An inaugural thesis on the relation between the sanguiferous and nervous systems : submitted to the examination of the Rev. Horace Holley, A.M. ; A.A.S. President, the trustees and medical professors of Transylvania University, on the 12th day of March, 1822 ; for the degree of doctor of medicine.

GPO 16—67244-1

AN

INAUGURAL THESIS

ON

THE RELATION BETWEEN

THE

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SUBMITTED TO THE EXAMINATION

OF THE

Rev. HORACE HOLLEY, A. M; A. A. S. President,

THE

TRUSTEES AND MEDICAL PROFESSORS

OF

TRANSYLVANIA UNIVERSITY,

ON THE 12th DAY OF MARCH, 1822,

FOR THE DEGREE OF

DOCTOR OF MEDICINE.

BY HENRY MILLER,

President of the *Lexington Medical Society*, and member of the K. A. *Society of Hippocrates.*

"Felix, qui potuit rerum cognoscere causas."—VIR.

LEXINGTON, KY.

PRINTED BY WILLIAM GIBBES HUNT.

1822.

To the Medical Faculty of Transylvania University,

As an humble testimony of the exalted opinion which I entertain of their professional acquirements, individually and collectively, and also as a small tribute of gratitude for the attention and friendship they have manifested, this dissertation is inscribed,

By the Faculty's friend,

And humble servant,

THE AUTHOR.

TO SAMUEL BROWN, M. D.

Professor of the Theory and Practice of Medicine in Transylvania University, &c.

WHOSE distinguished exertions for the elevation of the character of the MEDICAL PROFESSION, and whose exalted virtues as a physician and as a man, have gained for him the esteem and admiration of all who have profited by his instructions, this essay is respectfully inscribed,

By his obliged friend and

Very humble servant,

THE AUTHOR.

PREFATORY REMARKS.

When the exercise of preparing an inaugural dissertation devolved upon me, I experienced no inconsiderable difficulty in selecting a subject for my Medical debut.

The climate of Kentucky, within a few years, has undergone such a revolution, that if no new diseases have made their appearance, former ones have assumed a different physiognomy, and become more aggravated and difficult in their treatment. To record accurately and minutely the symptoms by which they are characterized, the vicissitudes in the gravity and temperature of the atmosphere, by which they are preceded or accompanied, and the success of the remedies employed for their removal, is the indispensible duty of every one, who is entrusted with the superintendence of the health and lives of his fellow-citizens.

It must at once occur that observations of this kind, conducted with accuracy and fidelity, would constitute a peculiarly appropriate theme for an inaugural essay. The candidate for medical honours could thus have an opportunity of manifesting his aptitude for medical observation and giving some assurance of his future usefulness in his profession.

Although Medical Topography is interesting and desirable, it should be recollected that the responsibility of its author is momentous indeed, and ought to be sufficiently awful to deter any but the most experienced from engaging in the undertaking. The pompous narration of cases, which never had an existence, and of extraordinary cures which never were effected, have in all ages presented the greatest obstructions to the progress of *medicine*. Nor do the evils, flowing from misrepresentation and exaggeration, terminate but with the lives of millions, who quaff, with eager credulity, every stream that issues from the fountain of the marvellous.

Believing that I could not with propriety compose a Medical Topography, limited as my experience has been to the span of a few fleeting months, I began to survey the various departments of medicine, determined to accelerate the progress of the most imperfect, by experiment, the only road to demonstration and certainty.

It required no very great depth of penetration to discover that Physiology is that department. But I was met at the threshold by the contradictory observations and experiments with which it already abounded, and it appeared to me that "the explaining, correcting and confirming the observations of my predecessors would be as honourable as hunting after new discoveries, of which the truly learned will find but very few, whatever the ignorant may imagine."

Nothing like uniformity of sentiment prevails concerning one of the most important and interesting subjects in Physiology, I mean the true relation between the sanguiferous and nervous systems. Is the irritability of the heart and arteries derived from the nervous system? or are irritability and sensibility distinct and independent principles? This is a question which has engaged the attention and exercised the ingenuity of the first philosophers, who have ever adorned the science of medicine, and still A. P. Wilson Philip and M. Le Gallois, two of the latest experimenters upon this subject, are directly opposed to each other, and both corroborate their views by a formidable array of experiments. When we contemplate the complicated construction of animated beings, and reflect that the assemblage of their functions is unitized by the all-pervasive principle of sympathy, we shall find no difficulty in accounting for this discrepancy of opinion; so true is the observation of a celebrated modern writer, "*La liason et la dependance que l'auteur supreme de la nature a etablies entre toutes les parties de ce compose marveilleux, sont si intimes, que le Prince de la Medicine nous a represente le corps anime et jouissant de ses fonctions, comme un cercle dans lequel on ne peut reconnoitre ni commencement, ni fin*"

The object of this essay is critically and impartially to examine this subject, to point out the errors of those who have laboured to elucidate it, and, if possible, to arrive at truth.

We acknowledge it looks like arrogance for juvenility to become the umpire of so many great and learned men, who have differed upon this intricate subject, and all that we have to urge in extenuation is, that we have assumed the office, believing that should we be so fortunate as to advance any thing worthy of consideration, our readers will be found with him,

'Prefering sense from chin that's bare,
To nonsense thron'd in whisker'd hair.'

DISSERTATION, &c.

The great system of animals has been divided by physiologists into four lesser or subordinate systems, the sanguiferous, the nervous, the lymphatic and the muscular. To us this classification seems rather to be the result of superficial observation than of that minute and philosophical attention to the economy of animated nature, which is so essential to logical accuracy.

