE.

THE AUTHOR of these *Dissertations* was one of the first, who leaving the *Old* Conjectural Method of Physical Writers, struck into a *New* and more Solid Way of Reasoning, grounded upon Observations and Mathematical Principles.

HE studied many Years abroad, where his great Learning, and successful Practice, procured him the Esteem of all Foreigners, and spread his Reputation into as many different Countries, as the Variety of Students of Physic in *Holland* owed their Birth to, every one

P R E F A C E.

carrying home a high Opinion of Dr
PITCAIRN's useful Knowledge in that
Science.

THESE Qualifications in his Art raised him in a little Time to the Professorship at *Leyden*, unto which he was chose in the Year 1691, as much to the Reputation of the *Scottish Nation* as his own. Here he began his excellent Lectures, in a Manner, which confirmed his Auditors in the just Notions they had conceived of him, as of one who was to banish the Old false Maxims of Physic, and lay more certain and infallible Fundamentals of the most comprehensive Art the Mind of Man is capable of attaining. It were needless to inform the Reader what *Errors* he reformed, what *new Lights* he spread over the Face of Physic, and what *admirable Hints* he gave for its future Improvement, such as the Genius of a *second PITCAIRN*, or a *present*
MEAD,

P R E F A C E.

MEAD, might indeed carry to that desirable Pitch, which other Learned Men have hitherto laboured at in vain. There is no Page in these *Dissertations* wherein something of this Nature may not be observed, and the Book it self will be the best Evidence of the Truth we assert.

HE continued in the Chair at *Leyden* sometime, and published a great many of the following Pieces in that Place, all which were admired by the Learned of the Faculty; and tho' some of his Opinions met with *Adversaries*, the Doctor had no Occasion to give himself the Trouble of a *Vindication*, the Justness of his Reasoning raising him up *Advocates* wherever Truth prevailed over Sophistry, and good Sense was preferred to the Jargon of unintelligible Terms.

HE had in all Probability continued longer at this Place, but some private

P R E F A C E.

Concerns obliged him to retire into his own Country, where his Fame had already made Way for an honourable Entertainment among all Persons of the best Sense and Quality. Here he continued his Practice with equal Applause and Success, keeping at the same Time a Correspondence with most of the great Men of the Faculty in all Parts of *Europe*, whom either his Writings or Conversation at *Leyden* had made his Friends and Admirers. Indeed he was the freest and most communicative of his Advice of any Person, perhaps, that ever made so eminent a Figure in his Profession; never refusing either to satisfy by Letter the Curiosity, or inform the Mind of the Enquirer. His *Friendship* with the great BELLINI, and Mons. HECQUET, must never be forgotten; and it is evident from their Writings, that they seemed to be proud of *that Name*, and took all Occasions to do Justice to the Merit of their *Friend*.

THIS

P R E F A C E.

THIS may lead us into some Part of his private Character, of which there are too many Witnesses living to make us say any Thing but strict Truth.

IN the Business of his Profession he was always ready to serve every one to the utmost of his Power, and even to contribute to their Health at the Danger of his own. He was a Man of too good Sense to be a Humourist in Physic, or refuse Attendance out of Pique, or Prejudice, or Affectation: He understood the Value of Life too well to sacrifice it to Caprice and Humour. There is one Thing more remarkable of him; That he was not at all concerned about Fees, and frightened from his Duty by the Sight of Poverty in his Patient, nay, he went with greater Chearfulness to those from whom he could expect nothing but good Will, than to

P R E F A C E.

Persons of the highest Condition. Besides, in Cases which seemed to require that Assistance, he not only gave away his Skill and Medicines, but extended his Generosity for the Provision of other Conveniences for the Sick, and left the Marks of his Charity, as well as of the Liberality of his Art, behind him. The Virtue of Charity was really so much his own, in the Use of it, that he contrived a most secret and decent Manner of conveying his Benevolence, and relieved many who knew not their Benefactor.

IN short, he was one of the greatest and most useful Men in his Profession this Age has produced, of a free and universal Genius, a good Orator, Poet, and Philosopher. He was of a pleasant, engaging Humour. Life sate very easy upon him in all its Circumstances. He despised many, but hated none. He loved his Friends. and laughed at his
Ene-

P R E F A C E.

Enemies. Thus he drew out Life to above fixty Years : And it was not long before he died, that he gave us that excellent Picture of himself in a Copy of Verses, which are at least equal, both in their Easiness, Simplicity, and Elegance of Thought and Stile, to any of CATULLUS, and far superior to any modern Composition of that kind. They have been printed by Mr. PRIOR, * who honoured them with an Imitation ; how near the Original, the Reader may judge.

Ad A M I C O S.

*D*U M studeo fungi fallentis munere vitæ,

Adfectoque viam sedibus Elysiis,

Arctoâ florens Sophiâ, Samiisque superbus

Discipulis Animas morte carere cano.

Has

* Gualterus Dannistonus ad Amicos.

P R E F A C E.

*Has ego corporibus profugas ad Sidera mitto,
Sideraque ingressis otia blanda dico;
Qualia conveniunt Divis, Queis fata volebant
Vitai faciles molliter ire vias,
Vinaque Cœlicolis media inter gaudia libo,
Et me quid majus suspicor esse viro.
Sed fuerint nulli, forsan, quos spondeo, cœli,
Nullaque sint Ditis Numina, nulla Jovis;
Fabula sit terris agitur quæ vita relictis,
Quique superstes, Homo, qui nihil esto Deus,
Attamen esse hilares, & inanes mittere curas
Proderit, ac vitæ commoditate frui,
Et Festos agitasse dies, ævique fugacis
Tempora perpetuis detinuisse jocis.*

His

P R E F A C E.

His me parentem præceptis occupet Orcus ;

Et mors seu Divum, seu nihil esse velit.

Nam Sophia Ars illa est quæ fallere suaviter

horas

Admonet, atque orci non timuisse minas.

To his F R I E N D S.

STUDIOUS the busy Moments to deceive,
That fleet between the Cradle and the Grave,
I credit what the *Græcian* Dictates say,
And *Samian* Sounds o'er *Scotia's* Hills convey.
When mortal Man resigns his transient Breath,
The Body only I give o'er to Death :
The Parts dissolv'd, and broken Frame I mourn,
What came from Earth, I see to Earth return.

The

P R E F A C E.

The Immaterial Part, th' Etherial Soul,
Nor can Change vanquish, nor can Death con-
troul.

Glad I release it from its Partner's Cares,
And bid good Angels waft it to the Stars.

Then in the flowing Bowl I drown those Sighs,
Which, spite of Wisdom, from our Weakness
rise;

The Draught to the Dead's Memory I com-
mend,

And offer to the now Immortal Friend.

But if oppos'd to what my Thoughts approve,
Nor *Pluto's* Rage there be, nor Pow'r of *Jove*,
On its dark Side, if thou the Prospect take,
Grant all forgot beyond black *Lethe's* Lake:

In

P R E F A C E.

In total Death suppose the Mortal lie,
No new Hereafter, nor a future Sky:
Yet bear thy Lot content, yet cease to grieve;
Why, e're Death comes, dost thou forbear to
live?

The little Time thou hast 'twixt Instant now
And Death's Approach, is all the Gods allow;
And of this Little hast thou ought to spare
To sad Reflection, and corroding Care?
The Moments past, if thou art wise, retrieve,
With pleasant Mem'ry of the Bliss they gave.
The present Hours in present Mirth employ,
And bribe the future with the Hopes of Joy.
The Future, few or more, howe'er they be,
Were destin'd erst, nor can by Fate's Decree
Be now cut off, betwixt the Grave and Thee.

To

P R E F A C E.

To conclude: As these *Dissertations* were the only Performances in *PHYSIC* which Doctor PITCAIRN designed for the Press, so I have strictly confined my self to them, forbearing to meddle with some other Pieces handed about in Manuscript, because I am well assured the Author never intended to make them publick, most of them being no other than Extemporary Discourses taken from his Mouth by Young Gentlemen, who studied *Physic* under his Direction, when Professor at *Leyden*.

IT was thought proper to leave out Doctor BOWER's Epistle subjoined to the *Latin* Copy; not only because I was resolved to give the *English* Reader nothing but what was Doctor PITCAIRN's Genuine Work, but chiefly because it seemed the less needful, that his *Dissertation upon the Motion which reduces the*
Ali-

P R E F A C E.

Aliment in the Stomach to a Form proper for the Supply of the Blood, is so very full upon the same Subject.

THE Matter in short is this: Our Author in that Dissertation *attributes the Digestion of the Aliment chiefly to the Action and Motions of the Stomach and other neighbouring Muscles.* Doctor HECQUET, a Physician at Paris, in a small Tract, lately espoused and maintained the same Notion; and Doctor ASTRUC of Montpellier wrote a little Piece upon this Subject, principally against Doctor HECQUET, contending, *That the Digestion was made not chiefly by Attrition, but by proper Juices dissolving the Meat by way of Ferment.* And Doctor BOWER's *Epistle* was intended for an Answer to Doctor ASTRUC, before it was known that Doctor HECQUET had made a proper Defence for himself. But the *English* Reader will be

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be at no Loss for *any* of these Pieces, if he carefully considers Dr. PITCAIN's own *Dissertation*, wherein he will find the Substance of almost all that has been said upon *either Side* of the *Question*.

LONDON,
1715.

G. SEWELL.



“ tion in the Schools of *Sophists and Metaphysicians*.

“ If he is in earnest, which I cannot
“ be easily induced to believe, his Judgment upon *Contraction* and *Compression*
“ is widely different from that which
“ Men of Sense have ever entertained :
“ For he allows that all the Parts of a
“ Circular Fibre upon its Contraction
“ approach to the Center; and yet denies that any Fibre presses upon those
“ Points, which lie between the Fibre
“ it self, and the Center. It is evident
“ to me, that if a Circular Fibre be
“ contracted into the half of its Length,
“ it ought to compress whatever lies between it self and the Center, to compress it, I say, into the fourth part
“ of its Space. After ASTRUCIUS had
“ taken away the Compressing Powers,
“ he ought also to do the same by the
“ Contracting Powers, and so to prove
“ by his Argument that there can be no
“ Contraction at all in a Circular Fibre.
“ ASTRUCIUS would manage this Point
“ in the following manner : “ There

“ There is no Point in the Circumfe-
 “ rence of a Circular Fibre, but what
 “ may be drawn with an equal Force to
 “ both its Sides, (according to the Di-
 “ rection of the Circumference;) but it
 “ is drawn neither from the Center, nor
 “ to the Center, because the *Arches* that
 “ lie neareſt, and are infinitely ſmall,
 “ which attract that Point, attract it at
 “ Angles, that are Rectangles in reſpect
 “ of the Diameter. Wherefore there is
 “ no Point in the Circumference of a
 “ Circular Fibre that can be moved,
 “ that is, that Fibre cannot be contract-
 “ ed. Which was the Thing to be proved.

“ ASTRUCIUS has assumed a Part of a
 “ Circular Circumference not different
 “ from a Right Line, which upon Con-
 “ traction he makes to be altered into a
 “ leſſer Right Line, without any Ten-
 “ dency of deſcending to the Center,
 “ or receding from it. But the *Geome-*
 “ *tricians* aſſume a regular *Polygon*, whoſe
 “ Sides are Right Lines, which muſt ne-
 “ ceſſarily upon Contraction be chan-

iv *To the READER.*

“ged into a lesser similar *Polygon*, and
“by consequence the Sides of it will
“approach nearer to the Center in proportion to its Contraction.

So far my Friend Dr. GREGORY.

For my Part, I will not call ASTRUCIUS's Book *Cacata Charta*, since ASTRUCIUS, in my Opinion, seems never to have gone to Stool, otherwise he must have perceived that the Muscles of the Abdomen have a Power of *Contraction* and *Expulsion*.

If Dr. ROBERT GRAY, or Dr. JOHN ARBUTHNOTT, those *Scots Æsculapii*, and HECQUET of *Paris*, that Reliever of Mankind, favour these *Dissertations*, I shall not be at all concerned for the Judgment of any others. For BELLINI is gone to the *Celestials*.

Some barbarous Expressions, unknown in the Days of CELSUS, have crept into these *Dissertations*, such as frequent Use, and the Poverty of the Latin Tongue, have long since made familiar, and almost necessary to *Physicians*.

A N




A N
ORATION

PROVING

The *Profession of PHYSIC*
free from the Tyranny of
any Sect of Philosophers.

Translated by Dr. SEWELL.

I.  O one, I presume, will be displeased, if I, who am chosen to the Professorship of Physic by the Illustrious Administrators of this * University, shall freely, without being swayed by Favour or Prejudice, lay before my Audience the chief Reasons, why the *Art of Physic* has so long baffled the Endeavours and Studies of so many Learned Persons; and what Assistances are necessary to be used, to carry

B 3

it

* Leyden.

6 *The EXCELLENCY of*

it to such a desirable Height, that the Life of Man may be placed in such a Degree of Safety, as his Nature will admit of, and the Powers of Man can secure to his Fellow-Creature.

This Freedom the Course of my Duty requires of me; this my Profession has made most grateful, and almost necessary for me; and this famous Republic, ever most tenacious of Liberty, secures my Exercise of such a Freedom from any Danger.

2. To deliver then my Thoughts without reserve: In my Opinion the Skill of Healing seems to be of greater Antiquity than the Study of Philosophy; because when Men first began both the Study of Physic and Philosophy, every one being determined to them either on the Account of his Body, or his Mind, the Reasons for Philosophy were only casual and accidental, but those for Physic were perpetual. For the elder Race of Mankind maintained Life in a poor Condition, exposed in the open Fields to the Injuries of the Weather, their first Sustenance being the Products and Fruits of the Earth, their next Advancement to its Creatures the Cattle: They first felt the Inconveniencies of Heat and Cold, that is, they grew sick, before they thought of providing Cloaths and Houses for themselves. These then were the first Diseases, those the first Remedies. Beside, the Cattle being naturally of a short
Existence

Existence, and no less obnoxious to Distempers formerly, than now, induced a Necessity for the Knowledge of Healing; and they who applied themselves to the Relief of them, were said to relieve Men too: For he seems to have preserved a Brother, who saved him from the Necessity of perishing, even by Hunger.

But Men then at last addicted themselves to Philosophizing, when after some Experience of the Efficacy of Remedies, they could in some sort of Security, and at leisure, consider the Qualities of Natural Bodies, and think of excelling the rest of Mankind in the Powers of the Understanding.

3. But since there are good Grounds to believe, that the antient Physicians attributed Diseases to the Anger of the Gods, and that Astronomy was the first Science which was cultivated by the elder Philosophers, and that the Names of the Gods were at the same Time affixed to the Stars, it is probable that those antient Physicians began their Enquiries with those Distempers which generally attend upon the Changes of the Seasons. From whence it follows, that according to the Notion of both the Antient Physicians and Philosophers, the Method of Reasoning in Physic ought to depend upon the same Principles as are of Use in Astronomy: And since in those Days all Philoso-

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phers were of one Sect, and Medicine was elder than all Philosophy, that Physic in its Infancy was not tied down and restrained to any Sect of Philosophers. But I am inclined to explain this Subject by a more curious and exact Enquiry.

4. It is unfair to assert any Thing for Truth, either in the Theory or Practice of Physic, which stands in such a Degree of Uncertainty, as no Man would willingly have the Security of his Property to stand: For no one ought to be in less Concern for his Life, than his Estate. From whence this Consequence arises, that is not allowable to advance any Thing into a Principle either in the Theory or Practice of Physic, which the Mathematicians, and Persons who are the least entangled with Prejudice, call in question: Because no Man would willingly submit to have his Affairs reduced to such a Hazard, that there must be a Necessity for a Disputation, the Success of which is doubtful for the Recovery of them; *but of all Things, Life is the most precious.*

From all which I draw this Consequence; That such Enquiries after Physical Causes as are generally proposed by the Philosophers, are entirely useless and unnecessary to Physicians: For these are Points which the Heads and Patrons of Sects have wrangled about from the Beginning of the World to our Days, and all to no Purpose.

5. Nor

5. Nor ought this to seem strange, since the Patrons of Sects, by attempting the Knowledge of the absolute Nature, and intimate Essences and Causes of Things, without any regard to the Discovery of their Properties, were forced to make use of many *Postulata's*, and but few *Data's*, by which means they unavoidably fell into great Variety of Opinions. It is evident to any one who has been a little more than ordinary conversant in the Mathematics, or the Practice of Physic, that our Knowledge of Things is confined to the Relations they bear to one another, the Laws and their Properties of Powers, which enable them to produce Changes in some Things, and to become altered by other Things: I speak of Corporal Things. Now these Powers, and their Laws, are discovered by their mutual Action and Reaction upon each other: For Action and its Consequences are those *Data* that assist us in the Discovery of the Laws of their Powers; but a Physical Cause, and the Nature of Things which the Philosophers so much enquire after, is *that unknown Something* in Things from whence they will have all its Powers and Properties derived. But that being impossible to be known without a prior Knowledge of its Powers, and a Discovery of their Laws, and no Effects being produceable but by its Powers, it follows, that while they remain unknown, there can
be

be no Knowledge of the *Nature* of the Thing; and when they are known, that Knowledge is of no Advantage. And therefore the Business of a Physician is to weigh and consider the Powers of Medicines and Diseases as far as they are discoverable by their Operations, and to reduce them to Laws; and not lay out their Time and Pains in searching after Physical Causes, which can never be deduced till after the Laws of their Powers are found out; and when they are found out, will be of no Service to a Physician.

6. It was then of no Use to our Predecessors in Physic, to have espoused any Sect, and corrupted a Science, in its own Nature above the Comprehension of the Vulgar, with uncertain, and very often with false Opinions. By these Errors the Art of Physic has been hindered from attaining a desirable Pitch of Perfection, and seems long since to be filled and over-burdened with Conjectures, in the Eyes of such Persons who forget to distinguish, that these Errors are not in the Art it self, but its Professors. For many being weary of the Disputes which, after so long a Course of Years, even to this Day, were occasioned by such Perplexities in the common Philosophy, and observing neither Remedy nor End of this Confusion, but that the Infection was still spreading, that the Physicians struck in with the Vulgar, and went over to a Sect; easily persuaded themselves that those Principles were
not

not much depended upon that were founded upon such uncertain and contradictory Opinions. This is what hindered the Improvement of Physic for so many Years; and this we must bid farewell to, if ever we intend to be Physicians or Free, if ever we would be thought never to have been the Slaves of *Rome*, or, at this Time, or any other, not to merit such a Slavery.

7. That Art which, of all others promises Safety and Health to Mankind, ought not in reason to be involved in the Conjectures and Dreams of Disputants; for no Man of common Prudence would intrust his Life to Him, whose Reasoning seems false to the Generality, and probable but to very few. But Physicians ought to propose the Method of Astronomers as a Pattern for their Imitation: These never take up, and adopt into their Science such Opinions as are grateful to the Vulgar, or generally received by Orators: Never in the Explication of the Motion of the Planets, call in the Assistance of a Romantic Hypothesis concerning the Structure of the World, however pleasing and plausible, but by comparing the Observations which have been made at great Distances of Times and Places, and put together in a Method familiar to them, and useful to all the Phænomena of the Celestial Motions, and so compute the Powers and Force which Bodies in Motion observe in their Tendency
to

to other Bodies, either moveable or immoveable. Let us, if we are inclined to deserve well of the Republic of Physic, that is, of all Mankind, follow this excellent Rule of *Theirs*. It is our Duty to compare the Observations that have been made by others, and continue to be made every where, upon Diseases and their Remedies, and without any Regard to Opinions, which are nothing in comparison to the certain Conviction of our Senses, to collect from what usually happens, what will, and what we are to do in that Case.

No one now, I presume, who is the least conversant in Astronomy, imagines any Stress to be laid on those Points, which are to this instant puzzled with frivolous Disputes, nor makes any Use of substantial Forms, subtile Matter, or the accidental Concourse of Atoms in the Demonstration of the Affections and Influences of the Celestial Motions: But the Astronomers being satisfied with the Allowances of a few *Postulata*, plainly shew that the Opinions of the *Sects* give them no Obstruction; nor are their Demonstrations at all disturbed, whether Substantial-Forms exist, or no, or whether there be any such Thing as Subtile-Matter, or not, in being. And do we still doubt to enlarge the Boundaries of Physic by the same Arts? Neither is it unreasonable to suppose, that lesser Bodies, which are the Objects of Physical Enquiries,

quiries, are subject to the same Laws that Astronomers have discovered in the greater. The Nature of all Bodies is certainly the same, and every Body is capable of being changed into the Body of another of any Kind whatsoever; and by consequence all Bodies, of whatsoever Magnitude or Minuteness, are obnoxious to the common Effects of Motion or Change. From whence it follows, that the Laws and Properties of the Fluids and Canals of Human Bodies may be defined, after we shall either have made more Observations, or compared and methodized those that have been already made.

9. Any one who fairly considers what has been hitherto advanced, will easily allow, that nothing ought to be used as a Principle in Physic, which is not as certain as the Objects of our Senses; for it is but reasonable that the Care for the Life of Man should exceed that for his Curiosity. This induces me to make some brief Remarks on a few Particulars, which our Predecessors, out of a fond Prejudice to their Favourite Sects, have admitted for Truth, and yet want the Evidence of Sense; that others may avoid the committing of those Errors, which have led so many Great Men out of the Way; and which may almost all be reduced to this one: The assuming such Things as certain, which Men of the best Learning and least Prejudice

dice dispute as doubtful ; or such Things whose Certainty does not amount to so good an Evidence, as the Perception of our Senses

10. Our Predecessors borrowed from a Sect the Fear of a *Vacuum*, *Occult Qualities*, the *Power of Attraction* uncorrected by any Laws of Acting, and transferred them into the Art of Physic, and endeavoured to impose upon themselves and others by this *Axiom* That the *Physician begins where the Naturalist ends* ; which, when spoke of the Patron of a Sect, is always false. Miserable must the View of our Republic appear in those Days, when all was over-grown and choaked with Perplexities of Words and Things : Men of Parts and Genius were obliged to submit to a Tyranny over their Reason, and bear the most insolent internal Slavery, to give up a vast Stock of Human Literature, the Toils of long and severe Studies, to be corrupted and debauched by the Leaders of *Sects* ; and those Heroes were compelled to deliver their Names to be obliterated with those of Sophists, who might have merited the Glory of an eternal Memory, for their Care in preserving their Fellow-Citizens.

11. But however miserable the Condition of Physicians may appear at that Time, yet is not the Happiness of our Age so great, as to make us extol our selves so very much above our Predecessors : After so great Improvements in Botany, and Anatomy, and the

Ap-

Appearance of a new Face of Things in so many other Arts, we still find the old Standard of Physic prevail every where. Our Ancestors were blamed for introducing a Heap of Jargon into our Art, of Things unknown to our Senses, and consisting entirely of Conjectures, and, in one Word, for too great a Fondness to *Sects* of Philosophy: We who have shook off this Weight of Stupidity, have, even we, been much more successful in the Improvement of our Science? Not at all. But after that Plague, which a Flood of Barbarians had brought upon us for the Destruction of Letters, was dispersed by an incredible Happiness, and the bright Genius of some Men had advanced the Affairs of Physic to a better Condition, when nothing remained but what we might reasonably have hoped for from the Discovery of the Circulation of the Blood; yet was the Success which was due to this Discovery, prevented by a Partiality to a Sect: And thus has this Age envied a Joy nearest to the highest Mankind ever knew since their Original.

12. I have often wondered how so many Learned and Ingenious Men, who could point out the Errors of their Predecessors to be avoided by others, yet could not themselves avoid falling into these very Mistakes: Let them bear the Honour of banishing occult Qualities, of subduing the idle Fears of

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a *Vacuum*, and the noisy Jargon of substantial Forms: But yet they have introduced occult Fermentations, and Pores that are obedient to the *Word of Command*; and their impotent Wishes, rather than their honest Studies for Improvement, have brought Things to that pass, that we long since have been at a Loss for Physic, in the midst of Physic it self. For what Difference, I pray, can we make between unknown Figures, and occult Qualities? Or what between the Influences of the Stars, and the Operations of subtile Matter? Which reflects most Dishonour on our Profession, to allow the Vessels a Power of attracting some Liquors, or, when we cannot solve the Difficulty by any other Means, to assume a Power to our selves of Poetical Machinery, and introducing Fluids exactly adapted to the Orifice of the Vessels? Which Hypothesis of the Fear of a *Vacuum* performs most Wonders for a Sect of Men? His, which gives a Liberty to any Body of running in to prevent a Vacuity in any Place? or his, who has filled the World with a subtile Matter, which does all that Work by it self, and which is infinitely minuter than all other Bodies? Who that has rejected the Sympathy and Antipathy of the Antients, can bear to hear Men dispute of the Contention and Agreement of two different Airs that meet within the Canals of our Bodies? Who does not plainly
see

see that the Natural and the Foreign Air perform the same Feats as the Innate and Adventitious Heats; and that the same Tale is told over again only in other Words? But I am weary of insisting so long upon so evident a Truth. This one Thing I shall not scruple to add, That I can prove that there is no Fermentation in the Glands of a Human Body; that all the Pores, and all the Orifices, are of a similar Figure; and therefore that the Diversity of Figures, and Ferments, introduced by the Adherents of a Sect, is of no manner of Use in the Theory or Practice of Physic.

13. It remains then that we cultivate Physic, not under the Disguise of such Fictions as these, but upon the Trials of Experience; that we suffer not our selves to be in the least Instance diverted from Truth by an unwary Partiality to a Sect, nor the Honour of our Profession lie at the Mercy of the Vulgar, and be governed by their Decisions: But let us at last exert our selves into Liberty, and let the infamous Mark of *Uncertainty*, ever flowing from a Fondness to a Sect, be at last wiped off, and removed from our Profession.

But since I have affirmed that the Enquiry into Physical Causes is unnecessary to Physicians, and that Assertion may seem harsh and rude to Philosophers, I have a mind to confirm and illustrate it by an Instance

stance that will place this Matter beyond the Hazard of Doubt or Dispute.

14. The Physicians who have wrote before us upon those Diseases of the Eyes, in which there are some Images that disturb the Sight, make no Scruple of assigning Physical Cause for it, which is the Corpuscles that swim in the watry Humour, which bring in an uncertain Motion and Floating to all Parts, imprint upon the *Retina* the Images of Flies, and other Things, that seem to swim at random before the Eyes. But while these People are tracing Mechanical Causes from their first Original, and searching after the latent Nature of these Affections, they have neither found out the Cause they searched for, nor assigned their proper Symptoms to each particular Distemper.

15. To make this plain, I affirm that no Corpuscles swimming in the watry Humour, or inclosed within the Eye, can paint any Image of themselves upon the *Retina*; the Proof of which is to be drawn from what is demonstrated by Writers of Optics.

For any one who considers carefully how very small Diameters of the Humours of the Eye must be assumed, and what the Laws of Refraction are, will easily find that the Images of Things placed before the *Retina* in the Eye, are projected wholly without the Eye, and are never imprinted upon the *Retina*, and therefore can never disturb the Sight.
But

But to confute the Notion of these Images, and prove that the Corpuscles contained either in the Aqueous or Vitreous Humour, or situated before the *Retina* in any Part of the Eye, neither produce these Images by obscuring the Parts of the Object, nor intercepting the Rays emitted by the Object: Let us remember this Axiom in Optics.

“ That there is no Point of a visible Object from which the Rays of Light do not reach to all Points of the *Cornea*, and by consequence, altho’ many Parts of the *Cornea* may be obscured, yet all the Parts of the Object will be seen by the Eye. ”

But if that Point of the *Retina*, in which the Rays emitted from any visible Point, ought to meet, be by any means so covered, and compressed, as to make its Position unfit to reflect the Image, then there can be no Preception of the Object. And if this Case happens in many Points of the *Retina*, all those Accidents will follow which Physicians have so long fancied to be effected within the Aqueous Humour: But I will briefly explain the Ways, for there are more than one, how these Phænomena may constantly happen.

16. Every one knows that what we call the *Retina*, is a Sort of Net-Work, whose Texture consists of a great Number of Fibres of the Optic Nerve, whence these Fibres, attended by the Blood-Vessels, are dispersed

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round the Bottom of the Eye, and that Part of the Eye that lies about the Infertion of the Optic Nerve abounds most with these Vessels. Therefore if the Eye is placed in such Situation, as to make the Rays necessarily fall upon that Part of the *Retina*, no Representation or Preception of that Object can follow. We will try the Truth of this *Phænomenon* thus : If any two Bodies are exposed to View in the same Line parallel to the Horizon, and on a Plane that passes thro' the Eyes a little higher, and at the Distance of half a Foot from each other : Then suppose the Left Eye shut, and the Right one turned to the Object placed upon the Left Hand ; and then let us approach the Object slowly, or recede from them, according as the Nature of our Eye requires. First, we shall perceive that we see both Objects distinctly, but at last we shall come to such a Point, when the Object placed upon the Right Hand will disappear, and yet we shall have a clear View of all Things round it. Now this Case happens at that Distance from the Objects, and in that Situation of the Eye, from the Rays falling upon that Part of the Bottom of the Eye which is so obscured and oppressed by its Reception of the Optic Nerve, and the Blood-Vessels, as to allow no free Room for the Impression of the Image. And in Distempers of this Nature, other *Phænomenas* happen after the same Manner. What makes
me

me more positive in this Assertion, are some Theorems which are of Use in the explaining the Circulation of the Blood: I have selected the following one, which is applicable to the present Case.

If the same *Phænomenon* may arise either from the Liquors flowing within the Vessels, or those without, it ought always to be ascribed to the internal, never solely to the external Fluid. But my Assumption is, that there is no external Force.

17. Thus then I have produced an Instance of Distempers which are not to be accounted for by a Physical Cause; so that it is evident that Physicians may know the State of the Part affected, and the Method of Cure, without the Knowledge of those Causes. For my Part, I am satisfied with the Illustration of any one Property only of Diseases, which may be of Use in explaining their *Phænomenas*, not pretending so much as to guess at a Physical Reason, being sufficiently assured no Man living is Master of one: For no one will attempt the giving a Physical Cause or a Mechanical Origin for the exciting that Change, which is a Property of the Mind, when Objects propagate Motion by the Mediation of the Nerves.

But however, tho' I know, nor am at all surprized, that the Physical Causes of these Symptoms, and their intimate Natures, should escape the diligent Enquiry of Physicians;

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ficians, yet I think I have explained either their Mathematical or Medical Causes, that is, such as are most useful for a Physician to know.

I wish it were in my Power to give an easy and plain an Explication of all the other Affections of our Bodies, and deliver a Method for their Cure. Could I do this, I should not despair of making some Return to those Illustrious and Learned Governors who have promoted me to the Professorship of Physic in that Republic, what has freed its Members from the most insufferable of all Slaveries, the Tyranny of a Sect.



T H E



THE
THEORY
OF THE
Distempers of the Eye.



VERY one who understands that Part of Geometry which treats of Vision, knows, that the *Focus* of the Parallel Rays falling from the Aqueous Humour upon the *Sphæra Vitrea*, after their Refraction made at the Convex Superficies of the Sphere, is distant from the Vertex of the Incidence nine Semidiameters of the Sphere: And that the *Focus* of the same Rays, after their Emerfion from the Sphere, is distant from the Sphere three Semidiameters and a half. Wherefore the Rays that are parallel in the Aqueous Humour, after their Refraction at the entire *Sphæra Vitrea*, included in the Aqueous Humour,

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converge to a Point that is distant three Semidiameters and a half from the opposite Superficies of the Sphere; or, what is the same, of the Point, or *Radiant*, which is distant three Semidiameters and a half from the *Sphæra Vitrea*, included in the Aqueous Humour, the Rays come out parallel behind the Sphere; and therefore the Image of that Point or small Radiant Body, will be at an infinite Distance from the Sphere, and by consequence will not be painted upon the *Retina*, and no Sensation of that Point can be excited in the Organs of Vision.

Wherefore, allowing the Observations in Optics, which prove that the same Refractions obtain in the ChrySTALLINE Humour, as in the Vitreous, it is manifest that no Image of the Radiant Body, which is distant three Semidiameters and a half from the ChrySTALLINE Humour, can possibly be imprinted upon the *Retina*; but, as is evident, the *Cornea* of no Eye is distant from the ChrySTALLINE three Semidiameters and a half of the ChrySTALLINE. Therefore no Vision follows from the Position of any Body in the *Cornea*, much less in the Aqueous Humour; or the Corpuscles that lie, or swim there, are imperceptible by the Eye.

From this Demonstration it follows, that in a Suffusion of the Eye no such Images of Bodies are perceptible, as the Writers of Physic ascribe to a Suffusion, who by a very gross

gross Mistake have attributed Symptoms entirely foreign to the Diseases of the Eye: But if those Images happen with an Obscurity of Sight at the same time, then an *Amaurosis*, or what is commonly called a *Gutta Serena*, will be the Attendant of a Suffusion.

2. Because, if these Flies, Spiders, and such Sort of Bodies, seem continually skimming before the Sight, when there appears no Sign of an external Inflammation of the Eye, an *Amaurosis* arises, the Reason of which, and the Method of its being generated, I have more fully declared.

3. If these Images are accompanied with an external Inflammation, there is also an internal Inflammation, and that too situated in the *Retina* it self. And as for this, I have long since made that Observation; for being convinced by Reasons in Optics, that those Images arose from a Defect of the Parts of the *Retina*, being too much covered by the extraordinary *Tension* and Oppression of the Blood-Vessels, I easily found that they who suffered by an Inflammation reaching to the *Retina*, must be affected by the same Symptoms.

4. And it is true in general, that these Films and Images in an *Amaurosis* arise from the Defect of the *Retina*, which is made unfit for the Reception of the Image, by the too great Distention of some Part of it, and the
too

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too great compressing and covering of other Parts. And because this Symptom of Oppression may happen in the Vessels of the *Retina* in any State or Condition, the *Retina* will be subject to the breeding all Sorts of *Tumours*, that may at any Time affect any other Part. Now in my Opinion, it is evident to any rational Person, that he, who understands these Things, cures by Art, and not by Chance.

Thus then I have demonstrated in a few Words the Theory of the Diseases of the Eye, and at the same time have given an Instance of the Usefulness of Mathematics in Physic; for the Method of Cure is easily to be drawn from this Theory; nor is it less plain how much they who make use of *Collyriums* in these Cases, baffle and impose both upon themselves and their Patients.



To Dr. SEWELL.

SIR,



HERE being some Mistakes in Dr. *Pitcairn's* THEORY of the DISTEMPERS of the EYE, I have, according to my Promise, sent you the following plain and easy Demonstration of what the Doctor means to prove. This

This is his Proposition in other Words---

The Muscæ Volitantes, or small Bodies, like Flies or Spiders, which appear to fly or swim about the Air, before the Eye, are not owing to any Bodies in the Aqueous, or any other Humour of the Eye.

LEMMA I.

The Focus of parallel Rays, or burning Point of a Lens of Glass convex on both Sides, is nearer or farther behind the Lens, according as it is more or less convex; nearer behind the Lens, if it be more convex, or a Segment of a lesser Sphere; and farther behind it, if the Lens be less convex, or a Segment of a greater Sphere.

LEMMA II.

If a distant Object, or such an one whose Rays falling upon a Lens are look'd upon as a Parallel, has its Image distinctly projected behind the Lens in its Focus, which is at a determinate Distance; as for Example, at the Distance of an Inch, by bringing the Object pretty near the Glass, the Focus will fly off to a greater Distance, that is, the Image will be projected farther behind the Glass than the fore-mentioned Distance; but if we would have the Image restor'd to the Distance of an Inch, the Object remaining

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maintaining still near the Glass, we must substitute another Lens more convex in a due Proportion, (whose Focus of parallel Rays is shorter than that of the former Lens,) and the Image will be distinct at the Distance of an Inch, as before, the Focus of the near Object in this Glass being at the same Distance from it, as the Focus of parallel Rays in the other.

Common Experiments, and the least Tincture in Optics, will prove the Truth of the
LEMMA'S.

The Rays which coming from a distant visible Object fall upon the *Cornea* of an Eye, are by the Coats and Humours of the said Eye refracted so as to unite upon the *Retina* of it, and there project the Image of the said Object, the Eye doing the Office of a Convex Lens: Now, if the Object be brought nearer to the Eye, (as for Example,) to the Distance of two or three Feet, and all the Parts of the Eye remain in the same Position, and of the same Figure as before, the Rays will be intercepted by the *Retina*, before they can project a distinct Image of the Object by their Meeting, which (could they pass on) would be behind the *Retina* by Lemma ii. But the Eye being made of flexible Coats, and yielding Humours, has the Power to alter its Figure, and become more convex, and so by
that

that Means its Focus is shorten'd by *Lemma i.* it being the same Thing as the substituting a more Convex Lens; and therefore by *Lemma ii.* the Object, tho' brought near, will paint a distinct Image of it self on the *Retina*, and so the said Object will be seen distinctly.

But if the Object be brought very near the Eye, (as for Example,) to the Distance of four Inches, it will be out of the Limits of distinct Vision, and no Image will be projected on the *Retina*, the meeting Points of the refracted Rays being far beyond it; neither can they be brought to the *Retina* by making the Eye more convex, because the Eye cannot be made convex enough for an Object at so little a Distance, as any Body may be sensible of, by the Pain that is felt in endeavouring to look at so near an Object.

There are indeed some short-sighted People, whose Eyes are so convex, that they can see distinctly at that Distance; but if the Object be brought within half an Inch of their *Cornea*, or else to close it, it will then be out of the Limits even of their Vision, and no Image at all of such an Object projected on the *Retina*.

If then no Object at the *Cornea*, by reason of its Nearness to the *Retina*, can be projected upon it, much less will any Object under the *Cornea*, that is, in the *Aqueous*

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ous Humour, or in any other Humour of the Eye. Which was to be demonstrated.

The same Thing may also be proved by two easy Experiments.

Exp. Take a Convex Lens of Glafs, and having set a Candle at any Distance before it, greater than that of its Focus of parallel Rays, the inverted Image of the Candle will fall upon a Paper held behind a Glafs, and be distinct at a Place easily found by moving the Paper backward and forward; then stick several Pieces of Paper upon the Lens, so that the Places of the Lens which are covered take up as much of it as what is left uncovered, or more, if you will; and then exposing it to the Candle as before, you will have as distinct an Image as before, though perhaps not so bright. Though dark Bodies should be within the Lens it self, as it sometimes happens, if the Glafs of which it is made be taken from the Top or Bottom of the Glafs-house Pots, the Image will also be distinct.

