1767

Lectures on physiology by William Cullen

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Lect: LV. Feb. 6th

On this subject we ought to put every question whether it can be answerd or not; and we should also say how far each one can be answered.—

The laws by which motion is excited in the nervous system. In the last lecture I mentioned four circumstances, with regard to impressions. I said the first, were purely mechanical, secondly those accompanied with a sense of propensity to motion, but without propensity to particular motion: Thirdly those attended with a sense of propensity and determination to motion, without any view to the end or purpose: & fourthly those in which there is a propensity w.t a view to the end to be thus obtained; It is the last set that are called most commonly voluntary. We will the end and effect: But it is agreed that we do not will all the means by which it is produced, such as the contraction of the several muscles. Further we do not properly will even the motions of our whole body or particular parts, which are answer to the effect of the will. In throwing a stone

2 I lift up my right arm & set back my right foot, and then bring my arm forward. now in this action I exert a variety of muscles without being either conscious of it or, the particular motions I use in the action. When a child first attempts to throw a stone, he does it awkwardly, but acquires more skill at every effort. Now no body will say that they have aims of motions to perform the actions more carefully. Therefore the last of the four sets of impressions, and the rest are merely shades of the same colours. A still further illustration is to observe that the most of our actions are in consequence of imitation. In many cases we have no more than the sense of velling imitation. There is a connection between the disposition to imitate & the motive. The volition may be the cause of the effect, but does not direct it. I will to sing a song which, in my particular case is a very ineffectual volition. A man in that case that he moves

Take

view then of volition in conducting motions. Some have talked of volition directing these motions and with a view to an end; I allow the view to the end but no more. By some of our actions we at all times without perception & other

without volition, you will perceive how far the opinion is wrong. This is the Athenian Doctrine. I am not disposed to take much pains about it, or to go into a long discussion of it; my prejudices are for the Athenian doctrine but my reason is against it. I will give the considerations that determine me on this subject. First to will properly is truely in directing the actions of the body. Secondly our views of ends and purposes are all determined by motions arising ultimately from impressions. And our perceptions are in proportion to such impressions and sensibility, taken together. These is the foundation of all our judgments of the operations of medicines. When I give a vomit I proportion my dose in bulk to a general rule; but upon experience I find that the person had more or less sensibility which therefore altered my rule. I find also that certain circumstances in the body increase sensibility in which case the dose must be less; and when I find a larger, or the usual dose do not produce the effect. I perceive it is owing to a quantity of mucus in the stomach. If the stomach in the beginning of a fever will hardly bear 5ss of Tartar emetic, & that in the advanced state it will scarcely be moved by 5ss xii. I find that the tar-

4 Money to vomit opposes the operation of the medicine, but the comatose disposition so usual in the end of fevers counteracts it. In the case of Phiala do we see that ~~xx xxxxxxxxx~~ what is the cause is merely in proportion to its mischievous effects? and that what we do and what we do not is directed? In the human body there is a constitution whereby the several impressions that produce diseases, at the same time excite such motions as counteract the effects of the disease, but we cannot see that it is with any reception of the end. Nature directs the means for the expulsion of the extraneous Body, brings on inflamation boues out sweats; It is the nature of our serum to change into pus and to undergoe putrefaction, to destroy the cellular substance, and make an aperture by which the extraneous Body is thrown out. But does nature constantly adapt this effort to the mischief of the extraneous Body; and direct it in proportion to the salutary end. That Blood from the same putrefaction and same heat, produces, in some cases, a poison instead of laudable pus. Now this is gangrene which I would not impute to the crude mistaking the matter, but to the state of organization, & of the nervous Power. Tho' there is a sentient principle in the soul yet that is invariably connected with the organization of the Body, and the chemical conformation of it. This sentient principle may have a share in the operation and I take it to be a sine qua non: But still it must be determined by the mechanism of the Body. "Id causa motum excitans in stimulo: causa efficax in animo est" and in V. 70 of Dr White: "Nor can we" says he "consider the mind as acting ingenerally or [illegible]

"

&

action". And he might have added that action is the immediate consequence of the nature of the stimulus. I conclude by pointing out what ought to be our conduct in physiologysing on the animal Body. We should trace with every Phenomenon of the animal Body, how far it can be accounted for by the Laws of mechanism or Chemistry, how far it is reducible to the general Laws of motion in other Bodies. Secondly we may examine the operation of a cause independant of perception. and thirdly when perception appears, we should consider the effect according to the steady Law whereby sensibility and impression bye-

ther determine perception. If we resolve any of these into the arbitrary motions of the will, we speak unintelligable jargon. By what laws is the action of the nervous Power excited? The first is very general, it is the effect of the repetition of the same action; the first effect of which is greater facility or greater strength. Every muscle becomes stronger: and the man who continues to lift a calf till it is grown up will at last be able to lift the Bull. In some measure it depends upon strengthening the fibre; but it depends more upon the nervous power being determined more freely and more copiously into the muscles. I think this is evident from the effect of electricity in curing paralytic muscles, where it not only restores the fulness of the muscle, but also the power of the will: and therefore it restores the communication between the sensorium commune and muscles. We have reason to believe that one of the causes of less mobility or of no mobility at all is stagnation. And mobility may be increased partly from the elasticity of elastic bodies which is acquired by repeated motion. The sense of stiffness or rigidity at first excites all first excite of motion; but repetition gives us agility in the same motions afterwards. I need give no more instances, but shall proceed to an illustration of a different kind. We have this proof of facility, that the motion can be renewed by weaker impressions than were at first necessary. A man takes a dose of ameticks and repeats it several times. The first effect of repetition is that the dose must be increased as the repetition goes on. We said that the force of repetition is constantly becoming weaker & weaker. But if this repetition goes on for a greater length of time it seems to procure a facility of motion in the nerves of the stomach, and now a much less dose than before will produce vomiting. It may be in some measure thus explained. Vomiting will take place sooner or later according to different circumstances of sensibility or mobility, and according as the person is disposed to be affected by one dose or the other. Now if that is the case while the repetition has not been able to

8 take place, so far the law of sensibility will take place: But habit is much more powerfull in the last case that our motions will be more easily renewed, from the mobility being increased. All habitual motions are thus easily renewed

Lect: LVI. Feb. 9th

I said that every action, by frequent repetition, becomes more easy and is performed with more strength. If we suppose the nervous power is confined to the nerves by the surrounding parts, we can easily see that these may resist the nervous power, according to their greater or lesser degree of sensibility. But by frequent motion, the nervous power will be accumulated and hence easier of motion. It appears that in consequence of this faculty, a smaller impression will be sufficient than that which produced the same action at first. It may then, be varied considerably by taking off the resistance. And I can suppose that irritability and sensibility are not properly and absolutely connected together. The explanation of irritability which I reserved for this place is this. Dr. Haller & others who mention a power of contractility residing in the muscles, make it a condition of the vis insita, but we have refused the vis insita and therefore the opinion of irritability depending on it. Others who refuse the vis insita of Haller use the term irritability. Gaubius has used it and advanced a proposition which most Physiologists, who refuse the vis insita have ranked. If there are impressions attended with perception that do not evidently to us produce contraction, only give perception, to these the term sensibility may be confined and the term irritability may be applied where contraction is produced. Dr. Gaubius defines irritability "et levibus stimulis in motus vorumpat in vomes". But sensibility and

10 irritability are totally distinct. I think the supposition of a peculiar organization that fits the fibres to be acted upon by the nervous power flowing into it with greater force is admissible, and this organization may vary in its circumstances, and may be more or less fit for receiving the nervous power; and this fitness I call irritability. Further there may be a difference in the nervous power. My conception is, first that the nervous power is confined to the nerves, to the muscular fibre by the vis insita if you will, of the surrounding membranes. I can conceive that upon repeated impulses the degree of expansion of these may be considerably varied. And the freedom of motions, if it be less proper to call it mobility may be considerably varied. I consider irritability as in the nerve and proper organs of motions and both more or less fit to produce contraction, as the last are more or less fit to to receive the influx of the former into them; and accordingly a force vastly less may in certain circumstances produce these motions.

We can easily hence understand the proposition of the moralists, that habit improves our active while it demenishes our passive powers, improves our irritability while it demenishes our sensibility.

Other Laws of Habit—

Next actions may be associated with impressions, that are not otherwise naturally stimulating. Thus the natural stimulii to the contraction of the Bladder of urine, is either its fullness or some stimulus within it. Now to renew this action every other circumstance that happens to be associated with it at the same time is often requisite. Thus people who make water before they go to Bed will naturally take

up the chamberpot and set about it when he is naked before the bed; and when a man has indulged too freely in strong liquors and is put to bed sooner than usual common, he will naturally arose at the accustomed time to do the office. Most of our actions thus may be associated with impressions that do not naturally prove a stimulus, but which ever after renew the volition. Thirdly actions are associated with actions without any final purpose, and too frequently repeated together, come to be almost inseperably connected; hence the uniform motion of both eyes. Fourthly actions frequently repeated with a determined force and celerity can only be renewed with the same degree of force at least very nearly. Hence the connection of every workman with his particular utensil; and a man will goe for a great length of time with his own pace who will not advance

at all if hurried. Fifthly associated actions are repeated only in the order in which they have been habituated. In the memory, when we want to recall certain verses of a Poem, if we catch the first word the rest follow spontaneously. This is the foundation of the ordinary train of thinking. Sixthly in consequence of these actions periodically repeated, after such repetition for a certain number of times, they become spontaneously periodical. In the instance of the Stafford Idiot who was used to repeat after the Clock thro' all the hours; this came to be so strong a habit that when the Clock was out of order the Idiot served instead of it. This appears a very misterious, but it is a simple law of the animal Oeconomy; admitting a certain order nothing is more easy than to exhibit order, if the repitition be strong enough. I conclude by sayeng that if any of you dont perceave the use of marking these

laws of habit, please to attend that every observer has remarked, that the oeconomy of man either physical or moral is made up of habit. I immagine that it is not strictly connected with the animal oeconomy but that it is in the vegitable also; In supporting our virtue and guiding our prudence we may depend upon it in great measure; but habit may be equally prejudicial to both.

Other general laws of the nervous system. And first some circumstances relative to contraction are to be taken notice of. Contraction is naturally succeeded by relaxation. Thus the the effects of stimulus produces contraction, yet when continued it alternately produces contraction and relaxation. A part of the illustration of the same is that when the stimulus is removed, the alternate contractions and relaxations continue to be renewed for some time when relaxation should

take place. If the nervous fluid is elastic, & it is accumulated in a muscle, by the elasticity of the surrounding parts, and if from its nature it endeavours to renew itself and has out of the nerve, relaxation takes place. There are two circumstances belonging to the law of contraction. The first is that this alternate contraction affects certain muscles and not others such as all the straight muscles, especially when they are cut out of the Body. On the other hand in muscles that are not straight as in in the vesica urinaria, we see nothing like alternate relaxation. When distended, a stimulus will make it contract, but it will go on to a relaxed state and continue in that. An explanation of this may be, in the straight muscles I can not conceive but that while the relaxation follows the contraction, it will not pull the muscle straight; The oscillation will produce the alternation. It is not easy to conceive that

16 the relaxation will stretch out the muscular
fibre. But when it is connected with a quantity
of cellular membrane, that to will hinder the
stretching out of the muscular fibre. A difficul-
ty attends the contraction of the muscle of the
heart, of which you may try this experiment.
Where there are a set of fibres about a hollow
cavity; first tho' they surround a cavity, they
are much in the condition of the muscles out
of the Body. I take it to be owing to this that
from the connection of the vessels it pushes out
a quantity of blood and is relaxed again. It
chiefly happens when the muscle is cut out of the
Body that the fibres more easily recover their
straight situation; and also the heart is in-
tirely muscular. Another seeming difficulty
arises from the motion of the intestines al-
ternately contracting and dilating but I im-
agine there is a fallacy. It is true the mus-
cular fibre in the Bladder suffers a relaxa-

tion by the nervous power shaking out of it 17
And the same motion in the intestines is
only propagated from one place to another.
Tis not the muscular fibre alternately dilated
or contracted it is only in consequence of the
motion of air or liquid that that alternation
is kept up. Further it is only the ordinary
degree of force that can produce this alter-
nation. On the other hand, a certain degree of
force continues to go on and contract, which con-
traction is not easily overcome by antagonist
muscles. This is what we call a spasm. It
certainly depends upon the particular orga-
nization of the muscular fibres. Next we consider
the alternate vicissitudes of exercise & rest,
sleeping and waking