We are satisfied that, in reality, there are only two subsystems, viz, the sanguiferous and nervous, which, by their various and intricate involutions, compose not only the muscular and lymphatic, but every vital texture of the body, however diversified in appearance, or dissimilar in function. There is, therefore, just as much propriety in speaking of the cephalic, bronchial, alimentary, hepatic, renal, pancreatic, uterine and cystic systems, as of the muscular and lymphatic; all are essentially nothing more than the ramifications of arteries and nerves.

The learned Dr. Haller contended, from a multiplicity of experiments, that only certain parts of the system are endued with sensibility. Among the *insensible* parts he enumerates the dura and pia mater, the tendons, aponeuroses, capsular and other ligaments of the joints, periosteum, bones, marrow, pleura, pericardium, mediastinum, and peritoneum. In his reasonings upon this subject, Dr. Haller regarded as evidences of insensibility, the absence of pain when these parts are wounded in living animals, and his inability to demonstrate the exis-

tence of nerves in their structure. For our own part, we are disposed to allow every part of the system a share of sensibility, not even excepting the bones themselves. All the arguments and experiments of Haller to the contrary appear to us inconclusive, and disease daily demonstrates their fallacy, as satisfactorily established by Dr. Whytt, in his learned controversy with Baron Haller.

Ever since the grand discovery of the circulation of the blood, physiologists have been also divided in their opinions, with regard to the relative influence of the heart and arteries in this important function. Some physiologists of the first respectability insist that the heart, "the primum vivens et ultimum moriens" of the animal, is the only active agent, while others, with more reason, allow a participation to the arterial system. The former consider the arteries as nothing more than mere conduits or tubes of conveyance, with the heart for their fountain. This is the doctrine, at least so far as regards the larger branches, taught by the learned and ingenious professor of the Institutes of Medicine in this University. He, however, allows them some share in the circulation, by attaching to them what the French are pleased to call a "tonicity" or constant nisus to contract. Notwithstanding our approbation and even admiration of many of the doctrines, promulgated by the professor, we are compelled, by observation, experiment and all the phenomena of disease, to reject the one now under consideration, as untenable and irreconcilable with facts. Were it not digressive from the object of this dissertation, we could adduce abundant testimony in favour of the irritability and contractility of every part of the arterial system, notwithstanding the ingenuity of Dr. Parry, with some, has rendered it equivocal.

We proceed to inquire whether the immense quantum of excitability expended in the contractions of the heart and arteries is derived from the brain and spinal marrow or from some other source.

In the prosecution of this subject, we shall, in the first place, examine the experiments, which have been instituted for its elucidation, and then adduce some facts and observations, corroborative of that side of the question, which we have espoused.

EXPERIMENTS.

Previous to the time of Glisson and Haller, it was universally believed by physiologists, that the heart derives its power of action from the nervous system, and especially from the brain, which was regarded as the centre of that system, the primum mobile of the whole animal machine.

During the prevalence of this doctrine, several theories were invented to solve the puzzling question, if the organs of animal and organic life are equally dependent on the brain, why are the former and not the latter subservient to volition?

The most ingenious and plausible attempt to remove this difficulty was that of Willis. This physiologist supposed that the heart and other organs of involuntary motion are supplied with nerves from that part of the brain, called the cerebellum, while the muscles of voluntary motion receive their nerves from the cerebrum. This theory would have answered tolerably well, if the omnipotence of its author could have confined the will immediately and exclusively to the cerebrum.

But this hypothesis, together with all those which pre-

ceded it, which had become venerable from their antiquity, vanished as the "dun mists of night," before the rising sun of Doctor Haller's experiments on irritability.

The experiments of this justly celebrated physiologist led him to conclude, that the heart is endued with a "vis incita," an "impatience of stimulus," independent of the brain.

Of the correctness of this conclusion there can be no doubt, since it has been confirmed by every subsequent experimenter, and even by the *nervous* M. Le Gallois himself.

The latter has shown that by removing the brain by successive portions, beginning at its upper part, the action of the heart continues unimpaired until we arrive at that part of the medulla oblongata, which gives origin to the eighth pair of nerves. The reason why even the destruction of the medulla oblongata affects the action of the heart we shall find by refering to the 269th page of Bichat's Physiological Researches, a work which can never be too often perused. We hope the difficulty and even impossibility of procuring the original of this and M. Le Gallois' production will apologize for our using the translation, in the examination we shall have occasion to make of their opinions and experiments.

Bichat had found by his experiments that a cessation of cerebral action is followed, in a longer or shorter time, according as the subject of the experiment is an animal of cold or warm blood, by a total annihilation of the motions of the heart. He rightly concluded that this resulted either, 1st, because the heart is under the immediate dependence of the brain; or, 2d, because there is between these two an intermediate organ, whose functions

are in the first place interrupted, and which thus puts a stop to those of the first. Pursuing his inquiries, M. Bichat demonstrated that although the action of the brain is dependent on the heart, the latter is not under the immediate control of the former; that the death of the brain destroys the action of the heart, by causing the death of an intermediate organ, the lungs, thus subjecting the heart to the direct and mortal contact of black blood.

The following is the chain or concatenation of effects which necessarily supervene upon violent injuries, inflicted on the brain.

1st. An interruption of the cerebral action; 2d, an annihilation of action in all the muscles of animal life, and of course in the intercostals and diaphragm; 3d, the consequential cessation of the mechanical phenomona of respiration; 4th, a suspension of chemical phenomona and consequently the colouration of the blood; 5th, the penetration of black blood into the fibres of the heart; and 6th, the debility and cessation of action in these fibres.

In this indirect and successive manner the death of the brain produces the death of the heart, although the latter is not immediately dependent on the former, for its stimulability or power of action.