Exp. Take the *Chrystalline Humour* of an Ox's Eye, or any Eye fresh taken out of the Head, and it will project an Image of the Candle as the Lens did, and distinct also, though you stick little Pieces of Paper upon it.

From these Experiments it is plain, that no Bodies, in any of the Humours of the Eye, can project their Images upon the *Retina*.

There

There is another Proof of this, which perhaps has not been taken Notice of before; for which Reason I mention it, though it is not so direct as the others.

It is observable, that those which see the *Muscae Volitantes*, see them more when they look at a bright Object, or have been just looking at it, than when they look at a dark one. Now if Bodies in the *Aqueous Humour* obstructed some of the Light which comes from the Object, and made *Muscae Volitantes* by hindering it from falling on the *Retina*, it would be easy for the Eye to open its Pupil, (which is narrowest when the Eye looks at a bright Object,) and take in more Rays. Whereas if the *Muscae Volitantes* appeared more when we look at dark Objects, we could not be help'd by taking in more Rays; because the Pupil is then as open as it can, in order to receive a great many Rays, which are reflected but sparingly by dark Objects.

Now if we suppose, with Dr. *Pitcairn*, that the Fault is in the *Retina*, which in some Parts of it is insensible, or not sensible enough to the Impulse of the Rays, this *Phænomenon* will be easily explained; for when looking at a dark Object we see it by only a small Impulse on the *Retina*, the Difference between the Impression on the Sound, and that on diseased Parts is not so sensible; but when the *Retina* is struck by a strong Light,

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Light, as in the first Case, we are more sensible that the Impression of the Rays is differently received upon the *Retina* diseased in some Parts.

There are, indeed, some of those, who are troubled with the *Muscae Volitantes*, that are affected a different Way from what I just mention'd, that is, they see those small Images very much, when they look at a dark Object, and scarce perceive them when they look at a bright one: But this will not take off the Force of the Argument us'd in the other Case. For in that, some Parts of the *Retina* are altogether insensible, (at least for a Time,) and that happens to those who have the *Muscae Volitantes* for a great while together: But in this Case the diseased Parts of the *Retina* are not so strongly affected or compress'd, as to be altogether incapable of those Vibrations which they ought to have; but then a small Light, or such as is reflected by a dark Object, is not able to excite them, though when the Eye is turned to a lucid or very shining Object, so great a Quantity of Light pushes in upon the *Retina*, as to cause sufficient Vibrations in the diseased, as well as the sound Part.

If you think this worth publishing, it is at your Service.

I am, Sir, your most Humble Servant,

J. T. DESAGULIERS.



A
DISSERTATION
UPON THE
Circulation of the Blood

Through the
Minuteſt Veſſels of the BODY.



R. HARVEY has informed us, in a System entirely new, and providentially discovered, that the Blood runs from the Heart through the Arteries, and returns to the Heart through the Veins: And contenting himself with recommending this single and general Hypothesis to the *Belief of Physicians*, has left all the other Particulars in the Dark, and unexplained. But when this was found not to answer sufficiently Medicinal Uses, the Learned began to dispute,
D whe-

whether the Blood was conveyed from the Arteries into some Parts of the Body, where the Arteries and Veins are dispersed with their Mouths unclosed, and open; or whether the minutest Arteries did not convey the more gross Blood for the Nutriment of the Parts, but only the thinner Part which was not to return to the Heart, and all the rest of the Blood passed through the largest Arteries into the Veins, which are connected to them by *Anastomosis*. It is plain to any Observer, that either of these *Hypotheses* contradict the Circulation of the Blood: For the first empties a large Quantity of the thicker Blood, (that is, such as is contained in the greater Vessels,) into the Parts of the Body, or rather the Interstices of the Parts: The second empties the thinner Part of the Blood, (that is, what is contained in the lesser Arteries,) which is appropriated to the Nutriment of the Parts, that is, it supposes that a great Part of the Blood does not circulate, but, as they express themselves, is detained and stagnated in the *Viscera*, and the Pores of the Parts. But since all the Blood is forced by the Impulse of the Heart, and the Arteries into a circular Motion, insomuch that while they act with their proper Vigour, the Blood cannot be at rest, it is evident, that it is impossible it should stagnate in the minutest Vessels, which must necessarily burst by the continual Accession of the Blood, or
must

must be swelled to an extraordinary Degree by that Blood which is not to be conveyed thro' the Veins; which Accident never happens to any Animal in a State of Health: And it is as plain, that it is not detained in the Pores, upon account of the continual Increase which, for the same Reason, must necessarily follow. For the more Blood that was dispersed in the Pores, the greater would be the Difficulty of its Returns from the Stoppage of the Veins by the circumambient Fluid, as shall be proved in the following Discourse.

2. As the Physicians, of all Men, seem covetous of new Discoveries, so they are commonly taken with the Novelty of Terms: Thus there arose a Set of Men, who observing that there was a Sort of Glandulous Fleih bundled up in the *Viscera*, and which was provided with all Sorts of Vessels, they made no Scruple of affirming, that there are Glands in all Parts of the Body, which receive the Blood from the Arteries, and transmit it unaltered into the Mouths of the Veins, which open even within the Glandulous Substance, while they send another Part of it, which is fit for Separation, thro' its proper secreting Vessel. But this Hypothesis has brought nothing new into Physic, but only the Use of a Term. For this is all that it amounts to, the calling a Gland that *Medium*, which the Antients call'd some-

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times the Parts and Substance of the Body; sometimes the *Anastomosis*, and which they would have to bear, properly, neither the Name of a Vein or Artery. This Notion, as was unavoidable, is pressed too with the same Inconveniencies; for as it has yet only appropriated the Arteries and Veins to open into the Cavity of the Gland, the Vein can only receive again a Part of the Blood, the rest will partly be excerned, and partly stagnated, to maintain the Substance and Nutrition of the Parts, which is entirely contradictory to the Circulation of the Blood, and is proved false after the same Way of Reasoning, as we made use of in the preceding Paragraph.

3. But since it is evident, that the Notions of Men ought to be such as are applicable to the Uses of Life, and not the Vanity of Dispute; therefore we may chiefly collect the Opinions of Physicians about the Circulation from the Books they have writ upon the Art of *Cure*. In those most of them discover their Belief of the frequent Extravasion of the Blood from the Mouths of the Hæmorrhoidal, Meſeraic, and other Veins; which Opinion they could never embrace who had any Knowledge of the continual Motion of the Blood from the remotest Veins toward the Heart. But all Physicians who have prescribed any Method of Practice agreeable, as they would have it thought,

thought, to the Circulation, unanimously agree in affirming that the Blood either stagnates in the Parts, or in the Glands; and because the Blood, whether of the thicker or thinner Texture, when detained in the Interstices of the Parts, might suffer and induce all the same Symptoms as were observed in the Blood by the Antients, who knew nothing of the Circulation; therefore the same Method of Cure which the Ancients made use of is almost every where followed by the Moderns, altho' generally contradictory to Experience and the Laws of the Circulation. For this Reason we are not to wonder why no greater Alteration is made in the Practice of Physick, since most Diseases arise from some Disorder of the Circulation in the lesser Vessels, which many of the Moderns plainly demonstrate they understand no better than *Hippocrates* and *Galen*.

4. But altho' many Fluids are separated from the Blood, which are never restored to it again, and so cannot be said to circulate, yet there is a Necessity for some Motion of theirs dependent upon the Circulation of the Blood, so that if their Motion ceases, this too must either sink into an immediate or a gradual Stagnation. Wherefore all Fluids that are secreted from the Blood, preserve some constant Motion towards the same Parts, though at sometimes a very slow one, as being pressed by the Blood, which too is flowing continually

tinually towards the same Parts. From whence it follows, that those who attribute no Motion at all to the Fluids secreted by the Blood, or an arbitrary Motion to any Parts, either do not admit of the Circulation of the Blood, or do not understand it. Nor will it appear strange, that such Physicians agree with the Practice of the Antients; and tho' they boast of the Circulation, yet that our Art owes very little to their Improvements: For the Circulation of the Blood is not more necessary for the Preservation of Life, than its perpetual Supplies of the Secretion of abundance of Fluids, and its Disposal of them into different Parts; and the Causes of most Diseases are to be look'd for in the Disorder of this Secretion, either as it is increased or diminished; insomuch, that he, who keeps to the Opinion of the Antients in the Business of Secretion, ought to practise after the same Method, as being ignorant of the Effects of the Circulation. Infinite is the Number of those who dissent from Dr. *Harvey's* Demonstrations, among whom Dr. *Willis* is his most eminent Opposer. It seems to have been the Design of this Person, to have endeavoured to overturn the Foundations of the Art of Physic, by the Reputation of his Learning, and his excessive Praises of Philosophy; for his Books are full of nothing but old Notions disguised under new Forms; and all his boasted Philosophy depends upon the uncertain

tain wandering of the Blood to all Parts of the Body, and particularly upon the voluntary Motion and Refluence of his Nervous Liquor through all manner of Passages. Let any one look upon the Books he has published, his *Pathologia Cerebri*, his *Treatises de Morbis Convulsivis*, and his *Pharmaceutica Rationalis*, where the Animal Spirits which are to produce the *Vertigo*, *Epilepsy*, *Convulsive Motions*, are ordered to move thro' the Pores, and any Interstices of the Parts, backwards and forwards, and in a Circle, (and by his good Will, he would have drove them into many other Curve Lines, had he known their Names,) since he had either forgot or despised the Knowledge of the Structure of the Brain, the Nerves, and the Laws of Circulation. But in other Distempers he makes Animal Spirits of a heavy Nature, and disposed to sleep; sometimes he attributes Perception to them, at others a Quality, like the Waters of *Styx*, and all entirely foreign to Fluids circulating in an Animal Body.

5. But Physicians of greater Sagacity seem to have avoided these Mistakes, and these will have all the Blood strained through the Glands, and part of it to return into the Veins, and the rest to be disposed of without the Glands into the secreting Vessel. And so, as if they had agreed the Matter before-hand, that some, at least, might fall into the Right, they took different Paths in their

Enquiries: They who cry up Chymical Medicines, attribute a certain Native Liquor to every Gland, which they distinguish by the Name of a *Ferment*, that is, some fluid Particles, that separating from the Blood as soon as it is made, pass off into Receptacles agreeable to their Texture, to which they are carried by a natural Tendency, that is, a Tendency of Assimilation. Such as they order the Matter, is the Quality of this Ferment, that the Blood, or the Part of the Blood, which is so separated, may be changed immediately into a Fluid of a different Quality; such a one as is observed to proceed from that Gland, or a similar Bundle of Glands. Thus, for Instance, they affirm, that part of the Blood being carried to the Glands of the Liver, is, by the Force of the Ferment of the Liver, which Ferment is innate, and congenial to the Glands of the Liver, immediately altered into mere Bile. The Maintainers of this Opinion are forced to say, the fermenting Liquors stagnate in any Part, and so cannot allow any Circulation of their *Ferments*; tho' to affirm that Fluids can come to a Consistence, and in a State of Stagnation, can mix with the circulating Fluids, without circulating themselves, is contrary to the Circulation of the Blood, the Preservation of Life, and the Nature of Things.

6. Yet I cannot help wondering, that there should have been any who could have
believed

believed that the Business of Secretion could be performed merely by the Assistance of Ferments: For though that Opinion (which grants that all Fluids contained in an Animal Body are either impelled in a Circle, or in some direct Line of Motion, and that no Fluid can naturally be in a State of Rest or Stagnation) were not contrary to the Circulation of the Blood, yet other Things besides Ferments are made use of for the Office of Secretion, that is, for the Preservation of the Circulation of the Blood; other Things, I say, which, however, when admitted plainly, demonstrate the Impossibility of Ferments, as shall be shewn hereafter. But they who have embraced this Hypothesis, though in Words they acknowledge the Circulation of the Blood, yet in Effect they have destroyed it: For how do their Opinion, who say that the Blood is detained in all the Glands till it is changed by the congenial Ferment, differ from the Antients, who taught that the Blood assumed different Qualities in different Places, and was affected by the natural Warmth, or particular Temperature of the Parts? Or what more successful Method of Cure could one proceed upon than the other? Whatever are the Grounds upon which they prefer themselves to the Ancients, they are all, to a Man, either ignorant of the Circulation it self, or the Effects and most noble Uses of it.

And

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And, indeed, since these Ferments have nothing to do with the solid Parts of the Vessels, but the Fluids secreted from the Blood, the Secretion must necessarily be at one Time performed without their previous Assistance, and therefore may be always so, without their Assistance.

The same Method of Reasoning confutes those, who assert that the Bile is secreted in the Kernals of the Liver, because it unites it self with the Bile naturally implanted in those Kernels, but will not mix with the Urine contained in the Glands of the Kidneys, depending upon the Experiment of a Paper, which, tinctured with Oil, will not let Water pass thro' it, and which, if it be first wetted with Water, the Oil will not pass. Because it is evident from what has been before shewn, that this Native Bile is to be accounted a Native Ferment, and by consequence ought to be entirely removed by the Force of the Circulation, and washed away by succeeding Fluids of any Sort whatsoever. Besides, it may be united to every Fluid contained in the Blood, as being before joined to all the Fluids of which the Blood is compounded, and so cannot possibly refuse a Union with any of them: For I do not intend to dispute here concerning the Attractive Forces.

7. Thus they who were not satisfied with those Chymical Ferments, but fell into a
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Method of explaining this Difficulty more agreeable to the Mechanics, and the new Philosophy, invent these Means for the Secretion of a Fluid from its Union with the Blood. For it being allowed on all Hands, that the Animal Blood is compounded of a Mixture of many Fluids, and that every one of these Fluids (if homogeneous) consists of similar Particles, and of a different Figure and Bulk from the Particles that compose any other Fluid; or (if heterogeneous) of Globules that contain Particles of different Figures and Bulk, and different too from the Figure and Bulk of other Fluids; they have supposed that there are within the Glands Bodies of a Sieve-like Form, to which the Arteries convey the Blood, which upon its Arrival there adapting it self to the Holes of that Figure, which is peculiar to the Mass of the Fluid, it conveys or forces some Part of the Blood into those Holes, in order to be carried off to the Secreting Vessels, while the other Fluids return again thro' the Veins: So that the Pores of the Glands must be of different Figures in different Parts of the Body, according to the Diversity of the Figure of the Parts of every Fluid contained in the Blood. This whole Business is illustrated by the Instance of a Sieve, which gives a free Passage to one Sort of Grain, and yet stops another Sort, not larger, but of a different Figure; and again by the Instance
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of a Strainer, that is pervious by some kind of Fluids, while others which seem of a finer Texture cannot pass. And there have been some who have joined this last *Hypothesis* with the former of innate Ferments; and their Way of Reasoning ought indeed to be followed by all the Patrons of Ferments.

8. For whatsoever kind of Ferment we suppose in every particular Gland, which is capable of changing the Blood impelled thither into a new Form and different Body, yet upon that Change, it ought to assume such a Figure, as is agreeable to the Orifice of the secreting Vessel proper to that Gland, and which ought to be so framed, as to exclude all Bodies of a different Figure; otherwise any Body of a sufficient Subtily may pass thro' it without any Assistance from the Ferments: To prevent which, all this plausible Tale of Ferments is brought upon the Stage, and all this Reasoning upon the Diversity of the Figures in the Pores received with great Applause. Upon this Account the Authors of the first *Hypothesis* of a definite Number of Ferments, are obliged to have Recourse to the second of definite Number of Pores: For they having supposed different Ferments in different Glands, which seem necessarily to require Sieve-like Substances of a Variety of Figures, or Receptacles more agreeable to one Ferment than another, there was no Reason for their disallowing

allowing the second *Hypothesis*, but their not understanding it. But however contradictory they may seem, who embrace the first and deny the second Opinion, yet still the second has brought no real Advantage to Physic, because the Assertors may frame at their own Pleasure any Figures in the Parts of Fluids and Pores answerable to them; neither can they be refuted, since they are so small as not to be the Objects of Sight. And thus it was easy for the Slaves to a Sect to adapt Pores and Reasonings to the Principles of the *Galenists*, however in themselves unsound.

9. There are two Reasons which seem to have inclined the Assertors of the second Opinion to make the Variety of Secretions daily observed in a sound Animal, depend upon the Diversity of the Figures. First, because they fancied, from the Instance of the *Sieve*, that some Bodies might pass thro', and others, tho' not of a larger Size, could not, if there were only a Diversity of Figures allowed. In the second Place, if it were not as they supposed, they could give no Reason why *Sweat* and other (if there are any) thinner Fluids, should not pass thro' the Orifices appropriated to secrete and carry off the grosser Fluids, which would endanger Life. The Grounds of this Fear, more insignificant than the Fear of a *Vacuum*, shall be removed at the End of this Dissertation. Now we must examine the Instance
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of the *Sieve*; and let us suppose a *Sieve* perforated with Circular Holes. If in this Case you apply spherical Solids of no greater Diameter than the Diameter of the Holes, they will pass, and run thro'. But if you apply to the Holes Grains of Corn, or any other Body of greater and lesser Diameters than the Holes, the greatest of which is greater than the Diameter of the Hole, the least is not, than they will not pass and run thro', if the largest Diameter happens to come parallel to the Diameter of the Hole; which is only a single Case in this Instance: Because they may be so apply'd, that the lesser Diameter shall fall parallel to the Diameter of the Hole, or if not parallel, it may be inclined at any Angle; and these Angles being infinite, produce an infinite Variety of Cases. And thus, without any regard to the Figure, this boasted Argument of the Sieve is easily confuted. Wherefore to place the whole Matter in the clearest Light; let *A* signify the Conditions of Admission; *E*, the Conditions of Exclusion; *q* the Turns of Admission; *p* the Turns of Exclusion; then the Quantity sought for will be $\frac{Aq + Ep}{q + p}$, as is evident from the Demonstration of the Great *Huygens*. And since, as is proved, the Quantity *p* is finite, but *q* is infinite, therefore *p* is lost, and the Product will be $\frac{Aq}{q}$, and by consequence

quence the Case of Admission will always happen.

10. Whoever attentively considers how great a Portion of our Blood is of a watry Subtility, or rather a watry Fluidity, not to say entirely watry, and which Water, or any Thing of an aqueous Fluidity and Gravity, can by Degrees and by a gentle Heat easily rarify and separate into any, even the minutest Particles; or if he considers the Nature of a Fluid, he will soon allow, that the Blood which flow thro' our Vessels by the Force impressed upon it by the Motion of the Heart, may be separated into Particles much more minute than the Orifices which it meets with in its Course; and yet every one of these separated Particles may be a Fluid, and perhaps a Compound of other heterogeneous Fluids; for every Fluid ought to be accounted a Body consisting of an infinite Smallness of Parts; which however, in different Fluids requires a different Force, to cause a Separation of those Parts: So that the minutest Solids of Fluids are not secreted in the Vessels and Glands, but the Fluids themselves, tho' sometimes but in a small Quantity: For it is not to be imagined, that the Force impressed by the Motion of the Heart and Arteries is so great, as to be able to separate the minutest Parts of the smallest Fluid from an Union with the rest; for if so, we should meet with Volatile Salts instead of Blood,
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dispersed thro' all the greater Arteries. But it is evident that Fluids do not require any peculiar or regular Figure, since they can adapt themselves to any Figure, and penetrate any Orifice, supposing the impelling Powers strong enough to break the Cohesion of the Fluid at the Entrance of the Orifice. From whence it follows, that if Fluids are secreted from the Blood of the Animal in a State of Fluidity, that there is no Occasion for any peculiar Configuration of the receiving Orifice, but that any will serve, if it be but large enough; neither are the Figures of the minute Parts of the secreting Fluid of any Consequence in the Performance of the Work of Secretion.

II. But suppose they are not *Fluids*, which are secreted in the Glands from the Blood in a State of Fluidity, but that they are minute Solids, which being reassembled and brought out of many small secreting Vessels into a larger, compose a Fluid Body, let us see what is requisite to put these in Motion. Here they assume, that the Orifice will admit and give a Passage to only a Body of a given Figure and Magnitude, excluding all others whatsoever; which is evidently false: For if the Body to be admitted is lesser than the Orifice, and can be so placed within it, that all its Sections passing thro' Planes parallel to the Orifice, are lesser than the Orifice given; then not only that Body, but an
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infinite Number of others of any Figure may enter and pass that Orifice. And tho' we suppose the greatest Section of the Body similar, and equal to the Figure of the Orifice given, yet because a great many different Bodies when cut bear the same Figure, therefore many different Bodies may pass thro' the same Orifice, or many different Secretions may be made thro' the same secreting Vessel. And thus this Hypothesis about the Necessity and Convenience of the Figure of the Pores, falls to the Ground. Thus, for instance, thro' the same Circular Orifice there passes not only a Sphere, all whose Sections are similar, and equal to the Circle of the Orifice, but a *Cone* and a *Cylinder* upon an equal Basis; and thro' the same Triangular Orifice there passes a *Pyramid*, a *Prism*, and a *Cone*, whose greatest Sections passing thro' a Plane parallel to the Orifice, are equal Triangles, and similar to the Triangle that makes the given Orifice.

12. Beside, tho' there were no Obstruction to the Admission of a Body into an Orifice of a given Figure and Magnitude, from the Magnitude and Similitude of that Body, yet the Situation alone may be an Obstruction. For suppose a *Cone* is to enter a given Triangular Orifice, altho' the Triangle measured by the Axis of the assumed *Cone* is not bigger than the given Orifice, but exactly similar and equal to it, or even much less,

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yet it is moreover requisite for that Section of the *Cone* to be situate parallel to the Orifice, and the Position must be similar while the Body approaches to it, or otherwise it cannot possibly enter. But it may happen infinite Ways, and all equally feasible, both that the Section may approach in a different Position, and that Sections of different Figures may be applied to the Orifice; because, beside a Triangle passing thro' a Plane parallel to the Plane of the Orifice, there is an infinite Number of Bodies, and great Diversity of Figures, which may be all Sections of a given Cone, since a Triangle is only one Section of a *Cone*. And thus, there is but one single Case wherein the assumed Cone can pass thro' the Orifice given; but there are two Ways an infinite Number of Cases equally easy and credible, in none of which it can possibly pass. After the same Manner, if a *Cube*, suppose of Salt, be apply'd to a square Orifice, every where similar and equal, but yet not parallel in its Situation, so that Side and Side, and Angle and Angle, exactly agree, the *Cube* in this Case will not be secreted thro' the given Orifice; but it may happen infinite Ways, that either the Angle may strike against the Side, (altho' the Surface is parallel to the Orifice,) and in none of those Cases it can pass; or that the Surface may not be parallel to the Orifice, (altho' it agrees in all other Things,) and in none

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of those can it pass. The same may be affirmed of any Solid, except a Sphere; for all the Sections of that, with the Planes passing thro' its Center, and parallel to any Plane, are Figures equal and similar, and of the same Situation, that is, equal Circles: So that a Sphere is the only Figure among Solids, which passes thro' a given Orifice at any Situation, as a Circle is the only one of plane Figures that admits a passing Body of any Figure, and at any Position, supposing the greatest Diameter of that Body is not larger than the Diameter of the Circle.

13. From all which I draw this consequence; That if there is a Necessity for an Agreement of the Pores and the Parts in the Work of Secretion, that no Secretion at all would ever be performed: But since we perceive that frequent and large Secretions are daily and necessarily made in every Animal, we must allow that there is no such Thing as that fancied Agreement in the Figures of the Pores, and the Particles secreted, as being what would entirely obstruct the Business of Secretion. And the Force of this Reasoning is founded upon this: If there be only one single Cause to make any Secretion at all, and there are infinite Causes to obstruct it; and if every one of these is as powerful as that single one, we must conclude that that Secretion is never performed at all. And this Argument depends upon the

same Evidence and Necessity, as that Conclusion does of our allowing him absolutely the Winner at the Game of Dice, who generally wins.

And to finish this Matter after the same Manner as we used in the foregoing Paragraph,

Let A signify the Conditions of Admission, E the Conditions of Exclusion, q the Turns of Admission, p the Turns of Exclusion: then the Quantity answering Expectation will be $\frac{Aq + Ep}{q + p}$, as is plain from the Demonstrations of the Great *Huygens*. And because the Quantity q is finite, but p is infinite, as we proved in the 12th Paragraph; therefore q is lost, and the Product will be $\frac{Ep}{p}$, that is, E ; and so by consequence the Case of Exclusion will always happen. Which was the Thing to be proved.

14. But there is another irremovable Difficulty against this Secretion thro' Pores of a different Figure: For, to instance, a Cylinder may enter and fill the Orifice of a Parallelogram, if the Parallelogram generating the Cylinder be equal to the Orifice, similar, and of the same Position. But such a Cylinder will enter and fill a Circular Orifice, if the Basis of the Cylinder is equal to the Orifice, and in the same Position. Wherefore, if we allow that Bodies swimming in

a Fluid do generally approach the Orifices obverting their greatest Sections of the same Position, (which Concession ruins our Opponents,) then the same Bodies may be secreted thro' Orifices of a different Figure, and with the same Facility. Again, the same Cone, according to its different Position, will enter and fill a Pore or Orifice of a Triangular, Parabolical, Hyperbolical, Circular, Elliptical, and an infinite Diversity of other Figures. Therefore allowing the same Position as before, the same Secretion will be made naturally, and with an equal Facility, thro' different Places, and different Glands. Which is contrary to Observation, and is a direct Contradiction to the Inventers of this Diversity of Pores.

15. It seems evident therefore, that the Orifices of our Vessels, and the Pores of the Glands and Parts of our Bodies, do not differ in respect of Figure, but in the Largeness and Extent of Figure. Give me leave then to repeat here our former Observation, that a Circle is the largest and most capacious Figure of all Figures upon the same Diameter, and that it admits the Planes of all Figures in any Position whatsoever, provided they are not of a greater Diameter. Wherefore since it is infinitely more probable, that Bodies of so many different Figures being conveyed to an Orifice not circular, will not fit it; and it is plain too, that those Bodies

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will by their Force and Motion change the Figure of the objected Orifice into some other, which will give Passage to them in any Position and Figure, that is, they will change it into a Circular. And this will happen much sooner, and more certainly, if they are Fluids which are to enter the Orifice, and be secreted there: For tho' the Orifice were not a Circle, yet since the Parts near to the Centre, that is, the Sides, are more pressed and dilated by the entring Fluid, than those which are more remote, that is, the Angles and Sides of the Orifice are more flexible and apt to give way, it follows then, that all the Parts of the Orifice ought necessarily to be dilated at equal Distances, and equally remote from the Center; and by consequence the Orifice will change to a Circle.

But I am willing to give a farther Proof of this Matter to the favourable Reader: If a Fluid is forced down into the Cavity of a Tube with a great Force, that is, a Force far exceeding the Gravity of the Fluid, it is evident from Reason, and confirmed by frequent Experiment, that the perpendicular Force toward the Sides of the Tube is always joined to the Motion of the Tube towards its Length, which Force endeavours on all Sides, from the very Axis of Motion, to propel outwards, and that with an equal Force; because there can be no Reason given why the Pressure should be greater to-
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wards some Parts of the Axis, and lesser towards others, but that Reason which may be drawn from the Gravity of the Parts of the Fluid, which the Question supposes of no Moment, on Account of the other superior Force which impels the Fluid. Now this Force is eluded, and the Tube for all that retains its proper Figure, if the Sides of it are strong, and not much elastic, unless the Pressure be with so great a Force, as to break the Force of the Cohesion of the Parts, in which Case the Sides of the Tube burst, and fall to Pieces. But if the Sides are flexible, elastic, and apt to give way, then it is impossible but that the Force must have its due Effect, and propel the Sides to equal Distances, on every Part from a given Point of the *Axis*; and those Distances must be of such a Length, that the Tention of the propelled Sides, and the Elasticity, will now become powerful enough to sustain the Shock of that Force. In which Case, whatever Figure the Tube had at first, it will afterwards be changed into a different one, all whose Sections perpendicular to its Axis will be Circles of a greater or lesser Diameter, according to the greater or lesser Force of the Fluid, or the greater or lesser Flexility, of the Tube in its different Parts. Now such kind of Tubes, and of such a Flexility, are all the Vessels in an Animal Body, and thro' these the Engine of the Heart propels all the Fluids with such

a Force, as far exceeds the Gravity of the Fluids propelled.

16. There will appear then no Diversity between the Figures of the Pores and Vessels in an Animal Body, since they are all circular, but only the Diversity in respect of their greater and lesser Diameters, which is a Difference that must have been allowed, whether we had called in the Operation of Ferments, or the Structure of Pores of different Figures. And this Simplicity, and those few *Postulata's* which distinguish our Hypothesis, is a genuine Evidence of that Truth, which the greatest and best Geometrician has been pleased to affix to it. For a good Geometrician never teaches to build a Problem in a perplexed Method, which may be done in a plain and simple One. And since my Discourse has led me to mention Geometricians, I cannot forbear congratulating this Age, and our Science, upon its producing many and great Improvers of Geometry to so high a Pitch, but particularly Sir *Isaac Newton*; since we must justly hope, that by the Assistance of the Principles demonstrated by that Great Man, the Powers and Properties of Bodies serviceable to Medicinal Uses and the Comfort of Mankind, may be discovered with greater Ease, and reduced to a greater Certainty. Nor do I disown that the Art of Physic pleases me not so much on any other Account, as its being capable of bearing
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the Method of Geometry in the same Manner, as all those other Arts which determine the Powers of Bodies; so that I cannot help pitying those who accuse the Nature of Bodies as a mean ignoble Subject, since the Geometricians demonstrate, in the most convincing Method, such a beautiful and so infinite a Number of their Properties.

17. But to return from whence I digressed: Since all the Orifices of all our Vessels are of the same Figure, that is, Circles, all the Pores of the Glands too must be circular, (I call those glandulous Sieves or secreting Mouths of the Glands, Pores, in this Place,) *and by Consequence there are no peculiar Receptacles of Ferments, and no Ferments at all in an Animal Body.* And indeed, since we have proved the Orifices of all our Vessels similar, the Ferments can in this Case contribute nothing to Secretion, but the Comminution of the Blood into Particles of a proper Smallness. But it is plain that this may be performed only by the Action of the Lungs, the Force of the Heart, and the Compression of the minutest Arteries. For if these Ferments are not mixed with the Blood, they cannot be the Cause of any Separation of Particles in the Blood, that is, they cannot be the Cause of any Secretion; but if they are mixed with it, they will be carried by the Force of the *Harvean* Circulation thro' all the Vessels of the Body; and
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any Ferment will cause a Secretion in any Place similar to the Secretion of its original Place, unless you suppose that it is obstructed by the Diversity of Figures, (as we advised these Patrons of Ferments to assert in our eight Paragraph;) which Opinion we have already refuted and discarded.

18. From what has been proved I draw this farther Consequence, That there is no intermediate Space or Body between the Evanescence of an Artery, and the Rise of a Vein, which can either be called the Pores or Interstices of the Parts, or reckoned as a Gland, that is, such a Space between which the Mouths of the Artery or Vein stand distinctly unclosed and open. For the Blood evacuated into that Space or Body would much more easily compress and force the Sides of the Membranes which compose the Mouths of the Vein to a Contact, than enter into that Mouth; and then the Blood would not return thro' the Veins to the Heart: But it does return, and thro' them too; wherefore there is Necessity for their Mouths to be joined, and connected to the Mouths of the Arteries; for there is no such Thing as that distinct Gland of the Porists, that intermediate between a Vein and an Artery, furnished with Pores and Orifices, or abounding with Ferments of different Figures, according to the Diversity of the Parts; but that Gland which is serviceable in Secretions,

tions, is Part of the Vessel which forms that Vein and Artery, and the Veins are nothing but Arteries turned back toward the Heart with a contrary Direction. From whence it follows, that no Parts of a human Body, besides the Veins and Arteries, require a Reparation, for Supply of which the Blood should be diverted either thro' the open Mouths of the Vessels, or Pores of the Coats, from its glorious Tract discovered by Dr. *Harvey*.

19. But altho' there are no such Glands as the *Porists* fancy, yet for the better Regulation of our Dispute, we shall call that Part of the Arterial Curvature from whence the first Root of the secreting Vessel arises a Gland. Wherefore we proceed to remove the second Difficulty which we mention'd, which seems to have induced a great many to fall in with the Hypothesis of the various Figure of the Pores. Because there are secreting Vessels of a different Amplitude opening into different Arteries, yet the Arteries and Veins are equally full of some Fluid; and because the antecedent Blood in the Veins resists that which is to follow thro' the Arteries, more than a Fluid already conveyed into the secreting Vessels does that which is to follow thither, that being resisted only by the Air, which will easily give way; (I speak now particularly of Secretories that discharge their Fluids without the Animal :) Therefore whatever Fluids can meet with
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Secretories large enough will separate at the same Time from all the Arteries. So that, while the thinner Fluids will pass from one Artery, or the Section of an Artery, thro' the secreting Veins, which at the same Time deny Passage to the grosser Fluids, these grosser, or comparatively grosser, will pass thro' the larger secreting Veins, either from another Artery, or a Section of the same. I do not here dispute of the Fluids which are discharged thro' the Lymphatic Vessels and the Nerves, it being sufficient to observe upon them, that there is such a Resource of Fluids in the Blood adapted to supply those Vessels, that they cannot all at one Time be directed to any Part. But I return to the secreting Vessels, those that are called such in the common Acceptation, because they carry the Fluid to be discharged without the Body. Now they are supposed to be generated either by the conglomerate Glands, such are the Kidneys and Liver, or from the conglobate, such are, in my Opinion, the cuticular Glands. These, I suppose, carry off the thinner, and those the grosser Fluids; and it is evident that the Orifices of the former are larger than those of the latter, as the Number of the latter is greater than that of the former: For it is requisite, that the Number and Bulk of the Vessels of the larger Orifices, should bear such a Proportion to the Number and Bulk of the Vessels

sels of the lesser Orifices, as to make it impossible for all the thinner Fluids to pass at once thro' the Passages admmissive of the grosser. But I would have it observed here, that the Secretions which are the Subject of this Discourse, do not include the Excrements, which are discharged thro' the *Alvus*, and never enter the *Venæ Lactææ*, since we dispute here only of those Secretions which are performed within the Animal it self, and arise from the Supplies of the circulating Blood; for as for those in the Stomach and Intestines, they happen without the Animal. Let us in the last Place remember, that pure Secretions very rarely happen, but that most commonly one is mixed and tinged a little with another, and that the grosser Part is dilated by the thinner, which is secreted at the same Time.

20. And now for the Illustration of this Point, it will be of use to observe, that

I. *If the Vessels are equal in Number in two Places, and each of an equal Distance from the Heart, the Quantity secreted in the first Place ought to be to the Quantity secreted in the second, as the Sum of the Orifices in the first is to the Sum of the Orifices in the second, since there is nothing beside which can cause any Difference.*

II. *And then, if the Orifices are equal, the Quantity secreted in the first Place ought to be*

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be to the Quantity secreted in the second, as the Number of the secreting Vessels in the first is to the Number of secreting Vessels in the second, since there is nothing beside which can cause any Difference.

And from hence (for we have omitted the Celerity, as supposing that equal from the Circulation of the Blood) any one by the Assistance of the common Elements of Arithmetic may compare the Quantities of any Secretions with others of a different Evacuation, that is, those which pass thro' the greater or lesser Vessels. It appears plainly, from what has been demonstrated, that, in whatsoever Animal the Orifices of the Vessels appropriated for the Secretion of the grosser Fluids, all taken together, more exceed the Orifices of the Vessels secreting the thinner, than the Number of these exceed the Number of those, more will be discharged from that Animal by *sensible*, than by *insensible* Evacuation. But since this never happens to a human Body in a State of Health, it is necessary that the Proportion of the Orifices in that Body should not exceed the inverted Proportion of the Number. So that we may safely infer, if the Veins secreting the thinner, are in Number to those secreting the grosser Fluids, as 4 to 1, and the middle Quantity of the Orifices of the Vessels appropriated to the grosser, is to those of the thinner,

thinner, as 9 to 4, that the Quantity of the thinner Fluid will be double that of the groffer secreted in the same Space of Time: Which is agreeable to *Sanctorius's* Experiments. If now, without altering the Proportion of the Numbers, we suppose the middle Diameter of the Secretories of the groffer, to be to the middle Diameter of the Secretories of the thinner, as 100 to 99, the Proportion of the groffer Secretion to the thinner will be the same, as 1 to 4. And this seems to be the Case of those who waste with too much Sweat, which arises from the Encrease of the Amplitude of the Vessels appropriated to the Secretion of the thinner Fluids. But if, the Proportion of the Numbers being still the same, it happens from any Cause that the Diameter of the Secretories of the groffer, is to the Diameter of the Secretories of the thinner, as 5 to 2, then the Quantity of the groffer Secretion will be about a third Part larger than the thinner; which is the Case of those who are afflicted with a *Diarrhæa*, a *Diabetes*, or a Salivation, from the Encrease of the Amplitude of the Vessels arising from the conglomerate Glands. From whence we shall have no Occasion to wonder why, upon the Encrease of one Evacuation, another is sometimes diminished.

21. But I had rather enquire what Advantages the Students in Physic may obtain from this

this Dissertation. First then, they will have no Occasion to apply themselves to that nauseous Doctrine of Ferments appropriated to every Part; which Hypothesis made the Art of Physic, in its own Nature obscure, an unattainable Intricacy. Again, we shall have no farther Necessity for inventing of Figures, and entertaining our Reason with idle Fictions; and we shall be enabled to judge more easily what sort of Medicines ought to be applied to the Disorders in Secretion, as soon as we understand that the successful Powers of Medicines depend upon fewer Properties than they have been hitherto imagined to depend; especially since, in the next Place, we have here shewn, that those Diseases, for which these Remedies are sought after, arise from the fewest and most simple Causes. Nor will it be nothing to a generous Spirit, willing to improve an Art that requires so much Time, to be condemned no more to so many eternal Compilers and impertinent Triflers, who by not understanding the Circulation, have too long and too unhappily prevented the noblest of all Inventions from answering the Hopes and Wishes of Mankind. I will conclude this Dissertation with this Suggestion, that from these Principles any one may easily attain to a Method of explaining the Symptoms and Uses of many of the *Viscera*, which are not as yet fully understood, and solve many Problems which escaped the

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Industry and Curiosity of so many of their Predecessors.