Lect. LVII. Feb. 11th

with regard to motion and rest we shall
offer our conjectures on the theory. Hitherto
the Theory of this subject has been acknowledged

to be obscure, and must be so till we know more of the nerves of which it is an affection. The cause of waking has been supposed to be a fluid secreted; and it has been thought that it must be interrupted, and that waking should cease for some time till it is renewed again. Very many objections lay against this theory. It is difficult to say how such a fluid as the nervous should be secreted or how it should have a receptacle. I pass over many arguments; the chief is this, that the doctrine of a fluid is not at all reconcilable with the phenomena of sleeping and waking. A person, after labour both of body and mind is under a strong propensity to sleep; a certain stimulus will dissipate that propensity, and establish the most perfect waking. Now stimulus may give motion but I have not the least Idea of its supplying matter. And the effect of stimulus goes so far that we can not suppose that sleep depends upon an exhausted accumu-

lation. Also sleep can be subjected to periodical habits, which too can not be explained upon the theory laid down. The periodical habits affecting secretion are much more liable to be interrupted than these that are purely nervous, such as sleep and waking very purely are. Sleep and waking depend upon a certain train and order in the train of our thinking arbitrarily. We must therefore seek for the theory of sleep and waking in the causes of motion and rest. My notion of the nervous power will appear

Gaubius on the Morbi solidi vivi P. 191 says "Hoc ενορμων

" voluntati" He adds "

" supersit." That is incompatible with any notions of an indivisible soul. He proceeds " " we agree that we are to go on in our query concerning it as residing in the Body. He says it appears

20 more readily in the solides than in the fluides; but if you go to Wallers notion of the fluetin, you can not avoid its formation in the fluid out of which the solid is formed"

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" compresione". This is the notion we would give you. Here is a quantity of Iron calined; it is no longer shows its magnetism; but with grease you restore that again; now if magnetism depends on a certain fluid, where was it when the Iron was in a state of oxyde. Sulphur is an electric; fuse it & it will be a nonelectric, it will conduct like water; again pour it into a Freshing glass it becomes an electric nay an excited electric. It has a quantity of matter accumulated around it that it had not before. The elective attraction and that of adhision depend upon a subtile elastic fluid; change that matter and a new modification takes place.

It applies itself to matter, modified or arranged 21 under a certain texture. Our nervous power is a mixture to which the subtile fluid is applied. "adjse observateur" I must not now give the comentary that this Paragraph would require. It must not be considered as belonging to that solid "in se simplicitor spectatum", but as it is connected with the rest of the system. It is not the fluetin of Waller nor is it the vis insita. I deny that it is absent in entire in entire; that would equally apply to distroy the organization in that fibre. The degree of flexibility must have a share. Nor would I allow that it has no connection with the Formæ partes. "nec quoad

"Deus" If he means by this to explain a vis insita, that we must not assume an hypothesis I grant him. I'd allow also where that hypothesis intervenes impression and

22 contraction; but nothing but mechanism can
be the foundation of all our reasoning.

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Dies dixi?

I agree with them that it is not elasticity &c.
It depends upon a matter under different modifications, and subjected to different laws from each of them. But it does not resolve the whole into sentient principle or exclude it. In what follows "

" " we entirely conclude with Gaubius. I would willingly comprehend the vegitable kingdom. I go on now to consider if we can find out the laws of it. the causes that may alternately produce this rest or motion. In sleep the nervous power seems to rest, owing to one of three causes. First interrupted motion while the power may still remain. Secondly supposing the passage free

the fluid itself by changing its condition is rendered immovable. Thirdly it is not impelled. I now consider how far these can take place. Interruption can happen from compression, producing all the Phenomena of sleep. In the apoplectic stupor there are circumstances different from natural sleep. In the case of a moderate compression from a quantity of water on the Brain a person feels sleepy; therefore a cause of this kind may take place. The causes depending upon the immobility of the nervous power seem more difficult to be understood. But they take place in cold, in cold. Heat is necessary to animals. In no animal does the temperature go lower than the freezing point of water. It is true that some animals live in greater cold than that, but they have a power of generating heat that keeps it up. In many a certain degree of heat is the sole circum-

stance determining life or death. In man cold benumbs particular parts; and it certainly acts by first inducing all the appearances of natural sleep. Cold acts by destroying the mobility fluidity and elasticity of our nervous Power. The hairs of animals that are benumbed, and small animals are recoverable to life by heat alone, as I have seen in swallows &c. The sleeping animals are waked in a greater degree of heat than is necessary to their Bodies. And this happens without affecting the mixture of the fluid otherwise than by putting it into a fluid state. Also to want of mobility of the nervous power I refer the operation of narcotic medicines. The theory must be very purely Hypothetical. I said just now that the action of attraction of cohesion is exactly connected with a state of mixture. Thus when we

consider the small quantity of the fumes of Lead that will destroy the fluidity of mercury and the small quantity of tin that will destroy the Ductility of gold rendering it brittle it depends upon a subtile elastic fluid. Since we are drawn to conceive how our nervous power may be in some measure changed in the same way, as in the operation of narcotics. I shall consider this hereafter. I dare say whether they operate on the mixture of the nerves or on the subtile elastic fluid, they effect the mixture of the matter of the nerves. Narcotics do not operate on the organization of the sensorium commune. You are acquainted with the experiments of White and Monro on this subject; White says that opium acts on a part of muscular fibre. Haller has doubted of that, but his opinion may be supported; and it is rendered highly proba-

ble from the topical affection of living bodies, and therefore in a great measure independent of the sensorium commune. And so we may conclude that narcotics act as cold, in destroying the mobility of the nervous fluid. As to the third set of causes that lay the body at rest. Lay a man quite at rest, lay him softly remove the impressions of light and noise and at any hour of the day most persons may be lulled to sleep. Also when the mind is occupied too much with one object the effect of impression is taken off and if no commotion is produced a person will go to sleep. such is the effect of a dull heavy discourse. But it is equal whether the discourse is dull or the hearer has not common apprehension. The diminution in point of force of external impression or the impulse of the arterial blood in the Brain

of the Brain, produces sleep. If the ner- 27
vous power is an elastic fluid it will al-
ways endeavour to come to an equilibrium
viz: a state of perfect rest; which though
difficultly compatible to its nature it comes
nearer and nearer to. Upon this have we
explained contraction and relaxation, and
so in sensation and motion. The repetition
of a sense, and motion resisting that repe-
tition is reconcilable, and I shall reconcile
it in another place. The tendency to equi-
librium must be owing to want of external
and internal impression, and to attention with-
out emotion or volition. Soundly whatever
disturbs the equilibrium wakes a man. —

Lect. LVIII. July 12th. —

We rejected the supposition of a fluid alternate-
ly exhausted and supplied again, as being the
cause of sleep and waking. It depends upon
the causes that occasion the motion or rest

of this fluid. As the nervous power moves certain portions of our system only, its motion may be interrupted. First by compression. Secondly by its being more or less fluid, as in the operation of cold and heat, which operate in this manner, and I alledge that narcotics probably act by destroying its mobility. Thirdly this fluid may rest if not impelled: as being elastic it has a tendency to a perfect equilibrium. The atmosphere around our earth would rest were it not for external causes, such as compression and rarifaction. So by the removing all external impression, and weakening the internal we bring on nearly a state of sleep. For there is an interruption to its motion, as otherwise the ordinary impressions that

move us when awake would move us also when sleeping which is not however the case. Some degree of compression does take place, but not clearly or widently: Any of the modes of compression that we know do not; But what is analogous to it will do; the nervous power is confined to the nerves. I said before that it was confined between either extremity and by them surrounding cellular substance. It may suppose it confined by the enveloping membrane. Probably it goes near to the subdivision of the nervous fasciculus. If the nervous power must goe to the extremity of the nerves, go along one fibre and not the rest of the same fasciculus, we should have stimuli acting distinctly on us in sleep.

30 We must suppose the medullary substance confined by that envelopement. I compare the nervous power formerly, to elastic matter running along a chord, wire &c; I now add that we know elastic matter would not be accumulated upon non elastics, By it was not exhibited by electrics, and is therefore surrounded by electric air: the medullary substance of the brain is in some measure confined; but it has a more free communication with the rest of the system than any other part. The nervous power is confined to the nerves more distinctly. But in some degree animal substance is flexile and contractile and every portion of simple fibre is in a stretched state and therefore tends more and more to contract. So soon then as the impression

of external and internal impressions is removed; the contractility of these fibres must be restored and render the motion of the nervous power less free. The investing membranes of them get into their contracted state and render the impression less free. This coincides with Hallers opinion where it is not explained by him; I explain it upon a different footing. His opinion goes upon the supposition of nervous tubes, being a continuation of arterial tubes and depending upon the mass of blood. I should confirm and illustrate my opinion by applying to the various phenomena of sleep and waking; I must be content however with general principles; some such applications will occur to

ns hereafter. I now go on to speak of some other general affections of the nervous system; and particularly of its general distribution. The nervous power must go into every part of the nervous system that is open; and is constantly present in all the organs of sense and motion; and is so present independant of the common origin. We may suppose its instantaneous action depends upon the nervous power in every muscle; and their contractility is not only simple elasticity but it is a power always tending to contract; which has been called the tonic power. The quantity admitted into, and at any time present in muscular fibres must be according to the degree of their extension. Hence in the contracted state the power of the will has no effect; on the other hand this proportion of nervous matter in the muscle, to the extension of the muscular fibres, explains that all sorts of extension proves a stimulus to muscular motion. Now whether extension is from various external powers, from the weight and tension of the parts, it must be connected with all these of external powers that stretch animal fibres. Hence the effect of extension producing contraction, will especially appear in those hollow cavities. Where there is such an opportunity for extension as in the stomach it is plainly illustrated. This applies to the whole system of blood ves-

vle. And if I say that muscular action is extended by extending the various surrounding elastic parts, a probability arises that the fullness or emptyness of Blood vessels in the cause of tension, or want of it, in the nerves. Some proofs additional. Let me illustrate the matter. In the Arterial system the first thing to be observed is curvature; it is especially by this length that they admit of extension, and therefore are liable to greater variety of it. The result of Dr Hales experiments on this is that an Artery contracts to more than its half, twist down from 27 to 12. Now the extremity of the artery is one extremity of the chord to be stretched, therefore the tension applied must have great effect upon the tension of the whole sanguife-

rous system, and must therefore affect the nervous system. This will explain the effects of the want of or increased determination of the Blood to the surface of the Body, where the extremities of the arteries chiefly are; and the external extremities every where meet with the same thing. Now while the surface of the Body depends upon the state of the surface and is connected with the arterious system, it must be added that this is the most extensive organ of sense. One application, if we may presume is (as I shall shew to be the case hereafter) that there is a connection between the different parts of our system, rationæ officii we must admit that such connection certainly is between the heart &

arteries. And a diminution of the nervous power in the extremities, will determine the same more copiously to the heart, and produce fever. Further of want of tension determines to the heart, the resistance will be much stronger still, when the extreme vessels are spasmodically affected. A particular difficulty arises to me from touching the same subject in a clinical, and in a physiological lecture; Here I am confined to give the principles, there, the applications. I go on to speak of other parts of the system; and first the stomach, as a source of the manifold internal impressions which I spoke of before. It is now to be added that it is a part of the system capable of the greatest resistance in respect of tension. It is at one time contracted to the capacity of an intestine, and at another distended to an immense size. Secondly its blood vessels are liable to suffer the same resistance. Now when the stomach is injected in these different states, in the one state, viz. the contracted, it receives very little injected liquor, in the other, to wit the extended, it will perhaps receive eight or ten times more. Now its muscular fibre must in a particular manner be affected in these different states. And what a prodigious quantity of nervous power is distributed to the stomach in one or other of these states.

38. It must further be variously affected from its sensibility. Again as an organ of motion it must be variously affected by tension, as the nerves are affected by the tension of its elastic membranes, and these by the tension of the blood vessels. Therefore the stomach must have very great influence on the equilibrium of the nervous system. The conclusion is, that the stomach, as the most fruitfull of internal impressions, must, by its equilibrium affect all the other parts. Is there any other reason for the sympathy of the stomach? When I have spoken of a part having considerable influence upon the rest of the nervous parts, it must

shew that by its influence upon the consensum communae; Hence the connection of the stomach with the head, and the good and mutual affection of each on the other. If the extremities on one hand and the stomach on the other do so influence, and be influenced by the common origin, there must be a never-failing connection between the stomach and the surface of the Body. You will find all the parts that are most liable to a vanity of tension and sensibility, are much more liable to various affections. So the intestines are next to the stomach, and next to them the uterus; also taking along with me the sensibility I would

to apply it to the genitals. I do not know of I am proceeding in a proper scale. But the lungs perhaps are still more subjected to these variations, that renders them liable to nervous diseases: Hinc Epilepsy &c ——

—— Lect: LIX. Feb. 10th. ——

I showed yesterday how far the various parts of the body, affected the equilibrium of the nervous system. The whole economy of the animal parts depend perhaps upon the equilibrium of the nerves. We must not just now enter into the Aetiologia & Symptomatologia. We have in many cases laid a foundation of the connections between impression and contraction.