The foregoing experiments and reasoning were confined principally, if not entirely to the brain; and so long as the influence of the spinal marrow remained undetermined and equivocal, it is evident, that the Hallerian theory of irritability, the characteristic of which is, its making that principle independent of the nervous system, could not be regarded as satisfactorily established. The spinal marrow, without doubt, is a most important part of the nervous system, and indeed professor Tiedemann has

lately adduced a great variety of curious and interesting considerations, which would induce us to believe that so far from the spinal marrow's being a mere continuation or elongation of the brain, according to the common account, the latter organ is, in fact, the production of the former; alias, "that the brain and cerebellum are an *efflorescence* of the marrow in question."

A late distinguished writer on physiology and pathology, Dr. Parry of Bath, also regards the spinal marrow as a distinct and independent centre of nervous influence. In the DXXXIX. paragraph of his Elements of Pathology and Therapeutics he remarks, "That the spinal marrow is not derived from the brain is evident, from its having been found in a state of perfect developement in fœtuses, which have been born at their full time, without cerebrum, cerebellum, or medulla oblongata."

To ascertain the relation which subsists between the spinal marrow and sanguiferous system, a series of accurate and interesting experiments have lately been instituted by Dr. A. P. Wilson Philip, and published in his invaluable "Experimental Inquiry into the laws of the vital functions."

These experiments were made principally on rabbits, which being an animal of warm blood, the results obtained are perfectly applicable to man, and other animals of the same class.

Our author found that by keeping up artificial respiration, (the intermediate function, whose disturbance, we have seen, causes the cessation of the action of the heart after the death of the brain,) the action of the heart was very little, if at all, influenced by the destruction or removal of considerable portions, or even the whole of the spinal marrow.

The animal was in the first place generally deprived of sensation and voluntary motion by a blow on the occiput, the thorax being then laid open exhibited the heart, beating with its usual regularity and considerable force.

In his first experiment on a rabbit, prepared in this manner, Dr. Philip found that the *removal* of the whole of the cervical portion of the spinal marrow did not in the least affect the action of the heart. The brain was then *removed* without any other effect being produced, "*the action of the heart still continuing to be more or less powerful, according as artificial respiration was renewed or discontinued.*"

The same phenomona appeared several hours after the commencement of the experiment.

In his next experiment the whole spinal marrow was destroyed, by passing a small hot wire into it, between the cervical and dorsal vertebræ, and directing it from thence upwards and downwards, throughout its whole extent: "*by which the action of the heart was not at all affected.*" In a frog, "after the brain and spinal marrow had been wholly *removed*, the heart beat *nine* hours gradually becoming more languid."

These experiments, which, if repeated sufficiently often to ensure their accuracy, might have appeared decisive to a less scrutinizing mind, were not considered unexceptionable by Dr. Philip. It has long since been ascertained that some motion may be excited in the heart, after its extraction from the body, and it might be objected that this is the kind of action remaining in the heart, after the removal or destruction of the spinal marrow. In fact this is the assertion of M. Le Gallois, who says that "by opening the cranium of an animal of any age

whatever, and by introducing through the opening a probe and thus destroying the brain and all the spinal marrow; if the thorax of the animal be then opened, the motions of the heart will be found still to continue."*

But M. Le Gallois says that these motions are of a different kind from the healthy motions of the heart, and notwithstanding their continuance that the circulation is stopped.

Now the most certain evidences, which we can possibly have, of the existence of the circulation are, hemorrhage from a divided artery, and the carotids appearing full, round and red, during the inflation of the lungs, and turgid though dark, during its interruption.

In order to ascertain whether the circulation is really affected, Dr. Philip availed himself of these signs in the prosecution of his experiments; and, in our opinion, he unequivocally proved that not only the action of the heart, but the circulation also continues, although deprived of the influence of the spinal marrow.

In his third experiment the animal, as in the previous experiments, was rendered insensible by a blow on the occiput, artificial respiration maintained, and the carotid arteries laid bare, and found beating: "the cervical part of the spinal marrow was then destroyed by a hot wire, *after which the carotids were still found perfectly round and beating.*"

In the 4th, 5th, 6th, 7th and 8th experiments the *whole* of the brain and spinal marrow were destroyed, or partly removed and partly destroyed, and yet the division of the

*Experiments on the principle of life, translated from the French, by N. C. & J. G. Naucrede, M. D. page 75.

carotid and femoral arteries afforded a copious stream of the vital fluid, which gushed out, *per saltum*, of a florid or dark complexion, according as artificial respiration was supported or discontinued. From various trials it was found that, in such experiments, the circulation ceases quite as soon without, as with the destruction of the spinal marrow; death in both instances seeming to be produced by the hemorrhage.

Between cold and warm blooded animals there are so many important differences, that in experimental investigations, a coincidence of result obtained from both, is a strong argument in favour of the accuracy and fidelity of the experiments, and the prevalence of the law, they are intended to elucidate. Dr. Philip, therefore, had recourse to frogs, as the most proper subjects for a repetition of his experiments. As the parietes or walls of the heart of the frog are transparent, he could easily examine the state of the circulation, and its affection, if any, by the loss of the spinal marrow. We shall take the liberty of transcribing one of these experiments, which appears to us to be an *experimentum crucis*, and which is thus briefly detailed by the modest and indefatigable author. "The brain and spinal marrow of a frog were removed at the same time. On opening the thorax, the heart was found performing the circulation freely." p, 72.

After all this we think Dr. Philip warranted in the following observation: "It appears from these experiments that the action of the heart is as independent of every part of the spinal marrow, as of the brain; and, consequently, that the opinion of M. Le Gallois that it derives its power from that organ, and particularly from the cervical part of it, must be regarded as erroneous."