COROLLARY.

From the Principles here laid down, it follows, that the inspired Air is not mixed with the Blood in the Lungs, for the Service of Respiration.



A DISSERTATION

Of the Causes of the different Quantity that the Blood flows with thro' the Lungs of living Creatures, and Embrio's.

THE Solution of a Problem ought never to be attempted by many *Postulata*, and the Assistance of dubious Theorems, which may be easily proved by a few *Postulata*, and the Assistance of a self-evident Theorem: Neither ought any Thing to be supposed to be transacted by the Passage of Bodies unknown in Nature, and unallowed in Dispute, thro' Pores unknown and unallowed: In the last Place, no Power or Faculty of Bodies, the Existence of which may

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be reasonably disputed, and many do dispute, ought to be made use of, when there is a Power nearer, and of a Force equal to the Work required, or a Quality so conspicuous, that no Body can doubt of, but is universally confessed, and allowed. Upon this Account I am displeased with their Reasoning, who, in order to explain the extraordinary Powers of *Mercury* beyond the Force of most other Bodies, when it is conveyed into the Vessels of Animals to expel some Fluids not easily put in Motion, do not scruple to recur to a certain Power of Salt extracted from the Ashes of Plants, a sort of Rival to Nature, which they imagine to be in *Mercury*, and endowed with Force enough to work out the Salts and Acid Fluids, and carry them off with it self thro' the Vessels of the Body. For these Persons take for granted two Positions very uncertain, if not evidently false, that all Diseases, for the Cure of which *Mercury* is made use of, arise from a Redundance of Acids, and that *Mercury* is of the same Nature as *Lixivial Salts*. They too philosophise much after the same Manner, who in order to shew why the Wood of *Guaiacum* is more powerful than other Woods (which Physicians use in Diseases of the same Kind) attribute to *Guaiacum* the Nature of Salts, which they call, from their Levity, *Volatile Salts*, because, besides other Uncertainties, they take

take it for granted that the Action of Stomach and *Viscera* in Animals changes all they receive into the same Forms, as we express from them by the Assistance of a strong Chymical Fire; which, as we shall prove in another Dissertation, is too large and unreasonable a *Postulatum*. Now I, to prevent being forced to use either too large or too many *Postulatas*, and uncertain or perhaps false Theorems, only observe that the Gravity of *Mercury* exceeds that of other Minerals, which Physicians apply for the same Purposes; and by consequence, it having a proportionable Celerity, (which is every where equal to the Celerity of the Blood,) is susceptible of a greater Quantity of Motion, and exerts a greater Force; and there is no other Quality wanting here, which any one will allow to be in Mercury, and other Medicines applicable to the same Uses. But I believe it very uncertain, whether Mercury be of the same Nature as common Salt of Tartar, unless it can be first proved that Gold is of Nature allied to Acids, and many other Matters yet obscure, be first explained: For as for *Guaiacum*, that Acid Liquor which it affords in a Chymical Distillation, as it shews the Gravity of the Wood, so it betrays a Quality in the Opinion of some, opposite to Acids.

From whence it follows, that the common Mercury cleansed from all lighter at-

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tendant Bodies, is, *cæteris paribus*, a more efficacious Remedy, than when it is prepared and join'd with Salts, and such Kind of Substances: And that the Force of Gold reduced into a Liquid, or any Form commiscible with the Blood, is proportionable to its Weight, and that such a Preparation of Gold would as far exceed all other Remedies in its Virtues, as it should exceed them in its Weight.

2. Now they who undertook the difficult Task of explaining Respiration, ought to have taken Notice of these Observations: For the Mistake of Physicians lay solely in this Point, since they run to philosophising upon the assuming of a Number of less known Qualities for the Explication of that which is performed by one single generally known Faculty of a Body generally known. But to make this plain, it is necessary to enumerate some of the most simple Symptoms, and common Phænomenas of Respiration.

1. *It is a Phenomenon, that the Lungs of an Animal, v. g. of a live Dog, upon opening the Thorax, immediately grow flaccid, and fall together, and the Circulation of the Blood, and the Motion of the Heart soon cease; which does not happen in other Creatures, all whose Blood does not pass thro' the Lungs.*

2. *That a Dog, stopping his Mouth and Nose according to Art, so that the inspired*
Air

Air cannot be emitted, immediately dies; which Case is not the same in other Animals.

3. *That a Dog shut into a Place full of Air, but closed according to Art, immediately dies, which does not happen to other Animals in the same Case.*

4. *That the Human Foetus lives in the Womb without the Assistance of the Air convey'd thro' the Trachea into the Lungs, and respired.*

5. *That a Human Foetus, when born, and wrapp'd up in its Membranes entire, lives in the Water without Danger of Suffocation, and yet when taken out of the Secundines, after it has once received the inspired Air, it cannot survive without the Continuance of that Inspiration.*

6. *That the Blood being drawn out by Transfusion from a Dog of a free Respiration, or a Puppy at its first Respiration, into another whose Mouth and Nostrils are closed, (and, if that seem necessary, as great a Quantity being taken from the one, as it has received from the other) the Dog, or Puppy, whose Mouth and Nostrils are closed, immediately dies. The same happens upon the Immission of Milk.*

7. *That a Dog enclosed, in the Pump of Guerikius's Invention, or commonly called Boyle's, the Air being extracted, immediately dies, but a Puppy lives much longer, and so do other Animals, who have a lesser Quantity of Blood passing thro' their Lungs.*

8. *That the Air, in which the enclosed Dog dies, is a little before the Death of the Animal of the same Gravity and Elasticity as it was when the Animal was first enclosed.*

3. These are the principal Phænomenas of that Respiration which respects Mankind; and because all of them discover a Sort of necessary Relation between the Circulation of the Blood, (in which the Life of Man consists,) and the Power and Nature of the Air, therefore we ought first to determine what we mean by the Word *Air*. It is evident, in my Opinion, that we ought in this place to take for the *Air* a fluid Body, capable of forcing it self thro' the *Trachea*, and the smallest Branches of the *Trachea* into the extremest Parts of the Lungs, but not capable of penetrating the Pores of the Coats that cover the Lungs, no more then it can those of Glafs. And because the same Fluid which we inspire upon the opening of our Mouths, is not known to us by any Quality, so much as its Gravity and Elasticity, it is sufficient to call the Air here an elastic Fluid, whose Density is proportionable to its Compression, since we know of no other Fluid beside the Air, which can be compressed into Spaces reciprocally proportional to its compressing Powers.

4 Now we must give the State of the Question. But neither ought it, nor can it be

be stated in other Words than Dr. *Harvey's*, who in his *Treatise of the Birth*, in his Book of the *Generation of Animals*, proposes to the Enquiry of the Learned:

“ How an Embryo can live in the Womb
“ of the Mother, without the Inspiration of
“ the Air thro’ the *Trachea*, as I shall soon
“ shew it does; and yet the same, when ex-
“ cluded, immediately respire, and cannot
“ survive so much as an Hour without Re-
“ spiration: But if continuing in the Womb
“ beyond nine Months, it can live and be
“ well without the Benefit of Respiration?
“ Or how it comes to pass, that a *Fætus*
“ born, and covered in its Membrances en-
“ tire, and still enclosed in its own Water,
“ can live without Danger of Suffocation for
“ some Hours; yet the same *Fætus*, when
“ out of the *Secundines*, if it once draws in
“ the Air thro’ the Lungs, cannot survive
“ without it so much as one Minute, but
“ immediately dies. In the same Manner,
“ when a *Fætus*, in the *Cæsarean* Operation
“ is taken out some Hours after the Death of
“ the Mother, it is found alive, and sur-
“ vives within the Cover of the *Secundines*,
“ not requiring the Benefit of the Air. But
“ as soon as it has once enjoyed it, if it be
“ placed again in the same *Secundines*, it is
“ suffocated for the Want of the Air.” So
far he. And from hence I shall begin to ex-
plain what others before me have thought

more probable, and adapted to the Solution of this Question, and by what Reasons they have confirmed their Opinions, and how often they have deviated from the Rule I laid down at the Beginning.

5. Whoever considers the Phænomena which we mentioned, will readily own the Errors of *Alphonsus Borellius*, (but the Error of how extraordinary a Person!) in the 113th Proposition, and the following Part of his second Book, of the *Motion of Animals*, when he declares that he has proved that the Particles of the Air are mixed with the Blood by the Force of Respiration. For, says he, because there is a watry ferous Juice always found in the Blood, and such a watry *Serum* being put into Motion by the Pressure of the inspired Air, turns to a Froth, which Froth is therefore impregnated with aerial Particles; and the same Water is capable of an easy Penetration thro' the Pores of the Veins: It is impossible but that it must carry with it some entangled Particles of Air, and mix them with the Blood: But since the Particles of Air mixed with the Blood are elastic, and are never pressed with the same Force for the Space of two Minutes together, therefore they will always free and restore themselves from their Compression, and by that Means propagate an Oscillatory Motion, (in which the Life of Animals, according to *Borellius*, consists,) which is uncertain, and
subject

subject to change every Minute. But it is plain from our former Observations, that this Opinion is vain and groundless: For this gives no Solution of Dr. *Harvey's* Problem. Any one may still *quære*, in Dr. *Harvey's* Place, how it is then possible to happen, that the *Fætus* when born, and covered in its Membranes entire, survives for some Hours without Danger of Suffocation, and yet the same *Fætus*, upon the Removal of the Secundines, if it once draws the Air into the Lungs, cannot subsist without it afterwards the Space of a Moment, but immediately dies.

For if it is necessary for the Support of Life, that some Part of the Air should be mixed with the Blood in its Course thro' the Lungs, the same Necessity requires that it should be mixed with the Blood of the *Fætus*, while it lies within the Secundines separated from the Womb: But the *Fætus* maintains Life within them without Respiration, and the Assistance of the gross and common Air, and yet when that very Air, upon the Removal of the Secundines immediately after the Birth, rushes into the Lungs, it cannot afterwards subsist without it. Again, any one who considers our first Phænomemon, will plainly discover, either that no Part of the Air enters the Vessels of the Lungs, or that it is of no Moment, and contributes nothing to the Action of Respiration,

tion. Because in Frogs, the Sea-Tortoise, and Animals of that Kind, and in Human *Fætus*, or any similar to it, when involved in the Secundines entire after the Birth, far the greatest Quantity of the Blood flows thro' the Heart, without approaching the Lungs, and requires no Assistance at all from the Air: And this is the Reason why those Animals continue alive so long a Time after opening the *Thorax*. But in Cases where all the Blood is carried thro' the Lungs (as in a Man after free Respiration) those Animals die immediately upon opening the *Thorax*, because upon the sudden Irruption of the Weight of the Air not passing thro', but compressing the Vessels of the Lungs, it is not the fine and more subtle Part, but the grosser Air which is excluded from the Vesicles of the Lungs, that Part of the grosser Air, I mean, whose Office it is to fill and distend the Pulmonary Vessels.

Again, if the Mixtures of any Part of the Air with the Blood in the Lungs is of Use or Advantage in Respiration, we may reasonably enquire of *Borellius*, how it comes to pass, that a *Puppy*, (whose first and private Passages for the Blood are not yet closed) should live longer in the Air-Pump, the Air being extracted, than a Dog, tho' of a much greater Strength? For if the Air, or a Mixture of Part of the Air with the Blood, is of any Use, there is an equal Danger of Death in both Cases.

6. But

6. But *Borellius's* Opinion is more evidently refuted, by the Help of the second and third Phænomenon, and again by the sixth and eighth: For if an *Oscillatory* Motion in the Blood produced by a Mixture of Part of the Air, is necessary and sufficient for the Preservation of Life, the Animal, whose Mouth and Nostrils are closed, but whose Lungs are inflated with Air, must have that Motion, and so must the Animal enclosed in a Place full of Air, but not open. For the elastic Air cannot be wanting in this Case; and, if we believe *Borellius*, neither Respiration nor Life can be wanting, as long as any Part of elastic Air remains: But it is plain from the Phænomena, that the Air does remain, and that of the same Gravity as when the Animal was first enclosed. But if the sixth Phænomenon is considered, it will appear, that this *Oscillatory* Motion, impressed upon the Blood by the Mixture of the Air, is neither necessary nor sufficient for the Uses of Life. Because the Air will not be more easily conveyed to the *Fætus* by the Assistance of the maternal Blood, than it will by the Assistance of the Transfusion we mentioned, from the respiring Dog to the Dog not respiring, which however will not live longer than if he had received no Blood mixed with Air: So very uncertain and fugitive is that Life which is expected from a Mixture of Air with the Blood.

7. There

7. There is no Necessity for examining the Notion of *Wolfgangus Wedelius*, who lays down in the 127th, and the following Pages of his *Physiologia Reformata*, that the Life of Animals depends upon a Sort of Reciprocation of a certain innate and vital Air, with the external Air mixing and communicating with the internal Mass of the Blood: By which Words it appears that he designed to adopt the Notion of *Borellius*, and substitute the Term *Reciprocation* in the Place of his *Oscillatory Motion*; but he has increased the Number of uncertain Notions upon which *Borellius's* Hypothesis depends, by bringing in upon it a certain vital Air; and so applying two Sorts of Air for the Performance of that Business which *Borellius* managed by one known Kind of Air. Let it suffice to remark, that this Reciprocation is proved useless and repugnant to the Nature of Things from the same Reasons, as *Borellius's Oscillatory Motion*, and Mixture of the Air with the Blood in the Lungs, was before; and so we have overthrown the very Cause and Foundation both of the *Oscillatory Motion*, and *Wedelius's* Reciprocation.

Neither is there any more Necessity for entering into a prolix Discussion of *Bohnius's* Opinion in the 78th Page of his *Anatomico Physiological Circle*, where he says that only a Part of the Air is conveyed into the Blood in Respiration, but that it is the most subtle
Part,

Part, and yet not elastic, tho' he allows it the very Cause of the Elasticity of the Air, upon Account of its perpetual Motion, which is peculiar to a spherical Figure. For *Bobnius* readily allows the subtle Air to be of a spherical Figure, and to enjoy the perpetual Motion of a spherical Figure, by which our *Vitality*, as he loves to express himself, proceeding from the Motion of the Blood ascribable to that Part of the Air, is kept up and preserved. This is *Borellius's* Hypothesis, and therefore no wonder it answers Dr. *Harvey's* Problem, and agrees with the *Phænomena* no better than that does.

8. But we must now examine their Opinions, who think it evident from many Arguments, that some Part at least of the Air is received into the Vessels of the Lungs for the Use of Respiration; which however we have already shewn, and shall farther shew, in the Prosecution of this Subject, to be false and groundless.

Let us then begin with that Argument, which is drawn from an Observation of Dr. *Lower's*. He observed that the Blood was sent into the Pulmonary Artery of a black Colour, but that it came out of the Pulmonary Vein florid and ruddy: Again, upon the Closure of the *Trachea*, that the Blood flowed black from an Aperture of the Cervical Artery. In the last Place, that in a dead Animal, if the Blood in the *Vena Cava*
con-

continuing still in a State of Fluidity, were forced thro' the Heart and the Lungs dilated at the same Time by the Bellows, it would spout from the Lungs of as ruddy a Complexion, as it did when the Animal was living. But he has not proved, which he ought to have done, that this Change of Colour could proceed from no other Cause, but a Mixture of the Air: For notwithstanding this Observation, it may proceed from the alternate Compression of the Vessels of the Lungs; and so the Solution of the Parts of the passing Fluid may be produced by the Irruption of the elastic heavy Air, and not by its Mixture with the Blood. And Dr. *Lower's* Observation equally proves that there was no such Pressure, as it does that there was no such Mixture. And every one will readily allow, that as much Air was mixed with that Part of the Blood, which comes out upon the first Aperture of the Vein, and at last settles of a black Colour at the Bottom of the Vessel, while it is falling thro' the Air, as can be mixed with the Blood in that short Passage thro' the Lungs: But on the other Side, that the Agitation and Solution of the Parts of the Blood is much greater within the Vessels of the Lungs, than in the Bottom of a Vessel at Rest. Lastly, to oppose one Observation to another, let the Patrons of this Opinion shew how it comes to pass, that the Blood which

we

we perceive of a red and florid Colour in the Time of Emission, being soon after exposed to the Air, often loses that Redness? And whether or no this Observation does not prove the Redness of that Blood entirely owing to the Pressure of the Lungs and the Heart? For it is not a Deficiency of the Air in this Case, but of Motion, and the Solution of the Parts impressed by the Heart and Lungs. But more of this at the End of this Dissertation. However, read upon this Subject the very Learned Dr. *Lister's* first *Anatomical Dissertation on Shell-Fish*, p. 101.

Let the second Argument be that which is drawn from the *Miasma's* and *Effluvia's* which kill suddenly by being drawn with the Air into the Lungs, and so are mixed with the Blood in the Lungs, which could not possibly be, unless their Vehicle, the Air, was carried into the Blood-Vessels of the Lungs. But it ought to have been proved, that the Powers of these *Miasma's* cannot stop Respiration, unless they are mixed with the Blood; for I see no Proof of that, nor any Reason why their Mixture with the Blood should occasion Death. Now we know that these *Miasma's* are joined with a greater or a lesser Gravity of the Air, which produces a greater or lesser Inflation of the Lungs than in their natural State; and from that alone this Defect of Respiration proceeds.

The

The third Argument is taken from an Experiment of Dr. Mayo's, shewing that the Blood, when it has been emitted for some Time, and freed from the Air in the Air-Pump, does not expand it self so much, as the fresh drawn Arterial Blood does in the same Engine, and by Consequence does not contain so much Air. But nothing certain can be concluded from this Experiment, unless it be first proved, that the following Proposition is false.

Upon the exposing of two equal Portions of the same Fluid, both abounding with an equal Weight of Air mixed in their smallest Spaces, a greater Quantity of Air may be extracted in the same Time from that Portion of the Fluid, which is divided into smaller Parts, than from that which is not so much divided, provided the same Force be applied to both.

The Truth of which Proposition is self-evident; for it is plain, that a Fluid of a closer Texture, *cæteris paribus*, cannot so soon, or with the same Force, be compelled to discharge the Air included, as one of a looser Texture; and we shall prove hereafter, that the Arterial Blood is of a looser, and the Venous Blood of a closer Texture.

This last Argument depends upon the Authority of *Sylvius* and *Thurston*, who affirm, that

that Air and a black Sort of Fluid was impelled thro' the *Trachea* into the Blood-Vessels of the Lungs. I shall reply to this from an Observation of *Malphigius's*, who disputing of these Kinds of Argument in his first Epistle *de Pulmonibus*, concludes thus: *From whence, as there is no natural Passage from all these Vessels, because the immitted Liquor makes more Passages for it self, than are usual in a State of Health, so we are convinced, that those direct and glorious Roads are broken upon any slight Impulse and Alteration of the Humours.* And indeed, it is evident to any one who tries this Experiment with Care, that it is impossible but the Vesicles, and those Vessels of the Lungs, whose Texture is so delicate, must be burst by the Force, with which the Air, and that black Sort of Fluid, is immitted into them.

These are all the Reasons, and all of one Stamp, which are equally favourable to Dr. *Mayo's* Hypothesis, as to *Borellius's* and *Etmuller's*.

9. Because he, agreeable to *Willis* and many others, determines, that the Air supplies the Blood in the Lungs with *Nitro-aerial* Particles, as he expresses himself, which Particles meeting with others of a *Salino-sulphureous* Nature supplied from the Blood, excite that Effervescence upon which Muscular Contraction depends, and which by consequence make a great Part of the Animal Spirits.

From hence he concludes that Animals die upon the Suppression of Respiration, for this Reason, because of the Want of that Salt of the Air, the Motion of the Heart flags, and then the Flow of Blood to the Brain is interrupted, and of Course the Distribution of the Animal Spirits, wherein the Foundation of Life is placed, ceases. But I shall not insist any longer in the Refutation of these, but only observe, that the Opinions which we have enumerated, which seemed new to the Authors themselves and others, ought to be accounted one and the same Hypothesis expressed in different Terms; so that whoever refutes one, refutes them all.

10. For it amounts to the same Thing, whether we affirm with *Etmuller*, that Part of the Air is mixed with the Blood in the Lungs for the Service of Respiration; or with *Borellius*, for the Preservation of the Oscillatory Motion; or with *Wedelius*, for the Continuance of the Reciprocation of two different Kinds of Air; or with *Bohnius*, for the Supply of the Blood with spherical Particles; or with *Mayo*, with nitrous Particles of Air; both which according to these Authors, are the Causes of its Elastic Quality, which indeed it has not: Because all these Opinions determine, that some Part of the Air is necessarily conveyed into the Blood by the Assistance of Respiration. But the Reasons drawn from the *Phænomena* are general, and

and prove that no Part of the Air, under any Denomination, enters the Vessels of the Lungs for the Service of Respiration: For not one of these can ever, from their particular Opinion, explain how it happens, that the *Fætus* lives without Respiration in the Womb, but that the Animal out of the Womb die without Respiration, altho' it is supplied with Blood from a respiring Animal, which Blood is impregnated with a Part of Air either *elastic*, or *perspirable*, or *reciprocative*, or *spherical*, or *nitrous*, See the 6th *Phænomenon*.

But these Great Men, offended against the Rule laid down at the Beginning of this Dissertation, because they had Recourse, without Reason, to Properties of the Air not sufficiently understood, much less demonstrated, when the Gravity and Elasticity of the Air seemed so plain and obvious to all, which they should rather have examined into, and adapted to the Business, than have entangled themselves with inextricable Difficulties.

II. We must now repeat our former Observation, that the Air, in which the included Animal dies, has neither lost its Gravity nor Elasticity; and therefore, that all the Air which was there at first, remains there still, and by consequence from a known Property of the Air, that no Air, or Nitro-aerial Particles, are drawn by Respiration into the Blood-Vessels of the Lungs.

Beside, it is evident from the first *Phænomenon*, that the Air, or whatever Body it is, which is to be drawn into the Lungs for the Conservation of Life, cannot penetrate the Coat of the Lungs; otherwise an Animal might survive a long Time after the opening of the *Thorax*, neither would the Lungs fall together; and when the *Thorax* was shut, the Air, by running from the Branches of the *Trachea*, and the neighbouring Vessels, into the Cavity of the *Thorax*, would continually obstruct the Inflation of the Lungs, and Respiration of it self, since the Air is a Fluid, which presses every Way. Again, it is evident that the Air, which could break the Sides of the Vessels in the Lungs, would break the Sides of the Vesicles too, and the Coat of the Lungs in which they are involved, and which forms a sort of Network there: But upon this Supposition there could be no Inflation of the Vesicles, and no Respiration performed. But that no one may imagine, that the Blood is conveyed into the Vessels of the Lungs, to receive the Air there, let us remember, that we endeavoured to prove in another Place, that the Ducts of the Arteries and Veins were continued Pipes; and indeed were they not continued in the Lungs, we should always eject Blood with the Air. But perhaps it may be of some Use to the Confirmation of this Truth, since others disbelieve it, because they

they have not seen it, to quote *Malphigius*, where, in his *Second Epistle de Pulmonibus*, he says, that the Blood (as is plain to Sense it self) runs through Vessels of a winding Nature, and is not dispersed into an open *Areas*, but is ever forced along through Pipes and Conduits.

12. But not to be so tedious in the Demonstration of so easy a Matter, let the sixth Phænomenon be sufficient: For if any Kind of Mixture of the Air with the Blood is sufficient for the Preservation of Life, then the Blood drawn from a respiring Animal, or Milk immitted into any Vessel where a non-respiring Animal lies, would give and preserve Life to that Animal, after the same Manner as the maternal Blood does to the *Fœtus*, since Milk bears an equal Portion of Air, endued with an equal or a greater Gravity, and so the Animal would not die; which contradicts the sixth Phænomenon.

But the particular Proof that the Air does not enter the Pulmonary Vessels, depends upon the second and third Phænomena; where it appears that there is Air enough to enter the Vessels, if there was any Possibility that it should enter. And that it does not enter, is plain from the eighth, since after the Death of the Animal, whose Nostrils are not closed, the Air is found in the Vessel in which it was included with the Animal of the same Gravity, as when it was at first inspired,

and included. The Cause of which Phænomenon we shall take this Opportunity of explaining. We observe, that the Air does not enter through the Pores of the *Pleura* of the nervous Circle of the *Diaphragm*, because it finds a more easy Passage through the Mouth, and the wide Duct of the *Trachea*, where it meets with a less Resistance. After the same Manner the Air admitted into the Lungs, finds a more open and less obstructing Passage through the Mouths of the Vessels leading to the *Trachea*, than it does through the Sides of those Vessels which are adapted for the Maintenance of a watry Fluid, of a thin Texture, and warm Nature, and so is drove by a less Force toward the Jaws than into the Veins, that is, the same Force which is sufficient to drive the Air towards the Jaws and Mouth, is not sufficient to drive it into the Pores of the Veins, which are neither so open as the Jaws, nor fill'd with a Fluid which is capable of making so little Resistance. And the Force of this Reasoning depends upon this, That the Air is an Elastic Fluid, expandible to all Parts, and therefore will be sooner, or easier drove thro' larger Passages; and where there is a less Force of an expanding Heat, than it will thro' much smaller Passages; where there is a much greater Heat, which makes the Compass of the aerial Parts too great, and encreases the Diameter. And this is so evident,

dent, that after the Air is once admitted through the *Trachea* into the Lungs, and partly by its Weight, partly by its Elasticity drove into the Vesicles, it can never afterwards be returned entire; but it will leave some Part in the Vesicles of the Lungs, especially in the extremest, which can never be imbibed by the contiguous Vessels; and the Lungs themselves, which are ever afterwards more inflated and lighter than they were in the *Fœtus*, plainly demonstrate that there is not room for the minutest Particles of Air to escape into the Blood-Vessels of the Lungs.

13. It now remains that we explain what Alteration that is which is made upon the Descent of the Air into the Lungs, which is necessary to Creatures after their Birth, and the first Act of Respiration, and yet is accounted unknown and useless to the *Fœtus*. In a *Fœtus* almost all the Blood circulates from the *Vena Cava*, and pulmonary Artery, into the pulmonary Vein, and the *Arteria Magna*, without any Regard to the Lungs themselves: For the Lungs uninflated, admit of but a small Quantity of Blood, because, since the Vesicles of the Lungs upon an Inflation become spherical, when that Inflation ceases, they will change to Spheroides, and being of an oblong Figure, grow flaccid of Course: But at that Time these Vesicles may and ought to be touched by all the contiguous Vesicles round them, and the

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Blood-Vessels in which they are involved, will be compressed and closed. Beside, the Branches of the *Trachea* are placed at Right Angles with the lower *Trachea*, and at obtuse ones with the upper; from whence it happens, that these *Branches*, (when there is no Inflation,) and the Vessels annexed to them, will forcibly compress the lower and interior Branches and Vesicles; and scarce any Circulation at all can be performed thro' the Lungs uninflated. Wherefore since the Vesicles in this State of Compression make a greater Resistance to the Blood, that pours from the Left Ventricle of the Heart, than that open and uncompressed Passage, which leads from the Rise of the Pulmonary Artery to the Rise of the *Aortal* Artery; it is necessary that almost all that Blood, which passes by the Orifice of the veinous *Anastomosis*, should enter into the other, or the Arterial *Anastomosis*, which will easily admit of it. But although, by its being proved, that very little Blood passes thro' the Lungs in a *Fætus*, it follows too that the *Fætus* does not respire by an alternate Draught and Return of the Air through the *Trachea*. Yet this Truth will appear more plain, when we consider some other *Phænomena's*: For the Air does not penetrate the *Secundines*; and although some Air was originally included in them, yet Respiration could not be maintained by that, as is manifest from the Experiment.

periment of an Animal included in a Vessel impervious to the Air.

14. The Lungs then of a *Fætus* continue uninflated merely from a Defect of Air, that is, such Air as living Creatures draw in with Freedom: For, since the Lungs do not adhere to all the Ribs, and where they do adhere, the Lobes may perhaps be distended, but the smaller Lobes and Vesicles will not dilate, although the Breast of the *Fætus* encreases, unless there be a sufficient Fluid to make that Dilatation, and of which there must be a constant and fresh Succession, as the Nature of Respiration, explain'd by these *Phænomena's*, requires. But neither of these can be obtained in the Womb: But as soon as the Animal is produced, and has drawn in the Air, the Lungs and its Vesicles are immediately dilated; and then, as a certain necessary Consequence, which we shall soon explain, the Circulation through the Passages proper to the *Fætus* ceases, and the whole Course of the Blood is turned into another Road. Nor could the Closure of those private Passages be prevented, if the *Fætus* in the Womb had received the Air into the Lungs, as we shall soon prove. The Air then, immediately after the Birth, being driven by its Weight and elastic Force, rushes into the Mouth, and the *Aspera Arteria*, as into Places where it finds the least Resistance; and then at last the Breast is capable

pable of being dilated, and elevated, after the Air by its Passage thro' the *Trachea*, has begun to support it; and being pressed by the Force of the circumambient Air, propels outwards with an equal Force.

15. The Air, I affirm, will rush in by the Force of its Elasticity and Gravity, not by any prior Dilatation of the Breast: But upon the Reception of the Air into the *Trachea* of an equal Force to the external Air, the *thorax* will not only be capable of, but will exert an immediate Dilatation; since *That* is moved by a Muscle which has no Antagonist, as the next Paragraph shall explain. But the received Air being heavy and elastic, will press equally on the Sides, as well as to the Bottom, and by consequence will necessarily break into the lateral Branches of the *Trachea*; and because they are situated at acute Angles with the lower Trunk, and at obtuse ones with the upper, therefore if the *entring* Air is of a sufficient Force to inflate the Branches and Vesicles, it is impossible but that upon the Increase of their Breadth, their Length must at the same Time be diminished, that is, it is impossible but that the Branches of the *Trachea* must be protruded upwards and outwards, and so forced to make Angles less acute with Respect to the inferior Trunk. Beside, if the *entring* Air can distend these Branches and the contiguous Vesicles by its elastic Force, it will
press

press the Branches of the *Trachea* too on all Sides from the internal Superficies: And because there is a greater Resistance towards the *Trunk*, and the Middle of the *Thorax*, which are therefore Parts of a lesser Angle, (since there all the Branches and Vesicles, both the inner and lower, from the same Side of the *Mediastinum*, and all the inward and outward of the opposite Side, make a Resistance;) but there is a lesser Resistance towards the Ribs, which already give Way, and the exterior Branches and Vesicles, none of which, beside those of the same Side, can make any Resistance, and which (I speak of the Exteriors) are extruded by all the middle ones on each Side; therefore while the Branches and Vesicles are filled with Air, they are thrust out together towards the Parts of the greater Angle, from whence the Cavity of the Breast will increase and swell, the Branches of the *Trachea* being separated, and giving Room for the Inflation of the Vesicles of the Lungs.

16. Upon an Inflation of the Vesicles of the Lungs, the whole Mass of Blood may easily circulate through the Vessels, which are interwove and dispersed between them. For since upon an Inflation they become spherical, they cannot be pressed in this State of Inflation by any neighbouring Vessels equally inflated, excepting in a few and very minute Parts: Wherefore almost all the Vessels

fels will have no Pressure, and the Blood will run more easily and in a greater Quantity from the Right Ventricle of the Heart into that Part of the Pulmonary Artery, which being extended beyond the oblique and less capacious Rise of the *Arterial* Passage, leads directly into the Lungs, since there is a less Resistance there, because the Weight of the flaccid Vesicles is removed, and the other Vessels were before turned back upon themselves. And therefore the Blood passing more freely through the Lungs into the Pulmonary Vein, will easily close up the veinous *Anastomosis*, by its continual working against the Valve, which lies opposite to the Blood that is to return into the *Vena Cava*; and that Valve being pressed with an equal Force on each Side, will soon grow immoveable, and deny any Passage at all to the Blood.

But the Air, when once inspired, must always be expired and inspired by Turns thro' the whole Course of Life; which arises from a Necessity easily to be accounted for. For since the *Thorax* is furnished with attolent and dilating Muscles, which are of so great a Force in Respect of their *Antagonists*, that they may be accounted as none; therefore the Muscle, or Series of Muscles, that dilate the *Thorax*, may be said to want an *Antagonist* Muscle. Wherefore, as soon as the *Ribs*, which fall together both by
their

their Weight and Structure, have re-expelled the Air out of the *Thorax*, the Muscles that dilate the *Thorax* will be immediately contracted; since the Animal Spirits, which then effectually endeavour at a Contraction, flow alternately into Muscles that have no *Antagonists*; which alternate Fluxion they exert into all the Muscles upon Account of the alternate Pressure of the Brain, arising from the Dilatation of the Arteries which beat there: But this is without any Effect, where there are equal opposite Muscles, and of an equal Contraction, from the same Causes.

17. While the inspired Air inflates the Lungs, and allows the whole Mass of Blood an easy Passage to them, if it becomes altered from any Cause, (either from the Encrease of its natural Gravity, or of its Elasticity, or from the accidental Accession of a greater Weight of some Bodies, which it is a Vehicle to) so as to distend the Vesicles of the Lungs too much, that is, to such a Degree, that the Blood-Vessels interwoven with the Coats of the Vesicles, are much straighten'd and compressed; then the Vessels will be closed up, and the Course of the Blood through the Lungs will be obstructed. Wherefore the Inspiration is the Cause of the Dilatation of the Breast and Explication of the Lungs, as it is of the free Circulation of the Blood, while it pours from the right Ventricle

tricle of the Heart into the Lungs. But upon a Redepression of the Ribs by the Force of their own Weight, and, as the Great *Bellina* expresses it, by the Assistance of their Figure, Position, and Articulation, the Vesicles of the Lungs are necessarily compressed, and forced inwards upon themselves, and the Branches of the *Trachea* are impelled at Right Angles: In the mean Time the Air included in the Vesicles is expelled towards the Passages of the *Trachea*, and the Jaws. But since the Air is an elastic Body, it cannot be expelled without pressing upon all the adjoining Parts; which is the Reason that the Blood, in its Passage thro' the Coats of the Vesicles, is more forcibly driven to the Left Ventricle of the Heart. And because this Blood passes thro' an infinite Series of Vesicles, which are compressed by the Fall of the Ribs between innumerable small Bodies, and is drove by the Force of the Air in the minutest Vessels, therefore every Particle of the last-formed Blood is so broken and comminuted, so separated from each other, or reduced to so small a Degree of Cohesion, that it is easy for any one Particle to pass off into some secretory Vessel answerable to its Bulk, wheresoever it finds a less Resistance than it does within the Blood-Vessel which conveys it. From whence it appears, that during a regular Respiration no Animal has any Occasion for a *Ferment*

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to work its Secretions. But after the Air is ejected out of the Vesicles, the Blood is no longer comminuted by its elastic Force, and the concurrent Powers of the *Ribs* endeavouring to restore themselves; and all the remaining Part of Expiration is spent in the Exclusion of the Air.

18. It is hardly worth while to explain at present, why Air of such a Levity as is insufficient to cause a ready Inflation of the Vesicles of the Lungs, and at the same Time to recline the Branches of the *Trachea* at obtuse Angles, will not answer the Necessity of Inspiration: Nor why, in a close Vessel full of Air, where there is only a lesser Expansion from the Heat, (for where the Heat is great, and the Place open, Respiration is obstructed for almost the same Reason as it is in *Vacuo*, as we shall soon prove,) yet the Elasticity of the Air, and the Inflation of the Branches and Vesicles of the *Trachea*, is necessarily encreased, as is observable upon the opening of Animals which die in that Condition; and thus Respiration is stopped together with the Circulation; beside, that the Air is then made more dense and heavy, because it is extraordinarily impregnated with the Particles perspiring from the Lungs and the Skin. Nor need we enquire why Animals die immediately in *Vacuo*, upon the Failure of Respiration, since there is no Air to inflate the Lungs; tho' younger and new-born

born Creatures die slower in this Case than the adult, because the private Passages of the Blood are not entirely closed up in the Younger; as from the same Reason, upon the opening of the *Thorax* in both, amphibious Animals, that is, those, all whose Blood does not pass thro' the Lungs, do not die so soon from the Defect of Respiration, as those whose whole Quantity of Blood does pass thro' the Lungs.

I had rather now explain the Reason, why a *Puppy*, tho' its private Passages are still open, if it once has admitted the inspired Air, and the *Trachea* be then immediately closed, and remain so, should yet die slower than a *Dog*. For upon the Closure of the *Trachea*, from the same Reason in both Cases, a Portion of Air is included after Inspiration, which is expanded to such a Degree by the Power of the Heat, that now no Blood can pass thro' the Vessels of the Lungs, as being too much compressed by the Air. In this Case then, it is necessary for the Prolongation of Life, that all the Blood should pass thro' those old private Passages, which it cannot now, nor indeed ever did before; wherefore there is Necessity for the Death of the Animal in both Cases; but the Puppy will die more slowly, because the private Passages, which allow Room for some little Circulation, still remain open. But if the Portion of the included and expanded Air
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be not so great, as to lock up all the Passages of the Blood into the Lungs, the Animal will still survive the longer.

But if the *Fætus*, either within or without the Membranes, is manag'd so, as to have no Power of respiring, yet still it will be longer in dying than an Adult, while both the old Passages are open, and the Vesicles of the Lungs uninflated with Air; nor will it die, but by the Defect of Nutriment, or the Force of the Cold, and then only as a Creature, whose Nature can bear neither of those Extremes.

I shall take an Occasion to enquire, in this Place, what Power that is in *Lightning*, which so suddenly extinguishes Respiration: The *Thorax* of a Youth, who was killed by *Lightning* about two Years ago at *Edinburgh*, was opened in my Presence, when I had an Opportunity of judging whether my Conjecture was right, which affirmed that the Lungs of the dead Person in this Case were flaccid, like those of Creatures that die in *Vacuo* in the Air-Pump of *Guerikinus* or *Boyle*; and then we could find nothing extraordinary, or which seem'd to affect the Life, but that strange *Collapsus* of the Lungs: The Hair and Clothes, indeed, seem'd sing'd and burnt. Wherefore, the Air which surrounded the Person, being suddenly, and to a great Degree expanded, could not inflate the Trenches of the *Trachea*, because its Gravity

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was

was lessened, nor could it enter the Vesicles, because the Expansion of its Parts was encreas'd. Nor did the *Phænomenon* of that sudden Death make me recur to framing new Properties of the Air, or calling in the Assistance of other Bodies unintelligible both to my self and others.