The doctrine of sympathy comes in here; but the term is occult and signifies no more but that there is a communication, and a cause of that communication but of which no Idea is conveyed. Such general terms are necessary in Philosophy, but there is always danger of abusing them. So Sir Newton, in attraction has guarded against the abuse of the term, yet foreign Philosophers justly brand us for the abuse of it. We ought to keep to the strict meaning of it and to limit the application as much as possible. ——

—— Sympathy. ——

This has been distinguished into general and particular. Pain or other irritation of one or other part shewing an affection

of the whole system, I call sympathy—
When it is a general affection it is called
general sympathy. It is a universal com-
munication of the nerves. If an irritati-
on in one part produces sensation or con-
traction in another part only, without af-
fecting the whole, and when that is no other
but the determined contraction, it is par-
ticular sympathy. So when a disagreable
accute sound strikes the ear, gives a disagreable
sensation in the teeth and no where else
we say this is a particular sympathy
between the ears and the teeth; but this
says nothing more than that there is a
communication of the parts of the nervous
system. Since the cause is evident in the
continuity of the medullary substance

which is accompanied with an oscillating
fluid; general sympathy is improper.
I shall use the term however but in the
White sense. But particular sympathies
do require our especial notice if such
there are; as they point out so many par-
ticular laws. It is necessary however that
we admit no more than truely and pro-
perly exist; therefore I begin with them
that I would reject. First sympathy be-
tween man and man is not the particu-
lar sympathy between one part of the
nerves and another. White has observed
that Yawning, &c. is the effect of a sympa-
thy of the nerves; But music and Dancing
might be brought in as an equally good
instance of this. They follow another

law. I reject all those actions that are associated by habit, as the uniform motion of both eyes, and the motion of the two pupils. When in an amaurosis, a light applied to the sound eye will affect the other, that is an instance of similar circumstances producing similar effects. But no communication of nerves is in the case appears from this, that the most seperate actions may be arbitrarily associated. There are consents betwen double parts of the body that have been refered to sympathy, but to be explained in another way. In the oeconomy of the course of the circulation, the times and circumstances must be uniform in the two kidneys, hence an association of motion; & if one kidney is constricted the other will be so also. And when one eye is affected with Inflamation it happens commonly to the other, as in a cataract: This is owing to the blood entering them at the same time &c. There is then probably an association which explains those Phenomena. Thirdly I reject those successive motions that commonly produce one another. A convulsive motion of the Stomach and Intestines often spreads to the throat. By a convulsion in the great guts, an inverted peristaltic motion is communicated to the stomach, which is not sympathy, but a successive propagation of motions. A fractured skull produces bilious vomitings. The connection with the stomach produces vomitings. But the inverted motion of

the duodenum produces an emulgens of the biliary duct. ——

Proper sympathy

White begins this subject with pairs of the head, but they are a general affection of the sensorium and it is no other than a general sympathy. If the stomach is first affected it is because it has a more constant relation to the sensorium commune than other parts. Wounds and contusions of the skull which give bilious vomitings, if they did so from there happening in one part and not in another they would be instances of particular sympathy. But on any part of the head they produce the same effect, and only when they are to a certain degree do

they produce these vomitings. All these effects whether general or more particular, that arise from pleasure, pain, motion or volition, are instances of general sympathy. So when the effect depends upon the degree of sensation. In fainting fatid applications to the nose rouse the person so affected, by increasing the power of the heart. A number of other impressions increase its power, for instance a glass of wine taken; this comprehends the wonderfull connection of the stomach seemingly with so many parts of the body. A glass of wine taken into the stomach is no more a proof or removing fainting by particular sympathy, than the application at the nose. One lady that I knew

from the state of her stomach has headach and Delirium, another has vertigo, and a third an inclenation to break wind downwards. The eyes lose their ~~lustre~~ after hard drinking, and after a large dose of opium, but the same opium injected into the anus or perhaps applied to the crown of the head will produce the same effect. It proves that opium affects the sensorium commune and it may be produced by a great number of narcotics. Various poisons operate upon the stomach because it is exquisitely sensible, and first receives the food. But I have seen it operate in the same manner when applied to the shoulder. I add if these effects are the usual im-

pressions from a variety of causes thro- during them, they only shew a connection that all of them have with the Brain. Palenes arises from the unexpected seeing of a serpent; but the accidental hearing of the hiss of it, or touch of its tail, would do the same thing. Some ladies who are equally alarmed at the sight of a mouse; if it gets into their drawers, will turn pale whether they see, hear, or touch it. This will explain how grief, vexation or fear dry up the saliva and occasion a loosness. Great and unexpected sounds will make us close our eyelids, which is a general sympathy. I shall give one illustration more; the sight of grateful food occasions an uncommon flux

do of saliva in a hungry person. The beautifull figure of a joint of mutton or the smell of roasted Beef will do the same thing; nay even speaking of them will do it. It is hunger that produces the flow of saliva; and what is very curious Boyle tells us of persons that were purged by smelling a cathartic medecine. I imagine that is not the case in fact, but it is the odour of the particular cathartic that had been used before and was accompanied with nausea, griping and purging, which sensations are again renewed in the memory; This is what I called the effects of signs; it is not because there is any particular sympathy in the nose, but because it is the organ

that communicates the impressions. 3d Thirdly if the effects are more owing to the state of the parts moved than of the parts impressed, they also will furnish us many instances of general sympathy. Thus if the eye is the particular organ of the expression of the passions, if fear, a fever, a stone in the biliary or urinary ducts, if hemorrhoidal, or menstrual pains, or inflamations of the bowels will all produce vomiting, it is to be said that all these do produce a certain state of the sensorium commune, and are all instances of general, not particular sympathy. The lockering of the jaws and the tetanus, are not only the effects of wounding the temporal muscle but they will

32 arise from a variety of other wounds, as amputation of the extremities. The locking of the jaw is merely a degree of the tetanus. They are general effects properly depending upon the degree of affection, and these muscles being nearer or more remote from the common origin.

Lect. IX. Feby. 16th.

I have taken off the mystery arising from particular sympathy, by shewing how many of these may be general. I said that communication of actions from degree of impression, general effects from variety of particular impressions: and what has been called particular, is truely general sympathy. Lastly however particular it may seem to be, if the effects depend more upon the state of the parts moved than that of the parts impressed, that too is general sympathy. Also the effects of volition are not particular sympathy and are here to be explained. I have said that the effects of volition appear in more or fewer muscles; it has been supposed that there is a particular sympathy between the muscles so combined, and the impressions; but there is not: the impression is only connected with the volition and this last with the several motion, which is as arbitrary a connection as that between perception and motion. White has observed that an irritation on the extremity of the rectum convulses the diaphragm, but this action of the diaphragm arises equally from irri-

tation of the Bladder of urine and intes-
tines, and from every general effort to
raise a Weight; The irritation is not
only connected with the diaphragm, but
is extended to the muscles of the scapula,
humeri, those between the vertebra and
extend to the face. There is a place of pub-
lick resort in this neighbourhood, where
you may study the expression of the cau-
tories as the painters call it. one man
shuts his eyes to perform this action, ano-
ther keeps them quite open; in the former
case the depressores palpebranum, in the
latter the levatores are employed. It is a
sympathy, reflexive, or pure officii, and is
perfectly arbitrary. I know some people
who find they have no desire, yet think it

would be them service to go to stool. &
and in doing so they shut their eyes and
grin as if the real stimulus was present.
To this head belong a great variety of D.
Whites particular sympathies. Tickling
occasions laughing. It has no connection
with the skin of the ribs; tickling the
soles of the feet will have the same ef-
fect. Acrids applied to the nose give
sneezing, and various irritations on the
trachea give cough. In most of the in-
stances where a variety of muscles are
combined, it depends upon connection
between volition and these, but is chief-
ly supported by habit. We shall be rea-
dy to believe that there are no particu-
lar sympathies at all; but there are some

that can not be rejected by the reasons I have advanced, such as the sympathy between the ears and teeth. The nullknow communication of nerves between these ears and teeth establish this as an instance of particular sympathy. I can not suppose that the impression is propagated along one fibre of a nerve and returned by another in a particular manner; much less can I suppose that it passes from the fibres of the auditory nerves to the common trunk, and returns by the teeth. If this was the case it would produce not only very indistinct sensations but innumerable sympathies. It can be explained by oscillations ~~communicated~~ propagated along contiguous & continuous membranes. White is averse to such explanation. It was necessary for him to establish a connection with the sensorium or sentient principle. But the propagation of oscillations is illustrated by Hawes distinguishing sounds with the soles of his feet and the tips of his fingers. Nothing is more evident than that vibrations can be communicated from the teeth to the ear, and therefore a return of vibrations from the ear to the teeth. But Dr Hawes perceiving sounds by the tips of his fingers and soles of his feet shews that soft parts are every where interposed. Therefore I do not hesitate to think that certain sounds make the gums bleed

Other instances. When White observes that cold water produces contraction of the small vessels, this shews to me that the skin, is liable to have oscillations, over the whole body. Flushings will give an Idea of this particular communication. An irritation of the Larynx will not only produce a cough but Vomiting. so in another place "as the ear is frequently inflamed when the fauces are inflamed" the communication with the Eustachean tubes is obvious; and the same thing explains what follows "a pain is often felt about the eyebrows by eating "strong mustard, and a pain in the "forehead from drinking cold water?"

Nothing is more evident here than the communication between contiguous and continuous membranes. "a stone in "the kidneys

"water?! Oscillations spread along membranes but they are not felt equally in every part of their course, but chiefly at the extremities. The irritation is at the neck of the Bladder, the other is at the orifice of the urethra where this last is very sensible. Thus it is that a shock is chiefly found in the articulations. There is a peculiar titillation in sneezings of the nose from worms, many feelings shoot out at the ends of our fingers; and come at the top top of the head; a pain in the hip and

60 joint will be felt only in the knees and ankles in Rheumatism. Its oscillations must in some measure be as the tension of the part, and as tension must depend on the fullness of bloodvessels, Inflamation must consist in tension, sensibility and communication of oscillation. So a little oil thrown into the rectum will relieve a strangury. I shall have another occasion to shew that the effects of bathing, friction and unction have not hitherto been well explained. There is then hardly any instance of a particular sympathy depending upon the common origin; it may be explained on the supposition of a nervous power in the parts, and in the common origin.

You may add sentient principle but it will not explain the cause. It makes us forget the connexion. I had almost said the subjection of that sentient principle to our mechanical part. I shall find another occasion more proper to take notice of fair instances of particular sympathy, without affecting my present doctrine.

Remarks.

The great share that the nervous power has in the animal oeconomy makes this part very important; therefore we must be anxious to know it, and difficulties only can turn us aside. But I fain hope we have a foundation to go upon, and therefore reason to enquire into it. The nervous system is constantly in-

62 Endeavouring to restore its equilibrium; if therefore we study the laws of equilibrium; if we study the laws of afsociation and habit; and if we can make out the communication by contiguous and continuous parts; we may in a great measure arrive at a tollerable knowledge of it. I confess I have been somewhat prolix; and I may give a better and shorter order another time. There remains the consideration of the particular senses; but as the greatest part of it is anatomical I shall pass it over. ——

— The Chemical Physiology —

Sect. LXI. Tell. 11th.