We come now to inquire into the origin and foundation of the opinion, alluded to in the preceding quotation. It is farcical indeed to reflect on the chain of reasoning and research by which M. Le Gallois became involved in the "laborious investigation," which resulted in the conclusion that the heart receives the principle of its actions from the spinal marrow. He informs us that a particular case of parturition, which came under his observation, excited a wish to know how long a full grown fœtus can live, after all communication with the mother has ceased. Little could the rabbits, even if they were endowed with more reasoning powers than man, have expected that the prosecution of this desire would lead the author to the experiments in question, which cost them so much life and blood, and were eventually productive of nothing but confusion. To be satisfied that this assertion is neither invidious nor exaggerated, let us examine impartially the experiments themselves.

M. Le Gallois took rabbits of from 5 to 10, 15, 20, 25 and 30 days old, and performed six operations on the spinal marrow of each, but to avoid prolixity, he only gives us the results,obtained from those of one day and ten and twenty days old. The six operations were 1st: The section of the spinal marrow: 2d, Decapitation: 3d, The destruction of the whole spinal marrow: 4th, The destruction of all the cervical portion: 5th, That of the dorsal portion, and 6th, That of the lumbar portion. He tells us that in rabbits of any of the ages above mentioned, the section of the spinal marrow between the first vertebra and occiput,and decapitation did not directly influence the circulation; which only became impaired by the suspension of respiration, and could be restored to its former vigour, at pleasure, by artificial respiration.

In every age, likewise, according to M. Le Gallois, the destruction of the whole of the spinal marrow, or even the whole of the cervical portion, was followed by a cessation of the circulation, indicated by the emptiness of the carotid arteries, or their containing only a *small stream of red blood*, the absence of hemorrhage after amputation, &c.

As these experiments directly contradict those of Wilson Philip, the cause is advanced to what legal characters term an "issue," and is now to be argued before the jury. We have undertaken to appear for Dr. Philip, not from any lucrative motives (for no pecuniary inducement is here presented,) but from an entire conviction of the righteousness of his cause.

In the first place, then, gentlemen of the jury, in the experiments of the French physiologist there appear to us to be a great many contradictions and a want of method, not discoverable in those of the English.

We are informed by M. Le Gallois that the destruction of the dorsal portion of the spinal marrow in rabbits, the day after their birth, does not annihilate the circulation: "at fifteen minutes the animal continued to live and breathe, and the hemorrhages were red." And yet immediately afterwards, we are told that "this experiment has not *always* the same result in rabbits of this age." It *frequently* happens that the destruction of the dorsal portion of the spinal marrow is immediately followed by all the signs, which indicate that the circulation is stopped. page 93.

Again, respiration is a little deranged, and the motions of the heart rendered "irregular and slower," but never extinguished by the destruction of the medulla lumbaris, in rabbits of one and ten days old. But the destruction of this very same portion of spinal marrow, in

rabbits twenty days old, was followed, in two minutes, by a cessation of the circulation. page 104.

How are these contradictions to be reconciled? If the heart receive the principle of its motion from every part of the spinal marrow, as M. Le Gallois contends it does, why should the removal of any one portion stop the circulation, at one age and not at another? It is nothing but an evasion of this question to say, as M. Le Gallois does, "this appears to be connected with the influence which each portion has on the circulation, and which increases with the age of the animal."

This assertion is evidently nothing more than a petitio principii, a mere ipse dixit, for the question again recurs, why should this influence increase with the age of the animal? Can it be because the action of the heart is more vigorous and the extent to which it must communicate its influence greater, in the adult than in the young rabbit, and having this greater resistance to overcome, it requires a larger supply of nervous power and feels more sensibly the smallest loss of it? This is the only plausible explanation which we can conceive M. Le Gallois could have given, if, from his lofty car of experiment, he had deigned to notice so *trivial* a circumstance. But even this would not avail him.

We again object, that if the size and extent of the body are small in infancy, the spinal marrow is correspondingly so also, and the action of the heart weak and feeble, and, therefore, if only a small action were required of it, it would still feel the loss of the same quantity of spinal marrow, as sensibly as the heart of a larger animal.

M. le Gallois next wished to ascertain, for each age, the precise extent and quantum of spinal marrow, which must be destroyed, in order to arrest the circulation.

With this view he destroyed a certain length of spinal marrow and then waited to observe its effects, and if this did not prove fatal, he destroyed another portion, and so on successively until the circulation ceased, when he supposed the object of his inquiry was accomplished.

But new and still more perplexing difficulties presented. When he destroyed only half the required extent of spinal marrow, at *one* operation, he was surprised to see the circulation stopped. "And vice versa, says he, when I had begun by a portion the destruction of which had been found sufficient to stop the circulation, if, by chance or design, I happened to destroy afterwards the same portion *at several times*, I often found that the *circulation was not stopped*, unless I destroyed another portion, and that sometimes considerable." "In a word, continues he, with each experiment there was a difference in the result, and which, in most cases, was too striking to be considered as purely accidental."

No wonder that these, on his theory, unaccountable results, should have almost determined him, as he informs us they had, "to abandon this dark question." But perseverance could only be succeeded by defeat, while an honourable retreat would be attended with humiliation and regret, and therefore, notwithstanding this broad hint that he was in the beaten road of error, the pride of M. Le Gallois would not suffer him to desist; but with the unrelenting and sanguinary persecution of a Robespierre, insensible to the tortures of his victims, he pursued his experiments to untie this Gordian knot, but Alexander-like drew his sword and cut it. I am afraid that the observation of Mr. John Bell will apply with too much truth to M. Le Gallois. "It is very singular, says he, that those who abjure theory, and appeal to experi-

ments, who profess only to deliver facts, are often least of all to be trusted; for it is theory which brings them to try experiments, and then the form and order, and even the result of such experiments must bend to meet the theories which they were designed to prove."