19. It appears then, from what has been proved, that the *Fætus* can live in the Womb without Respiration, since there are Passages open, (although the inflated Lungs keep theirs strictly sealed,) by which the Blood can circulate from the *Vena Cava* into the *Aorta*, in which Circulation the animal Life subsists. But the Infant, tho' born before the seventh Month, immediately respire; nor can it subsist any Time without Respiration, because, unless the Mouth and Nostrils are closed, the Air will rush by its own proper Force into the Breast, which thro' the whole Course of Life afterwards must be alternately dilated and contracted; and then the Lungs are inflated, and the Blood flows freely thro' them, and closes up the *Veinous Anastomosis* after the Manner we before described; and for the same Reason, as it flows with a greater Gravity into the left Ventricle, it necessarily closes the Arterial Canal, which opposes it self to the Blood which is flowing from thence into the *Aorta*. And therefore, after the Animal has once respired, and the anomalous Motion of the
Blood

Blood ceases, it cannot subsist any Time without Respiration, because that then, at last, upon the Closure of the *Anastomosis*, so frequently mentioned, the Blood cannot circulate, unless Respiration be performed by the Inflation of the Lungs. But I would have it observ'd in this Place, that while the whole Mass of Blood did not pass thro' the Lungs in the *Fætus*, there was an evident Necessity for the Dispersion of a greater Quantity of it thro' the *Viscera*, and the Vessels interwoven beneath the Skin; wherefore they were all more full of Blood, and the Skin appeared of a more ruddy Complexion, and the Brains of the *Fætus* were larger; all which *Anomalies* cease by Degrees in born Creatures after Respiration, by the Explication of the Lungs, and the large Increase of the vital Passages.

20. Before I go on to explain any farther Uses of the Lungs in born Animals, (for the Lungs are given for a future Service to the *Fætus*, if it once make its Way to Light,) it is necessary for me to answer the Objections against the Hypothesis which we have advanced, which is, That Life consists in the Circulation of the Blood, produced by the Motion of the Heart and Arteries; and that therefore Respiration is necessary to born Animals, because without that the Circulation cannot be performed. For it is not only *Pechlin's* Opinion, that an intestine Motion

of the Blood, which many suppose a Property in Fluids equally compressed on all Sides, has a necessary Connexion with the Life of Animals. *Pechlin* would have this Motion preserved by the Entrance of the Air into the minutest Passages of all the Parts: And altho' the Circulation of the Blood, and even of the animal Spirits, should cease in the mean Time, yet he imagines that Life would be still preserved, in the 3d Chapter of his Book *de Aeris & Alimenta defectu*. But every one knows, that when the Motion of a Fluid is once destroy'd, it can never be recovered or restored by the Motion of the Parts of a Fluid, or by any other Parts breaking in equally on all Sides on that Fluid, with a Motion round their own *Axis*, (for this, or something like it, is what these Authors mean, as *Pechlin* expresses himself in the 1st Chapter and 18th Page of the same Book.) And therefore *Pechlin* endeavours, to no Purpose, to prove that those Animals which seem dead to us in the Winter, and which we find afterwards to be really alive, have lost the circular Motion of the Blood from the Arteries of the Veins, which the Spring, by the Assistance of the *Intestine* Motion, and the Application of a more kindly Air, restores. The same is as ineffectually attempted by others, by drawing Instances from some Diseases, where Respiration and the *Pulse* seem extinguished and destroyed, while the Life is still continued.

21. Let this Observation suffice to answer both Instances : Suppose a Breast of a spheriodical Figure, let the lesser Diameter be fifteen Inches, and the greater twenty Inches. It is proved by others, that upon the Dilatation of the Breast, the lesser Axis is increased, and at the same Time the greater not diminished, and therefore the Cavity and Amplitude of the Breast becomes larger. Suppose the Encrease of the Diameter reaching from the *Spina Dorsi* to the *Sternum* the tenth Part of an Inch, and the Increase of the Cavity of the Breast will be 31 cubical Inches, and the Breast may and will receive so much Air, being dilated to that Degree, as to have its lesser Diameter increas'd the tenth Part of an Inch. In the same Manner, if the Increase of the lesser Diameter is the fifth Part of an Inch, the Breast will receive 62 cubical Inches of Air : But if the Augment of the Diameter is the 50th Part of an Inch, the Augment of the Cavity of the *Thorax* will be six Inches; and if the Augment were only the 100th Part of an Inch, the Increase of the Cavity would be three Inches, and so much Air would be drawn in for the Explication of the Lungs; and therefore in that Case they would be a little expanded. From whence it appears, that some Respiration may be performed, if the Increase of the Diameter of the Breast is but very small, and the Motion scarce perceptible.

tible. But if at the same Time the greater Diameter of the Breast, stretching toward the *Abdomen*, is encreased but in the least Proportion, (as it always happens in every Act of Inspiration, upon Account of the Motion of the *Diaphragm* towards the Parts of the *Abdomen*;) then a sufficient Quantity of Air may rush into the *Thorax*, and yet no Motion at all be observed in the Breast.

From these, and the like Instances, we may be ascertained, that so small a Motion of the Breast as is imperceptible to the Eye does not obstruct Respiration and the Circulation of the Blood, that inseparable Attendant of Human Life.

22. Let us now apply our selves to that Division and Solution of the Parts of the Blood, which is not obtainable either in the *Viscera*, or the Lungs uninflated, but is entirely owing to the Inflation, and which is the Cause of the greatest Difference of Strength and all other Powers between the *Fœtus* in the Womb and the Animal after the Birth, and is of the greatest Use and Service to Life.

While the Air is expired, it is evident that the opposite Sides of the Sections of the Blood-Vessels are suddenly reduced almost to a Contact; by which it is impossible but that the Parts of the Blood must be so separated, that not any two should cohere, nor any heavier Particle be joined to a lighter: And
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because it is only requisite for the Performance of Secretion, that the Particles to be secreted should not be larger than the Mouths of the Secretories, or if lesser, yet not too many, nor of too close a Cohesion, it follows, that upon the Comminution of the Particles of the Blood, which happens when the Lungs are inflated, and the Air expiring, that Advantage must be obtained, that the Blood without the unintelligible Assistance of Ferments should discharge the Offices of all Secretions, and of consequence perform all that is necessary for the Life and Convenience of Animals.

23. By the Assistance of these Observations we may give a better Reason than Dr. *Lower*'s for the Variety of Colours in the Blood: Upon an Inflation of the Lungs, the ruddy Particles of the Blood being lighter than the others, are necessarily more separated from the rest; from whence is derived its florid Colour in its Passage to the left Ventricle, and of its Superficies immediately after Venesection, the red Particles swimming at the Top by their natural Levity, or endeavouring at it, where there is the least Resistance; by their Elasticity, if they have any.

Beside, from hence another *Phænomenon* is easily explained; Why the Blood, which, upon its being poured into a deep Vessel, is often of a dark Complexion, tho' expos'd to the Air; and yet when poured into a wide

and shallow one, it seems florid: For, if there are any ruddy Particles in it, which have not as yet disengag'd themselves, they will more easily emerge thro' a few Superficies, than thro' an innumerable Quantity, and those of a greater Gravity. In the last Place, from hence we discover the Cause, why a viscid Blood, that contains some ruddy Particles entangled in it, altho' it is exposed to the Air, is not for the Generality ruddy and florid (tho' it was of that Complexion, upon its first Emission from the Veins) after it has lost that Motion which was the Cause of its Non-cohesion, which it enjoyed in its proper Vessels.

24. I will only add, that by the Constriction of the Blood-Vessels in the Lungs, the larger and last-compounded Particles of the Blood are divided and separated from each other, and that the same Cause necessarily makes the Parts of the lesser separated Blood of a closer Texture, and more difficultly resolvable into their first Elements. It is not now worthy of our Pains to examine curiously the Opinion of the Excellent *Malphigius*, who affirms, that a new Mixture, and new Figures agreeable to the Pores of the Parts, commence here; because our former Proofs evince it to be impossible, that such a Mixture or Confusion should be made in the Lungs, when there is only a Separation of Parts, unless he means that Hardness, and

and stricter Cohesion of the lesser Parts, which we mentioned before: But for my Part, I can see no Necessity nor Use for new Figures in this Case.

25. And thus much I have writ with this View, to inform the Students in Physic the Usefulness of the Rule laid down at the Beginning of this Dissertation, how many *Phænomena's* may be explained by a few known Qualities of Bodies: And I would advise Physicians not to think that they have dispatch'd a Problem well, by recurring for a Solution of it to Figures of all Kinds, subtle Air, and opposite Kinds of Salts, and Bodies, of which we know not so much as the very Names, and intestine Motions, and other Terms of a vain and pompous Ignorance.





A
DISSERTATION
UPON THE
MOTION

Which reduces the
ALIMENT in the STOMACH,
To a FORM proper for the
SUPPLY of the BLOOD.



E all experimentally know, that the Bodies of Animals lose their Forms by Hunger, and an Abstinence from Food; that the Vessels grow flaccid, and the Juices adapted to recruit the Circulation of the Blood fail in their Office; and, in one Word, that Animals die: It is as plain too, by Experience, that the Parts of the Fibres, Fluids, and Vessels, that make up the Form of an animal Oeconomy, suffer even in the soundest Bodies by Motion; that they are disunited, wore away, and impaired; and that by the Force of the natural Circulation of the Blood, that is, by the

the very Conditions and Laws of Life it self, Death becomes necessary : And hence is caused that continual Perspiration thro' the sudorific Vessels, and the Pores of the Skin : Since, as we explained it in another Dissertation, all Secretion is made merely by the Force which the Heart impresses upon the Blood, which compels all Fluids to endeavour to pass thro' those Parts where there is the least Power of Resistance. Wherefore, if we regard only that continual Perspiration, it is plainly necessary that there should be a Supply of Fluids to the empty, and an Addition of Parts to the decay'd Vessels in such a Proportion, as either upon a Trial by Weight we shall find is lost, as the excellent *Sanctorius* advises, or upon our own Observation of the Distances of Time, as Hunger induces the Generality to practice. From whence it follows, that the Conditions required for the Supply of those Diminutions of the Body, are a Fluid disposed to Sanguification, and a Compound of Particles similar to the Compound which is decayed ; which is necessary if we suppose the Animal to continue like it self.

2. But it is evident to any one who regards those Operations which the Anatomy of the Body, and the Actions of Animals, demonstrate, that the Aliment acquires in the Stomach and the Intestines that particular Facility of Motion which qualifies it to
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mix with the Blood. And therefore, if we can find the Nature and Quality of that Action in the Stomach, or what Similitude, or Proportion that Cause of the Fluidity of the Aliment in the Intestines bears to other Causes, which either are, or are accounted more known, we must be allowed to have solved this Question; and most Physicians seem to me to have erred in the Solution of this Question, because they did not sufficiently understand what the Question was: For we do not look for a Cause which has a Power to change all Sorts of Substances into a Fluid commiscible with the Blood, and consisting of Parts similar to the Parts lost, (now that Similitude is an Equality of Magnitude, Gravity, and Number,) but only such a Cause as has a Power on some Bodies, such as Mankind generally use for Food and Nutriment, and can convert them into a Fluid fit for Circulation. For then observing that there were some Animals which would devour and send into the Stomach the hardest Metals and Minerals, immediately concluded that they were to find a Cause which had a Force to colligate any sort of Substances which were offered to the Stomach. And accordingly you may observe, that they have introduced into the Stomach, either certain powerful *Demons*, and exalted invisible *Spirits*, or *Ferments*, and other Fluids, of various Denominations, which are
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supposed able to dissolve any manner of Substances: But had they remembered the State of the Question, and that all we wanted, was such a Cause, or the Knowledge of such a Cause, whereby certain solid Bodies (the common Food and Nutriment of Man) might be changed into Fluids adapted to our Nutriment, that is, into Liquids which could circulate with the Blood, and supply it with Parts of almost the same Magnitude, Gravity, and Number, with those Parts which, either by the Force of Motion, or Perspiration, were dispersed beyond the Compass of Circulation, and the Course of the Blood; and had they, in the next Place, observed that those Animals were not nourished by the hard Substances they devoured, then would they easily have seen, that such a Force only was sought for which could dissolve the solid Parts of other Aliments, so as to turn to our Nutriment; or how such Parts could be reduced in our Stomachs to a Fluidity sufficient for that Purpose. All which, if I am not mistaken, may be explained without the Assistance of a *Dæmon*, or a *Stygian* Liquor.

3. It is plain, that what is requisite for the most easy and simple Solution of this Question, is, to find such solid Bodies to be sent into the Stomach for Nutriment, as may, by the least Alteration of their own Substance, become nutrimental to the Animal;

mal; it is necessary too that that Change should be attended with a Facility of Motion, as is plain from the allowed Nature of a living Animal, whose Life and Nutriment depend upon the Circulation. Now since the solid Parts of other Animals, upon which we feed, when reduced into a liquid or fluid State, are by the least Alteration adapted to nourish us, because they bring with them Parts similar to those we lose, and so by the Hypothesis are adapted to Circulation; therefore it is manifest, that the solid Parts of proper Animals are those Bodies which are required in the Question: And therefore we are now only to look for a proper Cause, or what is the most simple and natural Force which can convert those Parts contained in the Stomach into Fluids fit to circulate with the Blood.

And, that we may make as few Mistakes as can be in the Search of this Cause, I would remark, that it ought to be such which can neither dissolve the Stomach, nor the Flesh of the Animal it is to nourish, nor such as can easily colliquate the Parts of others by the Force of a chymical Fire, or a *Stygian Menstruum*, (to speak in that way,) for this is compatible with the Life of the Animal; nor must it proceed so slowly, as that Cause, by which the solid Parts of Animals, without the Assistance of Art, and being left to themselves, resolve into Putrefaction.

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These *Postulatæ* I may justly claim, which however will quickly be made more evident.

4. It is but a reasonable *Postulatum* of mine, to require a Cause able to dissolve the Parts of other Animals in our Stomach, which cannot dissolve the Parts of the Stomach it self by that Action, by which it alters the solid Parts of other Bodies into Fluids; for we are not here looking for a Cause of sudden Death, but a Cause that assists in the maintaining of Life for some small Time. From whence it is evident, that there is no Fluid; neither can that be accounted the Cause in the Question, which inheres in, or is by any Means derived into the Stomach, and which, if the necessary Conditions are observed, and especially the *Postulatum* in this Paragraph, can dissolve, or convert the Parts of other Animals ingested into the Stomach, into a Fluid proper for Nutriment. Because, from what we have observed in the former Paragraph, it is plain that such a Cause is required, as can re-dissolve the solid ingested Parts of Animals into those very Particles, as near as may be, or Particles like them, out of which those Parts were before formed in other Animals, upon their Separation from their Fluids. Wherefore, since a Fluid that abounds with a Ferment, or can by any means dissolve the solid ingested Parts of other Animals, must by the same Action necessarily dissolve the Parts of the Vessels in
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the Animal, and the Stomach in which it inheres, or into which it is derived, it easily follows, that those Animals which we see are nourished by ingested Food, without any Injury to their Stomachs, contain in their Stomachs no Ferment at all, or no Liquid which can dissolve, digest, and convert into Chyle solid Aliment; nor would such a Fluid remove the Difficulty of the Question, since it would always remain to be explained how it should happen, that any Fluid should dissolve one Substance into the desired Parts, and those out of which it was lately compounded, and yet should not dissolve another Substance into the same Parts, which is in the like Degree, and as frequently its Subject of Operation, or which is always and in the same Manner expos'd to its Action, altho' this other Substance is compounded of the same Parts neither more in Number, nor stricter in their Union. And indeed it were miraculous, if a Liquid dissolving and digesting the Food of the Stomach, should not dissolve those Parts which are not more solid than the Food it self, and which, if exsected from another Animal of the same Nature, and ingested into the Stomach, would immediately be dissolved in it. So that we may well wonder what sort of Solvers of Medical Problems they were, who thought they had rightly explain'd the Manner of the Digestion of the Food in the
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Stomach, when they had not explained, nor so much as attempted to explain the Reason, why, upon the Digestion of Food in the Stomach, which is as easily digestible as the Food, yet the Stomach it self should not be dissolved? And this Question is the same as that which those famous Men had solved, after their Way of solving.

5. Hence it is manifest, that neither a Fluid abounding with an Acid or Volatile Body, nor a Salt or Acrid, nor a Compound of these or other Particles of any Nature, are the Instruments of the Dissolution and Digestion of Food in the Stomachs of Animals: Much less can this Operation be successfully performed by the invisible Spirits of *Helmont* and *Wedelius*, or the Dæmon of *Doleus*.

From hence we conclude too, that Digestion is not performed (as *John Bohnius* says and imagines in his * *Anatomico-Physiological Circle*) by the Assistance of a digestive Liquor or *Menstruum* derived from the salival Glands and those of the Stomach, which he calls not an Acid, but a diluted Salt; and which, by the intestine and vital Motion of its Parts, imbibes and adapts to it self, and so forms a sort of an Extract from the Food, of a milky and mucilaginous Substance, agreeable to its own Nature, and proper for

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* See Page 149 of his Circle,

the Nutriment of the Body. This Perform certainly is mistaken in many Instances; but it is enough for me to observe, that this Liquid or vital Dissolvent of *Bohnius* and *Wedelius*, and many others, can and ought, after the same Manner, to attract to it self, and imbibe the dissolvable Substance of the Stomach in which it inheres, and which is as agreeable to it, and subject to be converted into Nutriment: Which since it does not, we conclude that neither does it perform what *Bohnius* and *Wedelius* by their *Hypothesis* suppose, but do not prove. It is to no purpose for any one to make an Objection from the Roughness of the Superficies of the Stomach, and the viscous Nature of the Phlegm, which are capable of defending it from the Injuries of the dissolving or corrosive Liquid or Ferment. For the Question is, how it comes to pass that any Ferment should dissolve Flesh, and not dissolve Fibres, whose Cohesion is much weaker than that of Flesh? Now that viscous Phlegm, by its entangling and blunting the subtle Ferment, or the Air, or digestive Fluid, perpetually discharged from the Coats of the Stomachs, equally defends the Food as well as the Stomach from any Injury, and so spoils and baffles all Digestion.

6. And hitherto we have deliver'd only the Opinion of those who have not hit upon a happy Solution of the Question; or of those,

those, who have honoured a Question, that bears no Relation to this, with the Name of a true Solution.

We must now repeat and inculcate into the Reader, that whatever Men receive and ingest into the Stomach for the Conservation of Life, or the Circulation, and the Nutrim^{en}t of the Body, are either Animals or Vegetables, that is, Animals of the higher or lower Class of Beings, since both these enjoy a Circulation of Fluids, and consist of small Pipes and Fluids that supply and nourish those Pipes. From whence it appears, that the Foods which Men use, and by the Direction of Nature ought to use, consist of such Parts as exhibit the Form and Nature of Pipes and Fluids adapted to change into such Pipes. For whatever the Action was by which the Parts of a Fluid, that nourish any Vessel or fleshy Substance, were first altered into the Magnitude and Figure, and other Qualities of a proper Aliment adjoinable to that Vessel, yet some Parts of the nutrimental Fluid were merely by the Force of the subsequent Fluid drove close and adjoined to that Vessel for its Reparation: And it is allowed by all, that Nutrition is performed by a Conjunction and Insinuation of Parts secreted from a Fluid into Spaces left vacant by the Secession of others of a similar Bulk and Figure. And therefore it is plain, that the Parts of Animals resolved after the

most simple Manner, (that is, in such an Order, that those which cohered last should be separated first, and the exterior Parts first worked upon by an external Cause,) will necessarily change into a Fluid replete with Parts proper for the Nutrition of an Animal, that is, it will change to compound a Substance consisting of Pipes, and Fluids, alterable into Pipes.

7. Again, it deserves our Observation, that those Substances, which neither composed the Bodies of Animals nor Vegetables, cannot nourish the Animal, altho' they may be changed by the Action of the Stomach; and therefore that they are not adjoined to the Vessels for their Reparation, since they are not changed by the Action of the Stomach into a Fluid adapted to repair the Parts of Animals.

From whence I conclude, that nothing more is necessary for the Performance of Digestion, and the Dissolution of the Food in the Stomach, than the Separation of some Masses and Particles from each other, which were before united into one Body, by that Action which performed Nutrition; nor have our Stomachs any other Office in this Matter, than to force the Particles united before in the Form of Vessels and Fibres, to a Separation into their former Confusion, or as near to that State as can be, which they enjoyed when they were to be disposed for
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the Nutrition of the Parts; and therefore no other Force than this is necessary; for if any other were, and that Force can change Bodies into Figures entirely new, and all Degrees of Magnitude, then other Things beside Animals ought to contribute to our Nourishment.

Now since we are nourished only by the Parts of Animals of every Class and Order, and since we have shewn that there is no Fluid in the Stomach, whose Ferment prepares the Food for our Nutriment, it follows, that it is only the Motion of the Stomach working and comminuting the Food, which finishes Digestion by a Separation of the last-formed Parts into Pipes and Fibres of such a Nature as is observable in Animals.

8. Because it is not to be questioned, but the same Force, or one similar and equal to it, by which the Parts were first secreted from an Animal Fluid into the Pores of the Body for the Office of Nutrition, ought to be sufficient for a Reseparation of them, and reducing them into Figures not much different from, nor much unlike those which it at first enjoyed. But it is plain, that the nutritive Particles, which are to be adjoined to the Parts, are adjoined merely by the Force of the Heart and Arteries propelling the Blood, and performing all Secretions, as we explained before; and there-

fore a similar Force of the Coats of the Stomach, assisted by the *Diaphragm*, and the Muscles of the *Abdomen* can redissolve the Masses so united into Parts, as near as may be to those from which it was lately compounded; neither is there any Obstruction to such a Comminution, but that the Coats of the Stomach and the Food cannot so often and so easily come to a Contact in their smallest Parts, as the Parts of Fluids can: From whence it will happen, that the *Chyle* does not generally consist of Parts so small as those of the Blood, especially that Blood which suffers a new Digestion or Comminution in the Lungs. And there is one Particular which I desire may be observed in this Place, which is, as the Force of the Blood is greater in the larger Vessels, and those situated near the Heart, so the Parts conjoined by that Force for the Nutrition of those Vessels, cohere so strongly, that it is more difficult for the Force of the Stomach to overcome that Cohesion, than it is for it to redissolve those Parts, which are to supply Nutrition in the Vessels of a lesser Size, and more distant from the Heart: For the Force is, *cæteris paribus*, more languid in the lesser Arterial Vessels, because they are Parts of a *Cone* nearer to their Base: For altho' the Trunk of the Arteries is larger than any distinct Branches, yet it is less than all of them taken together; and the whole Bundle of the Arteries is to be consider'd

sider'd as a *Cone* whose *Vertex* is situated toward the Heart, and its *Base* toward the Extremes of the Body. And from hence is the Reason, why, in the exterior Arteries, or those more remote from the Heart, the Motion of the Blood, as it pours from narrower Passages into larger, is by Degrees retarded; but a more languid Force is always the Cause of a slower Motion. And it is manifest, that this is the easiest and simplest Method of solving the Question proposed, because this makes an easy Liquefaction of the ingested Solids in the Stomach, without the Assistance of a foreign Fluid; and yet, excepting the Fluidity, there is the least Alteration made in the Food (as being taken from an Animal) to adapt it for the Office of Nutrition.

9. Our next Business is, to shew that the Cause we assign for Digestion, and the Solution of the Food, which is part of an Animal Body, cannot dissolve nor comminute the Coats of the Stomach, in which the ingested Food is received. For it seldom happens that the Coats of the Stomach come to a mutual Contact, and the Contacts that are made between the comminuting Food, and the Coats of the Stomach, are always on the same Parts of the Food, but from successively different Parts of the Coats of the Stomach. However, this is the best Reason to solve the Matter. The Diminution of the

Parts of the Coats of the Stomach, which are taken away by this Contact or Attrition, is easily repaired from the Matter of Nutrition, which is continually dispatched from the Store of the circulating Blood for the Nutrition of the Parts; whereas there is no Recruit for the Parts of the Food, which are abraded by the Action of the Stomach. And hence it happens partly that Worms and other *Animalcula* live conveniently enough in the Stomach, and partly because as they are alive, they by their Motion withdraw themselves from the Strokes of the Stomach, which it is impossible for dead Substances, or their Parts, to escape. And what is of great Moment in this Case, if a given Body striking it self with a given Force on a Membrane, can perforate it, the Number of Membranes may be increased to such a Proportion, that the same Force being given, the exterior Membrane shall not be perforated: Because the Number may be increased to that Degree, that Part of the given Force (which would not be strong enough to perforate the single, exterior, unsupported Membrane) would be exerted upon the exterior, and the other remaining Force spent upon the other Membranes. And since Abrasion is a Perforation of a Membrane, or of an exterior Surface, which (when we speak of the Stomach) is supported by many Membranes, the Proposition is evident.

dent ; and indeed it is plain , that the Superficies of a Beam would not be broke by the Stroke of my Finger, which however would be broke, if the Thickness of the Beam was lessened, that is, the Number of its Surfaces diminished : But the Thickness of a Body does not elud the Force of a corrosive Fluid, and the exterior equal Superficies of Bodies of an unequal Thickness are dissolved by the same Force of a corrosive Fluid, and in the same Time, if other Circumstances are equal.

10. And here arises a *Phænomenon*, which the Patrons of a Ferment or a digestive Liquid cannot tell how to solve. It is observed, for Instance, that Digestion is performed better in the Stomach during the Winter, and in a cold Air, than in Summer ; which can arise from no other Cause than the Increase of the muscular Force (as at that Season the Force of all the Muscles is greater) and the compressive Force of the Stomach, and the *Abdomen*. But the Force of the Muscles is increased in the Winter and cold Seasons, because then the contractile Fibres become shorter (for which Reason the same Force will draw them into a greater Shortness, and cause a greater Inflation) from the same Causes as a Piece of Iron of any Length is found shorter in the Winter than in the Summer ; and so an Iron Chain, as it grows cold, becomes shorter than it was when

when it was hot, as is evident from the Experiment. But the Completion of this Matter depends upon the different Quantity of Perspiration: For the Excellent *Sanctorius* has informed us, in the 29th and 41st of his *Statics*, and the *second Section*, that Animals retain daily about a Pound of perspirable Matter in the Winter, which they emit in the Summer. From whence it is manifest, that there is an Influx of a greater Quantity of Fluids into the Muscles in the Winter, than in the Summer, and by consequence that this performs all those Matters, which any one may in vain expect from Acids, and other Liquors, that have no Place in sound Animals, and which are foreign to that Season of the Year; for the Produce of Acids is greater in the Summer, and then Liquors turn soonest to an Acidity. But in this Place I remark, that the Encrease of the *Saliva* peculiar to the Winter, belongs to and depends upon the too great Diminution of Perspiration. I would have those take Notice of this Remark, whose Ignorance of a Method for the Discovery of Truth in the Sciences, may perhaps put them upon framing new Winter Resources of Phlegm, in order to illustrate this *Phænomenon*.

11. For we have proved, that the *Saliva*, and whatever Fluid that is which descends into the Stomach, are no more fitted and adapted to dissolve the Food, than the Superficies

perfcies of the Stomach, and thofe fine Fibres, which are much more tender than any ingefted Food, even after it has been worked by the Teeth.

But there is no Occafion now for a curious Difcuffion of the Quality of the *Saliva*, that having been the Subject of every Writer, and therefore I had no Inclination to propofe it to my Readers in this Place: Neither have I thought it proper to describe the Action of the Teeth, a Subject equally common, nor any other Circumftances attendant upon the working of the *Chyle*, which Dr. *Lifter*, that moft Learned and Candid Improver of Phyfic, has moft happily performed, and left others only the Glory of borrowing from him. But fince that Great Man feems to attribute too much to Perfpiration, which he fufpects to be greater in the Stomach in the Time of Winter than Summer, it is proper for us to make a more curious Enquiry into that Opinion. The Air is a Fluid which defcends as well into the Stomach as into the Lungs, ruſhing in wherever it finds an Entrance, whether the Heat or Cold be exceffive: Wherefore, if the Air contributes any Thing by its Winter Quality to the Diminution of Perfpiration, the Superfcies of the Stomach will bear its Effects in the ſame Manner as the exterior Skin. Suppoſe then, that the Winter Air obſtructs Perfpiration, the Summer promotes it,
ſince

since both are diffused about the Skin, and descend into the Stomach, the Perspiration of the Stomach in Winter will be to the Perspiration of the same in Summer, as the Skin in Winter is to the exterior Skin of the same in Summer, which considerably exceeds the Winter, as *Sanctorius* has proved.

But the Authority of the Great *Hippocrates* introduced this Maxim, who affirmed *That Mens Stomachs were warmest in the Winter*: For he observed that the Stomach was strongest in the Winter; and then assumed from a Sect of Philosophy, that Digestion was performed by Heat; from all which he deduced, that a greater Heat must proceed from the Stomach in the Winter.

12. From hence it follows, that they whose Stomachs abound with any Fluid in too great a Quantity, or too viscid a Nature, cannot digest their Food well, nor are at that Time in a State of Health, the contrary of all which would happen, if Digestion were performed by the Assistance of a dissolvent Fluid. But the Cause of this *Phænomenon* is widely different from any Thing which the Patrons of Ferments are able to produce: For I think it is evident from what has been before said, that any Fluid in the Stomach, in so large a Quantity, that there is no Place into which it can pass with a sufficient Quickness and Facility, or of so viscid and resisting a Quality, as not to be soon and
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by a smaller Force removeable from the Place that separates the interior Superficies of the Stomach, and the exterior of the ingested Food, necessarily obstructs and retards Digestion: For it is necessary upon the Interposition of any Fluid too copious, or too viscid, that the Force of the Muscles of the Stomach must be eluded, upon which only, since there is no Ferment nor digestive Liquid, Concoction must depend.

And that some Advantage may be made from these Observations, it deserves our farther Observation, that the heavier the interposing Fluid in the Stomach is, it will more resist the Motion of the Stomach, and both frustrate the Force of Motion and Contact, and so prevent any Digestion, if the Quantity of the Fluid is such, as to make it necessarily, by its own Weight, diffused every where round the Food, as is requisite in a Fluid which is to dissolve and digest. From whence it follows, that acid Liquors, since they are of a heavier Nature, and salt too, obstruct Digestion; nor is that Gravity the Cause why Acids are so difficultly removed, and carried off from the Stomach.

13. From what we have demonstrated in the 9th Paragraph, it is evident, that small Vessels, not supported by a sufficient Number of Membranes, as the Stomach is, the oftner they reduce their opposite Sides to a Contact, must necessarily be oftner impaired,
and

and sooner broke. For if the Vessels almost fall together, while their opposite Coats meet with a certain Force, so that almost every intervening Fluid shall be so expelled as to leave nothing between, there will then be an Attrition of the Coats. And because this is the Case in the Lungs and its Vessels, as we shew in another Place, therefore we ought not to wonder that Erosion, and Symptoms of Erosions, happen more easily and frequently in the Lungs, than in any other of the *Viscera*. But this will more especially happen to those who live in a thick Air, abounding with the mineral Fumes of *Sea-Coal*, which are therefore heavier, and compress the Vessels of the Lungs with a greater Force.

From these Observations we may give a plain Solution of a Question which Dr. *Willis* proposes, What is the Cause why most *Asthmatical* Persons breath more easily in a Country Air, and yet it is more easy to some to use the *London* Air? The Doctor speaks of his own Countrymen. It is evident, that if the Gravity and elastic Force of the attracted Air remain the same, the same Animal will respire with an equal Facility, or the Blood of the same Animal will pass thro' the Vesicles of the Lungs with an equal Facility: And if the Force of the Air continuing the same, the Blood does not pass with the same Facility, then either the Flexility of the Vessels,

sels, or the Facility of the Blood in its Motion, must be so changed, that the Resistance made by the Lungs must be encreased. Wherefore it is no Wonder, that they who enjoy the Country Air with Ease and Health, cannot bear with the same Ease the heavier Air, and that of *London*, not only admitted into their Lungs, where the minute mineral Particles conveyed in the Smoke stick close, but also cannot bear it as diffused round their whole Bodies: Nor ought it to seem incredible if they who, by Nature, or by Distemper, that is, by some Change of Art, or the Course of their Lives, have their Vessels and the Blood in the Lungs become of a more resisting Nature, or the former become less flexible, or the latter less fluid, can bear the heavy *London* Air better than the lighter Country Air.

From whence it is plain, how wide from the Purpose Dr. *Willis* spoke upon this Subject, in the 2d Part, 1st Section of the 6th Chapter of his Treatise of the Operation of Medicines, where he assigns the finer Texture of their Vessels, as the Reason why some breathe more freely in *London*, never solving, but perplexing the Question with the Fumes of Sulphur, and such Words, while he neglects the known Property of the Gravity, which is greater in those Particles of *Sea-Coal* that pass into Smoak, and are drawn in with the Air, than it is in those of *Turf*, and *Wood*.

15. But

14. But this Attrition does not obtain in other Vessels, which are indeed often exposed to the Air, but yet are supported, as was before proved; among which I reckon the Stomach. But the Vessels and Vesicles of the Lungs are so far from being supported by any Structure of Muscles and Membranes, that they are pressed and impaired every Minute of our Lives between each Act of Respiration by the internal Superficies of the Ribs.

From whence it evidently follows, that it is to no Purpose for *Wedelius*, in the 6th Chapter of his *Physiologia Reformata*, to have used Abundance of Words to assert, that it is demonstrable to Sense, and the Evidence of Sight, that the Stomach contains a *Salino-Sulphureous Ferment*, and which he affirms is derived from a vital Fluid: For if this is true, then all the Blood-Vessels would be dissolved and digested by this intercurrent Fluid, (which is the greatest Part of the Blood,) by the same Means as Flesh and other Things, who Substances are not much harder than those Vessels, are dissolved by the Effusion of the same into the Stomach. And from these few Observations it appears, how ineffectual the Hypothesis of an Acid or Ferment are for the Explanation of these *Phænomena's*, and how much easier it is for us to remove the Difficulties that press this Question by Properties which are more known,

known, and of which we have a greater Certainty.

15. No one, I presume, who agrees with these Notions of mine, will for the future have any Doubt, whether Digestion is performed best after Meals, if assisted by a gentle and easy Walk, or some other unlaborious Exercise of the Body : For as long as Motion so assists and increases the Comminution of the Food by the Action of the Diaphragm, and other Muscles, as not to force the Chyle to leave the Stomach, and enter the *Lacteals* too soon, that is, before the Parts are reduced to a sufficient Minuteness, (in which Case a Crudity happens, which therefore consists in the Comminution of the Food into Parts of too large a Size, some of which however can enter the *Lacteals*;) so long a Concoction equally good is performed sooner, and a better Concoction in equal Time, or, which is the same, there is a Division of the Food made into Parts of a more proper Fluidity, and more adapted to Nutrition. For this Reason it is, that Digestion is not so well performed in Persons asleep, as in those awake. And this may suffice for a Physical Explication for our first Concoction, as we term it, which is previous, and is celebrated much after the same Manner, as that which we in another Place attribute to the second Concoction performed in the Lungs of born Animals. But we had before explained that

Concoction, of which the third, in the common Acceptation, is reckoned one Part, *viz.* that Secretion, which is made in the Glands and *Viscera*, of which Nutrition, celebrated by the Physician for the third Concoction, is a Species.

16. There is no Occasion now for a tedious Proof to shew, that after the Concoction in the Stomach and Lungs is performed, the Blood is become adapted to the Nutriment of the Animal, tho' it suffers no Change by a Ferment and Figures peculiar to the Parts, since these Assistances are not in Nature, or of no Use: It remains then that we finish this Subject, the previous Concoctions being made merely by the Force of the Heart and Arteries, by which any Particle of the Blood is made to pass into some Place, into which it is drove by others, if the Place be capable of receiving it: And therefore since all cannot be expelled into Secretories, (because these are neither sufficient in Number, nor Amplitude, or where they are, there can be no Nutrition,) or into Vessels commonly accounted Secretories, there is a Necessity that some should be secreted into Spaces of Fibres, which make up empty Vessels, which yet are so close, that the Particle which enters, and is forced onwards from behind, may come to a Contact on all Sides with more Particles in a State of Rest; which Particle, if it had met with an empty Space much less than

than it self in the Superficies of the Canal, perhaps by being drove thro' it had avoided that Contact, and so could not have repaired that Canal with any Nutrition. Nutrition then consists in restoring a Fulness of all the Vessels, which causes a Secretion of Part of its own Fluid into the Membrane of every Canal, in the Room of the Part discharged by the Fibres. From hence it evidently appears, that every Canal in an Animal is nourished by a Fluid, which it often carries within itself. For it is plain a Fluid cannot easily break thro' the Sides of its Canal, otherwise those Sides could not compose a Canal proper for the Conveyance of that Fluid; and that there is no Pore of the Coats of the Vessel, but what the Parts of the Fluid, which it conveys, can penetrate and work themselves into, if the Orifice of that Pore, either by a Distraction and Motion of the Part, or by Attrition and the Escape of some Particles from the Contact of the rest be but never so little widened and increased, (for as long as the Orifice is not increased, nothing of the Vessel is lost, and so there is no Occasion for a Supply by Nutrition.) For they who imagine, that nothing can enter those Pores, but the most subtle Fluids secreted in the Brain, or other Places from the Blood, they I say, do not seem to understand, that those very subtle Fluids existed such in the Blood before they were

received by the secreting Vessels, which are neither furnished with a Variety of Ferments, nor Figures.

17. But it is convenient, before we leave this Subject, to remove a Difficulty, which may impose upon an unwary Reader. For Instance, if we may believe the *Porists*, we find by Experience that certain Liquors may be injected into certain Vessels with sufficient Ease, tho' certain Liquors of a greater Subtilty, and abounding with a Force of lesser Parts, or as yet accounted such, cannot be immitted into the same Vessels with the same Ease. Since then the Passage of a greater Body, where a lesser is excluded, cannot be ascribed to a Difference of Size, it must be to a Difference of Figure. But in my Opinion, a very different Consequence is deducible from this: For since it is evident by the Light of Reason, that in two unequal Bodies, the greatest Diameter of one of which suppose equal to the least Diameter of the objected Orifice; but let one of the other, according to the Position it approaches the Orifice in, be greater than the Diameter of the Orifice; the first Body, whose Diameter is equal, can enter and pass through that Orifice, and necessarily exclude the second Body, one of whose Diameters, which it then applies to the Vessel, is greater than the Diameter of the Orifice; and therefore because the one Body passes, and the Circumstance:

circumstances continuing the same, the other does not, it evidently follows, that the Liquor consists of Parts, of lesser Parts, or of Parts absolutely less, than the second, altho' the Parts of the second may be more in Number, closer united, and heavier, or even more visible, or have other Properties, by which the common People measure the Thickness or Magnitude of Liquor. From whence there is a Method laid open of investigating of what Liquors the Parts of their last Composition are least, that is, have the least Diameters.