This, which I informed you was to make my third part, contains the doctrine of animal fluids, considered as mixts, and as being by exhausted and repaired. What I am to say is contained in the following few heads. First the separation of them in the functions of Chylification and sanguification. Secondly the separation of these in the secretories. And lastly the two chief applications of the last in excretion and nutrition. It is a large subject comprehending a great number of particulars. The best order is not yet determined. Boerhaave followed our order. Haller

64 followed a different; he has given a chapter distinguishing nature kind and only afterwards considers the nature of animal fluids. Both methods have their advantages and disadvantages; but Boerhaave is the best. Before I enter upon this part of my work I shall premise two remarks. In the nervous system we considered the laws of a power that admits of little illustration from the other parts of nature. Our present subject should not be so, and we should expect here more frequented paths. But even here we will not find all the clearness and certainty we would wish for. The chemical phylosophy explaining all the various effects of mixture is very far from being fully cultivated. And 68 we are to speak of mixts that are still sui generis. We shall find the changes in animal mixture to depend upon fermentation, which is acknowledged to be very mysterious; and we can not every where bring this matter to general principles; And let nobody think that the nervous system is to be deserted for the chemical since equal doubts attend both. The order I have marked out is attended with the consideration of a great variety of functions. As Boerhaave begins with the opening of the mouth, Manducation; but these things are so strictly connected with anatomy that they should not have place here. I immagine that

you all observe, a vast deal of interruption would attend the consideration of these several functions. ——

Consideration of the fluids and their applications to the purposes of the animal oeconomy. —— Animal fluids are made up of the aliment taken in. It may be supposed that there are some original elamina, that are not only the proper foundation for the whole, but that subsist thro' the whole of life. Animal are in constant waste and decay, loosing a portion of their bodies daily and hourly. These parts going away, we find are changed after a slower, but a different process from the fluids: however in the course of a year there is very little, if any of the same parts in the body.

All these in an adult animal are supposed to be properly formed of aliments taken in. Vegetable animal substance is formed of vegitable, which most animals feed immediately on. There may be a specific difference in the fluids and solids of different animals; yet they are generically, so much the same, that we conclude they are all formed out of vegitables. Some animals do live upon other animals alone, but these others are nourished by vegitables, ~~also~~ We procied generally but one step down, for the carnivorous, as I said, live upon vegitables or at furthest we go but two or three steps, for we at last land them in the vegitable kingdom. Perhaps some difficulty arises with regard to the first kind; But it is

68 Still probable, that there is no matter pro-
perly animal, and which can not be traced to
vegitable. Next animal substance so formd
of vegitable differs considerably from it. The
vegitable aliment is taken in in its own
proper quality, and the change is universally
made in the Body of the animal. Now
we are to enquire in what manner this
change is made. The change is first made
in the stomach; the vegitable texture is
chiefly broke down in manducation, but
the change of qualities first occurs in the sto-
mach. Man naturally lives upon both
kinds, but we have chiefly to consider the
vegitable. The operations of the stomach
may be reduced to three. viz: solution,
diffusion and change of qualities; which last

I express by the term assimilation. For 69
diffusion I formerly used the term admix-
ture. —— Solution must depend upon
a proper menstruum, with a proper divi-
sion of the solvend; a frequent agitation
of the menstruum with it; and a suita-
ble digree of heat and perhaps application
of air. The menstruum here has been va-
riously judged off. Before chemistry they
supposed a peculiar menstruum and vari-
ous Hypothesis. The menstruum chiefly
consists of the liquid parts of our aliment,
and is chiefly water however impregnated,
nor does the solvent power of the menstru-
um differ from the action of the water,
Next the Saliva coming from various
sources makes a part of the menstruum.

70 see Haller. The gastric Liquor from the
extremities of the arteries opening into the
stomach, and perhaps oesophagus. Thirdly
Mucus from the mouth, oesophagus, and
internal stomach it self. There are beside
these, fluids occasionally regurgitating from
the intestines into the stomach, such as the
pancreatic juice, the intestinal fluid, this
mucus; and to all these is added a quantity
of Bile. No experiments ascertain any pe-
culiar power, in all or any of these fluids.
Their fluid part is chiefly elementary, water,
and we do not see the properties they may
have besides. Further we not only know
not, that impregnations have any effect,
but we can discern their solvent powers more

more imperfect than simple water. 71
Therefore we consider the menstruum as
water. —— Division of the Solvend —
There are various preparations of cookery
which divide our aliment, beside mas-
duration, which is a gross triture neither
long applied nor going to minute division,
it only breaks down the grosser texture, and
admits the water more intimately. The so-
lution then is carried on by the powers of
the menstruum. A trituration was suppo-
sed to take place in the stomach, as in
the gizzards of our domestic fowls. But the
mechanism of these and the human stomach
is different, the Hypothesis has therefore been
deserted for these 40 years past, and therefore
Borelli and Pitcairn need not be refuted. We

are not interested in their disputes. We now say that in digestion, all that the stomach can contribute is by preserving the whole mass in constant agitation. The chimic hydraulic is very inconsiderable. The solution is promoted by the agitation, by diffusing the saturated portions and applying the less saturated. I must take notice of a trifling particular to explain this. We must not have the idea of stirring up from the bottom a body that subsides to it, the contrary here is the case viz to beat down from the surface, a body floating on it that it may be properly diffused. This agitation is performed by the peristaltic motion of the stomach. Their assistance

are placed in the action of the Deaphragm and abdominal muscles; they have been said to triturate but their powers are but trifling in that respect. Their actions are alternate, therefore their pressure is in proportion to the resistance they give in their alternate dilatation. It would be still more trifling to speak of the pulsations of the aorta or those of the arteries of the stomach and neighbouring viscera. The last assistance is that from heat which is a principal means in expediting and producing solution. But it has been too much exagerated. By being said to be nourished by the heat of the liver and surrounding viscera, leads to the consideration of a focus of heat. All heated bodies preserve their heat accor-

74 ding to their Bulk; hence the stomach preserves its heat more steady and constant. It would be thought that colder matters taken in would bring down the heat of the stomach, which it would do if it was not for the heat of the contained mass. This heat is not above 100 degrees of Farenheits thermometer, if greater it would coagulate vegitable and animal matter. It is sufficient to favour the solution. I have added that perhaps air is an assistance of solution. It is a curious question to determine if air does occur here and in what manner. It is taken down the oesophagus by the mucus and aliment; it is in the stomach rarefied and expanded; and the changes of the air must considerably contribute

to the azilation; more so than the other 75
powers. Perhaps also it operates in a different manner. These animal powers do not go far, nor is the solution here any way considerable. The animal matters are more dissolved than the vegitable; but it is their softer parts, while the membranous coat almost untouched. There are then other powers of solution in the progress of the matter along the alimentary canal; and the dissolution is much more strong. As to vegitables they are still less liable to be dissolved, and the fibrous parts of these do keep the alimentary canal almost untouched. Seeds also escape in the same manner. Such is mustard which is not broke, but a little

76 swelled. By the effects of mastication and maceration the fluid parts are dissolved and washed out, and in a great measure the cellular texture is broke down if not minutely diffused; this effect takes place in vegetables, and the operation is more intire in animal food. I will say that these powers are not sufficient for the effects I have spoke of, and we must look for other assistances.

Lect: LXII. Feb. 18th.

Many think that all that is necessary to our animal aliment is solution, and some think so also with regard to our vegitable aliment; to wit the nature of the menstruum and assistances of solution just now spoke of. All the power that Boerhaave and many other physiologists think necessary I have 77 acknowledged; but still the solution is not perfect; the more properly solid parts being known out. We could not by the assistance of solution, in the same time, operate solution to the same degree out of the body. It is enough to say we know, other powers are added, viz: the power of Fermentation in its largest and general sense; as comprehending vinous, acetous, & putrefactive. This we shall shew presently, is fit to break down the most solid parts of animals or vegitables; And I admit Haller's opinion that it does so, because it extracts the fixt air. If you read over Haller, you will find him present many doubts that

we shall have occasion to discuss. In the 648th. among the other means of solution he adds "Vorts

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"

parat". All very fair and a certain proof that fermentation has the power of breaking down the cellular texture and of preparing room for the fluid more freely to enter. But this does not happen for the reason that he adds "Sed

"

adparent." We know nothing of air as being the solution of most Bodies. Now by the several powers mentioned the solution of our aliment may be understood for the most part, in the case of all those vegetable or animal substances that have

a water for their menstruum. But there is manifestly present an oily matter, it may be a question whither it be really dissolved, and I must not discuss it till after. Tho' I think it is dissolved, yet it is undissoloid in the stomach, where as well as in the chyle and milk of animals we find it in its diffused state, but it is exactly diffused as appears from the white colour. We shall treat it under diffusion.

Therefore I pass over to the second effect of the operation of the stomach, viz:

Diffusion

Many have said that the solution of oil goes further, and have talked of the saponaceous fluid. I donot see any evidence of this in animal fluids; But if we regard its effects in diffusing oil among water, or

80. if we consider the foundation for such a supposition in the composition of the animal fluids, we can perceive no such thing, much less can we see it in the power of dissolving oil. and yet these are the only circumstances of saponaceous quality. I find this equally a property of every viscid fluid, and of certain clays diffused in water. The viscid fluids by their adhesion will give an opportunity of diffusion. Next we see no foundation for it in the composition of animal fluids. Salt and oil are in animal fluids but it is not without other ingredients. It may be an acid, an alkali, or a neutral soap. There is no certainty that there is either one or other; and indeed there is no probability of either of them. Thirdly as 81 to the mixing oil and water perfectly, there is no foundation for this in experiment. After a variety of trials upon saliva, mucus, and bile no diffusion is obtained, much less mixture: What union takes place is just in proportion to their viscidity; we shall speak of the more intimate union of oil afterwards

Assimilation

This is not perfected in the stomach but long after, in other parts, tho it is begun there. To enter upon this I have said that the aliment of animal bodies is properly vegetable substance. And I have alledged that vegetable substance in its nature and qualities differs

from that of animals. The change that produces the resemblance, we call assimilation. How it is doubtfull whether we should begin with explaining this difference, and enquire how the change is produced, or leave out of sight the changes produced, and first consider the means employed in changing, and from these determine the effects. Difficulties occurr in either way. The last is the most secure method and we therefore prefer it. Upon this plan then, I say a fermentation occurs. Here the ferments of the Chimists and Cartesians, were brevi manu and generally rejected. Opinionum commenta delet dies. But it is universally agreed that there is a fermentation; it is foun-

ded first upon the nature of the aliment which is disposed to fermentation. I advanced that a sacharine matter is the chief foundation of our vegitable aliment. Haller is wrong in rejecting sugar as one of the condimenta. If the experiments are true, the number of men and other animals, that live upon fruits of trees, of figs and dates, where a sacharine matter is fixed, must certainly receive their nourishment from sugar. But further the vegitable substances which make the chief part of our aliment are the farinacea; now if sugar is the basis of the fermentable matter, it is a proof that the matter of our aliment is of the sacharine kind.

84 Therfore we presume a fermintation of the aliment, so fermentable. Further we say it actually does in all cases ferment on the human stomach. Our aliment suffers inlamiscence, the intestine motion of it extricates the fixd air. And from our digesting food of vinous or acetous disposition there is no doubt of fermintation. Now we can say that none of the circumstances preventing fermentation have that effect. and first in this fermentation a degree of heat has not. In ordinary fermintation the heat must be somewhat less than that of animal bodies. But tho that be the case in the fermentation of wine yet

we know that its fermentation will go 85
on, in countries of higher degrees of heat, and tho' they be in close vesels, yet if they have a quantity of air included it is sufficient to carry on the fermintation to a certain degree. But there is air in the stomach. I said that air contributed to solution from its making agitation take place, but it is necessary to extricate the fixd air. A third circumstance hindering fermintation was the mixture of animal substance, which resists the vinous or acetous. But the experiments of Pringle and Mobraid have shown that they bring on and affect fermintation. The degree of heat,

the air and mixture of animal matter
there, all help fermentation in the sto-
mach. I maintain that it is by a pro-
cess of fermentation that our assimila-
tion takes place. From the general kind-
ey of animal matters it has been thought
they run on to the putrefactive fermen-
tation. But I say the fermentation is
not directly putrefactive; as that fer-
mentation does not directly take place
without the other two preceding. The
vinous passes to the acetous, and that
to the putrefactive. Most Chemists admit
this, that it can not be determined to the
putrefactive fermentation without going
thro' the acetous, nor into the acetous

without going thro' the vinous. I main-
tain that in the human body this is the
case, and in fact we find it so from
experiments out of the Body. If we put
them into proper circumstances with
regard to heat and air, we see that they
constantly run their course, of passing
from one fermentation to another. Obser-
vations in the body shew the same thing.
The vinous is perhaps not so evident,
but it is observable; and more certain-
ly is the acetous universally observed.
Most Physiologists are ready to admit
the vinous. Pringle and Mobraid main-
tain the vinous to take place, and it
is established by the production of a sim-

galar. vapeur, the gas silvestre. Boerhaave called it the "destruum fermentum"
It has all the qualities of mephitic air.
We have too many instances of this gas silvestre produced in the stomach so pernicious to animal life. But the mixture of animal fluids modifies the vinous fermentation so that the gas silvestre is prevalent. I think here then that either the vinous or acetous fermentation constantly takes place. A question remains, to what length the vinous proceeds, if constantly to the acetous?