This must have been the case with M. Le Gallois: he seems to have framed his theory first, and then to have exercised all his invention and sophistry to establish it. Indeed our suspicion is strongly excited, when we see him, notwithstanding every appearance was against him, still persisting in piling experiment upon experiment, which so far from realizing his anticipations, only served to expose to stronger light, the rotten foundation on which he was, in vain, labouring to erect a durable superstructure. The contradictions and inconsistencies, with which the work of M. Le Gallois abounds, are sufficiently numerous to justify us in doubting the legitimacy of the inference drawn from the experiments, where the whole of the spinal marrow was destroyed. "As soon as this operation is performed, says he, the throbbings of the heart are no longer felt; the carotids are empty and flat; the amputation of the thigh furnishes no blood; and the gapings, which take place in this case, cease at about three minutes and a half;" nor can they be continued by the inflation of the lungs. Now we are not disposed to deny the fidelity of M. Le Gallois as a narrator, and as his principal experiments were repeated before the committee of the National Institute of France, we can readily believe that all the phenomona enumerated did follow the entire *destruction* of the spinal marrow; nor do we conceive that this concession obliges us to acquiesce in the inference of the author, that the

Circulation is dependent on nervous influence, derived from the spinal marrow.

Having *removed* the brain by decollation without affecting the action of the heart, he justly concluded that the latter is *independent* of the former. Now if M. Le Gallois *had removed* the spinal marrow, and the circulation had have ceased, he might, with equal justice, have inferred that the heart and arteries are *dependent* on the spinal marrow. But he did not choose to proceed in this plain and simple way, he dreaded the consequences. When the head only was concerned in his experiments, he removed it very delicately and neatly with his scalpel; but when he came to the spinal marrow, he thought of nothing but battering and bruising. The instrument with which he destroyed the spinal marrow was as large as the cavity of the vertebral column, and this was forcibly thrusted into its tender and feeling substance. Is it to be wondered at, then, that the circulation was stopped? Or rather is it not surprising, that life could continue, after this rude operation, so long as it did, in some of his experiments?

Sudden death is very often the consequence of extraordinary violence, or powerful impressions made on less important parts than the spinal marrow. A large quantity of ardent spirits, or of cold water, when the body is overheated, taken suddenly into the stomach, has been known to produce almost instantaneous death. But are we thence authorised to conclude that the stomach is the immediate organ, from which every part of the system directly receives its principle of action? In resorting to such a supposition, either in relation to the stomach or spinal marrow in the present instance, we forget entirely the great and fundamental law of sympathy, by

which each part of the body feels and expresses its solicitude for every other.

Now had M. Le Gallois opened the vertebral canal and *removed* the spinal marrow, we are persuaded he would have met with entirely a different result; he would have seen the circulation long survive this mutilation. That this would have been the case we feel the more confident in declaring from an experiment of Dr. Philip, where the brain of a rabbit (which we have just seen M. Le Gallois admits to have no share in supplying the heart with its irritability,) was *crushed* by a severe blow. The following were the effects, as described by the ingenious author. "The side was rendered hard by a spasm for about half a minute. Neither during this, nor after it, could I perceive any motion of the heart by applying the hand to the side. The head was then cut off, about three quarters of a minute after the brain had been crushed. No blood spouted out and very little ran from the vessels." page 83.

It is surely unnecessary to make any comments on this experiment; the legitimate and,indeed,unavoidable inference from it is, that as the destruction of the brain by violence, suspends the circulation, so does that of the spinal marrow, while the *removal* of neither would at all affect the functions of the sanguiferous system.

Such then is a brief but faithful epitome of the famous experiments of M. Le Gallois. After having been in *labour* several years, and accouched by M. de Humboldt, M. Percy and M. Halle,* he brought forth; what? not a fœtus, which corresponded in maturity with its long resi-

*The committee to whom the National Institute referred the memoir of M. Le Gallois.

dence in the womb, but the feeble and emaciated issue of an abortion.

From this hasty examination and,we trust, satisfactory refutation of the most formidable, it appears that experiperiments will not support M. Richerand in the assertion that "Irritability is a wandering branch from the sensitive soul, that endeavours to regain a connexion with its trunk, from which it can no more be separated than an effect from its cause." On the contrary we have had abundant reason to believe that irritability and sensibility are entirely independent of each other, with regard to their origin, and perhaps we will not be accused of bigotry or enthusiasm, if we venture to predict, that the Hallerian theory, which declares this fact,

> ——————"Will time defy,
> As rocks resist the billows and the sky."

In the list of philosophers, who have, at different times, and in different countries, opposed this doctrine, Dr. Whytt of Edinburgh certainly stands conspicuously preeminent. For several years, the whole medical world were intimidated and anxious spectators of the doubtful conflict between this truly great man and Baron Haller. Now that the storm has subsided, and the eloquent pens,which kindled it, laid low in the dust, it is the business of posterity to take an impartial retrospect of their labours, and cull from them such valuable and useful flowers, as may contribute to enrich and adorn the science of physiology.

In an "Essay on the vital and involuntary motions of animals," Dr. Whytt endeavours to show, contrary to the opinion of M. de Haller, that stimuli, applied to the

muscles of animals, excite contraction by producing an *uneasy* sensation in them, or in their nerves.