18. I take leave to infer from hence, that nothing in the Stomach, nor the Intestines, nor in the Lungs, and much less in the Heart, in short, that nothing in any Secretion, or in Nutrition, it self can happen, which is capable of changing the Food into Chymical Spirits or volatile Salts, &c. For when the Food is comminuted and concocted in the Stomach, the Parts which have the least Cohesion are constantly divided first, and separated with the greatest Ease. But the Parts, out of which the Vessels were last compounded, or by whose Accession they were increased, cohere less than the Parts of those Parts, since they were divided and secreted from the rest by the Force of the Heart and the Blood, but the other were not. But after they were thus separated in the Stomach, so as to flow with Ease one

over the other, then they are expell'd by the Motion of the Stomach into the *Lacteals*. From whence it follows, that there is nothing tranſacted in the Stomach, from whence one may certainly conclude that Salts, Sulphur, or other Bodies, that paſs for *Principles*, can be extracted from the Concoction of the Food: Nor are they to be heard with Patience, who in treating of Phyſic, make uſe of ſo precarious a Philoſophy, who are not aſhamed to aſſert, that there is a Diſſolution of a *Nutritive Sulphur* made in the Stomach, and that *Chylification* is the Action of an *invisible Spirit*, that ſeparates and changes the Aliment (by the Help of a Heat and Ferment) into a *Nutritive Oleo-aquofe Sulphur*; and that an *Analysis* of *Alkali* and *Acid* is made in the Stomach to relax the Union of the Sulphur: For that Sulphur is a ſort of Reconciler of *Salts*, otherwiſe oppoſite to it ſelf, as *Wolſangus Wedelius*, an Author of great Gravity, endeavours to perſuade his Reader in the 9th Chapter of his *Phyſiologia Reformata*.

We muſt enter into another Courſe or Method of Reaſoning, if we would advance the Theory of Phyſic to the Dignity of the Subject, and aſſert an Art glorious in it ſelf, and neceſſary to Mankind, from mean Conjectures, and the Scandal of Uncertainty. And an Inſtance of ſuch a Method we have here given, in a Caſe of no great

great Difficulty indeed, but so much the more probable to be of greater Service for the future, as the Inconsiderableness of the Difficulty will less divert the Reader from a distinct View of the Method. Because, it is manifest, that nothing more is requisite to give a Physical Solution of this Question but to find such Solids to be ingested, as can most easily repair the Loss of the Parts that fly off from the Coats of the Vessels, and the Stock of the Fluids, and to fix upon the most simple Powers of the Stomach, or Powers to be applied in it, as are capable of reducing the ingested Solids to such Fluids, out of the Parts of which these ingested Solids were last made up and compounded. But it is plain, that the Parts of Vegetables, or of Animals of all Classes, answer to the first *Quæsitum*, and that the Motion of the Stomach, and *Abdomen*, and the adjacent Muscles, without a vain Enquiry after any other Assistance, sufficiently answer the second Requisite. But what is most necessary to observe here, is, that in the Solution of this, there was no Occasion for a Philosophical Knowledge of the Nature of Foods, or the Magnitude, or the Figure of Parts or Pores of them, or of the Motion of Fluids passing thro' those Pores; nor was it useful in this Enquiry to have known, whether there were any passing Fluid at all, or whether all the Parts of the Food were of the same,

or a different Figure. But it is sufficient, if we know that a Solid which grew into that Substance by a Conjunction of Bodies, before in a State of Fluidity, can be reduced into a similar Fluid, if those Parts are divided, and drove different Ways; and again, that there is a *Conatus* in the Stomach, by which the Parts of Solids may be so divided, and then that the Fluid being restored to its primitive Nature, or to it self, will pass into the Substance of Vessels in the same Manner as it did before into similar Vessels. And this is self-evident, that such Alterations are agreeable to Bodies enjoining any Figure or Motion, and that this does not require any Knowledge of the intimate Effence of Things, or a penetrating Inspection into the subtle and Physical Causes of Philosophy. What I have advanced seems to me a Proof, that the Food cannot be concocted without the Assistance of the Stomach, and the grinding Muscles of the *Abdomen*. It remains for me to prove, that the Powers of the *Diaphragm*, and the Muscles of the *Abdomen*, are of a Force sufficient to discharge the Office and Weight our *Hypothesis* lays upon them. Now these Powers, whether we investigate them by the Help of the 121 Proposition of *Borellius's* Works, or a Principle of Sir *Isaac Newton's*, deducible from thence, will appear to be very extraordinary. Whoever calculates this Matter rightly, will find that the Powers
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of the Muscles are in a *Ratio* compounded of the *Ratio* of the Longitudes, Latitudes, and Profundities, that is, in a *Ratio* of homogeneous Solids or Weights. But the *mean* Weight of the Muscle that bends the Third Joint of the Man's Thumb is equal to 122 Grains; that of the Right Muscles of the *Abdomen* to 3720; that of the *Pyramidals* to 126; of the *Oblique Ascending* to 2640; of the *Tranverse* 2640; of the *Oblique Descending* to 2040; the Weight of the Diaphragm is equal to 3960 Grains. Wherefore the Sum of the Weights of the Muscles of the *Abdomen* adapted to this Office is equal to 15126 Grains.

Now according to the 126th Proposition of *Borellius's* first Book of the Motion of Animals, the Power of the *Flexor* of the Thumb is equal to 3120 Pounds Weight; and therefore as 122 Grains are to 3720 Pound, so 15126 Grains are to 461219 Pound. From hence it is plain, that the Powers of these Muscles are not inferior to the Powers of any Mill Stone: And he *who knows that the Author of Nature never attempts any Thing in vain, nor performs one Thing by many Means, but many Things by a single one*, will easily acknowledge that the muscular Action of the Stomach, and the united Actions of the Muscles compressing the Stomach, are those Forces, which reduce the Food ingested into the Stomach into a Fluid, adapted for the Nutri-

Nutrimment of the Animal, and the Supply of the Decays of the Blood. But altho' we had not made use of the Powers of the Muscles of the *Abdomen* in this Case, yet the Powers of the Stomach it self are sufficient to perform this Duty as successfully as we could wish. The mean Weight of a human Stomach is 8 Ounces, and therefore by making a Calculation after the Manner of the preceding, the Power of the Muscle of the Stomach will be found equal to the Weight 12951 Pound, which is quadruple the natural Power of the Heart, by the 67th Proposition of the second Part of *Borellius* upon the Motion of Animals, which proves that the latter is about 3000.





A
SOLUTION
OF THE
PROBLEM

Concerning
INVENTORS.



HAVE long since made it my
Observation, that nothing was
more destructive to any State,
than the Credulity of the People,
and what naturally follows that, a perpe-
tual Desire of Innovation. For as often as
Men of Design and Cunning have begun
to slide into their Hearts and good Opinion
to that Degree, as to gain an implicate Con-
fidence from the People, we may observe,
that the Customs of that State have been
subverted, the Laws and Acts of their An-
cestors

cestors repealed, all Rights, both human and divine, violated, as standing in the Way, and obstructing the Desire of Innovation, and the Measures of the Deceivers of the Populace.

But I don't at all wonder, that the Artifices of the Cunning should gain more upon the unthinking Multitude, than the Reasons of the Wise and Learned; I rather wonder that some of the first Genius's and divine Spirits should often follow the Example of the People, and be seduced by the Authority of those whom they exceed in all Kinds of honourable Arts, and all Degrees of Vertue.

Wherefore it seems to me, that I shall acquit my self well, if I can shew those who are willing to cultivate Truth and Honour a Way to vindicate themselves from so base a Slavery, and remove that Cloud from their Minds, which the Authority of a few Men has spread before the Face of Truth: For to endeavour to bring the Vulgar to the Right, were an Undertaking of a Mad Man; but in order to do some Service to those of better Skill, and who are enflamed with a Desire of attaining higher Arts, I shall shew, in this Oration, in what Cases, and the Authority of what Persons ought to move us, or what sort of Men deserve our Credit, and as Relaters of what Facts, and, at the same Time, solve what was never before attempted,

ed, the noble Problem of *Inventors*. In the Pursuit of this, I shall use the Terms of Author, Inventor, Observer, and Historian, for one and the same Idea: And I would have it observed, that there are two Cases in this Problem; for either the Authority of the Inventor enters into the Conditions of the Problem, or it does not. The following Paragraphs will solve the first Case.

2. We ought to make a nice Distinction between those Things which are demonstrated by their own Evidence, and those that are so by the Light of other Things, that is, between such Things whose Evidence is such, that when we have once understood their Proofs, we cannot conceive them to be otherwise, and those Things which are neither demonstrated from themselves, nor other Things. Of the first Kind is this, *The Whole is greater than the Part*; of the second, this, *Pythagoras found out the 47th Proposition of the first Book of Euclid*. By Things demonstrated, I understand then such Things whose Proofs make it impossible that they should be otherwise than they are; from whence it follows, that they are always the same, and unalterable: But by Things not demonstrated, I mean such, whose Proofs do not make it impossible but that they may be otherwise; from whence it cannot be concluded that they are always the same. Arguments suited to the first Kind, are called

led *Demonstrations*, to the latter Probabilities. Hence it appears, that no finite Number of Probabilities is equivalent to a Demonstration; and again, that we are by no Means so certain in giving our Assent to Things not demonstrated, as when we give it to Things demonstrated; and therefore we ought not to adhere so positively to an Opinion unsupported by Demonstration, as to another that has that on its side.

3. We must further observe, that they who will allow the Credit of a Writer's or Author's Observations, that is, they who propose an Inventor, whose Authority enters into the Conditions of the Question, necessarily assume these Propositions for Truth:

I. That we always believe the Evidence of our Senses; which wants no Proof.

II. That the Inventors of the Observation propos'd, always told the same to others which they had found by the Assistance of their Senses; which is not a Demonstration.

III. That those Persons, thro' whose Hands the Observation comes deliver'd down to us, have in all Ages been so honest, as not to deliver any Thing to Posterity different from what they receiv'd from their Predecessors; which is not demonstrated.

IV. If

IV. If an ancient Observation is deliver'd without being put in Writing, then we must assume this Proposition for a Truth, that those Persons through whose Hands it is deliver'd to us, never have forgot the whole or any Part of that Observation; which is far from being a Demonstration.

From whence it follows, 1st, That we are more certain of Things demonstrated, than of any Fact taken from the Credit of History, containing such Observations. And, 2^{dly}, That we are more certain of Things, the Knowledge of which we receive by our Senses, than those we know from the Help of such Histories; and therefore that an Argument drawn from the Credit of such Histories, is not of Force against Demonstration, or the Evidences of Sense.

4. Besides, it follows from hence, that we are not so certain of the Truth of an Observation, as the Authors of it were: For they only use the first Proposition as a Thing certain and demonstrated; we by trusting to them, assume that, and the second too, as a Demonstration; and, after the same Manner, that we are not so certain of the Truth of an old Observation, or one that being formerly transacted, cannot be made again, as of a new one, or one which may be made at the Pleasure of the Observer; because in assent-

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ing to a new Relation of Fact, we only take for granted the first and second Proposition ; but, in an old one, we assume not only them as Truth, but the third Proposition too. In the last Place, we are not so certain of the Truth of an unwritten History of Facts, as of the Truth of a written one ; because, in the giving Assent to the Credit of the written, we only allow the three first Propositions as demonstrated ; but when we credit an unwritten one, we must make use of the fourth Proposition too as demonstrated, tho' it is not so : And by consequence we embrace more Things as demonstrated, which are not so in one Case, than we do in the other, that is, more Things which have the greatest Marks of Uncertainty.

5. It is easy to perceive from hence, that no Sayings of any Inventor whose Authority enters into the Conditions of the Question, such as *Aristotle* with the Peripateticks, and *Hippocrates* with some Physicians, and others with others, ought to be so interpreted as to contradict any Demonstration, or Evidence of Sense, or even any Opinion which is equal to an Evidence, founded upon Ideas supplied by the Senses ; or to contradict any Proposition, tho' undemonstrated, upon which all historical Credit depends ; or, lastly, any Opinion which is supported by Foundations not less probable than these Axioms are, upon which the Authority

thority of History depends. And we ought always to remember, that the Liberty to be exercised in interpreting of History, is so much the lesser, as the Authority of the Inventor or Historian is greater, or the fewer the Number of Things undemonstrated is, upon which, as taken for demonstrated, the History is founded.

6. But let us proceed to the second State of the Problem, that is, when the Authority of the Inventor does not enter into the Conditions of the Question. The Difficulty of which is solvable by the following Theorems :

THEOREM the First.

He ought to be accounted the publick Author of any Invention, who first laid down such Principles, from which that Invention is more easily deducible, than any Proposition of Euclid's, from his Axioms, Definitions, and Postulations : And who, in laying down these Principles, did not busy himself in drawing in such Corollaries as are of infinitely less Moment and Use than the Thing it self, which is the Subject of Enquiry. But if he neither laid down such Principles from whence the Invention is deducible with that Ease, nor did explain the Invention it self in expresse Terms, but advanced many other Things of less Moment, expresse and prolixly, as flowing from
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his Data: He is not to be accounted the publick Author of the Invention; which is the Subject of Enquiry.

This Proposition is demonstrated from this, that no Philosopher or Physician know every Thing, which is deducible from Things here.

THEOREM the Second.

Whoever first publickly mentioned the Invention in the Question, and spoke of it after the same Manner as it was afterwards spoke of by others, whom all Persons allow to have known that Invention, nor did at the same time, and equally or more expresly insist on other Things which contradict that Invention, he ought to be accounted the publick Author of it: But if he mention'd no otherwise than it was mention'd by others, whom all Persons allow to have been ignorant of that Invention, and laid down other Things more frequently, and more expresly, that contradict that Invention, he ought not to be accounted Author of that Invention.

This Proposition depends upon this Assumption, That if any Author has left it in Writing in ten Places, that the Number of the Stars is odd, and but in one Place, and, speaking of the same Thing, that they are even, it is credible that it was his Opinion they were odd. Wherefore, if any
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Physician speaks very obscurely of the Circulation, and very often has expressly laid down Things not only opposite to some Effects of the Circulation, that is, to Corollaries dependant on it, but plainly repugnant to the Circulation it self, that is, contradictory to all the Propositions upon which the Principles of Physick are built, it is not to be supposed that he knew the Circulation of the Blood.

7. But to set this Matter in the clearest Light; We are to understand, that something is then said to enter into the Conditions of the Questions, when the Change of that makes a Change in the Question. And therefore that is not said to enter into them, which, if changed, or in another State, the Problem is not alter'd. To apply this then to the first Case, in which the Authority of the Inventor may be assumed to be very considerable, it is evident that there is nothing false to be found in the Writings of such an Historian: But because we own our Belief from the Testimony of many Persons, that these are the Writings of that Historian, therefore we assume at the same Time all the Propositions laid down in the third Paragraph as certain; from whence it manifestly follows, that there is nothing contain'd in the Writings of that Historian that contradicts the Sense, or its Evidences, or other Things equally certain; and if any Thing

of that Nature is found in any of his Writings, that that is not the Writing of such an Historian, from whence the Truth of the 4th and 5th Paragraphs appear.

8. Farther, if the Authority of the Inventor does not enter into the Conditions of the Problems, then it may be look'd upon as nothing; for it contributes nothing toward the Solution of the Question, and therefore ought to be accounted as nothing. But when the Authority of the Inventor is measur'd by his Veracity, or his constant Inclination and Skill in speaking those Things which depend upon that Skill, it is plain in the second Case of this Question, that even his Skill and Inclination to speak agreeable to that Skill, are accounted as nothing, that is, they are not at all to be consider'd. From whence it follows, that the Words of an Historian or Inventor may, and often ought, in this Case, to be so interpreted, as to be contradictory to the Evidence of Sense, apparently false, and repugnant to Demonstration; as after the same Manner sometimes Men ought to be explain'd, as of no Authority in what they say, who themselves will own that they and their Company often speak of Things apparently false and absurd, and interpret one another's Discourse in that Sense.

From whence I conclude, when it is enquir'd, whether *Hippocrates* knew the Circulation

ulation of the Blood, (in which Question the Authority of *Hippocrates* is reckon'd as nothing, or of no Advantage, since no one will affirm that he knew the Circulation, because he was a Man of great Knowledge,) that we may interpret his Words with the same Liberty as those of an ignorant Person, so as to make them false and absurd, nor ought his Authority to be appealed to in this Question, as having asserted Absurdities and Contradictions to the Circulation of the Blood, nor his Words to be softened with a more favourable Construction. I infer from hence too, that in the second Case, *viz.* when the Authority of the Inventor does not enter into the Conditions of the Question, the two Propositions in the sixth Paragraph are necessarily true: For since in that Case his Authority is nothing, an Inventor, either in Philosophy or Physic, ought not to be supposed of such a Genius, as to have understood more than he has delivered in express Words; from whence the first Theorem is deduced: Nor of such Knowledge, as that he could not lay down false and absurd Propositions, and often did; from whence the second Theorem is derived.

For the more easy Comprehension of what has been advanced, I would have it remark'd in what Manner it may be applied to the Solution of the Question of the Inventor of the Circulation of the Blood. The Question

turns upon this, to discover whether *Hippocrates* knew the Circulation of the Blood. But it ought to be made evident, that the Term *Circulation* was used by *Hippocrates* in the same Sense, as it hath been by many of much a later Date, so as to discover a clear and distinct Description of the Circulation in *Hippocrates*.

But I affirm, that the Circulation is never expressly described by *Hippocrates*, and that there is no Passage in his Writings which can incline one to believe that that Motion was understood by him, but only that there was a Possibility that it might be so; for tho' he no where mentions a continual Circulation of the Blood, yet he often mentions such Things from whence the Circulation may be deduced, which however he never does deduce from thence, altho' it is an Invention of a much greater Consequence, than all those Things which he has inferred and tediously inculcated from Principles which he did know. For Instance, Venesection was known by *Hippocrates*; the perpetual Circulation of the Blood is deducible from that Operation; yet he does not discover this Circulation from thence, but runs on with a nauseous Loquacity in advancing Abundance of other Matters, some of which are meer Trifles, some absurd and destructive of the Circulation, and all of them of no Consequence at all. Let they
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who are too great Admirers of him, read his Books, *Of the Parts in Man*, *Of the Morbus Sacer*, *Of the Regimen of Diet*, and then they will plainly see how much he extols himself, when he relates Inventions of his own, which are in the least Degree comparable to that of the perpetual Circulation of the Blood. Indeed it is not to be believed, but that *Hippocrates*, a Native of *Greece*, and one who so often treats his Reader with trite Subjects, would have prosecuted the Circulation in a pompous oratorical Manner, if he had known it; since that, for its Usefulness and Glory, far exceeds all the Inventions of *Hippocrates*, and all the Descendants from *Æsculapius*. *Hippocrates* knew the Pulsation of the Arteries, and he ought to have collected the perpetual Circulation of the Blood from thence; but he collects no such Thing: But when he was to describe the Cause of the Pulse, he laid down a Proposition contradictory to the Circulation; which he had not done, if he had at all understood the true Cause of the Pulse, *viz.* the Circulation of the Blood. And what Cause do you imagine that *Divine Old Man* dreamt to be the Reason of the perpetual Pulsation between the Ears and the Temples? I do not speak of the Increase of the Pulse upon Fevers, and the Pain of the Head, which is not perpetual, and which *Hippocrates* has treated of in his Book of *Vapours*: For he

gives us the Cause of a perpetual Pulsation in his Book *of the Parts in Man*; which is this, There is Blood contained in all the Veins of the Body, excepting in the Veins which have a continual Pulse between the Ears and Temples; for there is no Blood in them: Because the Blood which is nearest to them, endeavours to retreat from them, and being turned into a contrary Channel, meets the opposite Blood, with which it contends, and from that Contention arises the Pulse.

Let it be observed in the next Place, that *Hippocrates* never spoke otherwise concerning the Motion of the Blood, than others have since spoke, who it is plain did not acknowledge the perpetual Circulation, and some of whom even denied it after it had been proved and demonstrated by Dr. *Harvey*. Let any one who is pleased to take that Pains, read over the Physicians of a longer Date than Dr. *Harvey*, and some of his Contemporaries, and he will certainly find the Truth of my Assertion; for I am not at leisure to recite their Opinions. Since these Things are so, we may conclude that the true Circulation of the Blood was unknown to *Hippocrates*.

Hippocrates knew the Structure of the Heart and its Motion, and writ a Treatise upon that Subject, and *Harvey* and other Moderns have writ upon the same, and I wish those who assert that the former knew the Circulation, would read attentively

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ly their Writings upon the Heart. In *Hippocrates's* Book of the Heart, there is not a Word of the perpetual Circulation, but many directly opposite to that Motion of the Blood: For after he has declaimed in his Manner, in abundance of Words, upon the Liquor of the *Pericardium*, of the Reason why the Water falling down upon the *Larynx* should provoke a Cough, he takes a deal of Pains to prove that the Auricles of the Heart are not the Organs of Hearing, because says he, they have not the Bores of the Ears, nor can hear the greatest Noise. *Hippocrates* was certainly profuse enough of Words, and therefore it is not to be imagined, but that he who descended to the Explication of so many insignificant Trifles in abundance of Words, would have spoke of the Circulation of the Blood according to the Dignity of the Subject, but that he did not understand it. But farther, when he had the fairest Occasion of giving a full and elegant Description of this Circulation, he only informs us, that the Mind of Man is placed in the left Ventricle of the Heart; but he every where affirms, that the Blood is put into Motion by the Soul, and drove thro' what we term the Veins toward the extreme Parts of the Body, and that it is forced back again thro' the same by the uncertain Motion of the same Soul; and when that ceases to act, the Blood is at rest: For

I think

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I think this a proper Remark, that *Hippocrates* often gives a prolix Account of Things, which are so manifestly contrary to the Circulation of the Blood, that he must necessarily be ignorant of it, when he wrote those Things. It is indeed possible that one of a moderate Skill in the Elements of Geometry, may advance a Proposition deduced by a tedious Train of Consequences, which may perhaps be found repugnant to some Principles of that Science; but it is impossible that one who understands those Elements, should often advance such Things as are plainly opposite to all the Propositions of that Science. Wherefore since *Hippocrates* has frequently and in express Words delivered Things not only obscurely contrary to the Circulation of the Blood, or to some Corollaries dependant upon it, but apparently repugnant to it, that is, Things evidently contradictory to all the Propositions of Physic, it is not to be imagined that he understood the Circulation of the Blood. I desire those who read *Hippocrates* so curiously, to find something which seems to shew the Circulation of the Blood, to extract and remark upon those Passages which discover the direct contrary; for they will find a prodigious Number of those; and I do assure them, that this would be a Task of much less Difficulty than that which they are upon, and yet would not prove of less Advantage.

9. We must therefore add to what has been said, that it is not simply enquired in this Place, whether *Hippocrates* knew the true Circulation of the Blood, but whether that Motion of the Blood is so confirmed and described by him, that others by the Inducement of his Reasoning, and not merely by his Authority (which ought to have no place among Physicians) could and ought easily to have allowed the true Circulation, or, farther, that they did, or professed that they allowed it; because the Question is, whether *Hippocrates* was the Author of the Doctrine of the Circulation, that is, whether he inclined others to believe the Truth of it. It is known, that the Geometricians, who have demonstrated any Theorem not expressly demonstrated by *Euclid*, or any other Geometrician, altho' it naturally flows from Theorems demonstrated by others, are accounted the Authors of that Theorem; and that they acquire the greater Reputation, the easier the Method appears, which they made use of in deducing their Theorem from others before known and demonstrated. And it is well known too, that the Geometricians never enquire whether such a Theorem was known to another, or accounted as true, (for that does not promote Geometry, and I may say Physic, where the Case turns upon Reason and Demonstration, not upon Authority,) but they enquire whether it was therefore demon-

demonstrated by another. There is no one who will allow a Geometrician to be the Author of a Theorem, which he has not demonstrated, or will think himself the less obliged to him who did first demonstrate it, because another Person took upon Trust, or founded upon Conjecture, a Truth which was geometrically demonstrable. In the same Manner, the Learned ought not to enquire with too great a Concern, whether *Hippocrates* has not asserted some Things, which we, who have drawn our Knowledge of the Circulation from others, may think lead that Way, altho' even that is false; but whether *Hippocrates* ever brought any one Proof of that Principle, by which others will own that they were induced to give Credit to the Circulation, which they were before ignorant of; but there never was any one who would profess that. For as for what some assert now-a-days, after the whole Subject has been demonstrated, that *Hippocrates* has clearly laid down the Structure and Use of the Valves of the Heart, that is nothing to the Purpose: For how many have there been, who have explain'd their Structure and Use better than *Hippocrates*? even all the Anatomists and Physicians since the Time of *Hippocrates*; who, however, were so ignorant of the true Circulation of the Blood, that some of them who knew *Columbus*, *Casalpinus*, *Servetus*, and others, and had

had read their Books, yet writ against that Doctrine of theirs. I conclude in the last Place, that *Hippocrates* did not know the true Use of the Valves of the Heart. This is evident from his Book *upon the Heart*, wherein the following Passage of the Right Ventricle, and its Vessel, appears: *It opens indeed into the Lungs, to give a Passage to the Blood thither for their Support; but it closes toward the Heart, tho' not very strictly, for to allow an Entrance to the Air, tho' not in a great Quantity.* From whence it is plain, that *Hippocrates's* Use of the Valves was, that so much Blood which was not to return might pass out of them, as was sufficient for the Nutriment of the Lungs, while the Air entred thro' the same Passages out of the Lungs; all which is entirely foreign and repugnant to the true Circulation of the Blood, and the true Account of Respiration.

10. It is not now worth our while to remark upon all those Passages, which shew that *Hippocrates* entertained a Notion directly contrary to the Circulation of the Blood, as explained by the Moderns: Give me leave to select a few Places out of abundance that might be mentioned. *Hippocrates* in explaining the Causes of Madness, after his Manner, in his Book *De Morbo Sacro*, has these Words towards the Conclusion:

Now if the attendant Symptoms of this Disorder are Fears and Apprehensions of Evil,
then

then it arises from an Alteration in the Brain which happens upon the Increase of Heat in the Brain from the Bile, where it is carried with a great Force from the Body into the Brain thro' the Veins which convey the Blood. But these Fears continue till it returns again into the Veins and Body, and then they vanish. But the Patient feels a sudden Anxiety and Dejection as the Brain grows cool, and is compressed extraordinarily; but that happens from the Phlegm, and that Affection causes a Forgetfulness in the Patient: But when the Brain grows warm on a sudden, he cries out and makes a Noise in the Night; and that Symptom happens to the Bilious, and not to the Phlegmatic, since they do not grow warm upon a copious Effusion of the Blood into the Brain and its fermenting there. But the Blood is conveyed often through the aforesaid Veins when it happens that the Patient sees a terrible Division, and is in as certain Fears as if he were awake; then his Face glows with Redness, and his Eyes grow red, and he designs some Mischief in his Mind; and so it happens too in his Sleep: But when he awakes, and comes to his perfect Senses, and the Blood is again dispersed in the aforesaid Veins, then the Symptoms cease.

From which Passage I think it is evident, that Hippocrates thought that the Blood return'd from the Brain thro' the same Veins by which it was conveyed thither, and that
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it fluctuated in the same Vessels backwards and forwards; which Motion he believing to be perform'd at a stated Distance of Time in the same Person, called those oxillatory Motions Periods.

II. And from hence it is manifest, how weak that Argument is in Favour of *Hippocrates*, which is drawn of his Book of *Dreams*, where this Passage occurs: *Rivers in an unusual State denote the Period of the Blood; their extraordinary Flows its Exuberance, and their Decrease its Defect; but we should increase the latter, and diminish the former by a Course of Diet.*

There never was any Physician, who, tho' an Adversary to the true Circulation, did not attribute some Motion to the Blood, but always thro' the same Vessels, after the Manner of the *Euripus*; wherefore they may, and usually do affirm the same as *Hippocrates* here does: For his Words allow a Motion to the Blood, but not a circular one; since Rivers do not return in a Circle to their Fountains, as it is now determined that the Blood does thro' continual contiguous Canals: And it is Matter of Admiration, that so many learned Men observing that *Hippocrates* every where ascribed a Period to the Motion of the Blood, should believe that *Hippocrates* knew and expressed by that Word the true Circulation of the Blood; whereas that Word, in his Meaning, signifies only

only (as it often does among the Philosophers and Geometricians) a Fluctuation in the same Vessels, at stated Times, (as the Place here makes it evident,) now into these Parts, and then into contrary ones, which Fluctuation is sometimes performed with a greater Quantity of Blood, and quicker, and at others with a less, and more slowly. But this will appear from another Passage of his Writings.

12. Now a little beyond the Middle of his Book upon the *Food*, he speaks thus: *The Root of the Veins is the Liver, the Root of the Arteries is the Heart: The Blood and Spirits move and are dispersed from these over the whole, and the Heat is dispersed with them.* Which Place, if we compare it with that of his Book upon the *Heart*, where speaking of the Ventricles of the Heart he says, *These are the Fountains of human Nature; from hence run the Streams by which the whole Channel of the Body is irrigated.* Which makes it plain, that *Hippocrates* believ'd the Motion of a Fluid toward the extreme Parts of the Body, returning thro' the same Vessels, to be performed in the same Manner from the Liver, as from the Heart. That this was *Hippocrates's* Meaning, is evident from his Book of the *Places in Men*, where not far from the Beginning he has these Words:

There are two Veins which lie near the Temples, between the Temples and the Ears, which reach

reach to the Eyes, and have a continual Pulse. For these only, of all the Veins, have the least Moisture, the Blood being turned away from 'em: But the averted Blood has a contrary Motion to that which flows in, and that which is averted has a Tendency to retire; but that which flows in from the Parts above having a Tendency to proceed lower, they meet here, and working upon each other in a Circle, produce a Pulse in the Veins. By which Words he means no more than that the Pulse is produced by the Motion of the Blood thro' the same Canal, from each Extremity of the Canal. And this is the Reason of the *Hippocratical Circulation* of the Blood in a Person in a State of Health; for in Fevers he assigns another Cause equally absurd, and repugnant to the true Circulation, in his Book of *Vapours*, where he makes the Air and the Blood pass thro' the same Vessel into contrary Parts: Which abundantly proves, that he who has not produced his Belief of the true Circulation in any Place of his Writings, nor produced one Argument for it, was intirely ignorant of the Manner of that Motion.

13. Altho' I am weary of writing so much on this Subject, yet I ought not to omit answering a certain eminent Writer, who produces these Words from *Hippocrates's* Book of the Regimen of *Diet in Acute Distempers*, *A Quinsie happens, when a large and glutinous Defluxion, either in the Winter or Summer,*

mer, falls into the Jugular Veins, and those Veins have attracted a more copious Flow of Matter, by an Increase of the Amplitude of their Vessels. First, all this is false, and repugnant to the true Circulation. Again, he himself very justly owns, that the Arteries may be as well meant in this Place, as those which we call the Veins. But we allow that they are what we call now the Jugular Veins, it only follows from hence, that the Blood moves in its Vessels sometimes faster, and at others more slowly: But there is not a Word here of its true and circular Motion. But that Learned Person, in part of his Writings, prejudices the Question in these Words; *If you will allow me that the Blood moves, I will easily prove that it circulates too.* But the Question is not whether the Blood circulates, but whether *Hippocrates* knew that it did; nor ought we to infer, that because it might have been found and discovered by what *Hippocrates* did know, that therefore it was discover'd by *Hippocrates*; since every Barber knew the Necessity of a Ligature in *Venesection*, which, however, did not give an Opportunity to the most acute Physicians, but within a few Ages, of discovering the Circulation, tho' it might have been discover'd more easily from thence than any Thing besides, and much more easy than from the Words of *Hippocrates*, even those which are supposed to contain it in the plainest Terms.

14. But we must examine a Passage of *Hippocrates*, in his Book *De Morbo Sacro*, where he has these Words: *A great Number of Veins, and those very Minute, proceed from all Parts of the Body to the Brain; but there are two large ones, one rising from the Liver, the other from the Spleen. Now that which is derived from the Liver, runs in this Manner: One Part of the Vein is carried to the Right Hand, near the Kidney and the Loins, and downwards to the internal Part of the Thigh, and reaches to the Foot, and is called the Vena Cava. But the other Part stretches thro' the Veins on the Right, and the Lungs upwards, and is divided into the Heart and the Arm: But its other Part stretches thro' the Throat, on the Right Side of the Neck upwards into the Skin it self, where it is conspicuous to the Eye; but it is concealed near the Ear, and there it divides, and its largest, thickest, and widest Part ends in the Brain: But in the other Part, where the Vein is less, part is carried to the Right Ear, part to the Eye, and part to the Nose: And this is the Course of the Vein from the Liver. But the Vein from the Spleen runs to the Left upwards and downwards, as that from the Liver, but lesser and weaker. Now we draw in a great Quantity of Air thro' these Veins: For these are the Vents of the Body, as drawing the Air to them, and deriving it to the rest of the Body, and cooling it in the Veins, and then emitting it again.*

From whence it is plain, that what we call the Veins now attracted and emitted the Air in *Hippocrates's* Opinion, that is, emitted thro' the same Vents by which they attracted it. From whence it follows, that he who did not use an exprefs Demonstration to inculcate the Belief of the Circulation of the Blood, ought to be esteemed ignorant of it, if he produced fuch Principles as we have heard *Hippocrates* advance; they being evidently to the Circulation, as we at present understand it.

These Words follow soon after, in the same Book, which deserve our Notice. *Now the Defluxion is greater toward the Right than the Left, because the Veins are larger, and more in Number there than on the Left, as stretching from the Liver and the Spleen.* From whence it is plain, that *Hippocrates* believed and delivered it as his Doctrine, that the Blood and Phlegm (which he makes to flow into all Parts) flowed thro' the Veins from the Liver and Spleen into all Parts of the Body, which is entirely contrary to our Circulation, and shews that he was ignorant of it.

15. But it appears more clearly what was *Hippocrates's* Opinion in this Point, from his 4th Book of *Diseases*. At the Beginning of that Book, he says, *The Stomach, when full, is the Fountain of all Juices in the Body, but when empty it drains from the decaying Body.*
But

But there are four other Fountains, each of which empties into the Body, (that is, the Bile, the Blood, the Water, and the Phlegm, of which he was then speaking.) After then these Fountains have received their Proportions from the Stomach, and they are again emptied, they drain from the Body. It is certain the Heart is the Fountain of the Blood, the Head of the Phlegm, the Spleen of the Water, and the Situation of the Bile is in the Liver. Again, he farther adds in the same Book, But those Parts which I have termed Fountains, when they are full, always transmit into the Body; but when they are empty, they are encompassed and drain'd by that on all Sides: And the Case is the same with the Stomach; for the Case is resembled by this Instance; If any one pours Water into three or more Vessels, and places them on a plane Surface, and at the same time disposes it so that there is a Communication between them by Pipes; and then pours the Water gradually into one of the Vessels till they are all filled; for the Water will flow from one Vessel to the rest, till the rest are filled. But, when the Vessels are full, if any one draws the Water out of one, the Water will in its Turn flow back (you see that it will flow back thro' the same Pipe that conveyed it) into the Vessel, (that is, into the Vessel from whence the Water is drawn;) and the Water will be refunded from the Vessels

in the same Manner as they received it. Thus, without Question, the Case is in the Body.

And now, I think, it is plain enough, that *Hippocrates* knew nothing of the true Circulation, since we may be abundantly convinc'd from this Passage alone, that, in his Opinion, the Blood and Juices irrigating the Body, flow backward and forward through the same Canals, like Water from one Vessel to another, reciprocally flowing from that to the first, thro' the same Pipe. However, we take Leave to add the Authority of *Aristotle* in this Point, if that can influence any one. He, in the 4th Chapter of his *Third Book of Animals*, says, *The Blood is derived from the Heart to the Veins; but the Blood does not arrive at the Heart from any other Part; for that is the Original and Fountain of the Blood, and its first Receptacle.* It is plain, that *Aristotle* argues here against those who believed the Blood returned back to the Heart thro' the same Canals. So that if we have any Regard to *Aristotle*, the Opinion of *Hippocrates* is, that the Blood flowed and returned thro' the same Vessel, as Water would do if put in Motion within a Canal closed up on all Sides, and at each End, which, in *Aristotle's* Opinion, who allows, with *Hippocrates*, that the Heart is the Fountain of the Blood, is impossible; because Streams do not flow back to their Fountains. But that we may not believe that *Aristotle* thought that the Blood, which
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does not return towards the Heart the same Way it passed, any more than Streams can return the same Way to their Fountains, did return back another Way, that is, from the Arteries into the Veins. Read only what he says in the 5th Chapter of his *Third Book of the Parts of Animals*. *The Veins proceed from larger into less, till they become so narrow, as not to be capable of conveying the Blood.* And, indeed, if *Aristotle* was as ignorant of the Circulation, as these Words of his prove he was, it is not credible that *Hippocrates* knew it, or that *Aristotle* discovered any Traces of it in his Writings.





A
DISSERTATION

UPON THE

Circulation of the Blood

IN

Born Animals and Embryons.