Lect: LXIII. Feb. 19th.

I had begun the means of assimilation & said that it was a fermentation, from

the nature of the aliment, the phaenomena that occur, and the experiments that have been made: and I added that none of the experiments quoted to the contrary had any effect. I said that vinous and acetous fermentation takes place from Dr Pringle's & Macbride's experiments. A question may be put whether the vinous passes always to the acetous, or ends in the animal mixture. It is extremely probable that our aliment undergoes an acetous fermentation, & it is the natural course of the vinous to proceed to the acetous. Further no circumstance in the stomach should prevent the vinous going the length of the acetous. I took off the objections of heat and shewed it not incompatible with the vinous, but only

90 of difficult management, and that it
hence is determined to run to the acetous.
Boerhaave concluded that the heat here
was incompatible with the vinous fer-
mentation. But the air here is compati-
ble with vinous fermentation, and still
more favourable to the acetous. The next
question to be put here is whether the fre-
quent acidity is natural, or always to be
considered as the effects of a morbid state.
Undoubtedly it is a morbid state and the
acetous fermentation either goes to too high
a degree or subsisted longer than the oeco-
nomy appears to shew. But we conclude that
there are means for covering the acidity
from hence that in innumerable inst-
tances where we know it takes place

91 it does not prove a disease; Many obser-
vations shew acidity to be almost con-
stantly present, as appears in ruptures
and vomits, where it shewed it self by no
morbid symptom. Every body will allow
that there is a provision in the oeconomy
it self for correcting acidity. But these in-
stances are so frequent that they lead to
believe that the acetous fermentation is
constant; you will find these proofs in
Haller and every other Physiologist. He
says there is no animal without an
acid. Not to speak of the ruelus and
acid flavour of the Breath, if there are,
as I believe there are, observations where
the acidity did not, and an alkaline qua-
lity did appear; this however is a very rar

92 case; and we must say that the acidity is produced it is coved again: And there are diseases that cover acidity and carry matters to the other extreme of alcalescency. Therefore the fermentation is universally and naturally acetous. What is the use and purpose of it? I think to answer this it is necessary to stop our present consideration, and to consider the late and present state of the theory of chylification. After the theory of menstrua contrived by the Chemists and adopted by the Cartesians, had been rejected by the mechanical physicians, they substituted another equally exceptionable. Herne Boerhaave gained just reputa

tion by moderating both these theories. He rejected the acid or alkaline menstrua of the Chemists and Cartesians: and he could not miss to perceive that no force in the stomach could be equal to trituration; and therefore he reduced that to azelation, the alternate action of the Diaphragm & upon the supposition of the menstrua which he adopted. But in both respects he fell short; he went no farther than to account for solution; the assimilation he did not attend to, & he rejected our fermentation which did not escape him altogether; he took notice of the fermentiscere incipiens, and contrived the means by which he said it was checked. but his theory does not account for the change of vegitable to animal substance.

He indeed, on the other hand considered the vegitable nature not changed, but that it disappeared by the addition of more and more of the animal nature. In the 120 P. after carrying the aliment to the subclavian vein he says "ad assimilationem corporis". I say he insinuates that the vegitable nature disappears in this way of animal nature. He does not shew us the means how it should be yielded to be blended with, or converted by them. In the next Par: he shifts the question. After pointing out the body contained in these four elements has not in one instance explained the matter. Let the vegitable be but 1000th part of the whole and the rest animal, yet as the animal matter is constantly lapsing off & the vegitable constantly taken in, the animal should lose in time all its animal parts and be entirely vegitable; there is therefore a change of quality. Boerhaave, a man of so much judgement, did not miss seeing this, and endeavoured to account for it by a mode of reasoning in his 700 P. which has prevailed universally for 50 years past."

"
"
" nlmitur". In the next he says "ut ducbus
"
"
" sunt". In the P. he urges the same with regard to the

96 heart "

"

" ". and he concludes "sic
evidebur de". the whole conclusion is
that the particles of the chyle are brought
to be of all the possible sizes; and because
they are brought to be perfectly round
they are fitted to pass thro' every part of
the body. Forma implies figure, but we
use it for the complex sum any body.
you only learn that it is brought to a cer-
tain size in N. 247 "

"
"
" accommodatius". all this
has been adopted by the schools of physics
for 40 or 50 years past. I have shewn that
all the changes of the particular qualities

of Bodies are performed by seperation 97
and combination. There are Bodies un-
changable by any power in our system;
these are atoms or elementary particles.
all the other changes are in proportion
to the various proportions, and arrange-
ment of these as to one another, and all
is performed either by addition or subtrac-
tion; all by chemical combination. No
mechanical force can break down a mix-
ture; you may by that means break
down an aggregate into its integrant
parts. so in an acid and alcali, you
may rub off a corner or make a hole
in another part. The whole of this Car-
tesian and mechanical philosophy seems
to be extremely ill founded and admissa-

98 ble no where. We must seek for the change in the chemical qualities and enquire what is added and subtracted. See Gaubius's 600 P. "

" Blanditiem creando" Hear how he answers it " non satis constat "

"

"

" quadrate". I wish he had said it would neither apply to fluid nor solid. he adds "

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" ". Indeed Boerhaave does not intirely shift the question of assimilation. But what he says of it is neither admissable as means nor does it explain the matter. Haller in his sanguinis natura & 99 indolis, has hardly touched the doctrine of sanguification, but he has spoke of it in P. 769 in an ambiguous, undetermined way " Sanguini "

" this he hints at as the means.

" nune

"

" not a word more; it is changed, but except repeating circulation &c. " mutatur ita

"

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" diluat". What is pointing out effects as so many facts but does not in the least shew the manner in which they happen. Look at his greater

100 worth; the 900 page of this second volume, 8th section of the Book "Quid de chyle ufiat;" this he comprizes in half a page and hardly says more than what I have quoted from his Primae Lineae

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". wherever you see that dead roll of vague terms you may conclude there is nothing under "

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". these are general causes of general effects, but they do not touch the particular production of the application of animal fluids. You see from this how much demand there is for an attempt tho' it should be but

in the way of conjecture. The disinguishing 101
ing part of animal matter from vegitable is its more ready and spontaneous putrefaction, and giving out matters that did not appear in the intire vegitable and only in the vegitable when putrified. There is an intermediate state between the putrid and nascent vegitable. We want to account for that. It might have been thought enough to have taken it up in the course of fermentation. I must own that it is not easy to find that from any observation in nature else where. There is an acid and a mucus that likewise appears, but no art seems capable of stoping it at that intermediate state. When animal mat-

102 tors have lost the qualities of vegitable they are not advanced to any state that we can call animal. I think the chief question with regard to the inter medeate state is whether it is not the vegitable matter runing its course, or a portion of the animal fluid that has gone further. In the human species animal fluids run fast into putrefaction, unless they have a constant supply of vegitable matter, this is evident in the case of survey and fasting. It is probable then, that the proper animal fluid consists of vegitable and animal mixts. What means does that happin? Perhaps it may be of simple unfermented vegitable as Boerhaave has advanced. But I can not allow that because a fermentation always takes 103 place. Therefore I conclude that there is fermentation, and I consiquently conclude that fermentation to be necessarily ne[illegible]sent. I know one experiment shewing that the mexture can be performed by unfermented vegitables; and I now add that vegitables in their vinous state can not be combined in mexture with animal matter.

Lect. LXIV. Feb. 20th

I would undertake a proof that the whole business of Chylefication and Sanguification is performed by a chemical, not at all by a mechanical operation; I observed that it appeard from the whole history of the human

oeconomy from scurvy and fasting; that the animal fluids can not be preserved but by a certain mixture of vegetable and animal aliment; and the question is, in what condition the vegetable aliment applied to the animal fluids: Perhaps, I said with Boerhaave, in its entire state; but I imagined the vegetable undergoes a change; first vinous and then acescent. I said that the mixture of vegetable and animal was incompatible with experiments and analogy. I think all the observations that support fermentation in general lead to an acetous fermentation. Vegetables in their acetous state may be mixed with animal fluids; the mixture of vegetable acids with Bile is an

exception. The bitterness of the Bile, and acidity of the acid are changed and the yellow colour of the Bile is changed into a green. The acid appears very frequently in the stomach it very rarely appears in the intestinal canal after the bile has been applied; and it seems to be a purpose of the oeconomy to cover acid with Bile. Now it is enough that I have given you what appears to be the probable theory; that the production of animal fluid is by a vegitable acid prepared, and that the rest of the work is finished by the application of a certain portion of animal fluid. The saliva and gastric liquor begin the business in the stomach; the covering the acid is only performed, as further advanced, by the

effusion of the intestinal liquor, and the pancreatic juice, the former is akin to the gastric, the latter, to the saliva; and lastly by the bile. But the influent lymph in its passage thro the lacteals to the thoracic duct also helps. Further these united masses are poured into the common mass of blood immediately before it is applied to the lungs; and tho' this may be a principal organ of sanguification, yet it is not finished here; if the blood does remain in diffusion it is not finished but in the common blood vessels and general circulation. I shall say how much nearer we can go when we come to talk of the blood in the greater vessels; each of these means would bear a good deal of discussion. The

covering of acid, as I have said, depends on the animal fluids applied. The spitatores have their stomach liable to acidity; and when the peristaltic motion of the stomach is weakend by various causes, the acidity appears, because that weather action does not emulge the exhalent arteries, or bring out sufficient gastric liquor. Whatever diseases in these organs detains our vegitable aliment a certain time beyond its natural length, gives occasion to acidity. These prove without doubt that the fermentation of the stomach will run on to acidity, if it was not covered. From this theory we can see why nature, for final purposes, as she does in other cases, has made acid stimuli to the stomach, that by bringing out gas-

tric liquor, it may provide its own remedy. Beside the use of the Bile in covering acidity in the intestinal canall, by it the oily and watery fluids are blended, or diffused, if you will, into a more homogeneous fluid. The Bile has no other quality to do that than by its acidity; Oil is not only diffused, but it seems to be absolutely mixed; does not appear in the blood in its oily form. In what manner is oil made to enter into the proper animal mixture? It is probable that it is by the union of acid. It would require some chemical detail; but the affinities of acid and oil are well known; so all mankind are led to take oil in their aliment; and we choose to take oil in our fresh vegitable aliment, that especially which is [illegible] acescent; these must 109
mutuall contribute to cover each other. Both acid and oil do disappear in the common mass of Blood; there chyle is formed. I can not say but it is absorbed by the lacteals, and exclusive of other matter. So nature pours out fluids into other cavities which are again taken up by other absorbents. But the anatomists have never been able to fill the lymphatics by their extremities unless where they wound them, and then they absorb water oil &c. Many observations are against us; and promiscuous absorptions especially appear in the lacteals. They do absorb other matter, but only in so far as they are dissolved in the