After a careful perusal of his work, the only argument of Dr. Whytt, which we conceive to have any claim to validity, is the following, that "Whatever lessens or destroys the sensibility of the system, also lessens or destroys the irritability or power of motion." "Opium, continues our author, which is remarkable for its power of impairing or destroying the sensibility of all the parts of the body, also lessens or suspends the irritability or moving power of the muscles."

Now it must be evident, that, before Dr. Whytt could fairly deduce any inference from this fact, affecting the question in debate, it was incumbent on him to have demonstrated, unequivocally, the modus operandi of opium.

When taken into the stomach, or applied to any part of the system, does it produce its deleterious effects through the mediation of sympathy, or by absorption and commixture with the blood? If through the former channel, do we not know that there exists between the nervous and sanguiferous systems, a most active and powerful sympathy? And if through the latter, which the experiments of Fontana and Philip appear to prove, every part of the system being pervaded by the opium, the very root of sensibility and irritability will be attacked, and their simultaneous destruction, so far from establishing their identity, is an occurrence we should naturally anticipate.

The limits, usually assigned to a dissertation of this kind, prohibit our entering into any thing like a detailed examination of Dr. Whytt's work, or even adverting to numerous experiments of other gentlemen, both in the affirmative and negative of the present question, and we must conclude, according to the division of our subject,

by adducing a few facts and observations in favour of the independence of irritability and sensibility, which appear to us no less decisive than the experiments, the results of which have already been stated.

1st. As nerves are the only media of sensation, and as where they do not exist, we cannot expect to find sensibility, if we can point to any one description of matter, into the composition of which nerves do not enter, which nevertheless is evidently endued with irritability, or some other modification of life, this is certainly evidence presumptive and positive, that irritability and sensibility are not necessarily connected.

Now in the blood, and in the whole system of vegetables we have all the phenomona of vitality, with the exception of those dependent on nerves, which make no part of their organization. But as these are controverted subjects, for their elucidation, and if possible, the confirmation of our assertion, we beg leave to submit a few general remarks—FIRST,

ON THE VITALITY OF THE BLOOD.

There is not, perhaps, in the whole circle of the science of medicine, a doctrine better substantiated, both by reasoning and experiment, than that of the vitality of the blood: and yet, strange as it may appear, there is none less generally received. We can account for its unpopularity only by referring to that pertinacity, with which the human mind is disposed to adhere to early conceptions and habits of association, which induces it to reject every thing, wearing the aspect of innovation.

This disposition of our nature may constitute some apology for the blind zeal, misplaced respect and devotion-

al bigotry of the peasant, in matters of science, but cannot be urged in extenuation by the philosopher.

To explore the mysterious labyrinths of nature, and to remove the dark curtain of obscurity, which envelopes her face, is his province; and entirely to divest his mind of all prejudice is an essential prerequisite to any considerable advancement in this laudable pursuit. We are aware that there is something in antiquity, so venerable and solemn, that the polishing touch of the hand of improvement is regarded as little less than derogation and sacrilege. But we *must* disregard the opinions of our predecessors, when evidently erroneous, we *must* lay aside our preconceptions, we *must* attend to the voice of facts, to the voice of nature, through the medium of experiments, if we wish to become useful and successful cultivators of science.

Philosophy has no connexion with servility. That physician, who is so dearly espoused to doctrines which have nothing better than grey hairs to recommend them, in contravention to accumulated facts, daily observation and conclusive experiments, is not worthy of the appellation his arrogance has usurped.

All we ask, then, is a candid and impartial examination of the subject under consideration, and we will risk our reputation, as a seer, that such investigation will inevitably result in the conclusion, that the blood is strictly and literally possessed of life. Nor is this a modern doctrine. It is clearly inculcated in a great many passages of the sacred writings, and in the works of the most celebrated philosophers, and admired bards of antiquity. Not only did the latter believe the blood to be endowed with vitality, but they honoured it with the immediate seat and residence of the soul itself. Hence, in

lamenting the death of Demuchus by the hand of Achilles, Homer, as translated by Pope, exclaims,

"Gigantic chief! deep gash'd the enormous blade,
And for the soul an ample passage made!"

The avenue for the soul, here spoken of, could permit its exit only through the medium of the blood, with which it was incorporated. Again, his heart being transfixed by the irresistible dart of Patroclus, Sarpedon quietly submitted to his fate, while

"From the wide wound gush'd out a stream of blood,
And the soul issued in the purple flood,"

The opinions of Virgil are entitled to great respect, inasmuch as to a warm and enthusiastic imagination he added a correct taste for general literature. From many passages of the Æneis of this writer, expressive of his belief, that the soul is seated in the blood, we select the following.

In the fall of Liger, by the sword of Æneas, the soul is represented as escaping through the incision in his breast.

"Tum latebras animæ pectus mucrone reludit."

'Then through his breast his fatal sword he sent,
And the soul issu'd at the gaping vent.'

In the battle between Turnus' army and the Trojans, under Ascanius, in the absence of Æneas, Privernus received a mortal wound by the dart of Capys;

"———Ergo alis allapsa sagitta,
Et lævo infixa est lateri manus, abditaque intus
Spiramenta animæ lethali vulnere rupit."

'The second shaft came swift and unespy'd,
And pierc'd his hand, and nail'd it to his side,
Transfix'd his breathing lungs, and beating heart,
The *soul* came issuing out, and *hi s'd* against the dart.'

In the two preceding quotations, we peceive, the soul and blood are made synonymous terms.

Upon this point, we shall only cite another passage from the works of the Latin poet. As the personages, who gave origin to it, are no others than the Phrygian and Rutulian kings themselves, it is too conspicuous to escape observation. We allude to the rencounter of Turnus and Æneas. In consequence of the fatal blow, which the former received from the hands of the latter,

"———Illi solvuntur frigore membra,
Vitaque cum gemitu fugit indignata sub umbras."