R. *Harvey*, after others, has explained and demonstrated the Circulation of the Blood, which Physicians imagined peculiar to born Animals. Any one who is but the least conversant in that Art, will own that Physick receives great Improvement from that Demonstration; but nothing is more serviceable in Life, nor can I imagine any Discovery to be more grateful to a Mind that is searching after the ultimate Cause of Things, that Cause which is known to God only, the Author of all Things, than to have discovered and acknowledged that the *Original* of Animals ought to be derived from God himself. Because it is now known, that the Blood is alternately received into,
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and expelled out of the Heart of the Animal; wherefore, neither any Heat, or Ferment, nor a Fluid, however impregnated with Salts and Spirits, nor any other Force continually and not alternately impressed, expels the Blood, or nutritive Fluid, out of the Heart, or Region of the Heart: For if so, the expelled Blood would not return to the Heart, as being obstructed by that Motion acting perpetually, and not alternately. But that Force alternately exerted in the Heart does not proceed from the Womb of the Mother; for what proceeds from the Womb to the Heart of the *Embryon*, falls down into the Cavity of its Ventricles, and not into the Ducts of its Fibres, where the Power of Contraction consists: Besides, that the Heart of an *Embryon*, when freed from the Womb, is contracted, and the Blood circulates. That Power then is to be derived from some Part of the *Embryon*. Now the Law of Circulation proves that nothing is returned from any Part of the Animal to the Heart, which was not before conveyed with the Blood from the Heart to that Part; and I have my self shewn, that the Secretion of Fluids in an Animal (either returning or unreturning Fluids) is performed by the Necessity of Circulation, which objects the Particles of the Liquid to be secreted equal to the Size of the Orifice of the Secretory, and that there is no other Mechanical Account
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of Secretion: And therefore that there are not only secretory Vessels and others existent, before any assigned Secretion, but also that the Secretion of the Powers refunded for the Contraction of the Heart is performed before any assigned Constriction of the Heart, or before any Circulation is commenced; or that the Contraction of the Heart, which expels the Blood to the Part which secerns the Body, or Powers for the Contraction of the Heart is performed before any Secretion, or Refusion, and Communication of the contractile Powers. Again, the Circulation shews us, that the Marrow of the Brain, or *Spina Dorsi*, is that Part from whence the Force that expels Blood alternately, is impressed upon the Heart: Nor is there by any Changes and Metamorphoses common to some Sorts of Animals, any Alteration made in those Powers, and their Relations, by which Life and Circulation does subsist in those Creatures; and by consequence the Communication between the Heart and the Marrow of the *Spina* is not changed. From whence it follows, that the Heart and the medullary Substance have always a mutual Relation to each other by the same Powers, and operating in the same Manner, and that this Relation existed in the same Manner at the first Contraction of the Heart, as it does in a succeeding one. Wherefore the Powers of the Heart and medullary Substance had the same Beginning, and

and act together; and by consequence no Animal is ever produced mechanically. And from hence I draw this Consequence, that the Fluid derived from the Male brings with it an Animal into the Womb and *Ovaria* of the Female, which before enjoyed the Circulation of the Blood, and the Benefit of Life. And I know not whether they who stile themselves *Theologians* and Interpreters of *Jove*, ever produced any Thing more worthy of *Jove*, or more glorious to Mankind.

1. But proceed we to other Matters, and explain some Qualities of the Circular Motion proper to the Blood, demonstrated by Dr. *Harvey*. Now we may collect them from what follows:

If a Fluid in which some solid Corpuscles swim, flows thro' Canals, whose Sides converge to the Parts of Motion to which the Fluid it self moves, or diverge from them, or if the Sides are parallel to the Line of Motion, the Motion of the Fluid is more easily and frequently obstructed in the Canal, whose Sides converge to the Parts of Motion, than in a Vessel of parallel Sides; and the same Motion is more easily obstructed in a Canal of parallel Sides, than in one whose Sides diverge from the Parts of Motion. And farther, the larger the Angle of the Vertex of the Triangle thro' the Axis of the Canal in these converging Sides, is, the more easily and frequently is the Motion directed

directed toward the Vertex obstructed; but the lesser that Angle is, the more easily and frequently is the Motion of the Fluid toward the Parts declining from the Vertex obstructed.

2. It is evident, if the Motion is from the Basis to the Vertex, *v. g.* of a truncated Cone, it may easily happen (if any solid Corpuscles swim in the Fluid) that the Fluid may carry a Solid, which may close up the narrower Orifice of the truncated Cone: Beside, by the Position of Solids swimming in a Fluid, and their continual Alteration by striking against the Sides of the Canal, it is hardly to be prevented, but that some of those Bodies being at last conveyed into a Section of the Vessel sufficiently narrow, may mutually strike upon each other, and, being supported by the Sides concurring with the Line of Motion, compose a solid Arch, which will obstruct all Passage. And it is evident that this Arch will be the firmer, as it is more forcibly pressed by the succeeding Fluid. And in the last Place it is plain, that this will happen more easily and frequently, *cæteris paribus*, the more the Sides of the Cone converge, that is, the larger the Angle of the Vertex of the Triangle is thro' the Axis of the conical Canal.

3. If the Sides of the Canal are parallel, and so the Canal it self either cylindrical or prismatical, &c. it is evident, that the first Cause

Cause of Obstruction vanishes, since there is no Body which can enter such a Canal, which cannot pass thro' the Parts of it with the same Facility; but the other Cause arising from the casual striking of the Solids at Sections always the lesser towards the Parts of Motion, happens but seldom, nor will that give any Obstruction, since its Force ought to be increased by the Force of the subsequent Fluid. This is also a Consequence from what has been before laid down, since a Cylinder is a Cone, of whose Triangle thro' the Axis the Angle at the Vertex is the least of all.

4. But when the Motion is in a Canal, *v. g.* which is conical from the Vertex to the Basis, or thro' a Canal whose Sides diverge from the Parts of Motion, no Accident arising from these Reasons obstructing and stopping the Motion, takes place; since a solid Corpuscle which enters the narrower Orifice of the Vertex, may very easily pass thro' the large Sections of the Canal, and the Corpuscles cannot be so easily forced to strike against each other, from the concurring Resistances of the Sides; and if they accidentally should compose an Arch, that being unsupported by the Sides of the Canal, would be easily carried away by the Force of the subsequent Fluid.

5. From whence it follows, that in the smallest Veins, and at their first Rise (in which, from
their

their small Difference of their Distance from the Heart, the Velocity of the Blood is equal, as in the nearest Arteries,) Obstructions do not happen so easily and commonly as in the Evanescence of the Arteries; and that the Motion of a Fluid is more easily obstructed in the Arteries, than in the Nerves. For the Difference of the Velocities in the Arteries and Veins may be diminished to such a Degree, as to become lesser than any given Quantity; and therefore the Velocity at the Evanescence of an Artery, and the Rise of a Vein, is equal. But the Difference of the Resistances and Obstructions happening within the Arteries and Veins, is not altered, tho' you assume the Sections ever so near their common Vertex, since the Angle comprehended between the Side and Axis of the Cone, remains the same always, and in every Part.

From whence it follows, that in every Distemper, the Symptoms, which may as well arise from an Obstruction of the Motion of the Fluid in the Arteries, as from a Stoppage of the Motion of the Fluid thro' the Veins and Nerves, it is always to be supposed, that the Fault is in the Arteries, rather than in the Veins and Nerves.

6. Now we think fit to give an Instance of this in the soporiferous Affections of the Brain, *viz.* a complete Apoplexy, a Carus, Coma, Lethargy, and Palsy, which last, tho' not an Affection of the Brain, yet has a near Relation to an Apoplexy. They who have wrote upon these Distempers, have not scrupled to transfer the Cause of these Symptoms, which lies within the Vessels, into the Nerves, or, as Dr. *Willis* speaks, into the Pores of the Brain: Whereas the Place of its Situation and Action is always within the Arteries, according to what we here prove. The famous *Sylvius*, in his 2d Book of the *Practice of Physick*, discoursing upon the Apoplexy, has this Passage: *I am fully persuaded, that the Animal Spirits may be made so heavy and devoid of Motion, that an Apoplexy may follow; since it is evident, from Experience, that Men, upon the taking a Quantity of Opiates, or Spirits of Wine, have fell into a Sleep and an Apoplexy.* The same Person, upon the Palsy, says thus: *It arises from a Fault of the Animal Spirits, as often as they are made heavy and motionless by Opiates, or a Dizziness.* And speaking of a Carus, and a sleepy Coma, *The Cause of these Symptoms*, says he, *is from an Induction of a Narcotick Power upon the Animal Spirits, which deprives them of their Motion.* And, lastly, the same Person, after a verbose Disquisition about the Nature of Opiates, concludes,

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in the 26th Chapter of the same Book, *That the Narcotick Power of Opium is join'd to its sulphurous, that is, its oily Part, which renders the Animal Spirits sluggish, inactive, and more unfit for Motion.*

What Dr. Willis has said upon these Distempers, amounts to the same Thing. For he affirms, that they arise from the Admission of a venomous Substance into the Brain, which either intirely extinguishes the Spirits, or forces them to retreat to the inner Parts. In his Chapter of a *Lethargy*, he says thus: *Opiates subdue the exterior Power of the Spirits, so that the rest being diminished and chased into the inner Parts, are oppressed and destroy'd.* And because the Nature of this Distemper cannot be explained, without accounting for the Cause of Sleep, it is worth while to hear what he says upon that Point in the 16th Chapter of the Physiological Part of his Book, *Of the Soul of Brutes.* *The Animal Spirits,* says he, *are the Subject of the Brain, out of the Cerebellum, otherwise the Pulse and Respiration would cease in the Time of Sleep.* Since the Nerves that move the Heart and Breast, according to Willis, proceed from the *Cerebellum.* Thus the exterior Animal Spirits of the Brain, either by a voluntary Motion, (to this Case he refers the Powers arising from Musick, and Lassitude after Exercise, in which Cases he says the Spirits contract themselves into a lesser Space,) or by the In-
cursion

curfion of a foreign Body (to this he refers the Extinction of the Spirits by Opiates) withdrawing themselves from the exterior Pores of the Brain, where they usually expatiate, retreat into its innermost Cavities, where they repose, as it were, at Leisure, and induce an equal Lassitude upon the Spirits residing there, and restrain the Efflux of others, which would flow into the Nerves, and draw them into the same Repose.

7. All this shews, thar *Sylvius* and *Willis* believed that the Nature of these Symptoms of Opium, and the Cause of Sleep, could not be explained by any other Means, than by the introducing an obstructing Body into the Nerves, that should hinder the Motion of the Fluid that passes through them. But we here shew that there is no such Thing; and by consequence, that a Cause answerable to all medicinal Uses, ought to be derived from a Body dispersed through the extreme minutest Arteries of the Brain.

8. It seems strange that these Persons should receive no Light from the reading of a Book published by the Learned *John-Jacob Vepser*, upon the Apoplexy. For he, in the 252d, 251st, and 250th Pages, and in many other Places, says, *The Head is dozed by Opium, by a plain Experiment, which is the notable Quality of Fermenting in Opium, or its converting into Vapours, (by which it turns the Serum into Vapours,) and many of these Va-*
N *pours*

pours insinuate themselves into the Passages of the Animal Spirits or Nerves, and in some measure obstruct them; for Opium operates by stuffing the Passages of the Nerves to that Degree, as to deny a Passage to the Spirits; which is more probable than the fancied Fixation of some Animal Spirits by the hot and sudorific Qualities of Opium. So far this great Man, who deserves much of the Profession of Physick.

9. It is plain that *Vepſar* was mistaken in placing the Operation of Opium in the Nerves, and not rather making it in the Veins. For there the Blood being in a quicker Motion, and warmer, is more easily turned into Vapours; and when it is converted into Vapours, it will necessarily distend the Arteries, and press round the Canals of the Nerves, and make its own Passage into them more difficult. But this is plain from what we have before demonstrated.

That very Industrious and Learned Physician *Etmüller*, would have done well in attending *Vepſar's* Observations on this Subject: For *Etmüller*, in a Disputation upon the *Diaphoretick Power of Opium*, published in the Year 1679, says, that Opium induces a certain Lassitude and Heaviness upon the Animal Spirits, and from them a Languor and Inactivity in moving the Fibres of the Organical Parts; for if we depend upon *Etmüller's* Philosophy, it restrains the Elastick Force of the Spirits.

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He afterwards affirms, that there is no Alteration made in the Blood by *Opium*, since two Grains of *Opium* do not seem sufficient to alter 20 Pound of Blood, and work upon so great a Quantity to that Degree, as to resolve the Animal into a Sweat. He allows indeed that 20 Grains of volatile Salt will provoke a Sweat; but then he advertises, that those 20 Grains seem better to answer the Quantity of 20 Pound, than the two Grains of *Opium*.

10. It is easy to observe that we have answered these Notions in the 2d, 3d, 4th, and 5th Paragraphs of this Dissertation: But because I see many unwary Persons every Day drawn into Mistakes by *Etmuller*, it will not perhaps be unacceptable to sift his Doctrine with some farther Accuracy. For he ought to know the Manner how *Opium* exerts its Powers, who pretends to give a Solution of the soporiferous Affections of the Brain.

It is plain, from these Passages of *Etmuller*, how difficult it is for one to disentangle himself from Prejudices: For while he denies that the Blood is at all altered by *Opium*, because the Alteration, which resolves the Animal into Sweat, requires at least 20 Grains of volatile Salt of Hartshorn; but 2 Grains of *Opium* (more than which he thinks it unsafe to give) is very disproportionate to that Quantity; he does not at the

same Time take Notice, that 20 Grains of volatile Salt are far more disproportionate to an Ounce of Wine, if an Ounce of Wine will excite Sweat, or at least from that Quantity of Wine which provokes Sweat in the Generality of People. It is sufficient, if the Force of Opium is to the Force of volatile Sudorific Salt as 20 to 2, and to the Force of Wine as 480 to 2, if 480 Grains of Wine provoke Sweat.

11. But he does not at all explain what the Powers and Qualities of Opium are, nor does he inform us of any Thing more than that the taking of Opium brings a Heaviness upon the Animal Spirits, following the Expressions of *Sylvius* and *Willis*, (which *Vesfar* had clearly refuted,) affirming that Opium acting not within the Arteries, but the Nerves, was the Cause of that Heaviness; which is refuted by my Theorem.

I shall then dismiss this Subject, after observing that the famous *Etmuller* is evidently mistaken, in affirming that *Heetical* Persons are freed from Night-Sweats by the administering of Opium. Here he has deceived himself; for Opium is proper for the quieting a Cough, which increases Sweat by an immoderate Agitation of the Body; and if Opium is mixed with *Potter's Antiseptic Powder*, Salt of *Saturn*, and, as the best Physicians practise, with the *Jesuits Bark*, it diminishes the Cough and the Sweats which
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that excites. But if Opium be given simply to Hectical Persons who have no Cough, it always excites Sweats. Thus much I have observed for the Use of young Physicians.

12. What I have deduced in the fifth Place, proves, that the Cause of those Affections that provoke a kind of Sleep, exerts its Powers within the Arteries. I speak of that Cause, which being situated within the Vessels, produces those Affections. Neither do I here discourse of the Causes that coagulate the Blood, from whence we derive those Affections sometimes; for these ought to be placed within the Arteries, as the Thing it self proves, and we have observed.

For whatever can coagulate the Animal Spirits, that will first coagulate the Blood, and so will not enter the Nerves; because we dispute of the Cause of those Affections which resemble a *Carus*, flowing or consisting in the Vessels.

These Things being settled, we may now proceed to explain those Narcotic Powers, which so many Physicians would have to be the Cause of the soporiferous Affections of the Brain.

13. The *Phænomena* or Symptoms mentioned, prove that the Sweat is provoked by the taking of Opium, the Blood being rarified, and causing an unusual Distention of the Arteries, as the Pulse plainly informs us; wherefore if such a Quantity of Opium

is taken, as if able to rarify the Blood in the Brain to that Degree, that the small Arteries situated between the Nerves shall contract them extraordinarily, and deny a Passage to the Fluid inherent in the Nerves, the Animal will be thought to sleep, and all those Accidents will happen which accompany soporiferous Affections derived from a Cause flowing thro' the Vessels of the Brain.

The Heart will be contracted, and also the Muscles which serve alternately for Inspiration, because both these Muscles and the Heart have no Antagonists; and therefore a less Quantity of Liquor will suffice to contract them: But if the Force of Compression be every where increas'd, by increasing the Quantity of the Opium that is taken, the Nerves at the Heart will also be too much compress'd, which will make the Pulse beat little and seldom, and at last be quite gone. Which Thing not being observ'd by Dr. *Willis*, made him absurdly, and contrary both to the Sense of Anatomists, and the Doctrine of the Circulation of the Blood, affirm, that the Nerves which serve for involuntary Motion, *viz.* the Motion of the Heart and the Thorax, are not affected by a Body which is said to destroy what is in the Nerves of the Brain, altho' carried thro' the Arteries, which are all about the *Cerebrum* and the *Cerebellum*. Now if this was true, the remaining Part of the Opium that is taken must be carried off by
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all the Arteries which tend to the Brain, and compress all the secreting Vessels that lie about the sanguiferous Vessels, which are dilated by the Rarefaction of the Liquid that runs thro' the small Arteries. Therefore the Vessels which make a Secretion of the Gall and Pancreatic Juice are compress'd, and so (if the Morbific Matter of a *Diarrhæa* is fecern'd thro' the Secretory, Pancreatic, and Biliary Ducts) a *Diarrhæa* will be thereby suppress'd, the Canals of the Kidneys will be compress'd, and the Animal will not be able to piss. The Perspiration thro' the Skin and Membranes will alone exert it self, the sudoriferous Pores which are in the Ends of the Vessels and in the Skin, not being stopp'd or hinder'd from acting, by the Dilatation of the small Arteries or other Vessels compressing them more than ordinary. The Force of this Reasoning lies in this, that how much soever the Perspiration is increas'd, it has no Ocession for particular secreting Vessels, but throws it self out of the Pores of any Vessels, as well as secreting ones.

14. Whence it will be no difficult Matter to explain the soporiferous, anodyne, and astringent Force of Opium, better than we can be inform'd out of *Sylvius's* or *Willis's* Philosophy; and to shew that Wine and all other Liquors that are apt and ready to rarefy, will be sufficient to cause a Sleepiness.

Nay it may be caus'd also by any Liquors tho' not too apt to rarefy, if a Quantity large enough be taken, and so much of it be carried to the Brain, as to produce the requir'd Dilatation, and consequently a Constriction of the Nerves. For this Reason, it is no Wonder that some People become sleepy and drunk by drinking Water; neither will the Cause of it be any longer hid, for (*cæteris paribus*) the rarefying Force of Liquors, which cause an equal Degree of Sleepiness by different Quantities, is reciprocally proportional to the said Quantities. Therefore any volatile Salt will cause a Sleepiness, and it is wrong to throw in any Remedy of that kind into the Vessels to drive away an Apoplexy, unless the too great Viscidity of the Blood require it: Neither must we use it to extinguish an Acid, for the volatile and acid Salt of Amber attenuates viscid Blood; but any volatile Salt may be applied outwardly to provoke Motion, just as is done with the Smoke of Vinegar.

Any Body may easily understand, that if there be two Animals alike in other Respects, and having Nerves of equal Bignesses, and equally distant from one another, which have the Arteries of their Brain of unequal Contents, the Animal who has the greatest Arteries will be soonest drunk, and he that has the least will sooner have the Head Ach. For a greater Quantity is requir'd to thrust
out

out the Sides of a greater Artery to a given Degree of Tension, than the Sides of a lesser; for the Quantity of Liquor must be as the Square of the Diameter.

15. I cou'd add to this what the Physicians of all Ages have said of a *Vertigo*; but I will only quote two. The first is that *Cassius*, who publish'd Problems before the Year 1400. His Answer therefore to the Question why circular Motions cause a Giddiness, is this: *Circular Motions hinder Transpiration from being perform'd, the Air thrusting in vehemently and hindering it; and likewise as the Body is mov'd circularly, so are the Matters within us. Since therefore they are agitated together with us, and cannot transpire; even when the Cause of their Motion ceases to act, they continue to go round in a Circle. And such a Motion of the Humours is the Cause why Sense imagines something beyond Nature.* This is what he says, according to *Gesner's* Translation.

Think ye that Dr. *Willis* says any Thing more to the Purpose? Let us hear what he says in his 7th Chapter of his second Exercise, *Concerning the Soul of Brutes: The Spirits in the Brain are like Water in a Vial, which is turn'd about together with the Vessel that contains it; and when once a Vortex is made, the Water keeps its Motions some Time, even when the Vessel is at rest: After the same Manner, when a Man's Head is turn'd,*
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the Spirits in the Brain are whirl'd about, and have, as it were, spiral Motions, and some Parcels of them are obscur'd, are carried here and there in Vortices, and often transversely.

16. I shall omit what has been put out on this Subject in *Etmuller's Name*; for it is evident that this Great Man would have publish'd his Works with Emendations, if his ill Fortune had not hinder'd him: For all that was publish'd under the Name of *Etmuller's Practice*, was only put out by such as did it for the sake of filthy Lucre. Which I here mention, lest any one should look upon those Things to be mine, which Booksellers will perhaps put out contrary to my Knowledge, and give out that I dictated them to my Scholars.

I return to *Cassius* and *Willis*. If they had known that the Obstructions arise in the Arteries sooner than in the Nerves or Veins, and that the Distention of the Vessels produce the same Effects, as those that are ascrib'd to a Tumor, or a Matter that obstructs those Vessels, (when we don't know the Quality of that Matter,) they would not have taught that a Vertigo arose from the Liquor of the Nerves being whirl'd round, but they would have look'd for the Cause of it in the Arteries: For the Make of the Nerves and the Brain, discover'd by the most Ingenuous *Malpighi*, hinders any such Effect, and shews those Things to be false, which

which are alledged by *Cassius* and *Willis*.

17. But tho' such Symptoms cou'd be excited by the Liquor which flows thro' the Nerves, yet it is not right to attribute them to that Motion, which appears to be in Things plac'd about us, that seem to turn round. Because it is plain from Optics, that no Object appears remov'd out of its Place, as long as its Image remains in the same Place in the *Retina*, and circumscrib'd after the same Manner: But the circular Motion of Liquor in the Nerves and Filaments of the *Retina*, does not change the Place of the Image. Therefore we must not ascribe the Giddiness, or *Vertigo*, which happens to People that turn round, to the Vortices of the Liquors. Therefore if we wou'd know the Causes of a *Vertigo*, we must look into *Lawrence Bellini's* Book of the *Distempers of the Head*, where that great Physician and Philosopher demonstrates, that a *Vertigo* is not occasion'd by a circular Motion of the Animal Spirits, but (when it becomes a Distemper) by a Removal of the *Retina* or Nerve by the Distention of the Arteries of the Eye. Whence it appears that he made use of such Theorems as we do.

18. Hitherto we have disputed of the Theory agreeing with some Distempers; now to shew the Use of our Theory, we must explain, what stead they may stand us in, in the Cure of those Distempers. For in
sopo-

soporiferous Diseases, generated after the Manner here mention'd, first of all we must open the Arteries or Veins, all stimulating Medicines must be us'd; but such Salts as are commonly call'd volatile, and Spirits drawn from Hartshorn, Urine, and such Substances, and such Remedies also as are call'd Cephalic, are not to be us'd. I know very well how many People I shall have upon me for this Assertion; but having exactly demonstrated the Matter, I don't value the Opinion of the Multitude. Then I advise, that in a *Vertigo* we must not use any of those volatile Salts, but such Things as hinder the Rarefaction of the Blood: I speak of the Cure which must be made after necessary Evacuation. For it is evident that in an *idiopathical* or *original Vertigo*, no less than in an Apoplexy, the Arteries and Veins must be open'd; but in any other the Patient must be made to vomit, and that for several Reasons. For first of all a Vomit washes away the Filth of the Stomach, and the Passages for Perspiration become more free, which being suppress'd, had so increased the Quantity of the Blood, as to cause a *Vertigo*, for the Reason shew'd by *Bellini*. Then that Liquor is washed out, which afterwards being mixed with the Blood, would either have caused the Blood to increase too much in Quantity, or to be too much rarefied, and by that Means have produc'd a

Ver-

Vertigo. There are also other Cases when Vomiting is necessary, when the Distemper arises from a foul Stomach.

19. But let us see what Method of Cure agrees with *Willis's* Theory. We know by Experience, that it is good to open a Vein in Apoplexies, (observe here, that we speak of such an Apoplexy whose Cause is within the Vessels,) and that such an Help does by manifest Reason expel such a Narcotic Force as we spoke of. Now, if the Spirits in an Apoplexy become unmoveable or torpid, by a soporiferous Body's being admitted into the Nerves, as *Sylvius* believed; or if the Nerves be so clogged up by such a Body, as to hinder the Spirits from passing thro' them, as *Vespaerius* will have it; or lastly, if Bodies causing Apoplexies kill the outmost Companies of the Spirits, or their Centinels that stand at the Gates, as *Willis* teaches, we must let Bleeding alone, and have Recourse to a knew and unknown kind of Remedy. For I dont believe that opening a Vein can recal to Life Companies of dead Spirits, and raise up the unmoveable and torpid ones, neither that it will draw out or diminish the Matter which clogs up the Nerves: But volatile Salts, as they call them, and Spirits drawn off from Animal Substances by Chymical Fire, will be made use of by famous Men, but with very ill Success. For I have said before, and again affirm, that such Salts
and

and Spirits make an Animal sleepy, and like Opium, dull the Senses, and stop the Journey of the Spirits thro' the Nerves. But you must take care not to compare a Grain of Opium with a Grain of volatile Salt, for one Grain of Opium often produces the same Effect as sixty or more Grains of that Salt.

20. Having a great many Reasons to suppose that the Nature of Opium must be like the Salts of Hartshorn, I persuaded Mr. *Alexander Monteith*, an excellent Man, and a very famous Surgeon, well skill'd in Chymistry, to make some Chymical Experiments upon Opium: He having often try'd the Thing, shew'd me five Ounces and five Drachms of a volatile Spirits, (as they call it,) drawn from a Pound of Opium, which perform'd the same *Phænomena* as Spirit of Hartshorn; and besides, from the Opium was drawn off an Ounce and two Drachms and a half of fetid Oil; and lastly, the *Caput Mortuum*, which smelled like Hartshorn, weigh'd seven Ounces and six Drachms. So that it is no Wonder if the same Things are performed by volatile Salt, and Spirit of Hartshorn, as by Opium, if a Quantity fit, and proved by Use, be taken into the Stomach.

I dont know whether it be worth while to observe what *Sanctorius* says in the 18th Chapter, Sect. 4. of his *Statics*, that he himself experienced, namely, that he perspired more sleeping than waking, because from
what

what I have already said, any Body may know the Reason of it, especially if the Sleep be caused by rarefying Medicines, and apt to occasion Sweating. And the Force of it consists in this, that Opiates cause Sweat, and that that which could not obstruct the small Arteries, cannot obstruct the Nerves.



A DIS-



A
DISSERTATION

Concerning the
CURE of FEVERS

BY
EVACUATION.



Physicians believe that continu'd Fevers arise from the ill Quality of some Liquor or Body, exciting those Symptoms which every Body knows to belong to Fevers; to which Body or Liquor they have given the Name of Morbific Matter. Some will have that Matter to be a Humour, which is commonly secreted in healthful Bodies, but so changed in the Sick, as to occasion the Symptoms of Fevers; and which of it self, that is, by the natural Push of the Blood, cannot be secreted: Some say that it comes from without, (calling it the *Miasma*,) and joining it self to the Liquor which must naturally be secreted, excites Fe-

Fevers. No matter which of these are in the right; for all Things will happen in the same Manner, whether the morbid Matter invades from without, or the Humour within be chang'd into morbid Matter.

2. Physicians embrac'd these Opinions after they had observ'd that most People in Fevers are depriv'd of the Transpiration thro' the Skin, or that other Evacuations, which belong'd to them as Animals, are stopp'd or diminish'd. But these appeared almost evidently to those who observ'd how Fevers went off; for some appear'd to be carried off by Sweating, others by Plenty of Urine, and others by a Looseness; and that there wou'd be a *Crisis*, when the Secretion was provok'd through any of those Glands which carry the Humour out from an Animal. Wherefore they imagin'd that there was some Sort of Matter that fed the Disease, which was to be expell'd from the Body of the Patient, after it had been made ready to flow, or so chang'd (by causing a Concoction and Digestion, as they call it) as to be easily rooted out of the Body.

We shan't dispute of that so much celebrated Concoction, but only enquire what Kind of Secretion or Evacuation must be us'd in Fevers, if any is to be us'd. In which Inquiry we shall say nothing at all of the Cure by Blood-letting, because we are resolv'd only to consider those Evacuations which are

commonly made in a sound Animal by Ways naturally open to them, and which Physicians endeavour to provoke, after Blood-letting, when they think it necessary, and Vomitting, if that be necessary; and indeed it is often so.

3. But because now a-Days a great many People are of Opinion that Fevers arise from the ill Quality of the Ferments, which they suppose to belong to every Part, or to the ill Quality of the fermenting Parts of the Blood; and Smatterers like this Opinion mightily, setting up for Philosophers and Physicians, when they have got a few Words by the End: I thought fit to give an Account of this Subject, in the Words of the most ingenious *Nicholas Steno*, in his Preface to his Dissertation, *Concerning a Solid naturally contain'd in a Solid*. These are his Words:

Besides the subtile Fluid which goes thro' all Things, we observe at least three Kinds of Fluids in Animals, the first of which is external, the second is internal and common, the third internal and proper to particular Parts.

By the external Fluid in Animals, I mean that Fluid which not only encompasses the Fluid that we see like an Atmosphere, but also touches the remaining Parts of the Surface of the Animal continu'd thro' the larger Holes, as the whole Surface of the Aspera Arteria, the whole Surface of the Way of the Aliment, &c. Then, he says, I call that the internal Fluid,

Fluid, which does not communicate with the external, but by the intermediate Passages or Strainers of the Capillary Vessels. The internal common Fluid is that which is contain'd in the Veins, Arteries, Lymphatics, and perhaps in the Nerves.

The proper internal Fluid is that which is round about the capillary Vessels of the common Fluid, and is different, according to the Difference of the Places in which it is, &c.

Then he adds, that the Reason why in different Places different Juices are excreted from the same Blood, depends upon the Places themselves, which, he says, is explain'd by the three following Considerations.

I. *The Consideration of the Capillary Vessels of the internal common Fluid, which alone is regarded by those Men that ascribe all to a straining thro' divers Pores, of whose Opinion I have been for some Time.*

II. *The Consideration of a proper internal Fluid, which alone obtains with those that ascribe a particular Ferment to every Part, who may be partly in the right, tho' the Term of Ferment is built upon a Comparison taken from too particular a Thing.*

III. *The Consideration of the Solid of every Part, which is follow'd by such, as by attributing to every Part its particular Figure, pretend to know something proper to each Part; which indeed we know nothing of, and which, according to the Knowledge that we have*

hitherto had of Matter, can be nothing else than the porous Surface of that Solid, and the subtile Fluid going thro' those Pores. I shou'd, says he, make too great a Digression, if I shou'd apply what I have laid down to the Explication of what daily happens in our Bodies, and can be explain'd no other Way: It is enough to hint here, that the Particles, which after various Manners are separated from the external Fluid, are carried into the internal common Fluid by Strainers, from whence, being also secreted different Ways, and being by a new Straining transmitted into the internal proper Fluids, they are by Apposition joined to the solid Parts after the Manner of Fibres or Parenchyma's, as they are determin'd by the Property of each Part, unknown to us, and included in the Consideration of the three Things aforesaid.

4. But although in our Dissertation of the *Circulation of the Blood through the smallest Vessels*, we have shewn, that such Ferments are not found in the Bodies of Animals, yet, to be understood by those who cannot comprehend a mathematical Demonstration, we shall explain the Thing so, that even Beginners may easily know what we mean. From what *Steno* says, it is plain, that the Question is, How it comes to pass that so many different Liquors are secreted out of the same Blood, and after what Manner? Why Bile in the Liver, Urine in the Kidneys, and other Liquors in other Parts? The
An-

Antients attributed it to a different Attraction; which Opinion may be better illustrated now by such as understand Sir *Isaac Newton's* Philosophy, than it cou'd then be by them. Since that Time a great many Physicians having thrown out the Word *Attraction*, wou'd have this performed by Ferments, which they suppos'd to be different in the different Glands or Strainers of different Kinds. But we have shewn that there are no Glands, which should be look'd upon as Strainers, bor'd with Holes of different Diameters. We have also shewn, that the Orifices of all the Vessels are similar, and circular; whence it follows, that the first and third Consideration of *Steno* are of no Force. But it follows also, that if with these Men you lay aside Attraction (which if you admit, there will be no Need of Ferments) for want of Glands that have Passages of different Figures, the Ferments, or those internal Fluids which are proper to every Part, must be all wash'd away and carried off by the Force of the Blood going thro' the Arteries. And if any are stopp'd, that may happen as well in one Place as in another, being stay'd by no Difference of the Places, (which is not any where suppos'd,) and therefore the Secretion will be made thro' any Part, without Regard to any Ferment.

5. I have often wonder'd, that so many People would suffer themselves to be impos'd

upon, when at the same Time they boasted their Knowledge of the Nature of Things: A great many of the Antient Physicians and Philosophers ascrib'd to every Part of the Body Qualities, or a Temperature made up of Qualities, by whose Help, they said, the Secretions and Actions were directed. Our Authors of Ferments justly look'd upon those Qualities and Temperatures as a Refuge for Ignorance, because they had been invented without Foundation, built upon no *Phænomena*, and known only by Name: Therefore they said that every Part had its particular Ferment and Secretion. But the Nature of no one of those Ferments is better known to these great Improvers of Physick, than the particular Nature of the Temperatures were to the Antients. Neither is any Property of the Ferment of any particular Part better known to these Adepts, than the Nature of occult Qualities to a Peripatetician. Whence it is too plain, that this Contrivance has introduc'd no new Thing in Physick, except Words, as I just now said in my Dissertation, *Concerning the Circulation of the Blood thro' the smallest Vessels*, when I spoke of the Glands.

6. Let us proceed to other Matters. We have said, that it is observ'd that Fevers go off by increasing the Secretion thro' the Skin, sometimes by increasing the Secretion through the Renal Glands, or by causing a
Diar-

Diarrhæa thro' the Glands of the Liver of the Pancreas, or the Intestines. We need not speak of other Kinds of Crises, unless any one will add to the rest the Jaundice, which sometimes comes upon a Patient as the Fever goes off.

Then we observe, that there are no secreting Vessels, and no Glands in our Bodies serving for Secretion, which cannot be increas'd to such a Bulk as to be able to receive and separate every Humour, even that which is naturally apt to be secreted in other Glands. For we have observ'd, that in the Jaundice the gross Liquor, which is naturally secreted in the Glands of the Liver, is then secreted in the cuticular ones, and that the too great Influx of Saliva thro' its Glands is stopp'd, by causing the Patient to sweat, and drawing off the salival Liquor by the cuticular Glands, we see that a *Diarrhæa* is stopp'd by turning the Humour into the Passages of Transpiration open'd by Sudorifics, and that a Spitting cures a Looseness, and that a Looseness being again excited, the Spitting will cease, which also, as well as other Secretions, is taken off by an abundant Flux of Urine.

7. It is observ'd in Fevers, especially, how often any Liquor may go thro' any Passage dilated by Art or Nature, tho' there is no kind of Fever but what goes off for the most Part by the Glands, or rather by Sweat thro' the

Pores, sooner than any other Secretion: Therefore there is no Kind of febrifick Matter, but what can be brought out thro' the Glands design'd for Transpiration. For tho' part of the Blood, (whether upon Account of the Fault of some Secretion, and an Hindrance of the Motion of the Humours, or the ill Quality of the Fluid introduc'd thro' the chyliferous Vessels,) or any Humour may be forc'd or chang'd into any Nature, yet that is not the Thing wanted; but we wou'd only know in what Condition of Corruption it is chang'd or perverted, when it causes Fevers.

For the Solution of which Problem, Experiments must be made use of, which shew that it is a Property of the febrific Matter, to be able to go off thro' any Vessels, which usually happens. But this Thing will be more manifest from what follows, where we must consider, in what Proportion the natural Secretions are, and what Reasonings may be deduc'd from the Knowledge of it to serve our present Purpose.

8. Namely, from the 59th Aphorism of the first Section of *Sanctorius*, the Excretions made in a given Time have commonly this Proportion, that if the

Excretion by Stool be as 4,

That by Urine is as 16, and

That thro' the Pores of the Skin as 40,
or more.

It

It is plain by this, that Perspiration is a Secretion which is double the Sum of the other Secretions, (we take here the mean Quantity of the Perspiration,) and twelve Times as great as the Excretion by Stool. Here we must observe, that the Excretion thro' the Mouth made by Respiration (which, as *Sanctorius* in his 5th Aphorism, Sect. 1. says, does amount to about half a Pound a Day) must be ascrib'd to Perspiration; for the Vesicles of the Lungs are no less expos'd to the Air than the whole Skin: Neither can the Transpiration, breaking out of the Vessels and Vesicles of the Lungs, be naturally hinder'd, any more than that which is made at the Skin thro' the Vessels that end there. For the Perspiration is made thro' the Pores of the Vessels that are expos'd to the Air. There are therefore sudoriferous Vessels like lengthen'd Canals (tho' we shall make use of that Term with the Vulgar) in the Skin, more than in the Lungs, in which there are no sudoriferous Canals. If therefore, to return to my Purpose, that Excretion thro' the Mouth be added to the Perspiration, the cuticular Excretion will be the Triple of the Sum of the others, and fourteen Times more than the Excretion by Stool. Wherefore the Perspiration will be at least ten Times as much as the last-mention'd Secretion in our Country. For the Perspiration arising from the Lungs is equal to the

Excess

Excess which one may ascribe to the Perspiration at *Padua* more than in *England*.

9. Because Fevers (and several other Distempers) arise as well from the Suppression of the cuticular Secretion, as from any other Suppression, and that that Suppression is double, or even triple of any other; therefore the Suppression of Half or a third Part of the perspirable Serum, will generate a Fever equal to that, which wou'd be occasion'd by the Suppression of all the other Secretions together. And because the cuticular Secretion is at least ten Times greater than that by Stool, therefore the Diminution of the tenth Part of the perspirable Serum will raise a Fever equal to that which the Suppression of the Stool wou'd occasion. For the same Reasons, the Help of half or a third Part of the Perspiration will be of as great Service in expelling a Fever, as the Help of all the other Secretions together; and the Help of a tenth Part of the Perspiration will be of as great Service as the whole Excretion by Stool, and the whole Perspiration will do ten Times the Service as ten Times the Excretion by Stool.

10. It is evident, that since the Matter of any Secretion may be carried off by increasing any other Secretion, and any Secretion may be increas'd in any Proportion by a proper Medicine; and lastly, since Secretions may be so increas'd, as to have the
same

same Proportion as they naturally have, therefore a greater Quantity of morbid Matter may, in a given Time, be drawn by a cuticular Secretion, than by any other, in Proportion of the Quantity of the cuticular Secretion which naturally happens to the Quantity or Weight of any other natural Secretion. Wherefore a Distemper will sooner be carried off by making an Evacuation thro' the Pores of the Skin, than by any other Secretion, and that in the Proportion mention'd, especially where the Pores of the Skin are very much open, after the Manner declar'd at the End of the second Section, which will be repeated in the 12th.