110 chyle. I observe this with a view to the
seperation of the faeces from the chyle.
Very probably a putrefaction takes place in
the intestines, which forms a matter that
is not miscible with the chyle. What is re-
jected is pushed on slowly thro the canal
till the more fluid parts are taken up
by the absorbents. Whether or no the Bile
occasions a particular precipitation, and
whether a considerable portion of the faeces
are formed in this way you may judge.
How far putrefaction contributes may be
another question. In the purest water
putrefaction seperates a substance more
or less earthy; hence Bales, to obtain a
pure water proposes a putrefaction of

it. In some measure matter may be thus
far made fit to be carried along by
the chyle. It is certain that the animal
fluids themselves furnish a quantity of
feculent matter, as appears in the mecon-
ium. Further, as to the question in the
further progress, the chyle is taken into
the lacteals, and mixed with the Lymph
refluent from every part of the body.—
What change this makes is difficult to
say; I will make some remarks on
it. In every cavity of the body to prevent
corrosion of parts there is a fluid exhales.
What is its nature we know not, or whether
it be promiscuous; the probability is that
it is of a particular nature only. This
fluid is reabsorbed but not directly returned

to the common mass of Blood. It is returned, after mixture with the new taken in aliment in the receptaculum chyli. As to the nature of the conglobate glands, I can not say what change it there undergoes, but there appears a change. I will point out a fact, that from the vastly larger size of the conglobate glands, as the animal is younger, they seem to be particularly adapted to the infant state. Scrophula affects the lymphatic system which which last is different at different times of life. This disease commonly attacks us in our younger years; on the other hand I am disposed to say it is limited, and does not occur under nine or ten months after birth, and in nine out of ten it occurs after two years old. What it implies I own is very uncertain; your conjectures may be as ingenious and solid as mine. The next change after affusion of lymph, is in the lungs. On the business of sanguification much has been said, notwithstanding which it is as uncertain as ever. The frequent and constant change, in the capacity of the vessels in the lungs, gives an opportunity for a more accurate and perfect mixture, especially as all the matter proper to be mixed are brought together. Much has been imputed, by the mathematicians, to the pressure of the air but that is now reduced to a very small matter. We allow that the pressure of the

air is somewhat, but it is demonstrable to me to be inconsiderable. It can only contribute to the mixture; and no other effect requires any further notice. They have thought of first absorption of air but that theory begins to be almost intirely deserted; The absorption may be admited as possible, but is not easy probable, they may entangle and inviscate air. The mass of air entering by the alimentary canal is much more obvious. Various have been the theories on this subject, but the progress of chemistry has corrected them. So even the theory of Brian Robinson is not supported with regard to the acid of the air, much less will it be applicable to the lungs. The change of colour happens there, which we will inquire into after this. It can be produced to a certain degree without the application of the air. Instead of absorption we must think the chief purpose is to give opportunity for an exhalation. A mephitic air exhaling from the lungs is no longer doubtfull; what are the causes or purposes are not determined. We may say that mephitic air arises from different bodies in consequence of mixture. The putrefaction into which animal bodies run may be said to produce it. The venous blood may then, require ventillation to give occasion to exhale that, now loose lying mephitic

air, and it is not to be taken off but by the application of common atmospheric air. This is a conjecture. But this explication may be connected with the preparation of Blood. It is possible then that the exhalation depends upon moisture and that the application of the staple gives a separation of mephitic air. But that too is a conjecture and the subject this important has but lately been started. I would allidge that all the past theories as to the effects of respiration may be readily thrown a side. I need hardly say that the mechanical figuring and forming particles of size and shape is to be entirely rejected. I shall now take up the fluids as they move in the larger vessels.

Lect: LXV. Feby 23d.

With regard to the employment of animal food we know nothing more than the solution of it, tho' I am persuaded it may admit of some other changes than solution. Observations say that there is an acid present in the stomachs of carnivorous animals; and that the pure exhalations of animal food with the admixture of vegitable, is capable of acescency; but these observations are not confirmed, nor are the experiments, mentioned to support them. Therefore we must now consider solution alone, or be open to new light upon the subject. We must next consider of what nature and

quality the Blood is in the vessels. Dr Cullen's essay de spontanea sanguinis separatione has prevented me in throwing light upon the matter. And Haller on the nature of the Blood seems to keep by the opinions that were 20 years ago; except in a few particulars. First our common mass of Blood appears to be a homogenious, but it is a heterogenious aggregate; I shall therefore speak of it as such and shew its different parts. In the larger vessels we should not perceive its parts, if it was not that upon stagnation there is a suspension, which must guide us in our whole enquiry, and therefore. First. If blood be drawn and exposed to the air, we perceive that it is a smoaking fluid, and in a short time loses a portion of its weight. This has of late been spoke of under the title of halitus sanguinis. and that will be greater or lesser according to greater or lesser heat, or surface. It concretes into a mass in a temperature lower than that of the body. The mass at first appears homogenious, and afterward, goes into two distinct portions. The red part remains in a concrete state, and by degrees gradually becomes more and more firm. Also we find a considerable quantity of fluid surrounding the red mass. This is the separation of the Blood into crour and serum, and is the most common

ly known; But the spontaneous seperation goes further, and the crust goes into two seperate masses. The one retains much of the nature of the crust. above it is spontaneously seperated a yellowish white mass more firm than either the whole crust, or that which is below. This is called the inflamatory crust. Till of late it was mistaken for a morbid part of the blood, and it is only within this 100 years that this seperation even as morbid has been taken notice of. But we know that it is common and is a constituent part of the mass. Put blood in a porous cloth and pour a quantity of water upon it; the water will carry the red part through

and the will remain a part. In every respect like the spontaneous seperation called morbid. In 999 times of 1000 we can shew this matter present in the blood of man and I believe of all other animals. Hewson who of foreigners, first pointed it out, calls it coagulable lymph. Haubius stiles it fibra sanguinis; When the crust is let fall into very warm or cool water a portion of this seperates into fibrin. They supposed it a constituent part, and the mathematicians could hardly convince them that the passage of such a mass thro' the canals of the human body could not take place. We want a proper term for this new substance; the term coagulable lymph is a

long-wood and amberguris as if there was a lymph not coagulable, we shall speak of this under the title of lymph.

If the serum is exposed to the coagulable heat it coneries into a firm gelatinous mass, and when cut down into small portions, it shews a thin watery fluid: subsiding from it which is not of the same concreting nature. The whole of serum universally is of a saline taste, and more and more so as the water is seperated from it, it also resembles the coagulable lymph. Further this fluid exhales with a gentle heat, and if applied to the concreted serum the portion exhaling becomes considerable, and the other becomes firmer and firmer.

In this too the coagulable lymph resembles it, and by the same sort of drying may be brought to the same horny substance. Now both the one and the other collected in proper dishes have the same sensible & chemical qualities. Whether the halitus has not more air I shall say by and by; it is to be considered as the volatile part. Hence these parts of the blood, the red globules, the coagulable lymph, and the serosity. These are the constituent parts of our common mass. There are also other parts, but whether they are constant and make a natural part of the whole, we shall enquire hereafter. These three last mentioned we shall consider as the principal.

124 They are kept very uniformly blended together. When blood is taken from a large orifice, and received in a vessel that can be closed, and is kept in the heat of the human body, it preserves the same fluidity as in the body, and no separation of its parts takes place; this we impute to heat and diffusion. I conclude heat to be a means of fluidity, because all the circumstances be the same, and only cold supervene, there is a proportional convention as the vessel becomes cooler. Convention is therefore merely from a diminution of heat, but it does not take place unless in a separation of the mass. If the blood is received in a close vessel, or one with

a very small orifice, there is a convention, but no separation. And this happens because the fibrin has not escaped; for when the blood is taken into a vessel with a pretty large surface, there is always a separation, and the other circumstances mentioned. The fluidity depends upon heat and mixture, separating every where; the parts disposed to convolute and bodies united merely by the attraction of cohesion seem to require time to separate, as we see in the superficial cohesion of water and oil, And this will be various as the adhesion is stronger or weaker. The convention will also be prevented more probably, as there is more of the fluid that does not convolute, interposed between the

concerning fluids: suppose the lymph reduced to its smallest particles, and to be surrounded with serosity, with which it has not such an adhesion, as its particles to one another, they may be long kept thus separate. If a few particles are moved up and down they must constantly accrete. By insinuating a body that attracts the lymph more strongly than the serosity does, we will accrete on a serosity, as by putting in a stick, the stick unites with the lymph and we extract almost the whole of it from the serosity. This was Hewsons experiment. He by beating with a rod, brought out filaments more or less of a membranous

appearance. And in that way of a quantity of blood was received into a closed vessel, the cool, a spontaneous separation did not take place. Now the effects of heat, of diffusion, and of the application of other bodies being considered, we can see how the separation in various circumstances, takes place, more or less. The blood is disposed to separate into three distinct parts; by stirring we prevent the diffusion, till the whole concretes, and becomes uniform. If the blood trickles down the arm, that is a degree of agitation that prevents coagulation. If you destroy the fluidity before time is given for the separation to take place, and so if you take

blood into a cold vessel, with a flat surface and allow the it to trickle down the arm, much more if you receive it into a number of small vessels, you will have no separation of coagulable lymph. We consider the separation of lymph as a mark of the inflamatory state of the blood. But you see the absence of it gives no proof of the absence of the inflamatory state, unless you shall have guarded against all the above circumstances in taking the Blood. We are ready to say that the blood is more dense or more fluid as there is more or less of serum, but if you judge so abstracting from the size of the orifice, the manner of its flowing, its being

received into a cold or warm vessel, & more as there is more or less accidental stirring, & more or less time given for a separation, such a judgement of the state of the blood must be very falacious, as it must vary more or less according to these circumstances. And there are extremely few instances in which we can form any judgment of its state while it flowed in the vessels. We judge of the density by trying the crust, and we take a knife to make the trial. But suppose we should, with Brian Robinson, take a glass tube and load it with quicksilver, and examine the weight that would break through it, still the falacy lies in the circumstances

129 mintioned above. As it is more or less de-
tached from crucr or serosity, the form of
its connection will be very different.
When coazulating lymph separates spon-
taneously it puts on two appearances:
first when its makes a thin layer on the
surface of the crucr, it shows more con-
tractility and is drawn in like a purse,
forming the crucr round it: and there is
in that case a greater proportion of serum
in the blood. The other case is that the
coazulable lymph forms a much thicker
layer on the surface, is expanded and
takes the form of the vessel, and the
quantity of serum is greatly less. These two
appearances I have not yet connected with
particular states in diseases nor with exter-

nal circumstances. But it depends upon 130
circumstances, such as separate serum
from coazulable lymph. There is also a
means of interrupting the serosity in the co-
azulable lymph, more or less, but we know
not what it imports in the state of the
blood. ——

Lect: LXVI. Feb. 24

I took notice of the various external cir-
cumstances that influenced the spontane-
ous separation which is ordinarily into cru-
or and serum; and at other times the
crucr goes into two parts, the serosity, &
coazulable lymph. I said they all influenced
the mode of coagulation; And that the judge-

ments of physicians were on a very uncertain foundation, on this subject. I advised that the particular state of diffusion which they had while in the vessels, and the immersion or contact of a dry and solid body influences the separation. This may take place within the vessels, if they have constantly a fluid exuded upon their surface, and which prevents the accretion of the lymph, with the dry and solid parts. Polypi happen in the vessels; in any one portion of the arteries, but especially in the cavity of the heart. If any portion of the vessels becomes dry, a polypus takes place. If the edge of the lacerated membrane is prevented from closing by the blood,

it is not defended by any exudation, and therefore an accretion of coagulable lymph will be formed round the orifice; and this it is that causes the thrombus, in the case of the wound of a vessel. (see Hollis)

The Nature of the constituent parts of the blood. — Red Globules. —

The red globules have, till very late, from the time of Leuwenhoek, been considered as not differing in nature from the nature of the Blood, and only by mechanical composition or aggregation; that they are the same with the serum, but that a certain number of these will form a red mass. Leuwenhoek imagined that each red globule was composed of six others, each of which

133 composing the red globules were made up of
six &c; he resolved the second order into
six others perfectly pelucid; this opinion,
however begins to be discarded; it is a ques-
tion in fact that does not admit of reason-
ing. It is enough to say that hardly any
other microscopical observer has confirmed
this opinion; and many other physiologists,
among whom are Dr Senac & Haller, can
see nothing like his composition. Gaubius
advances doubts that he has met with no con-
formation of. But if they are not a different
matter why do they appear in a different
form. One solution is to suppose them of this
quality, that they are not properly miscible with the other parts, as oil and water

the particles of which as the water, can be dis- 134
tinguished and always appear of a globular
form. Gaubius enters so far into this that
he finds these globules properly oily, while
the greatest part of our fluids are of aqua-
tory nature. But we can not admit them
to be oily as they are diffusible in water,
and diffusible to a greater degree, in our com-
mon mass of Blood. Their separating by them-
selves is not enough to say they are oily, nor yet
their being inflamable when they are dry: there
may be oil in them to account for these pro-
perties, as we see in the case of many sub-
stances. I think they are not to be ranked
among pure oil; they are always of a de-
termined size. In that there is no mystery;

135 If it is diffused in water under a given degree of agitation, the particles shall always be of one determined figure; because it depends upon the degree of ~~adhesion~~ division, and that upon the adhesion in the diffused matter & on the degree of breaking down. They are specifically heavier than the other parts, and occupy the lower part. Several have supposed that they have in themselves very little adhesion: but that is very difficult to determine as they have an adhesion to coagulable lymph which we can never entirely separate; it would appear however that they have very little cohesion; for it is manifestly lost and left as we separate the lymph. We know of no mixture of any portion of animal flu-