"The streaming blood distain'd his arms around,
And the disdainful soul came rushing thro' the wound."

It may not be improper to remark here, that the word *vita* is anglicised promiscuously *life*, or *soul*, whilst the best lexicographers agree in translating *anima* by *soul* only. The word anima is used in all the above quotations except the last: that Mr. Dryden has put the true construction upon this, is evident from action and passion being attributed to *vita*.

Having made the blood the residence of the soul, Virgil would be led, of course, to seek for the passions in the same reservoir. Hence, in several parts of the Æneis, he refers to the blood, as containing the noblest passion of the soul, love. We have an instance of this in the commencement of the fourth book, in which the unfortunate Carthagenian Dido is the heroine.

"At regina gravi jamdudum saucia cura,
Vulnus alit venis, et cæco carpitur igni."

"But anxious cares already seiz'd the queen:
She fed within her *veins* a flame unseen."

But the doctrine of the vitality of the blood does not depend for its establishment upon the authority of *names*. It has been submitted to the ordeal of experiment and stood the test with admirable fortitude; with a fortitude which could be inspired, only by the durability of truth.

When assertion is diametically opposed to assertion, and passion usurps the place of reason, this is the only umpire, to which the decision should be referred. In the language of a favourite author, "however probable an opinion may appear, which will not admit of demonstration by rigorous experiment, no importance should be attached to it, by judicious minds." Old Sir Robert Bramble, in the "Poor Gentleman," gives it as his opinion, that a man who will not listen to argument, should have his brains blown out; we should not be disposed to inflict a less severe punishment on a man, who will not attend to the voice of experiment.

Mr. John Hunter, one of the greatest physiologists the world has ever produced, was the first who subjected the blood to experiment, for the purpose of ascertaining the validity of its claims to vitality. The experiments of this patient and laborious physiologist, though appropriate and extremely well devised, were not sufficiently extensive and diversified. So that a chasm still remained. This has been more than closed by the ingenious reasoning, unanswerable arguments and interesting experiments of Prof. Caldwell. For full satisfaction on this subject we must refer to Mr. Hunter's Treatise on the Blood, Inflammation and gun-shot wounds" and to the lectures of Prof. Caldwell published in a collection of The-

ses for 1805, Philadelphia. By these experiments, the blood is shown to possess an inherent power of self-preservation, a power of maintaining its own temperature, independent of that of the surrounding medium, and a susceptibility to the impressions of stimuli; properties, which are universally regarded as evidences of the existence of life, in matter by which they are manifested.

With regard to the nature or essence of the principle of animation we are entirely ignorant; "such indeed, are the narrow limits of the human understanding, that the knowledge of first causes is almost always denied to it. The thick veil, which covers them, envelopes in its innumerable folds whoever attempts to rend it asunder." We are advised of the existence of life, as well as all other matter belonging to the imponderable class, by its effects only; and wherever we see the attributes of life, above enumerated, whether in animal or vegetable, solid or fluid matter, we are, according to the soundest principles of philosophy, constrained to acknowledge its existence. Whenever we experience, in our bodies, the sensation of heat, we attribute it to the action of caloric; and this whether the caloric be evolved from the combustion of wood, phosphorus, hydrogen or sulphur.

We repeat it, then, without the fear of contradiction, that on the score of experiment, of correct reasoning and observation, more evidence has been adduced, in favour of the doctrine of the vitality of the blood, than is usually required to establish any principle in medicine or philosophy. Not even the Newtonian doctrine of gravitation, which its sanguine admirers have been pleased to entitle "a rock amid the waste of ages," can boast a better right to universal credence.

We feel so perfectly persuaded of the importance of

the doctrine of the vitality of the blood, and of its happy application to the explication of a vast number of the phenomena of health and disease, that we shall conclude our remarks upon it, for the present, in the words of a favourite poet;

> "Hoc opus, hoc studium parvi properemus et ampli,
> Si patriæ volumus, si nobis vivere cari."

II. OF VEGETABLES,

As a species of living matter possessing irritability and not sensibility.

Ever since philosophers have been convinced that the rising of the sap, and the circulation of the juices,in vegetables, cannot be explained upon the principles of capillary attraction, and more especially since the luminous experiments of Mr. Knight, recorded in different volumes of Tilloch's Philosophical Magazine and in the London Philosophical Transactions, all have allowed that they are endowed with irritability. That this irritability is similar to that which pervades the system of animals is manifest, from its obeying the same stimuli, and producing the same motions with animal irritability.

Indeed the irritability of some plants exhibits an exquisite sensibility (if we may be allowed the expression) to the impressions of stimuli, and between the actions of their different parts there appears to be a real association or sympathy.

Of this description are the Mimosa or sensitive plant, and the dionæa muscipula. "The divisions of the leaves of the sensitive plant," observes the ingenious and learned author of Zoonomia, "have been accustomed to contract at the same time from the absence of light; hence,

if by any other circumstance, as a slight stroke or injury, one division is irritated into contraction, the neighbouring ones contract also, from their motions being associated with those of the irritated part. So the various stamina of the class Syngenesia have been accustomed to contract together in the evening, and thence, if you stimulate one of them with a pin, according to the experiment of M. Colvolo, they all contract from their acquired associations." Here we have indubitable evidence of the existence not only of irritability, but of that great prerogative of living matter, sympathy, notwithstanding the absence of brain, spinal marrow and nerves,and this fact alone is sufficient to establish the position, that irritability and sensibility are independent principles. But we are aware that it is not universally conceded that vegetables are destitute of a nervous system, and that some *amorous* philosophers have even gone so far as to bestow on them mind, susceptible of agitation and enjoyment, from the alternate play of the passions of love and hope, fear and jealousy!