From this it follows, that a Distemper can't be so easily remov'd by increasing the Secretion by Stool, as it can by increasing the cuticular Secretion, unless the Increase of the former be to the Increase of the latter in an inverse *Ratio* of the Secretions, or as the Quantity or *Moles* of the latter is to the Quantity of the former in a sound Body. Wherefore the Secretion by Stool must be an Hundred Times greater than the natural, that there may be as great an Evacuation made in the Space of one Day, as is made by a Perspiration ten Times greater than the natural in the same Time; or else he must have a hundred Stools, who in a State of Health us'd to have but one; and two hundred or three hundred, if he us'd to have
two

two or three. But he that in one Day, in a State of Health, us'd to have ten Stools, must when sick (if he wou'd be cur'd by Stool) have a thousand Stools a Day.

II. Then it follows from the Premisses, that if you have any Fever under Hand, (the same holds in any Distemper arising within an Animal,) that it is ten Times more probable to cure it by Sweat, than by Stool. For since the tenth Part of the Perspiration, or a Perspiration thro' the tenth Part of the Skin, is equal to, and as easily caus'd, as the Secretion by Stool; therefore the Probability of the Cure to be effected by Perspiration, is ten Times greater than the Probability of the Cure by Stool. For it appears that there is but one Chance for this last, and ten Chances against it, that is, as many as there are Quantities of Perspiration equal to it. And therefore the Expectation of Stool is as 1 to 11, and the Expectation of Perspiration as 10 to 11. (See the famous *Hugens's Book of Reasonings on the Play of the Dice.*) Therefore the Expectation of Perspiration is ten Times greater than that of purging by Stool; or the Value of the first Expectation is ten Times the Value of the last. Now it is the Part of a prudent Physician to make use of the most probable Means of Cure.

I said that Fevers are for the most part driven away by Sweat, or by increasing the Perspiration so as to make it sensible.

Sancto-

Sanctorius, in his 9th *Aphorism*, *Sect.* 1, 2. says, that any cold Weather that happens in Summer hinders about a third Part of the Perspiration, and that unless it becomes sensible, it generates Corruption, or Sickness. Thus far he says. But by Sweat or increas'd Perspiration, I mean that that happens when the Humours are concocted.

12. We have hitherto spoken of such Secretions which are increas'd by a Medicine taken inwardly, and passing thro' the Ways where the Blood circulates. Wherefore what has been said of Secretion by Stool, has a Regard to that which is perform'd in the Glands of the Liver, of the Pancreas, and of the Intestines, the Increase of which Secretion is made by Medicines properly purgative, or acting upon the Animal beyond the first Ways.

For as to the Excretion which is made by Help of lenitive purging Medicines, or freeing the first Ways from the Foulness sticking in 'em, they need not be any more referr'd to Purgation, or the Increase of Secretion by Stool, than the washing of the outward Skin ought to be. For these Lenitives only promote the Perspiration of the Intestines like that of the Skin, and to be ascrib'd to it; for when the Pores of the Intestines are open, a greater Quantity of Perspiration breaks out, than from an equal Quantity of the outward Surface of the Body. And these Pores are open'd
by

by Medicines washing off the Filth, and chiefly by proper Emeticks.

No wonder therefore, if when the first Ways are foul'd and daub'd over with too much Filth, by making use of a softening Medicine which just washes, there appear sometimes manifest Tokens of Concoction, and a necessary Quantity of Sweat breaks forth, the Intestines promoting it, when by an absterging Medicine they are eas'd of the Burden of the Filth.

We must here observe, that the Proportion of Secretion given by *Sanctorius* obtains in healthful Bodies, in which this excellent Physician has examin'd all that is voided by Stool, made up of what has pass'd the Lacteals, and what not. But we chiefly speak of the Excrements sent down from the Mass of the Blood thro' the hepatic and pancreatic Ducts, and also by the Passages of the intestinal Glands. For in Bodies that are healthful, and take no Physick, this Excretion thro' the Ducts, which draw their Liquor from the Mass of the Blood, is very small in Quantity, and scarce perceivable in those that go to Stool but seldom. Wherefore the *Ratio* of the cuticular to the ventral Secretion, will be much greater than the *Ratio* of 10 to 1, or even greater than the *Ratio* of 100 to 1. What may be deduc'd from hence, is obvious to any one.

13. Let there be two elastick Canals having similar Orifices of unequal Diameters; let them receive at every Pulse Quantities of similar Liquors proportional to the Orifices; and from the Knowledge of the Elements of Mathematicks it will follow,

First, That if the Number of Pulses in the lesser Canal be greater than the Number of Pulses in the great one, in an inverse *Ratio* of the Orifices, the Quantities of the Liquid which flow in a given Time thro' the unequal Canals, will be equal; but the Velocity of the Liquid flowing thro' the lesser will be greater than the Velocity of that flowing thro' the biggest, in a *Ratio* of the Pulses.

Secondly, If the Number of Strokes or Pulses in the greater Canals, be greater (that is, if the Turns in which the great Canal receives its Liquor, come quicker in the same Time, or are more in Number than those in which the small Canal receives its Liquor) the Quantity of the Liquor flowing thro' it in a given Time, will be greater than that flowing thro' the other in a *Ratio* compounded of the *Ratio* of the Number of the Pulses of the greater, to the Number of the Pulses of the lesser, and of the *Ratio* of the Orifice of the greater, to the Orifice of the lesser; but the Velocity of the Liquor flowing thro' the great Canal, will be to the Velocity of the Liquor flowing thro' the small one in the given *Ratio* of the Pulses.

From

From whence it follows, that where the Pulse is more quick than naturally, that is, where the Number of Strokes or Pulses is greater in the *Ratio* first given, (as it happens in Fevers,) the Velocity of the Liquid going thro' the Arteries is greater than the natural, tho' the Pulse is less than the natural, that is, the Canal is less, and not so much dilated. Then if the Number of the Pulses in the great Canal be greater, that is, if the Pulse be both quicker and greater than the natural, the Quantity of the Blood going thro' in a given Time, that is, in the compound *Ratio* mention'd in the second Place, (this is often the Case in Fevers,) and the Velocity of the Blood will be in the *Ratio* of the Pulses, or as the Quickness of the Pulse. Let those whose Business it is, see how these *Phænomena* of the Pulses may be explain'd by a Circulation of the Blood slower than the natural, ascrib'd to Fevers by several Pretenders to Physick.

This is what I thought fit to say of the Cure of Fevers by Evacuation. But take this Caution along with you, *viz.* that it is absurd at any Time to say that Fevers are cur'd without any previous Evacuation. For we did not intend to speak of that Kind of Physick, but only to shew the Ignorance of those who have lately wrote, that Fevers were sooner cur'd by a purging Medicine, than one that promotes Perspiration.

14. Since

14. Since I have so often spoken of Perspiration, I beg Leave here to explain and demonstrate *Bellini's* Theorem; of which, tho' it is a very fine one, no Body that I know of has given a Demonstration. This is the Theorem.

The whole Quantity of Perspiration coming out of a Villus, or hollow Fibre, or small Canal, whose Weight is one Scruple, is the thousand two hundredth Part of a Scruple.

This I will shew from the following Method.

Sanctorius has affirm'd, that what is perspir'd in the Space of 24 Hours, weighs 50 Ounces, which Ounces amount to 1200 Scruples, that is, $50 \div 24 \text{ } \mathfrak{D}$. Therefore in the Space of one Hour we perspire 50 Scruples, and every Minute of an Hour $\frac{50 \text{ } \mathfrak{D}}{60}$, or the Quantity of 5 Weights, 6 of which make one Scruple. And as the mean Weight of a Man's Body is 160 Pounds, which are at least equal to 60000 Scruples, or $50 \times 1200 \text{ } \mathfrak{D}$, every Hour, from the whole Body will perspire a Quantity not less than the thousand two hundredth Part of the whole. And therefore every Part will in the same Time emit the two hundred thousandth Part of it self, or in the Space of every Hour each

P

Scruple

Scruple will emit by Perspiration $\frac{1}{1200}$ of a Scruple.

Now in a Man, the Sum of whose *Villi*, thro' which Perspiration is perform'd, is the sixtieth Part of the Body, or of about 3 Pounds, the said Sum will be of at least 1000 \varnothing . Now thro' this 1000 \varnothing of *Villi* must be sweated out every Hour 50 \varnothing of perspir'd Matter, or thro' 1 \varnothing every Hour will pass out $\frac{50 \varnothing}{1000}$ or $\frac{1 \varnothing}{20}$. Wherefore in the Space of one Minute, or $\frac{1}{60}$ of an Hour, will perspire (out of 1 \varnothing) $\frac{1 \varnothing}{60 \times 20}$ or $\frac{1}{1200}$ of a Scruple, as was found by that eminent Man *Lawrence Bel- lini*.

15. And because the Weight of the Perspiration, *ceteris paribus*, answers to the Weight of the perspiring Body, therefore in a Body weighing 120 Pounds, or 45000 Scruples, the Perspiration of 24 Hours will be equal to 900 Scruples, and the Perspiration of every Hour to $37 \frac{1}{2}$ Scruples. Therefore every Hour the Perspiration of the whole Body (and therefore of every Part and Scruple of it) will be the thousand two hundredth Part of it, because 45000 \varnothing are equal to $1200 \times 37 \frac{1}{2} \varnothing$.


Lastly, in such a Body, whose outer Skin or *Cuticula*, together with the Skin of the Womb, Lungs, and Intestines, made about
two

two Pounds, the Sum of the *Villi* thro' which the Perspiration passes at last, is not less than 750 Scruples, or the 60th Part of the Body: For the Body was of 120 Pounds, or of 45000 Scruples. Now thro' 750 Scruples every Hour $37 \frac{1}{2}$ were to pass out, or thro' 1 Scruple $\frac{37 \frac{1}{2}}{750}$, which are equal to $\frac{1}{20}$ because $20 \times 37 \frac{1}{2}$ are equal to 750. Therefore every Moment, or every 60th Part of an Hour, there went out (thro' a *Villus* or small Canal of one Scruple) $\frac{1}{60 \times 20}$ of a Scruple, or the thousand two hundredth Part of a Scruple. *Which was to be shewn.*





A Short
DISSERTATION
Concerning the
E F F E C T S
O F
ACIDS and ALKALIES
I N T H E
CURE of DISTEMPERS.

 **M**OST of the Writers of the last Age, who have treated of Physic, or at least such of them as are now esteem'd, have affirm'd that most Distempers did arise from an acid Body flowing in our Blood. Some others of late have affirm'd, that all Distempers are occasion'd by too great an Influx of an alkalic Body, or too great Plenty of Humours. Ignorance and Laziness, besides an eager Desire of Gain and Fame, produc'd these Sects; for it was easy to inculcate the common Notions of Acids and Alkalies, and
with

with those two hard and founding Words to gain the Applause of the common People. Let us then examine the Matter in a few Words.

2. They that deduce all Distempers from an Acid or Alkali, ought to give some certain Meaning to those Words: For if you say that an Acid is such a Body as takes away a Distemper, when (as is supposed) it has imbibed an Alkalic Salt, you both deceive your self, and occasion a Dispute about a Word, and shew that you don't understand what an Acid or an Alkali is. One might as well say, that all Distempers and their Cures arise from a Terrestrial and a Celestial Matter, calling that Terrestrial which is corrected by the Celestial, and Celestial that which is moderated by the Terrestrial. But it is evident, that unless a certain Meaning be fixed to these Words, the Dispute among Physicians about Acids and Alkalies becomes as useless as a Dispute about a Terrestrial and a Celestial Matter: For since these Words have no certain Signification, and there may be infinite Kinds of the Terrestrial and Celestial Matter, differing in Subtily of Parts, Purity, and Simplicity of Mixture; as there are infinite Kinds of Acids, differing in Volatility, Fixity, and Purity, and one Acid is destroyed by another. Hence it follows, that if a Distemper be supposed to be occasioned by some Acid, we don't from that

Chymical Theory resolve what Medicament to use, any more than if the Disease did not, or ought not to be supposed to owe its Origin to an Acid. Neither can one from such a Theory know what Sort of Alkali to apply, not knowing what Sort of Acid caused the Distemper; neither also can it be known, whether an Alkali must be taken rather than an Acid, and be opposed to the Distemper; and if an Acid must be used, what Kind of Acid it must be. Nay, it is a Mercy if a Physician with this Theory, does not in the same dreaming Way define the Kind of the Acid, fit indeed according to his Theory, but in it self pernicious. Let the Patients think themselves well used, when they fall into the Hands of a Physician, who attributes nothing to his Theory, but all to Practice.

3. What remains therefore, is, that we only learn by Use and Experience, what Remedy is proper for a given Distemper; for finding of which Remedy this Theory is of no Use, as being built but on few Observations, and those perplexed; it can therefore impose upon no one but an uncautious, nor please any but a lazy Person, who is not used to the Labour of the Mind. And what I say of this Theory, I have before said of any other Theory not built upon a sufficient Number of Observations, nor after an Astronomical Manner, that is, concerning all
such

such Hypothesis, which for Want of a competent Number of Observations (and those faithful ones) have not carried the Thing so far, as to bring it to be treated of Geometrically. I have given an Example of it in the Distempers of the Eyes, (*see Sect. 14, 15, 16, 17.*) which God willing, I will illustrate in the Edition of the Problem of *Cassius Felix*, who was commonly called by the Name of *Iatrosophist*. *Bellini* gave an Example of it concerning letting Blood.

4. But to come to the Matter: It is observed, that there is no Sort of Evacuation, but what may be perform'd in the same Man, the same Way affected, as well by Alkalies as by Acids: For Sweat is occasioned by Acid Salt of Amber, and that Acid volatile Salt which the *French* draw of from Silver and Tin. *See the Memoirs of the Royal Academy at Paris for the Year 1692.* The Bones of Fishes, of all Animals, any Blood, especially that of a Goat, Salt of Hartshorn, and several other Alkalies, do likewise provoke Sweat. The same Things are also Diuretic. But Spitting may be provoked by Quicksilver, that has no Acid in it, and by corrosive Mercury made by an Acid, or the same Corrosive precipitated by an Alkali: It may also be occasioned by the Force of Cold shutting the Pores which serve for Perspiration, or by a Stone stopping the Urinary Passages. Wherefore all Maladies

which owe their Origin to Evacuations either stopp'd or too much increased, are neither occasioned or to be cured by an Acid or Alkalic Body alone.

5. Blood-letting, which carries off several Distempers, and occasions some, does chiefly shew that Diseases owe their Rise and Cure to other Things than Acids or Alkalies. This also appears from the monthly Courses of Women, the Want of which occasions several Distempers, commonly ascribed to the vitiated Quality or Crasis of the Blood, whether arising from an Acid or Alkali, as Pains in the Head, Ulcers of all Kinds, Inflammations, Convulsions, Fevers, &c. which all are carried off by the Return of the *Menses*. Nay there is scarce any Kind of Disease, but what may and does arise from the Encrease or Diminution of the *Menses*, and may be carried off by their being restored to a Regularity. Here also we must observe, that if the Abundance of an Acid or of an Alkali causes all Distempers, Blood-letting or the Monthly Flux is of no Use: For since such a Body must be equally spread all over the Blood, it will go out of the Animal Body in Proportion to the Blood emitted, or be retained in Proportion to the Blood retained, and still continues to be a Cause of a vicious Blood. I have always laughed at those Men, which preferring an Hypothesis to Experience, made use of that Argument against Blood-letting,

letting, when they ought to have made use of it against the Supposition, that Acids and Alkalies were the Causes and Cures of all Diseases; they might also have made use of it against the regular flowing of the *Menses*. This was the Argument of ignorant Chymists, who did not know that Blood-letting did commonly let out the Morbific Matter, which is for the most Part viscid, and not prejudicial as it is an Acid or an Alkali; and the Blood by that Means becomes fitter for Circulation and the Nutrition of the Animal; and that it carries off several Obstructions, especially Inflammatory ones, as *Bellini* has demonstrated in his *Treatise of Blood-letting*. But if the Distemper was occasion'd by any Salts freely wandering about the Vessels, Blood-letting or the Monthly Courses would be in vain.

6. Jesuit's Bark shews, that the Cure of Fevers is owing neither to an Acid nor to an Alkali; for whether you call the Bark Acid or Alkali, you will see several Things, which like it produce Acid and Alkalic Liquors, and Acid or Alkalic Salts, which yet do not carry off Fevers like this *Cortex*. For if you ascribe the Cure only to the Acid or Alkalic Powers, you must ascribe the Power of effecting that Cure to every other Bark, which has such Acid or Alkalic Powers. And if you say that there are several Kinds of Acids, and also of Alkalies, and that one
Kind

Kind of Acids gives a Tincture to one Kind of Alkalies sooner than others, such an Assertion will signify nothing. For first, all those Things would expel Fevers, some indeed sooner than others, there being different Intervals of Time, which does not happen; then you don't ascribe the Cure to any Acid or Alkalic Body, but to a Body which is proved by Experiments to have several other Corpuscles besides the Acid and the Alkalic ones: And it is to those Powers or Corpuscles that the Cure of Fevers is owing. For if the Forces were of the same Kind, and only different in Degree, that is in Quantity; any Acid or Alkalic Bodies would do the same as the *Cortex Peruvianus*, if a greater or a less Quantity (according as Use shewed) was given. For we know that it is not any Quantity of the Bark which expels a Fever. I believe the Experiment to be true, that an Infusion of the Bark (commonly call'd *Quina Quina*) in Water, tinges with Red the Juice of *Heliopotrium* mix'd with Water, as well as Acids do. But a Decoction of Sassafras Wood gives a redder Tincture to the Juice of the *Heliopotrium* mix'd with Water, for which Reason the Bark of *Sassafras* ought to be more Acid than the Jesuit's Bark: But yet Jesuit's Bark cures intermitting Fevers much better. Lastly, I caused some Chymical Experiments to be made upon Jesuit's Bark: From two Pounds of it was drawn an Acid Spirit,

Spirit, which tinged with a red Colour five Ounces and a half of Solution of *Heliotropium* or *Turnsole*; the same Sort of Spirit was drawn off from several other Barks, not one of which could cure intermitting Fevers. Besides, this very Acid Spirit drawn from Jesuit's Bark does no good in intermitting Fevers, wherefore it is plain that in this Case an Acid does no Service, neither can any Benefit be hoped from any Degree or Difference of Acids. Moreover, if you say that one Acid or one Alkali differs from another, and that there are in the Things themselves some hidden Properties of those Salts, then you fly off again from the boasted Powers of Acids and Alkalies, and fall back shamefully to occult Qualities, and such Trifles.

7. Tho' I have here argu'd concerning the Virtue of an Acid in the Cure of Fevers, yet it is not improper to take notice, that a Decoction of Chamomile Flowers in Water tinges Syrup of Violets with Green, Solution of Turnsole in Water with Red, and Solution of Salt of Saturn with White. Here we have a Marine, an Acid, and an Alkalic Salt; yet these Flowers carry off an intermitting Fever with the same Success as the Bark, tho' of a quite different Virtue with Respect to the Acid Salt. But before I proceed to other Things, I cannot but take Notice of those Men, who used to object to me, when I gave my Lectures at *Leyden*, that
the

the Powder of the Bark must of necessity stick in the Stomach, not being able to mix with the Blood upon Account of its Gravity, though at the same Time we know that it swims in Water, Oil, Spirit of Hartshorn, and rectified Spirit of Wine, to shew what Detriment is brought to the Art of Physic by the ignorant Industry of some Men.

8. Now for a Word or two to those that deduce all Distempers from an Acid, and pretend to cure them with all Ease imaginable with an Alkali. The Honourable Mr. *Boyle* has long since shewn, that there is no Acid in the Human Body; and yet how many cry, that the Ulcers in the Lungs arise from an Acid, and refer that sharp Spittle, which *Hippocrates* takes Notice of to a corroding Acid? But, as I have often observ'd, there is nothing Acid in that Spittle, but a great Quantity of Salt, or of a salt Body, like Hartshorn; for this Spittle does not change Infusion of Turnsole into a red Colour; but it turns Syrup of Violets into green, and makes the limpid Solution of corrosive Sublimate become white. Of the same Nature is the Water drawn from the Belly of living Patients sick of a Dropsy, as I have often experienced; and therefore they are quite mistaken, who have long affirmed without Contradiction, that a Dropsical *Ascites* is occasioned by an Acid gnawing the Lymphatic Vessels.

9. But

9. But least our Alkalic Physicians should triumph, by saying, that even according to my Observations all Distempers may be carried off by Acids, I would have them observe that in many Fevers, Pains, Deliriums, old and inveterate Ulcers, and especially of the Bladder, *Penis* and *Uterus*, the Bodies of Cantharides have proved very successful, both apply'd outwardly to the Skin, and also taken inwardly into the Stomach. But eight Ounces of Cantharides, by the Help of Chymistry, have afforded me 13 Drachms and a half of Spirit more Alkalic than Spirit of Hartshorn, 12 Drachms of Salt more Alkalic than Salt of Hartshorn, eight Drachms and a half of black fetid Oil, and three Ounces of *Caput Mortuum* smelling like Hartshorn; which being applied to the Skin of those that imagine no Remedies but Acids to have any Virtue, would cure them of that Madness. But if, when the Madness is over, the Spasmodic Motions, and Grief, and Despair of Success, should afflict them, they must make use of the Roots of Casmunar Zedoary, and the wild Valerian, whose Decoction with Water tinges Syrup of Violets with Green, and Turnsole with Red, and which may also serve for a Remedy to those who attribute all to Alkalies. The Patrons of either Sect will be cured by the *Ipeca-coanna*, or *Virginia Snake-Weed*, if they have a Dysentery, or want an Alexipharmacon: Because a Decoction

coction of these Roots in Water tinge Turnsole with Red, and Syrup of Violets with Green. But I am at a Loss to think how these Gentlemen will go about to cure themselves ; for it is pleasant and useful to become a Philosopher and a Physician in two Words. But a Philosopher and Physician of this sort, in order to disprove my Opinion, will in vain have Recourse to white or black Hellebore, both which Roots tinge Turnsole with Red, and Syrup of Violets with Green ; and therefore can neither be a pure Acid, or a pure Alkali.

10. Now I'll give you an easy Demonstration of two Theorems deduced from the Honourable *Robert Boyle's* Discoveries. The first is this :

There are no Fermentations of the Blood in the Human Body, since Mr. *Boyle* has shewn that there is no Acid in it.

Then the Plants that we eat, how full soever of Acid they are, yet they are soon chang'd into Alkalies by the Action of the Stomach, and of the Lungs and Heart, which cause the Circulation of our Fluid ; therefore Acids are so far from causing or curing Distempers, and of destroying the Alkalic Salts of the Blood, that Acids receiv'd into the Blood do rather beget an Alkalic Humour. No Body doubts but that there is Marine Salt in the Blood, or a small Quantity of Salt like Sea-Salt, and that the said
Mr.

Mr. *Boyle* shews evidently: But *Raymond Vienssens* has of late pretended to find an Acid in the Blood, having (as he says) endeavour'd to go farther than Mr. *Boyle*. This *Raymond* from fifty Pounds of Blood drew off half an Ounce of Acid Spirit, after he had mix'd in about an Ounce of Salt coming from calcin'd Blood, with three Ounces of Bole or Earth, by Help of a reverberatory Fire. These are his Words: Now the mean Quantity of Blood flowing in an Human Body scarce exceeds twenty Pounds, and therefore if what *Raymond* says be true, the Quantity of that Acid Liquor, which could be drawn from the whole Mass of my Blood, would not exceed an hundred Grains, in which Liquor there must be a great Deal of Water: Therefore that Salt may be look'd upon as nothing. But *Raymond* does not observe, that that Acid Spirit comes from the Bole; for three Ounces of Bole in Glass Vessels have easily been made to yield about a Drachm and a half of Acid Spirit. I take every Day five Scruples of Sea-Salt at Dinner: *Raymond* unknowingly drew a Spirit from a Salt like this, or the Spirit or Acid Phlegm of the Bole. From these Things therefore its plain, that Sea-Salt quickly changes all Acids Salts into Salts like the Salt of Hartshorn by the Force of the Circulation of the Humour flowing in the Body of the Animal; and that *Raymond Vienssens's* great Book of Prin-

Principles is ridiculous almost from the Beginning to the End.

But to return to the Matter, I have found by Experiments, that the greatest Part of the Remedies of the fiercest Distempers have nothing in them of Acid or Alkali, or of a Body made up of both: And therefore that those who ascribe the Cause or Cure of all Distempers to Acids or Alkalies, are altogether in the Wrong.




SOME



S O M E
OBSERVATIONS

Concerning

WOMENS *Monthly Courses*:

I.  F young Animals excreted as much as they take in, they would not grow; therefore in an healthful and growing Animal a greater Quantity of Blood is daily accumulated than has been or will be lost. The Quantity of this accumulated Blood is known from the Encrease of the Bulk and Weight of the growing Animal. Hence it is plain, that in an Animal that has done growing, there is a greater Quantity of Blood accumulated than that which before was lost.

2. For whilst Animals grow, the Stomach, or the Heart, is increas'd in such Manner, as to be in a Ratio of their Bulk, if we compare the Stomach and Heart with the other Muscles and Membranes: But the
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Forces of the Stomach and Heart are increased in Proportion to their Bulk; therefore the Increase of Forces is proportional to the Increase of Bulk. This is plain in the Heart, and in the other Muscles, and therefore in the Stomach, if it has only the Force of a Muscle; for from a greater Stomach, which has a greater Number of Glands, and abounds more with warm *Effluvia*, will proceed a greater Quantity of Ferment; and a greater Quantity of Heat will arise, either out of the Stomach, or the *Viscera* next to it, which are increas'd together with it; and for that Reason a greater Quantity of all sorts of *Effluvia*, which, as some will have it, the Stomach throws out, to change the Food into Chyle.

3. Because in a growing Animal the Ventricles of the Heart did receive and throw out a greater Quantity of Blood than what was equal to the Quantity lost, that is, greater than the Nutrition and Reparation of the Body only would require; therefore it is plain, that when the Body ceases to increase, there is also a greater Quantity of Blood generated in a sound Animal, than what is sufficient for the Nourishment or Repairing of the Losses of the Body: Since the Stomach and the Heart are increas'd in Proportion to the similar *Viscera*, and the Forces of similar *Viscera* are increased in Proportion to their Bulk. Therefore the Question is, in what Pro-

Proportion the Blood is accumulated above that Quantity which is necessary for Nutrition, and to repair the Losses of the Blood lost, in Animals that have done growing, and have not their Magnitude any way increas'd.

4. Let us examine the Effect of this Thing in some Animals. We observe, that in Women that have almost done growing, an *Hæmorrhagy* is every Month excreted through the Vessels of the Womb, and they have a Flux of Blood out of their Body, during a Period known to every Body. If the Quantity of Blood expell'd at that Time be divided by the Number of Days and Hours between two Courses of Blood, you will have the Quantity of Blood which is daily and hourly added over and above what is lost; and you will also find how much Blood must be accumulated, that it may be able to make its Way every Month thro' the Vessels of the Womb.

5. It is evident, that in Animals that walk erect, the *Momentum* of the Blood is less thro' the ascending than thro' the descending *Aorta*; and therefore that in the said erect Animals, the Blood is carried with a greater *Momentum* or Force through the descending Trunk of the *Aorta*, than thro' the ascending Trunk of it in prone Animals. Then it is plain, that the Blood flows in greater Quantity through the descending *Aorta* in those erect Animals, in which the descending

Aorta has a greater Number of, or less resisting Ramifications, than in those that have fewer, or more resisting ones.

6. Now Women (who are upright Animals) have more and larger Ramifications from the descending *Aorta* than Men, namely, the Arteries of the Womb, (I call descending *Aorta* any Ramification of it) then in Women the descending Branches are of less Resistance than they are in Men. For those that are in the Womb having no Support, are for the most part expos'd to the free and unresisting Air. And therefore in Females, (I speak of erect Animals,) sooner than in Males, this Monthly Flux of Blood is frequent, and must pass thro' the Womb.

Hence it will be plain, that prone Animals have not that periodical Flux of the Womb, nor erect Males, unless upon Account of some particular Cause. For we don't lay down, as a Cause of the *Menses*, such a *Plethora* as is capable of breaking any Vessels, &c. For Observations shew that only Vessels of that Nature serve for that Flux.

Lastly, We shall not hereafter wonder that some Difference is observed between those Actions which depend upon the Brains of Males and Females, since from what has been said it is plain, that a greater Quantity of Animal Spirits are secreted in a given Time in the Males than in the Females; and if we speak of any other Flux, we shall find something

something for our Purpose in the 65th and 66th *Aphorism of Sanctorius, Sect. 1.* where he has these Words; *The Bodies of Men in Health, who use very moderate Food, are every Month heavier than ordinary, viz. about one or two Pounds; and about the End of the Month they return to the usual Weight, like those of Women; but the Crisis is made by the Urine's being more plentiful or more muddy.*

From the following *Aphorism, Before the said Monthly Crisis made by Sleep, either the Weight or the Weariness of the Body is sensible, and at last all Things are quieted by a more plentiful Evacuation of Urine than ordinary.* Note, That we don't reckon as a Cause of the Monthly Flux, a *Plethora*, in respect of all the Vessels, or that which happens in any Place, and breaks the Vessels, however small they are; but such a *Plethora* as affects the Vessels of the Womb, or those Vessels which are expos'd to the Air in the lowest Place, &c.






OF THE
INCREASE

OF THE
Quantity of the Blood
IN THE

NATURAL STATE,

AND THE
PROPORTION of that INCREASE.

1.  F we should every Day excrete as much as we take, we should never grow, and there would be no Increase of Body in young Animals.

2. Therefore in young Animals the Quantity of the Blood is increased, and the Question is, In what Proportion?

3. From the Increase of Weight it is easy to know how much any one is grown; but because that Increase is so little every Day, that *Sanctorius* not weighing to a Nicety, look'd upon it as none, the Body must be weighed

weighed not every Day; but every Half Year or Year; and this Increase of Weight thus found, and divided by the Number of Hours or Days, will give the Increase of the Blood which nourishes each Day and each Hour.

4. But by this Increase one may know how much the Blood, partly fluid, and partly join'd by Apposition to the Fibres, is increased, or the Sum of each Argument; for the fluid Blood is equally heavy with that which is harden'd, and the Blood which is accumulated does not immediately nourish and grow hard: But yet we can't know by Weight how much Blood is gone into Nourishment and Increase of the Body, and how much the Excess of the flowing Blood in the Vessels is separate from each other, for every Day.

5. *Sanctorius* observ'd that the Excretion in Men was perform'd every Month by Sweat, Stool, Urine, or Hemorrhagy, more at one Time than ordinary; but that it often was made thro' several Places, so that the Evacuation made thro' any one Place is too little to be observ'd in a rude Manner; besides, some of those Evacuations are such as may be attributed to an Accumulation made without the Animal, from which we cannot make an Estimate of the Quantity of the Blood.

6. Therefore the Quantity of the Increase of the flowing Blood, which is not yet harden'd, must be found separately from the Quantity of the Blood which is gone to the Nutrition and Increase of young and growing Animals; it must, I say, be found from some Evacuation made in a sufficient Quantity, and all at once, from the Blood-Vessels themselves, and under the Form of Blood; for the Evacuation made by Urine is made from Places without the Animal, in which the Excrement may be accumulated, the Blood at the same Time not being increas'd.

7. Therefore to make an Estimate of the Quantity of the Blood separately from the nutritious Blood, it must be done from the Evacuation of the Blood made all at once, and for a small Time, which may be long enough for Observation, but not made by any Ferment proper to the excerning Part; for we could not by that Method esteem what is the Increase of the Quantity of Blood; besides, it has been shewn, that there are no such Ferments in an Animal, and that there are no such Difference of Pores in the Parts to which that Evacuation may be ascrib'd.

8. Neither shall we here consider any attracting Forces, either of the Blood, or of the Vessels, or of any other Bodies; we shall only see what the Force of Gravity has to do in the Solution of this Question, consider'd

accor-

according to the Diversity of Vessels in some Animals.

9. Because we see and consider no Force of the increased Blood, except that of Gravity; (for there is no other commonly known,) it will be evident that that Evacuation must be made from the lowest Part of the Body where the Sides of the Vessels are perpendicular to the Horizon, and therefore the Force of Gravity greater.

10. But because even in the greatest Animals the Interval of the upper and lower Part is small, therefore the Excess of the Gravity of the Fluid in the lower Part is very small; therefore that desir'd Excretion of the Blood must be made in that lower Part, or the Part of that Part which is interwoven with several Vessels of small Resistance, that is expos'd only to the Air.

11. Whence it follows, that this Excretion is scarce observable in those Animals which Nature has made prone, and such whose lower Parts, that are interwoven with Vessels, are not expos'd to the Air; or in which the Sides of the Vessels which are expos'd to the Air tend not downward: Therefore no Brutes (except Monkeys, which go often erect) have such a visible Excretion.

12. Then it follows from this, that Women rather than Men must be liable to this Excretion, because they have their Womb situated in the lowest Part, having Veins
con-

conveniently, the Vessels expos'd to the Air, and perpendicular to the Horizon, their Sides being naked and looking outwards, and having nothing to support them; therefore Women must have this Excretion thro' the Womb.

13. It follows also, for the same Reasons, that Men whose *Hæmorrhoidal* Vessels are by any Means increas'd and widen'd more than ordinary, may have such an Excretion.

14. And in either Sex before the Blood begins to flow, there must be a Pain and Tension of the Vessels, and all such Symptoms as accompany Tension.

15. But the Quantity of Blood thus excreted every Month, divided by the Number of Hours and Days, will give the Quantity which every Day or Hour is generated, more than what had been carried off or spent in Nutrition that Day or Hour. Therefore it is no Wonder if all those horary or daily Quantities added together make up a Bulk of such a Weight as to be able by its Gravity to break the Vessels of the Womb, and cause a periodical Flux almost every Month.

16. Wherefore the increased Weight of the Body found every Day, if you take from it the Weight of such a Part of menstrual Blood as belongs to it, will be the true Weight of the hardening Blood, or of the Blood which goes into Nourishment every Day or Hour.

17. We may say, that the menstrual Blood of Women sweats out thro' the *Villi*, or small Ends of the vanishing Arteries; or the Beginning of the Veins of the Womb, or from their Limits; or because the Arteries and Veins are continuous, and at their Meeting make a parabolick Line, the *Vertex* of it being the said Place of Meeting, therefore we say, That the menstrual Blood flows thro' the Vertices of the sanguiferous Vessels.

18. Now the Blood flows thro' the Vertices of the Vessels in Women sooner than Men, because in Women there are more sanguiferous Vessels about the lower Parts expos'd to a free Space than in Men; for a Man is a Woman without a Womb. Therefore the Blood runs in greater Quantity to the lower Parts of Women, than those of Men, &c.

19. Therefore because the Women have more sanguiferous Vessels expos'd to a free Space than Men, the Blood by its Gravity will distend those Vessels of the Woman, and tear asunder the *Villi* or hollow Fibres, and so run out, as soon as the Women are old enough, for the Blood to be in such Quantity as to fill up the other Vessels of the upper Part of the Body, and that by it the Vertices of the Vessels, (that is, of those which run along the inner Surface of the Womb,) by repeated Impulses and Gravitations, are dispos'd

pos'd to give Way to the pulling afunder the *Villi*, hollow Fibres, or capillary Vessels.

20. But this does not happen to the Females among the Brutes, which are naturally prone, because the Vessels of the lower Belly, and therefore of the Womb, are not more liable to be press'd by the Gravity of the Blood, than those of the Head, &c.

21. Let there be two People in Health, one of which has the monthly Flux of Blood, and the Womb and several Vessels, situated in the lower Parts, and expos'd to a void Space; and the other has no such Parts; but in other Respects they are proportionable in Bulk, this Flux will happen by a Distraction or pulling afunder of the *Villi* by the Gravity of a greater Quantity of Blood. For I have prov'd that there is no secreting Ferment, or Ferment which causes a Heat in any Part of the Body. We suppose all other Things alike, except a greater Gravity, which alone is the Cause of this Flux.

22. The Vessels in Women ought to be suppos'd no less firm than in Men; for from Gravitation towards the Inferiors alone, it is, that when Girls come to the Age of Fourteen, the *Menses* flow, and not in Men. Because how firm soever the hypogastrical Vessels are suppos'd in Women, yet since their *Villi* are liable to be drawn afunder, and are more urg'd to it than in Men, they will at last be pull'd afunder;

afunder; especially since the Impetus of the Heart is equal in Men and Women, and therefore the Blood flowing in a greater Quantity to the lower Parts of Women than of Men, and yet not receiving a greater Impulse from the Heart to force it out, and make it return by Circulation, of Necessity it will press with a greater Gravity on the inferior Vessels of Women, and at last run out, namely, thro' those Parts where it gravitates more, &c.

Note, That the Vessels of the Womb are the lowest of any, I mean of all those Vessels which are not expos'd to the free Air, or of such Vessels as run to the Parts which are not expos'd to the free Air. For the Legs and Feet are expos'd to the free Air; for which Reason the Ends of their Vessels grow hard, and the Parts of the Intestines are also rubb'd by hard and moist Parts, which slip by them, whence their Vessels grow hard. Therefore the Vessels of the Womb are necessarily the weakest of any.

23. But it is to be observ'd, that the Intestines, and the external Parts, especially the Feet, are always rubb'd with some kind of Solids, namely, Filth, Cloaths, Shoes, and all other Things which resist the Touch; and that all the Parts of living Animals become callous by Attrition, and being touch'd.

238 OBSERVATIONS *concerning*

24. In the Male the ascending *Aorta* bears a greater Proportion to the descending one, than in the Female, that is, the Ascendent is greater in respect of the Descendent, in a Man than in a Woman.

25. Hence in Men a greater Quantity of Animal Spirits is separated in a given Time, &c. Then it follows from hence, that of Necessity a greater Quantity of Blood must go to the lower Belly in a Woman than in a Man.

26. Then also the Effect of Gravity is equally distributed all over the Body of the Man, which exerts it self, or is gather'd together in one Part of the Woman, and made sensible.