136 ids that brings them to the same colour; not is there any thing in the nature of the globules that has any connection with a given colour. But the various changes that we perceive it to undergoe in the different parts of the system we perhaps understand better. Sr Isaac says, as they are accumulated & laid upon one another, they become redder; I think upon this we can account for the variety of colours in our mass of blood, which we discover by the complexion. The ordinary colour is in consequence of the other parts being diffused and dividing the red globules to a certain degree. All blood is more florid when drawn out of the vessels than when the serum is separated: and the colour is

darkened in proportion to the separation of the serum. And when the lymph is separated they still become darker. When the serum is separated, we find the cruor more florid above, where it is contiguous to the air, and darker at the bottom. When the separation has taken place, after the mass of cruor is so intire that you can take it from the surrounding serum, if you invert it, the florid surface now at the bottom will take on a darker tinge, and that which was at the bottom, now at the top will become florid. The cruor is nimore than a porous mass, and the thinner serous parts make their way to the top & dilute the cruor. The experiment is more

left perfect according to the density of the serum, and sometimes it will take to the sides and shew florid spots. You produce an efflux of serum in wounded parts and more florid colour; & the same thing explains the difference between arterial and venous blood. Haller is very fond of denying this diversity of colour in the venous & arterial blood. V. 136 "

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"
" diversitatem". We could shew that it is difficult to shew the proper experiments. With regard to colour "
" videtur". I can however venture to suppose the venous and arterious blood differ in colour. The arterial blood,

in the extremities of the arteries parts with some of its more fluid portion; there is a quantity exhaled and vanished, and a quantity that fills the vasa minorum generum. The portion that goes off by the last is returned to the veins but separate: In the veins there is not the same impulse; nor is it perfectly mixed till it has gone thro' the lungs and passed the right ventricle of the heart. I would conclude that several phinomena might here be explained; that in the arteries, the several parts of the common mass are more perfectly diffused, and the spontaneous separation is much less; but taking blood from large arteries has been too seldom practised to throw much light on the subject: The difference of the saline matters in the blood does not seem to conform this. The alcalene and neutral salts give the blood a more florid state, as these matters that give coagulation more quickly give the blood always a darker colour. No doubt then that the difference of colour depends upon the quantity in which the red globules are gathered together. The blood is seemingly applied in the lungs to give the blood its red colour; but it appears in the chick in ovo before any blood air is applied to the lungs. The experiments have been made in vacuo and with the same change of colour since, a member of the academy of Turin has experiments shewing very plainly that the air

has some effects upon the blood: but they do not render it doubtful that the greater or lesser accumulation of red globules has this effect. It is enough to say that the air operates upon the blood in these circumstances. He covers the one portion of the blood drawn, with oil, and leaves the other uncovered; and the covered portion is always of a lighter colour than the other. We have shown that a halitus escapes. It consists probably of an aerial part. Its separation depends much upon the application of air. The exhalation, then, resolves the blood and brings up the halitus to the surface. We may allow that the air has some effect out of the body, with the other circumstances already taken notice of; but they do not show us that it takes place in the vessels. Next as to the colour. That they are colourless in the minute parts of our body is improbable. Senac supposes the colourless particles of a particular figure, but he is probably mistaken. He had also associates in this opinion; but microscopical observations are fallacious, & vary as you view them thro their diameter or thro one edge, or even the same parts in different shades of light. Vallisnari his associates have constantly found the figures spherical. I must say that the action of diffusion must be to produce the spherical figure only. Haller, in the smallest size of globules, and after many trials, always contends that colour does appear. The red globules diffused in water, and divided to a

143 greater degree than happens in the human body, still retain their colour. I therefore am against Senac's Doctrine, supposing the smallest particles not red coloured.

Lect: LXVII. Feby. 25th.

As we can not account for the colour so can hardly explain any other quality of the red globules. We can not say how its particles are formed. When abstracted in hemorhages, they are soon restored. They are very much in proportion as the assimilating power. Whether or no they are pretty strictly in proportion to the strength of aliment, we shall afterwards enquire. They are formed from our aliment, and at last lose their distinguishing qualities and are carried off by the various excretions. Experiment shew us that they are subjected to putrefaction; If we could say of what use they are in the oeconomy it would be serviceable, but we can not. Jacobi and Haller say, they generate heat. But heat is not to be supposed to exist in one matter of the blood and not in the rest. But must depend upon a matter which may be peculiar, but must be common to all. Haller advances a bold proposition. "Ruber

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" sit". That the heat of the blood is always in proportion to the red globules, and these to it. I know not how he says that a person after a hemorrhagy has, the same way, a greater heat than

he had the day before. It is not constantly as he says. Except the L. which diminishes heat, and which may be supposed to happen from diminishing motions. If Birds have more heat than quadrupeds and these more than men, I do not believe that can be said to be owing to the proportion of red globules. The heat is less in the amphibia but nobody will say that that is in proportion to the red globules. We shall meet with this again in Haubins. What other means do the red globules serve? They are manifestly of the greatest specific gravity of any of the particles of the blood, and therefore they preserve the diffusion more steady. It is probable that some

such means was in a great measure necessary in our blood. If a portion of the lymph is not dissolved, but only diffused it is probable that the red globules have more attraction to it than the serosity, & keeps what serosity is necessary, and allows the rest to pass off into the smaller vessels. Otherwise in a thousand instances we should see obstructions formed. Some have magined their solidity is a counterpoise to the action of the vessels, and their gravity an impulse to them; as to that we can not say. Concerning their solidity, a question has been put whether they are solid or fluid. I take them to be fluid, as all the phenomena can be explained upon that supposition. That they

are incapable of a further subdivision, it therefore solid. is not true; as we can diffuse them to any degree we please in water, till they intirely disappear, and as ~~exactly~~ minutely dispersed in water, as salt. —

Coagulable lymph is the chief part of animal fluids either in quantity or quality. It is difficult to separate it or to have it exactly in the state in which it was in the living body. We can prove it is exactly the same with the albumen ovi, which we may take for the subject of our examination. That it is the same, appears from its coagulating, with heat, acids, alcohol, which qualities it has in common with no other body which we know, and also from its being insipid. Further it exactly resembles it in its manner of hardning upon evaporation, and the appearances it puts on. There is only one quality in which they seem to differ viz: that the albumen does not, without the means of evaporation, seem to congeal in the cold, which the lymph seems to do. But the coagulable lymph, while fluid in the body, if it is infused in water it will afterwards remain fluid in the cold without separating or congealing. The same albumen being deposited in a fine cellular membrane and having less water in it, accounts for that difference. When con-

coeted to a certain degree we know no
means of diffusing it in water again, tho
the division of it depends upon water alone.
the albumen, hardened by evaporation
is difficultly diffusible in water

Therefore this lymph
is the proper animal fluid and out of
which the others are formed, and the body
nourished, as the albumen answers these
purposes in the chick in ovo. Again
on the other hand we presume this lymph
is formed by saliva, & gastric liquor joined
with vegitable acids or vegitable matter
in some other state. This liquor is the
intermediate state between animal and
vegitable matter, but is never vegitable

and putrid at the same time. Putrefaction
is the spontaneous change to which it is
liable: and it is constantly proceeding
to that change by degrees; it loses its
firmness of cohesion; in union with alco-
hol or acids, and evolves saline matters
which I shall not here explain. I have
now to add that it is the saline matter
in generating ~~towards~~ in its progress towards
putrefaction, that joining with water
forms the serosity. This saline part pro-
duced by change in the lymph is what
especially distinguishes the serosity. We
may speak of the attenuation and exaltation
of oils but to be sure, without meaning;

181 and tho' it be here we can not say, in
what state it exists; probably the saline
matters are of different kinds; but experi-
ments to ascertain them are difficult,
and Marggraaf has not been able to speak
of them with any clearness. We perceive
most distinctly an amoniacal salt, of the
same volatile alkali as in other bodies,
but with a peculiar acid, the so much
talked of acid of urine. See Marggraaf
who has taught that with regard to its
effects combined with oily matters, it
does not go so far as to explain any of
the peculiar properties, or even its own
production. Farther a principal pur-

182 pose seems to be to dissolve a portion
of coagulable lymph, even in the cold
to hold it suspended and to form the se-
rum of the blood. Probably in the human
heat it holds the most part of the coagu-
lable lymph. I dare not be certain; for
there is probably a portion of the coagulable
lymph only fluid in consequence of the
means of diffusion spoke of——

Proportion of the Parts of the
Blood. Most Physiologists have formed
bold judgments of this, from spontaneous
separation. I need not say how difficult, nay
how almost impossible it is, in any particu-
lar case to judge from the circumstances

153 mentioned above. It is plain that Haller had no Idea of cruor, which he constantly takes for the united mass of cruor and lymph, without attending to the greater or lesser quantity of serum in their pores. What the proportion of the red globules is to the other parts of the blood, whether a tenth or twentieth is difficult to determine. The lymph, considering how much of the cruor it makes, and how much of it is dissolved in the cruor, makes the largest part of our fluids. It is diminished on the one hand, by its tendency to putrefaction, and increased on the other by the assimulatory power. The serosity depends upon the proportion of liquid aliment, the foundation of which viz. water, is in large proportion in our aliments. I stop here because these things are unavoidably a subject of the Pathology.

As to other parts of the blood, it is alledged that the chyle prepared in the stomach and intestines, in the lacteals or their passages, goes to the lungs so far unchanged, as to appear in its proper form, as is observed in V. S. We must not think it a constituent part of the blood. If we examine the blood daily, we will find this a rare case and ought to

to conclude it a morbid appearance.

Further many of the particulars quoted are by authors of no credit in point of discernment, and with regard to some of them it comes out that they mistook the inflamatory crust for chyle. consider how slowly the chyle is taken in by the subclavian vein; secondly consider its division in a coloured fluid, and you will say it is next to impossible that it can appear in blood taken from a vein. I can imagine it may form milk; but I deny that Chyle can be found in eight or ten ounces of Blood.

However it is probable that the assimilation may not be finished in the lungs, and therefore a further process may be necessary. —

Lect: LXVIII. Feb. 26th.

I said yesterday that the chyle was thought after passing the lungs, to remain in a mass, and that facts are quoted to that purpose; it is however, difficult to believe them. If we consider how large a portion of coloured matter it must be diffused in, and add the diffusion from the venous blood, and the powers of the Lungs in giving an accurate diffusion; we will say it is impossible that it should ever be in a

separate mass. The assimilation of our aliment may not be performed from one application of the lungs; and there may be a portion of our mass in an intermediate state, between chyle and lymph and this portion may have a tendency to vegetability. The like external appearance of milk and chyle has been a strong confirmation of the opinion I at first set out with examining. But few experiments have shewn that milk and chyle are the same; however there may be a portion of the common mass not assimilated. I add that it is lymph deviating from its more perfect nature, towards putre-

faction and forming serosity, and our excrementitious fluids as in the urine. There may be several intermediate steps between perfect lymph, and the saline state in which it is thrown out of the body; and therefore there will be another portion of our common mass. But these two still are portions of the same matter, rather varying in degree than species. But are there not matters quite different from lymph, ens or serosity. A writer of the greatest industry, & I had almost said ingenuity, on this subject, speaks of two other substances, the gelatinous and the mucous part, & and has been followed by Haller and Gau-

bites. By the first he means the same
gelly
we obtain by strong broth. I allege there
is no fact or argument for supporting
this opinion but one; it is not so coagu-
lable by acid, alcohol, or heat as the lymph,
and not so convertible; There is no other
foundation for it than that it is extrac-
ted from animal solids. But the extrac-
tion of gelatinous matter from animal
solids, is not a solution of an aggregate
into its integrant parts; it is the reso-
lution of a mixt into its constituent
parts. If it is the former, it was with
all its qualities as a gelly formerly in the
blood. If the latter, we see it is the effect

of mixture to form a neutral substance,
and therefore it was not with its proper-
ties of gelly in the blood. Geoffroys experi-
ments in the french academy make it cer-
tain that it is a resolution. In extract-
ing gelatinous matter from different ani-
mals, he found that different degrees
of coction produced different matters, &
no one entire substance was got out:
and therefore so clear a demonstration
that the animal substance is constantly
suffering resolution, shews that we can
not judge of the entire state of this matter
in the blood. Take albumen ovi or coagula-

162 the lymph. tho' it does not easily, yet it admits of resolution to a degree that a broth or jelly may come from it. The other matter is what he call the mucus, or mucosity; His thinking that to exist in the blood. is as much without observation as the foregoing. It is true the serum is viscid, and draws out into long threads; and thus far resembles mucus. But will any body say that two fluids are the same because they agree in one thing viz: viscidity. Haller draws the same conclusions as Senaac, because we take in a great deal of mucus in our aliment. But we clear our animal aliment of

their mucous parts as much as possible; 163
nor will the vegitable mucus account for it; and it goes upon a supposition that it passes into our vessels quite unchang'd. Many substances do; but as it is aliment it must be supposed to have undergone change. Senaac uses as another argument its being very copiously secreted: as there is no internal surface of a cavity over which air is to pass but that mucus is secreted from it. We have had a disposition to imagine that every secreted fluid existed in the common mass, but such an opinion is extremely to be doubted. And Senaac can not apply the sup-

164 position till he shews the presence of
mucus; he has strained most surprisingly
to do this. He bids you scrape a stomach
and says you will find the inside of it to
have a good deal of mucus covering it,
which you will find supplied by a fresh
exsudation after scraping, which, he
says could not have been contained in
the crypta, or follicles. But it can not
be easily determined, how much these
receptacles, which are very numerous,
can contain; nor can he draw his con-
clusion without accurate measurement,
ascertaining that circumstance. Beside
this argument proves a great deal too much

and therfore nothing, viz: that mucus 165
is secreted in the viscid state in which
we find it, which is contrary to the na-
ture of secretion, and an observation that
we have made, to wit, mucus, or the matter
forming it is poured into the crypta we
find extremely liquid and acrid, as in
sneezing, which the new secreted mucus
produces; and it acquires its viscidity on-
ly in consequence of stagnation. Further,
can a mucus pass thro' such small
vessels? The fluids universally are se-
creted in a very dilute state and only
thicken by stagnation.