27. Lastly, Iron and Steel provoke this menstrual Flux (at a proper Time, that is, after the Bones having done growing, do not turn off the Increase of the flowing Blood, because this Flux does not happen to Girls before they come to Maturity and have done growing) by its Gravity, by which they increase the Impulse of the gravitating Blood, or by their Weight remove the Obstacles which hinder the Blood, as it endeavours to flow out; as Mercury also does better by a Force of the same Kind, but greater.

28. *Observe*, That Quicksilver and Steel carry off too great a Flux of the Belly, as well as too great a monthly Flux, by equally

ly removing the Impediments of other Secretions, and so increasing them, as being by a circular Motion carried equally to all the Parts of the Body.

Especially take Notice, that a lesser Capacity, and so the less Dimensions of the *Thorax*, and a less Quantity of Vessels requir'd to nourish it, and a greater Capacity of the lumbar and hypogastrical Region, &c. in Women than in Men, shew that the Diameter of the ascending *Aorta* is less, and that of the descending one is greater in Women, &c.

1. Lastly, A Foot of Mercury weighs as much as 14 Feet of Water: Whence the Gravity of Water is to the Gravity of Mercury as 1 to 14.

2. Air raises Water to 32 or 33 Feet.

3. Air raises Mercury commonly to 29 Inches.

4. The Gravity of Air is to the Gravity of Water, nearly as 1 to 1000. And

The Gravity of Air is to the Gravity of Mercury as 1 to 14000.

Mercury rises to 27 or 28 Inches,

Water rises to 32 or 33 Feet.

The Gravity of Water is to Mercury as 1 to 14.

Which is agreeable to Experience; for

$$28 \times 14 = 392 \text{ Inches,}$$

And

$$33 \times 12 = 396 \text{ Inches, a Foot being} = 12 \text{ Inches.}$$

Where-

Wherefore in the New Moons, &c. when the Water is rais'd to 14 Feet, the Air will be rais'd to 14000 Feet, and the Mercury in the Barometer will subside one Inch.

Again, when upon any other Account the Air becomes lighter, so that the Mercury may subside one Inch, or the Air may be rais'd to the Height of 14000, the same Thing will happen to Women, which would happen at the New Moons, unless they have been thus affected on the last New Moon.

All these Things may be thus deduc'd.

We see no Ferment in the periodical Flux, therefore there is an Accumulation in Animals which do not grow, that is, those which only nourish themselves, and repair what they have lost of their Substance, do make up a Bulk equal to that which was lost. For after they have done growing, the Force of the Stomach remains the same for some Years, &c. or rather, as I imagine, is for some Time exactly, or only able to repair the Bulk, (I mean the increased Bulk.)

If the Force of the Stomach is increas'd in Proportion to the Bulk, all this will be plain.

That the Forces of the Stomach and Heart are increas'd in Proportion to their (increas'd) Bulk, appears from the Increase of the whole Body. For the Heart and Stomach are increas'd in Bulk and Proportion to the other Parts; but the Increase of Forces is proportionable

tionable to the Increase of Bulk, *cæteris paribus*; this is plain of every Muscle, and so of the Heart, and also in the Stomach, if they have only the Force of a Muscle.

But altho' (as Dr. *Lister* would have it) it should act by Fermentation, the same Thing would be true, because a greater Quantity of Ferment would be secreted from a greater Stomach, or a greater fermenting Putrefaction wou'd arise.

1. It was to be shewn, that when the Increase ceas'd, then, by the Force of the Heart and the Stomach, (which *Viscera* were increas'd with their Forces in Proportion to the other Parts; and therefore at the Time of their Increase made and drove out more Blood than the Nourishment of the Parts alone requir'd,) more Blood is made and driven into the Artery, than the Nourishment of the Body requires, as long as one Body only is to be nourish'd.

2. Therefore that Part of the Blood must be evacuated thro' those Parts where the Blood makes the greatest Impulse, when the Increase of the Body ceases; I say it must be evacuated in those Animals whose Vessels are not capable to bear it.


3. How great the Increase is of that Blood which does not nourish, must be found; and that being found, one may know why the Evacuations are for the most part monthly.



Concerning the
I N G R E S S
O F T H E
D I S T E M P E R

Commonly call'd, the

Veneræ Lues, or Pox.

I.  V E R Y Part of the Animal Body may be inflam'd, altho' without the Help of any Contagion; and therefore also be ulcerated, without the Contact of any other Animal. For whatsoever retards the Blood or the Seed, or thickens them in the Vessels, causes an Inflammation, which occasions a Rupture of the Vessels, and an Ulcer.

2. In both the *Indies, Africk*, and the Southern Parts of *Europe*, where Men liv'd slothfully, and almost like Barbarians, forgetting or being ignorant of what *Moses* enjoin'd in the 14th and 15th Chapter of *Leviticus*, the Filth or Particles of *Sanctorian*
Expi-

Expiration, which was in them more thick and gross, by pressing the Genital Vessels caused Inflammations, and an Ulcer, and *Gonorrhæa*, and other Symptoms of the Effects of Debauchery, (the same as I have often observ'd in Dogs, and much oftner in Rabbits,) tho' they had never been at *Naples*, nor could have the Contagion from that Place.

3. In the Southern Countries the Expiration is for the most Part greater than in the Northern, and the Venereal Act more frequent. Wherefore if the Southern People do not pay a constant Obedience to the *Mosaic* Law, (and some Parts of Animals will not be easily kept under Subjection, or be confin'd by the *Mosaic* Prescription,) it is no Wonder that they, without any Contagion transmitted from their Parents, are seiz'd with those foul Venereal Ulcers, whether it be the *Neapolitan* Disease or the Leprosy, or the Scurvy, which is a Northern Disease, arising from a Stoppage of the Expiration, and an Encrease of Gluttony; for too much Eating and Drinking, without using any Exercise, stops Expiration.

4. The *Venereal Disease* among the Southern People is cur'd by the Use of a Decoction of *Guaiacum* Wood, *Sarsa* Root, sharp-pointed Dock, Burdock, and such Things in Water. They are unwise who teach that *Sarsa*, *Guaiacum*, &c. are good to

take away the Acrimony of the Blood; for I could extract nothing out of them but an Acid Spirit or Liquor. They give Relief by causing Sweat, and washing away the perspirable Filth which sticks about the Vessels.

5. But since the Northern Filth is more dense and heavy than that of the Southern People, as also our Blood is thicker than theirs, as being made out of Food which is not much warm'd by the Sun, they must be rubb'd and expell'd by heavier Metals, among which Quicksilver is of great Service. Therefore when the Northern People are troubled with a Leprosy, the Whites, grievous Pains, or a Scurvy accompanied with Ulcers, they must make use of *Mercury*: For a Leprosy, before the *Neapolitan* Disease was talk'd of, was cur'd by *Mercury*, and now it is no longer heard of.

6. If Gold be ground small (as it may be) into such little Parts, that their Surfaces, in Respect of their Bulk, may be so great, as to make those Particles as light as Water, and fit to swim in the Blood, these Distempers will more safely and sooner be cur'd by Gold than Mercury.

7. Add to this, that he who first had that Disease or Plague, did not get it from the *Effluvia* of others.

8. The Poison of Vipers, or Leaves of Tobacco thrust into the Veins when they are open'd, immediately kill an Animal; and yet

yet taken in the Stomach does no Hurt; nay, I my self have given Arsenic to those who, having the Belly-ach violently, could be eased by no other Means, and had receiv'd no Benefit from Opium, and Salt of Amber, or Salt of Hartshorn taken in a great Quantity.

9. Hence it follows, that it is a barbarous Custom, and unbecoming Men, to confine very innocent Citizens (who have the Misfortune to be hated by some of those Priests who were raised up from the meanest of the People) to their own Houses, and to forbid them all human Conversation, for trifling Causes, tho' they are infected with no Contagion.

10. Wherefore, after having administer'd a Vomit two or three Times, let Mercury be taken for two or three Days, twice a Day. When the Patient's Mouth begins to ach, let him abstain from Mercury three or four Days, then let him be purg'd every other Day. When his Pain in the Mouth is over, let him take Mercury again, and let this Method be repeated till the Symptoms cease.

The same Method will serve for a Leprosy, as I have said before; afterwards the following Means must be used in either Distemper: Namely, let the Ulcers be washed with a Decoction made of Roots of sharp-pointed Dock, *Helenium*, Sulphur, Allom, of each two Ounces; let all be boil'd in eight

R 3

Pound

Pound of Lime-Water, till it be reduc'd to fix, adding towards the last, of Water-Cresses, Water-Trefoil, and *Cochlearia*, an Ounce of each; when it is strain'd mix with it a little camphorated Spirit of Wine. It will also be well to lay upon the Ulcers an Ointment that has in it two Drachms of red Precipitate, one Drachm of white Precipitate, two Scruples of Oil of Tartar *per deliquium*, and two Ounces of Pomatum: Let it be applied at Night, as the Patient goes to Bed: But it will be proper in the Morning, before the Ointment is laid on, to use the following Cosmetic Water, made with two Ounces of Litharge of Gold, a Drachm of corrosive Sublimate, and ten Ounces of Vinegar; let them infuse for seven Hours in a tinn'd Vessel, and be often stirr'd; after the thick Part is subsided, let the clear Part of the Liquor be poured off, and when it is to be used, drop into it Oil of Tarar *per deliquium*, till it looks milk white; then with a Feather lightly wash the Ulcers with this Water, and then lay on the Ointment. In the mean Time let the Patient drink *Guaiaicum* Beer, made with putting two Pounds of *Guaiaicum* Wood into two hundred Pounds of Beer that has not work'd, and boiling it till a third Part is consum'd. When it is strain'd off, it must be made to ferment, and whilst it is fermenting hang in the Liquor in a Linnen Bag, half a Pound of Antimony not powder'd,
and

and four Ounces of sharp-pointed Dock:
When the Fermentation is over, put this
Beer in a Barrel, with a little dried Rose-
mary, and some Rinds of Oranges; add be-
sides the Juice of five or six hundred *Mille-
pedes*; when the Beer is clear, let the Pa-
tient drink nothing else.






Concerning the

SMALL-POX.

I would have those that are sick of the Small-Pox to be cured after the following Manner.

1.  Would have the Patient be let Blood whilst his Fever lasts ; and tho' the *Small-Pox* begins to come out, still be let Blood till the Fever is over.

2. When the Fever is over, and the Small-Pox is come out, (for if the Fever does not go off when the Small-Pox appears, still the Vein must be open'd to carry off the Fever,) let the Patient often drink any distilled simple Water, to be had at the Apothecaries, that is without Taste, into which you must infuse for some Hours, without Fire, Sheeps Dung, and then add Syrup of white Poppy, or Opium, if the *Diarrhæa* lessens. Let him drink Barley-Water with *Laudanum* and Syrup of White Poppy. This Drink, which is often given in the *Variolæ Confluentes*, or Flux Pox, (as Physicians call it,) causes

causes a Spitting, and cures by that Means. Apply nothing to the Face, unless you would still more hinder the Expiration which is already hinder'd, and bring back the Fever; the Day after the Small-Pox is broke out, give the Patient Water-Gruel.

3. If the fifth Day after the Small-Pox is broke out, or the sixth, or the seventh, or eighth Day, the Small-Pox goes in again, a Vein is to be open'd again, and Cantharides in Powder must be laid to the Neck.

If the Small-Pox be of the Confluent Kind, when the Distemper is over, a Purge must be taken.

4. But it becomes me, who have but a little Time to live, being in my sixty first Year, to behave my self like a Man; for *Publius Syrus* says, (and I am also of his Opinion,) that it is the Part of a Christian, or of one that would behave himself as such, *kindly to set a Man right who is out of his Way*, therefore I shall subjoin some Remedies very useful for those who are troubled with Epilepsies, Palsies, or the Gout.

In an *Epilepsy* or *Palsy*, after Vomiting and Blistering, give the Antiepileptic Tincture. To the younger Patients give Mercury and Broth with Earth-Worms. The Antiepileptic Tincture is made of wild Valerian Root, and white Dittany, of each six Drachms, of Castor, Pigeons Dung, of each half an Ounce, six Drachms of the clammy Bark of Oak, half an Ounce of Cinnamon,

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mon, as much of Rosemary Tops, two Ounces of Senna Leaves, Jallap, and Turpeth, half an Ounce of each; make a cold Infusion of all in eight Pounds of white *French* Wine for ten Days.

When it is strained, add Powder of Human Skull, and Shavings of Elks Hoofs, of each two Drachms, and four Ounces of Sugar; mix in four Ounces of Oil of Amber, and two Drachms of Spirit of Castor: Give two Ounces to a Patient of about seven Years of Age, and to an elderly one four.

It is often good in Palsies to give this Tincture without the Purgatives, when the Distemper begins to go off. It is also good for the Patients to rub and chafe the affected Limbs strongly before the Fire, and then to dip them in cold Water.



FOR



FOR THE
Arthridis, or GOUT.



Urging Medicines will signify little; Vomits are of Use, and afterwards Mercury, given by little at a Time. Apply to the Part where the Pain is *Mefues Balsam*, commonly called *Balsamum Guidonis*.

To those Parts where the Gout is, apply continually Linnen Clothes, wet with the following Liquor: Hot spring Water eight Pounds, white or yellow Arsenic two Ounces, six Ounces of unslack'd Lime; set altogether upon a slow Fire for 24 Hours.

If the Patient have a Pain in his Stomach, give him preserv'd *Nux Moschata*, Powder of the Sarsa Root, and Jesuits Bark, but oftenest Oil of Cinnamon, and preserv'd *Nux Moschata*, and preserv'd Ginger.

It will be good also for the Gout, to pour into twelve Pounds of white Wine or Beer, four Quarts of hot Milk, then having taken away the Curd put a Pound of Berries of Hawthorn into the remaining Liquor, and boil all for half an Hour. Let the Patient drink a Pound of this Morning and Evening.



O F T H E
D I V I S I O N
O F
D I S T E M P E R S.



L L Distempers are either from the *Fluids*, or the *Canals*, or compounded of both, or without the Animal.

The Diseases of the *Fluids* are either of the *Blood*, or of the *Liquors* secreted out of the Blood, either from their Increase or Defect, and thence arises a vicious Quality, that is, a *Fever*.

The Diseases of the *Canals* are a *Wound*, a *Tumour*, an *Ulcer*, an *Inflammation*, &c.

Therefore to the Diseases of the Excretory ones belong *Sleepy Symptoms*, which are owing to the Defect of the Excretion in the Brain, and the *Palsy* for the same Reason: But the *Epilepsy* arises from the Increase, and the *Vertigo* from the Defect. *Madness*
from

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from the Increase. A *Vertigo* is a Tumour or Obstruction. A *Gutta Serena* is properly a Tumour of the Arteries of the *Retina*, or of the Optic Nerves, (for every Obstruction is a Tumour,) and therefore belongs to the *common* Diseases.

A Suffusion is a Disease *without the Animal*, and is a Kind of an *Abscess* or Tumour, like a *Steatoma*, or Tumour of Fat.

The *Ophthalmia* (a Species of which the *Gutta Serena* is) is a Tumour with Inflammation, and therefore belongs to the *common* Diseases.

An *Epiphora* belongs to the Increase of Secretion, unless there be an Inflammation, and then it is a *compound* Disease.

An *Hæmorrhagy* of the Nose is a Wound, and belongs to *common* Distempers.

A *Ranula* belongs to the *common*, being a Tumour under the Tongue.

An *Angina* or *Quinsy* belongs to the *common*, for it is a Tumour with an Inflammation of the Glands of the Throat, and often of the Muscles.

An *Asthma* is an Obstruction, and so a Tumour (sometimes schirrous) of the Lungs, and belongs to the *common* Distempers.

A *Pleurisy* is a *common* Disease, namely, a Tumour with an Inflammation.

A *Peripneumonia* is a greater Kind of *Pleurisy*.

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A *Phthisic* is a *common* Disease, namely, an Ulcer of the Lungs or Kidneys, &c.

An *Empyema* is an Ulcer of the *Pleura*, and of the internal intercostal Muscles, open'd into the Cavity of the *Thorax*.

A *Syncope* is for the most Part a Kind of *Asthma*, and truly of the Heart.

A *Palpitation of the Heart* is a Convulsion, and that often of the Splenic Arteries.

The Diseases of the *Stomach* are Diseases *without the Animal*.

A *Stone* in the Kidneys or Bladder, is a Disease *without the Animal*. See Dr. Lister, *Part 2. of Springs*, &c. and he also says the same of an old Gout. Each of these Distempers is a Sort of Tumour.



All the Diseases of the INTESTINES



Belong to the Increase or Defect of Excretion, or to the *common* Diseases. Likewise the Diseases of the *Liver* and *Spleen*, except the *Hypocondriac* Distemper, which is a Disease in the Intestines, *without the Animal*.

The *Dropsey* is a Wound of the Lymphatics, and is a *common* Distemper.

The

The same may be said of the Diseases of the *Kidneys* and *Bladder*.

The *Green-Sickness*, or *Chlorosis*, is an *Anasarca*, or Tumour, &c. and is a common Distemper.

The *Hysterical* Affection is of the same Nature as the *Hypocondriac*.

The other Diseases of Women (besides *Fevers*) belong to the Increase or Defect of Excretion, (for the *Menses* and *Lochia* or *Cleansings* are Excretions, or at least Wounds, as the *Hæmorrhagy*,) or to the common Distempers.





OF THE
SCURVY.



As the *Fever* is an ill Quality of the Blood, or of all that is to be excreted, whilst it flows in the Vessels, so the *Scurvy* is an ill Quality of all or most of the Things which are excreted whilst they flow thro' their excretory Ducts. Or,

The Defect or Increase in the excretory Canals.

Note, That since the Humours to be excreted do not appear to be vitiated in the excretory Ducts, unless the Blood it self be vitiated, therefore the Scurvy does not consist in such a Vitiation; wherefore we shall say, that the Scurvy is a Disease compounded of the Distempers of the excretory Canals in Complication, that is, of the Defect of several of them in their Excretion, of the Augment of several, &c. and of the *common* Diseases, and often Diseases *without the Animal.*

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Ulcers, &c. is in some Measure known; and so by consequence the Cure of Diseases, which may be referr'd to Ulcers.

3. If a Disease be compounded of several Symptoms of different Kinds, such a Disease may be referr'd to what Kind you will; but always to such a Kind as the *strongest Symptom* belongs. *Note*, That the Pain is not always the strongest Symptom; as for Example, in an Inflammation, that Symptom is said to be the most urgent, which can kill the Patient in the shortest Time.

Now we must shew that the Division here laid down, agrees with the Method of Cure us'd by the *Physicians*; especially with that which belongs to the Diseases where Surgery is of Use; which comes nearer to the Nature of several Diseases according to our Division. See *Sleepy Disease*, p. 248.

But we must first define what the *Scurvy* is, and it is plain, that the Scurvy is not a simple Disease; but several Distempers seizing the Patient at a Time, which have nothing common to each other but the *Slowness of the Pulse*, which does not beat so fast as naturally it should. Wherefore it is peculiar to the Northern Nations of *Europe*, whose Pulse is naturally slower than that of others; and perhaps that arises from the Blood's retiring inwards, (see *Bellini*, Page 100, and Page 528.) which makes the Pulse beat slow. Therefore Blood-letting is not good in such a Case;

Case; because letting Blood will excite that Dimotion, or Removal of the Blood inwards, which is proper to the Northern People, and which gives us the Scurvy, and is the Occasion of our slow Pulse. But if this Distemper depends upon contrary Causes, (such as are the Causes of a quick Pulse, as the *French Climate*, &c.) there will be excited a Feverish Dimotion, &c.

Therefore a *Scorbutic* Dimotion does not require letting Blood, that is, when we know that an inward Dimotion will follow upon opening a Vein; and therefore that is so seldom done, that it may be look'd upon as never done.

Wherefore we must not so much fear letting Blood in a Scurvy; but this Fear was introduc'd by fearful and ignorant *Germans*.

Therefore we shall rather say, that the *Scurvy* is a Complication of several Distempers different in Nature, except that *in all of them* the Pulse beats slowly.

When therefore several Diseases seize on an Animal, the *Germans* mistake such a Case for one single Disease.

No Wonder then, that the *Germans* are deceiv'd in the Cure of the Scurvy; because not one but several Remedies are requir'd, it being a Complication of several Diseases. And indeed if the greatest Part of the Diseases (or Symptoms) may be taken off by moderate Remedies, then will the Scurvy be

said to be carried off by them, and that it is of such a Nature as Dr. *Willis* calls *Sulphureo saline*, because the Sulphur, or Heat, is the most prevalent. But if the greater Part of the Diseases that have the Name of *Scurvy*, are us'd to be taken off by *Aromatics*, and the *Cochlearia*, &c. then that *Scurvy* will be of the Kind which *Willis* calls *Salino Sulphureus*, because the Salt or Coldness prevails. But generally, the Things call'd *Nasturtian* and *Antiscorbutic*, prevail; because commonly in this Case, the Pulse beats more slowly, and such Remedies occasion a swift Pulse.

Therefore the Disease which the *Germans* now call the *Scurvy*, the Ancients *Lienositas*, or Obstructions, is compounded of a schirrous *Asthma*, Ulcers of the Mouth and Legs, Pains in the Limbs, the Palsy, convulsive Motions, Looseness, a Stoppage of Stool, an *Atrophy*, and several *Exanthems* or *Enchy-mosis's*.

But because all have not these Symptoms, it happens that some have not the *Asthma*, (then the *Scurvy* is said to be hot from the Manner of its Cure,) and to them hot Things or those which are truly antiscorbutic, as *Nasturtium*, &c. are not necessary or profitable: But if the Patient had an *Asthma*, Aromatics and Medicines with Pepper would be of Use, which are proper for an *Asthma*, as also Steel and Pepper are good for a cold
Scurvy,

Scurvy. If the Patient has a Pain in his Limbs, then it is good to breath a Vein, and give *Mercurius dulcis*, otherwise not.

If he has Tumours in his Stomach, or in his Colon, or any Sharpness there, then Steel is convenient; but if he has no Sharpness or Tumour arising from a sharp and viscid Humour, Steel will do no good, at least there is no Need of it, *Mars* being only fit to attenuate what is viscid, &c.

Because of the Ulcers (if there are any) a Decoction of Guaiacum, with vulnerary Herbs, will be convenient.

If the Patient has the Palsy, give him those Antiscorbutics, which are said to be hot.

But if he has convulsive Contractions in the *Oesophagus*, &c. give him volatile Acids with Laudanum, that is, Salt of Amber.

And thus may the Cure of the Scurvy be easily perform'd, by resolving it into the Symptoms of which it consists, and whose Remedies are known.

Add to this, that strong Purgatives are not convenient for the Scurvy, which is attended with Convulsions, because they irritate too much. But they are convenient in a scorbutic Palsy.

Then, when there is a Looseness, you must hardly use any Purgatives; neither are the sharp and pepper'd Antiscorbutics good in

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that Case, &c. Lastly, For Spots use *Antiscurvics*; for the scorbutic Spots are livid, and almost black, as in the Black Jaundice.

Wherefore the Method of Cure is not here (nor in any other Distemper) to be found out from the unknown Nature of the Cause; but from the known Cure of the Symptom. For I don't apply a Decoction of Guaiacum or Sarsa, &c. to scorbutic Ulcers, because they carry off the Acid, or fixed Salt, but because they dry and heal other Ulcers, whatever be their Nature or Cause.

For Ulcers were cur'd before Men thought of any Acid in them; for, as *Celsus* says, *the Remedy was not found out after the Reason, but the Reason was look'd for after the Remedy had been found effectual.*

Note, That the Scurvy appears to be what the Antients call'd *Cathexia*. See *Caelius Aurel.* B. 3. and *Sylvius*, p. 704, and 705.

And tho' I have said that all the Symptoms which accompany the Scurvy have this in common, *viz.* a slow Pulse, yet this is not always true, (see *Sylvius*, p. 705.) but then the Exception holds good only when there is an Inflammation or Phlegmon, or a rambling Gout. And oftentimes also without this, those that have the Scurvy are seized with an uncertain and wandering Fever, like an intermitting Fever, to which they are liable. Wherefore nothing is always common to this compounding Symptoms, whence the *Scurvy* is not a simple Disease.

Note

Note again, That *Pechlin* (in the 177th Page of his *Observ.*) determines the Cause of the Scurvy to be a *Salsugo*, or a Mixture of an Acid and an Alkali, and that as the one or the other exceeds, the Remedies for the most Part must vary, or else that one must use saline Bitters, and volatile Medicines, such as the volatile Salts, the *Cochlearia*, stringy Trefoil, *Strobylinum*, &c. which yet do not agree with a Patient sick of the Scurvy, who is of a bilious Complexion, who ought rather to take Things that have a small Sharpness mix'd with balsamic Bitters, as Spirit of Salt, or of Vitriol, made sweet with Spirit of Wine, to which if you join the Bitterness of Aloes, Myrrh, Wormwood, Ceraur, you will have another Kind of antiscorbutic Remedy.

Water-drinking is a Cure agreeable with either Course, (as it is a Dissolver of Acids and Alkalies,) and chiefly drinking warm Water, whence Tea-drinking, and a Decoction of Guaiacum Wood, and the Root of sharp-pointed Dock in Water, are all good.

The *Sleepy Disease* is cur'd by stimulating Medicines, (or such as are fit to awake out of Sleep,) that is, provoking the Secretion of the Spirits, namely, by Vomits, sharp Purges, Castor with Vinegar held to the Nose, Oil of Amber, Spirit of Hartshorn, sneezing Medicines, blistering Plaisters, an Issue behind in the Neck, and an Electuary of Cephalics or Aromatics

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matics. Lastly, opening a Vein will take away the Foulness, and that Stagnation which hinders the Secretion and Derivation of the Spirits, &c. The same will do for a Palsy.

An Epilepsy (which for the most part arises from a Repletion and Irritation) is cur'd by letting Blood, because when the Blood is in too great a Quantity, it makes too great an Affluence of Spirits in the Brain, or an Increase of Secretion, as an Irritation makes an Increase of Derivation. For which Reason also, Purging Medicines are convenient, because they diminish the Quantity of the irritating Humours; for when the Spirits have more Acrimony than ordinary, they have the same Virtue as a greater Quantity; and for that Reason Vomits are used, and a *setaceous* Remedy. Then a strong Decoction of *Guaiaicum*, to make a great Evacuation. Lastly, Anti-epileptics, all which have a narcotic Power, or hinder the Derivation of the Spirits. You may say the same of native Cinnabar, for *Mercury* hinders the Emanation of the Spirits in the Brain, by compressing the Nerves that lie between the Arteries.

A *Vertigo* is a Tumour or Obstruction, and is cur'd after the same Manner as an Epilepsy, that is, by whatever takes off a Stagnation. Wherefore also Anti-epileptics and Narcotics meet in the End; because they rarify

rify thick Blood, and hinder too great a Derivation of Spirits into the Heart, which give a Velocity to the Blood, and cause a Swelling of the Arteries in the Eyes, &c.

A *Catarrh* is cur'd by those Things that take off the Secretion about the Head.

A *Gutta Serena* is cur'd by such Things as take off *oedomatous*, or white, soft, and insensible Tumours, Purgatives, (if there be an *Ophthalmia*, a Vein must be open'd) sudorific Decoctions, blistering Plaisters.

A *Suffusion* is cur'd like a *Steatoma*, &c. that is, a Depression of a confirm'd Cataract is proper, as cutting off for a *Steatoma*.

An *Ophthalmia*, or Inflammation of the Eyes, is cur'd like other Inflammations, namely, by Bleeding and mild Purges, and then repelling Medicines, Anodines, Digestives, and Resolvents applied to the Part, or Dissolvents. See *Riverius*, pag. 54 and 55.

An *Epiphora* is cur'd with Astringents, and such Things as turn the Secretion of the Serum another Way; as also a *Catarrh*.

An *Hæmorrhagy* is cur'd like Wounds, by Bleeding and Vulnerary Medicines, &c.

A *Quinsy* is cur'd like Tumours accompanied with an Inflammation.

An *Asthma* (except it be convulsive) is a Tumour nearly schirrous, and is cur'd (in *Cachochymies*) by a Vomit, which hinders the Increase of the obstructing Tumour, which would be occasion'd by the Viscosity of
of

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of the Stomach, &c. and by all attenuating Medicines, and which evacuates Tumours that do not come to a Suppuration. See *Rivierius*, pag. 100, and 101.

A *Pleurisy* is cur'd like other inflam'd Tumours, &c.

Spitting of Blood is cur'd like an *Hæmorrhagy*, that is, after the Manner of a Wound.

A *Phthisic* is cur'd like an Ulcer, as also an *Empyema*.

Vomiting is cur'd by Astringents, and Medicines which diminish Excretion, among which, the most excellent is the Water of the perpetual Fountain at the Town of *Disart* in *Fife*, that noble and chief Province of *Scotland*, where the *PITCAIRNS* have their Patrimony.

An Obstruction of the Liver is cur'd after the same Manner as any Tumour or *Schirrus*.

The *Jaundice*, like any other Obstruction, namely, by such Remedies as take off a Laziness, as (after Vomiting to remove the Obstructions) Steel, Mercury, and Gold-Dust, which overcome those Stoppages by their Gravity; because the Jaundice is an Obstruction of the small Glands, or a stuffing of them by a too thick and viscid Bile, and it is followed by a diminish'd Excretion, or Secretion in the Liver.

But I might call back Fevers themselves to this Division, where the Pulse is most quick.

For

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For then a Fever is the increas'd Secretion of Animal Spirits flowing to the Heart: Because, since in a given Time a greater Quantity of Spirits is separated, therefore an equal or a given Quantity is secreted in a less Time, and so the Spirits fall more frequently in the Muscles of the Heart, and the Motion of the Heart is more quick or frequent.

But if the Quantity of the Blood be increas'd, (by the Diminution of any Secretion, the rest not being increas'd, as it often happens to those that are going to have a Fever,) then in a given Time (I don't yet suppose the Pulse chang'd) a greater Quantity will be expell'd thro' the Heart, and run thro' the Brain. Therefore in an equal Time a greater Quantity of Spirits, that is, of nervous Juice, will run into the Nerves, from the Arteries of the Brain, and being secreted will be sent into the Fibres of the Heart, which will cause a more strong Contraction of them, and a stronger Expulsion of Blood from the Heart, propagated to more distant Places in equal Times, whence the Pulse will be more frequent, and a Fever will be occasion'd.

And this is the Reason why letting Blood is proper in Fevers, because the Quantity of the Blood being diminish'd, the Secretion of the Spirits is also diminish'd.

But because Blood-letting in sharp periodical or intermitting Fevers, does not immediately

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diately help, when administer'd the common Way, there must be given, after the Patient has been made to vomit, the *Peruvian* or *Jesuits Bark*, (call'd *Quina Quina*,) or, what is better, Powder of Flowers of Cammomile, then a Dose of Steel, or Filings of Iron, and the Patient must ride on Horseback pretty often, which will be safer and more effectual.

From what I have said it is plain, that there's no such Thing as an Art or Method of Curing; but only the *Practice of it*, as *Virgil* says, and that Remedies were found out by Chance, and not Design, (except Blood-letting after the Circulation was known,) and will still be so.

2. That Physic therefore is the Remembrance of those Things which Use has shewn to be an effectual Remedy for such and such Distempers: For the Nature of the Bodies flowing or residing among the Veins is not known; and therefore it is by Observation only that we know what is proper for each Disease, after we have often experienced it to be successful in that Disease.

3. But he appears to cure by Chance, not Design, who does the same Things over again, which can't be done by others that try the same Way. And therefore that can't be attributed to Method or Art.

4. Whence either *Zacutus* the *Portuguese* cur'd by Chance, or was too much guilty of Lying.

Lying. By Chance, because if he had known some of the Cases of which he was ignorant, and improv'd by it, they that came after might have follow'd his Steps in Physic.

5. Therefore, as an Example of Cure, or of the Way of applying Remedies, we must propose the Cure of a Quartan Ague, by giving the Jesuits Bark or Cammomile Flowers in the same Manner. For in this Way of Cure we neither know the Nature of the Bark, or of the Flowers, or of the Blood, or of its Motion, which causes the Fever to be Quartan. We only know by Observation, that in this Age this sort of Fever is always carried off by these Helps.

6. Therefore, in order to carry off all other Remedies as happily, we must change one unknown Body into another unknown Body, which does not belong to any Method or Art; for a known Figure is not only to be given to an unknown Body by help of a known Figure, which Geometry teaches, or Mechanics perform; but the unknown Figures of the Parts of a Body must be chang'd into other unknown Parts, or unknown Forces are to be chang'd into other unknown Forces, which Chance sometimes performs, but Art cannot shew it.

7. For it is most evident and manifest, that neither Blood-letting nor Purging, nor
any

any other Excretion through the Pores of the Skin, or other Glands, can carry off Fevers, whether continual or intermitting, with the same Success as the said *American* Bark or Flowers of Cammomile do an intermitting Fever: And therefore he that would expel continual Fevers with the desir'd Success, must first have experienc'd a Remedy as good as the Bark is for driving away Fevers; and therefore the Praise of this must be reserv'd to Chance and Fortune, and not to the Art, Sagacity, or Design of Man.

8. We call that Body unknown to us, not only whose Weight and Figure, and Quantity, and Situation, and Quantity of Motion, and Cohesion of Parts, and Forces of Attraction, are unknown to us; but we shall also call unknown, such an one whose Weight and Colour we know, if we compare it with another, (as Gold,) but remain ignorant of the Cohesion of its Parts, and attractive Force, if we compare its Parts with the Parts of other Bodies: Thus Lead and Gold are Bodies unknown to us; that is, their inmost Nature is not understood by us Men. In one Word, that is unknown, all whose Relations to other Bodies we are not acquainted with: And therefore no Body will ever (unless by Chance) change Lead into Gold, if he knows no more of their Natures than we do at present; yet those Physicians

ficians are like the Alchymists, who boast of curing Diseases whose Natures depending upon the Nature of the Bodies causing them, are not more, but much less known to us than the Nature of Lead or Gold.

Therefore I don't doubt but that I have solved this noble Problem, viz. To find a Remedy for a given Disease.

Jamque opus exegi-----




THE



THE
METHOD
Of CURING the
SMALL-POX,

Written in the YEAR 1714.

*For the Use of the Noble and Honourable
Family of MARCH.*

1.  F a Child, or any Person grow sick, feverish, or has a Pain in the Back, or *Spot* of the Breast, Loss of Appetite, Drowsiness, short Cough, Sneezing, watery Eyes, or some of these; but always accompanied with some Heat, and frequent Pulse, or Drought. In this Case Blood is to be taken at the Arm, or with Loch-Leeches; and if the Fever ceases not, tho' the Pox appear, let Blood a second or third Time. Mean time, give the Child

2. Spoonful of Syrup of White Poppies at Night, and in the Night-time also, till Sleep or Ease comes.

2. After the Pox appears, and Fever is gone, then steep a Handful of Sheeps Purles in a large * Mutchkin of Carduus-water, or Hyfop-water, or Fountain-water, for five or six Hours; then pour it off without straining, and sweeten it with Syrup of Red Poppies. Give of this a Spoonful or two, every fourth or fifth Hour, to make the Pox fill, and preserve the Throat. Always at Night-time, and in the Night, give a Spoonful or two of the Syrup of White Poppies for a Cordial, that keeps down the Fever, and keeps up the Pox.

3. If the Pox run together in the Face (which is the only Thing that brings Hazard) use the Infusion of the Purles, and the Syrup of White Poppies oftner than in other Cases; also about the eighth Day from the appearing of the Pox, or a little before that, give the Child to drink of Barley-water, sweeten'd with Syrup of White Poppies. This will make the Child spit, which saves the Child.

4. The Child's Drink may be Milk and Water at other Times, or Emulsion, but use the first rather.

5. Apply nothing to the Face. Use no Wine, or winish Posssets.

T

6. If

* A Pint Measure.

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6. If any Looseness comes before the fourth Day of the Eruption, stop it with Syrup of Poppies, and five or seven Drops of liquid Laudanum given now and then till it be stopt.

Let the Child's Diet be all along a thin *Bread-Berry* in the Morning, a weak Broth, and soft Bread for Dinner, and Milk and Bread at Night, or Sugar-Bisket and Milk, and about the fifth Day from the Eruption, give the Child Water-gruel sometimes.

Note, If at any time the *Small-Pox* disappear, with a Raving before the fifth, sixth, or eighth Day, from the Eruption, then let Blood again, and apply a large Blistering Plaister between the Shoulders, and give an Emulsion.

2. If the *Small-Pox* fall down, without raving, then apply a Blistering Plaister large between the Shoulders, and give an Emulsion, and boil in a Gill of Water, and as much White or Red Wine, half a Dram or a Dram of Zedoary-Root sliced, two Figs, and two Scruples of Theriac or Diascordium; sweeten it with Syrup of Kermes and White Poppies, each half an Ounce.

3. In the End of the Disease, that is, about the tenth, eleventh, fourteenth, &c. Day, after the Eruption, if the Child's Defluxion is gross, either apply a new Vesicatory, or give often the Spirit of Hartshorn, in Syrup of Violets, or a Vomitor.

Lastly,

Lastly, When the Pox is blackened sufficiently, or about the fourteenth Day from the Eruption, let the Child drink Whey, eat Pottage, &c. Broth with Prunes, unless the Child's Belly is open enough of it self.

But if the Child is so young or unlucky, as not to cough heartily, and force up the Defluxions; or if the Frost thickens it, apply to the *Slot* of his Breast a Poultice of Theriac, Diascordium, Alkermes, Oil of Rosemary, and Cinnamon, with warm Claret, in a double Linnen Cloath often.

2. And to the Throat apply, in a double Linnen Cloath, a Poultice of Cow's Dung boil'd with Milk, and soft White Bread: Put a little Brandy to as much as you apply at a Time.

3. For the Defluxion also, give inwardly some of this, which has a Dram of *Sperma Cæti*, well mix'd in a Glass-Mortar (not a Brass one) with fine Sugar; to which add, at Leisure, Syrup of Violets, or Balsamick, or Poppy Syrup, with some Spirit of Hartshorn.

If the Pox was confluent or run together on the Face, then, after the Person is recovered, give a Purgative, to bring away the Remainder of the Pox within the Guts.

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J. T. DESAGULIERS L. L. D. not D. D. Page 22. Line 12.
 for what, read which. From Page 230. to Page 241. the
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 read draw off.