Another part is mentioned with more

166 probability, which we largely take in, &
which is copiously secreted, which again
is reabsorbed, and might be thought an
ordinary part in our blood; viz: oil but I can
not think so. I have seen
extravasated blood, but never saw a
particle of oil in it. It is true there
are in writers several observations of
oil in the blood, meaning on the sur-
face of extravasated blood, or of urine.
But that happens in disease, in which
case there are powers that may separate
it. See in Haller how few facts he has
to produce in favour of the oil being
a distinct, separate portion of the com-
mon mass. I own that we will be afterward 169
greatly embarassed for want of a proper
solution of this kind, but we must rather
desert the problem than adopt false facts.
Oil taken in is deluted in the stomach,
is still more united, in the lacteals the oil
appears there still, but it disappears in
in the common mass. But take the blood
or serum and treat it in any way as
by water, you will not be able to separ-
rate any oil. I think it entirely absorbed
by perhaps an acid of which I spoke al-
ready, and it may be sometimes, tho' in
fact it is rarely evolved. There is an-
other part of the common mass lately

taken notice of viz:

Elastic Air

That air is present in the most part of bodies that we know, and particularly in animal fluids is a fact; but it is present there in an absolutely fixed state and certainly does influence the mixture of animal, as it does that of other substances. Our enquiries however must be as to air in its elastic state, or in such a one as it can easily recover its elastic state. Air is present in all the water of our Globe, and is incomprehensible, but here it is only diffused; for when pressure of the atmosphere is taken off it immediately recovers its elastic state.

It is possible that air is introduced into our Lungs, by being entangled in our viscid fluids; but it is neither evident nor applies to the purposes imagined; and the opinion of air entering by the Lungs is now deserted: It is thought that it is rather exuded from them. It is taken in with our aliment into the primæ viæ, where it appears copiously, and where a portion that was fixed was extricated. It is also present in its elastic state in the chyle, at least it shews its elasticity, by the least diminution of pressure. If it is in the chyle it must be more or less in the thoracic duct. Blood passed under the

reciever of an air pump, when the air is exhausted shews air, but prodigiously little either in quantity or quality. The same experiment made on the urine shews much smaller proportion there. The animal process then fixes this air more and more. Here is again a singular quality viz; that there are powers there that can evolve it, as in the milk, in which again it is in considerable quantity, and in the Bile which has undergone still more of the animal process. The Bile under the air pump, swells to 4 times its natural Bulk. It is present also in the saliva, which shews that here there are powers that evolve it

And while the white colour has been made an argument that milk is made of chyle, the presence of air in it has been adduced as another. But we must not confine nature to one way of operating. What I have said gives you a general view of the proofs of air being present in different portions of our fluids. But what effects it has upon the fluids, and these to be exerted is very doubtfull. There is a difference between atmospheric and mephitic air. When the one, or the other is present, & what power seperates either is unknown. It appears that there are perhaps particular passages that are fitted to contain

172 or transmit air, as in emphysematous tumor produced over the whole body, wch is an operation for the cure of certain diseases, While some suppose it to be in common to the whole of the cellular substance. But as oil &c may prevent that being in common to the whole, others have supposed a particular part of the cellular substance only, fitted to transmit it. Innaxe embraces this last supposition, and says by tearing the cellular membrane an air escapes. His arguments chiefly rest upon the necessity of it, and he says, without it the air would not be prest into a firm solid mass.

I have now finished what I had to say 173
upon our common fluids; but there are
secreted fluids which I must speak of &
we will begin with the function that pro-
duces them.

Sect: LIX. Vid. p. 47.

Many other fluids, as I said, besides the com-
mon mass, require our notice. In a natural
state we have thought that all of them did
formally exist in the blood, and are formed
out of it. This power in the oeconomy is what
we call suretion, altho' it properly implies
a separation of one part from another. If we
consider in how many parts of the body it
has place, and the influence it has in the oe-

Mr Coventry, we must perceive it to be very considerable. See Dr. Hallers introduction to this subject in the seventh volume of his Elementa Physiologiae. He does not pretend to give any system himself, but mentions what has been said by others. I also shall give no explanation of this function; & shall only remark what attempts have been made towards it. The first question is then, whether the secreted fluids did previously exist in the common mass? I have no doubt that they are materially there. But it has been thought that they are formally there, and only let by means of the Diffusion in the common mass. This supposition is extremely doubtfull. as I said yesterday, in milk and one or two cases, which I denied to exist in the common mass; and I even doubted that of all. Yet the exhalation poured into every cavity of the body, absorbed again, and returned by the Lymphatics to the blood is undoubtedly one of the constituent parts of the blood, and approaches in every property to the serum. Also the urine and matter of perspiration, which as far as we can guess, resembles the serosity, formally exists in the mass. Here we may understand the business of secretion, more nearly. The exhalation is no more than the separating the serosity from the red globules; and also the secretion of the perspirable matter, and urine, are separations

one in the same way, leaving the lymph behind. I own that the mucus often resembles the serum: as also the saliva and pancreatic juices, but they differ so much from it, that a great deal is to be accounted for in their secretion, and considerable changes in it take place. But the bile, semen masculinum &c are not to be supposed to exist, in any degree in the mass of blood. As to bile it has been supposed that an alcaline serosity has been conveyed to the liver, and a quantity of oil taken up from the intestines to form a sapo: But this, in fact, is not the case. Bile is not a sapo viewed in its qualities as far as we know. We shall find that such views

can go but a little way in explaining the several secretions. Every chemist knows how ignorant we are of proper mixture in our fluids. And the best chemist will be most cautious, in his application of chemistry to the subject. The greatest part of our secreted fluids are neither to be perceived in the blood, nor the matters out of which we can account for their formation, therefore the secretory apparatus is to be enquired into as the cause of the change. We take in to account, more than the secretory organ. According to the blood's velocity to the secretory organ there is more opportunity given for a separation; and

therefore a great deal of labour has been bestowed upon the velocity of the blood to the secretory organ, and to the angles he it is oblized to make in its progress. But in the first place it proceeds upon the supposition of a previous existance of the form of the secreted liquors in the blood, and that they only ned an opportunity for spontaneous separation. But the whole theory must fall with this supposition upon which it is founded, and which is not well known. Tho' there were matters of different kinds in the blood, the disposition of it is not such as to be readily liable to such separation. If there was no flexosity, no ramifications in the vessels, there

might be an opportunity for such separation. But they are very whose ramified and more so as they come to the ends of their course. A. - a supposed will pursue the course, and the lighter, and of unequal figure will be pushed to the side and go off: but there is no foundation for this. There are ramifications in the shortest space, and what was just now in the axis of the trunk must impinge upon the branch; and this must happen equally to the most solid and ponderous, as to the lighter parts; and the uniform diffusion, will certainly be performed, and kept up in this way. In the case of the bile it is secreted from venous blood, different

from all the others, which come from arterial. There is some degree of separation in the fluids that pass off by the vas mirorum generum, and the exhaled fluids. Upon the other hand every secretion is made from vessels that do not carry red blood, and must have a smaller portion of the red blood than the bile has. so far this is a preparation. All the means of preparation in the course of the circulation is of very little consequence, and it chiefly by them depends upon the secretory organ. What it is, is doubtfull. Anatomists have been disputing this 100 years concerning the structure of the glands, which, and their discoveries have thrown little light upon the matter. They say there are very

where diminishing series of vessels, and that the secretory and excretory canaliare continued vessels; at least the most obvious excretories are formed by the union of the secretories. The secretory vessels pour their fluids into a receptacle between them and the more obvious excretories. All this is performed by a Malpighian structure. Whenever we can observe intervening receptacles, of which we have an instance in the mamma, which a thin fluid when poured into the receptacle and afterwards changed. The question is how a series of secreting vessels can produce the secreting fluids. There is said to be a series of apertures which will let

182 off particles of one size, and exclude others.
But if you go a step further, where the whole
of the chaps is homogenous, you can have
no idea of the parts passing thro' as in
the case of salt dissolved in water, therefor
the notion of different apertures can not
go a great way. But it is true in fact
that different apertures have an influ-
ence on our secretories, upon what footing
soever, as in the fœtus and adult. In Bird
it may be supposed that the matters
in a fœtus may be different from those
of an adult. But we can not discern any
difference in the blood of young and
old in viviparous animals. The vessels

are different; the bile in the fœtus is vis- 183
cid and much than oil is formed,
and are easily refered to the different size
of vessels. There are further different de-
grees of constriction upon the secretory
vessels. Hydrocyanic acid which was just be-
fore separated with its usual taste and
smell, becomes none an insipid water.
We can not easily apply this in the case
of other secretories, as in the saliva.
The fibrae motrices give such difference
of fluids secreted that different apertures
must have effect. Also different impetus must
make a change in the secretions. Every dif-
ferent order will secrete the fluid of any
other order. Hypothesis, not a few, have

been started on this subject: Winslow explained secretion thus; that the several secretory organs were filters, and acted just as a filter first dipt in oil, which will transmit oil, and retain water, and vice versa. But this will not apply. Also the theories of the attraction of capillary tubes have been much talked of; but these are destitute of analogy, founded upon a false theory of attraction; and tho' it may apply in some, there are constantly others in which it can not apply.

As to mixture, the difference of aperture may have some effect. In the decreasing series, if you allow the different apertures

to go a certain length, it is but supposing the various secreted fluids combined. But the whole that anatomists have arrived at is observing in general some different distribution; in some cases that they unite like ~~a tube~~ the of a bristle, and and are curled in others; But they find no shadings in the appearances. This leads to the second set of powers, the interposition of solids. We can suppose mixture, absorption or fermentation to take place. As to absorption we can suppose that by abstracting the thinner, the thicker is left, which gives the chief form to masses: If the aqueous parts are abstracted it will give a thicker

186, but a more concentrated or acrid, as the bile. As to mixture and fermentation, the whole of their doctrine is so obscure, that any thing I could say would be purely hypothetical. We may speak of them in general, but we can not pretend to particulars with any sort of confidence. But that they are to be admitted is certain. For many as great a mystery which was formerly as dark we now know. It is produced from the serum of blood as J of the academy of Turin has shewn, that the serum of the blood is changed into an exact similitude to pus. We see nothing more, necessary in the change of pus. Serum may be effused in the several cavities, and not pass into pus. But still the doctrine is ill foun- 187
ded for many times the matter extravasated in an asphites resembles pus as I myself have seen, and Haller takes notice of it in his collection of Dissertationes academicæ. When the effusion is considerable a quantity of red blood will be mixed with it. There is a certain state of impulse that effuses thinner or thicker serum, a matter more or less disposed to this change. A little stagnation, with perhaps a little exhalation, is all that is necessary with regard to the formation of pus. The quantity and quality of the several secretions, will appear afterwards better, in

188 the Pathology. I might have occasion to collect a few chemical facts, which are, however in a bad condition, and even they will occur in the Pathology. As to the business of nutrition, it is not to be separated from that of generation, where indeed we would meet with a great variety of curious speculations, but this I can not enquire into on account of the situation of my course. — I here beg your leave to conclude my Physiology which I could wish might have been more perfect, but its being my first course will plead my excuse at present: and we will do better another time In the Pathology I shall follow Gaubius as a text book; you will therefore

take care to have him in your pockets. 189.

— the end of the second Volume —