Having proceeded thus far, they have declared it utterly impracticable to discriminate between an animal and a vegetable! They have almost despaired of finding a function or class of functions, which shall constitute the true line of demarcation between the animal and vegetable kingdoms.

"From all my speculations on this interesting subject, says Professor Caldwell, (and it is with me a favourite object of pursuit) I am firmly of opinion, that there exists no incommunicable characteristic, and I will venture to add, no congregation of characteristics, which serve to constitute a complete partition-veil between the animal

and vegetable kingdoms. The numerous and highly diversified subjects of these two important kingdoms of life, appear to be nothing else than different individuals of one extensive family, descended from a common parent, and exhibiting the most unequivocal testimonies of their kindred nature. Like the delicate tints of light and shade in a well finished picture, they so gradually intermingle, and run into each other so insensibly, that it is literally impossible to say with definitude, where the one terminates and the other begins."*

It may not be improper to present a brief exposition of the analogies between animals and vegetables, on which, we suppose, the foregoing remarks of the professor are founded.

1st. They both have life. The application of stimuli elicits motion in each, and both are excited to the propagation of their species by the genial rays of the vernal sun.

2. The analysis of both affords the same elementary constituent principles, viz. oxygen, hydrogen, carbon, and azote, the latter abounding most in animal matter, which disposes it sooner to assume the putrefactive process, when deprived of vitality.

3. Both are regularly organized, and possess digestive, assimilative and nutritive functions.

4. Plants as well as animals have their periods of infancy, increase, maturity, decline and death.

5. Plants, like animals, propagate their species. It was upon the sexuality of vegetables that the celebrated Swedish naturalist constructed his admirable system of Bot-

*Translation of Blumenbach's Physiology, vol: 1, p, 47.

any. In the important function of generation, there appears to be a great similarity between animals and vegetables; many of the diminutive and inferior species of each perish, so soon as this great business is completed.

6. Some vegetables, like many animals, hibernate.

7. The leaves of plants, as well as the feathers of animals, are deciduous.

8. Plants, like the polypus and some other animals, are propagated by section.

9. Animals, while young, are tender, feeble and succulent: so are vegetables.

10th and lastly. Are animals subject to the invasions of disease? So are vegetables.

It must be admitted that these are striking resemblances, and such as unequivocally prove that vegetables, as well as animals, are endowed with vitality. But in all this we do not see any indications of sensibility, and, therefore, notwithstanding the professor has pronounced "all researches after an exclusively distinctive characteristic between animals and vegetables, irrational and visionary," we are humbly of opinion, with Blumenbach and Bichat, that those functions, which are dependent on the brain and nerves, are enjoyed alone by animals; that vegetables are entirely destitute of nerves, and that this circumstance constitutes a complete "partition-veil," between these two great kingdoms of living matter.

Anatomy is a demonstrative science, and where conjectures and speculations commence, its province terminates. When, therefore, a physiologist tells me that vegetables have nerves, I at once demand of him a view of them, and as no anatomist has as yet, and, we are sure, never will demonstrate the existence of nerves in the

structure of vegetables, surely scepticism is natural and perfectly justifiable.

But other reasons induce me to disbelieve in the existence of a nervous system in vegetables. It is scarcely possible to conceive of nerves, without the idea of sensation being associated with them. Indeed, the latter is as much the effect and necessary concomitant of the former as the secretion of bile is, of the peculiar structure and organization of the liver. Has the all-wise and beneficent Architect of the Universe endowed vegetables with capacities of pleasure and pain, without investing them with volition, by which they might approach and enjoy the objects, productive of the former, and avoid the latter? Firmly and immoveably rooted to the spot, which gave them existence, miserable indeed must be their situation, if they are *feelingly* exposed to the action of external, deleterious and often destructive agents, without the means of escape or redress!

We are disposed to indulge speculative philosophers in the contemplation and admiration of their ideal graduated scale of existences, when they confine it to the animated part of creation, while they proceed no farther than the poet, when he says,

> "See thro' this air, this ocean, and this earth,
> All matter quick and bursting into birth!
> Above how high *progressive* life may go!
> Around, how wide! how deep extend below!
> Vast chain of being! which from God began,
> Natures ethereal, human, angel, man,
> Beast, bird, fish, insect, what no eye can see,
> No glass can reach; from infinite to thee; &c."

But when they would have me believe that this chain descends, by evanescent gradations, to the vegetable

kingdom, they will excuse me if I should be too incredulous to attend to their fanciful reveries. In my mind, the important circumstances of its always being included in circular or curved lines, its heterogeneousness, continual activity, sympathy between its molœcules, its increment from within, its powers of assimilation, its capability of reparation, its birth, increase, decline and death, and its being held together by the attraction of vitality,* do not constitute more unequivocal landmarks between living and dead matter, than does the absence of a nervous system in vegetables, between the two great kingdoms of *living* matter.

If, then, irritability or contractility can exist in the blood and in vegetables, independent of nerves, it is certainly a legitimate induction, that it may exist in the heart and arteries, equally independent of nervous influence, and a great many physiological and pathological facts powerfully corroborate this inference. We shall, on the present occasion, briefly advert to a few of them.

1st. An attention to the progress of generation, or what Dr. Caldwell has happily called "animal evolution," in oviparous or viviparous animals, will afford no impotent evidence of the independence of irritability and sensibility. Whatever theory of generation we may adopt, there must be a time, between conception and the visible development of the fœtus, when vital action commences in some one point of the ovum, which, for some time after impregnation, consists of nothing more than a little mucus, which even Blumenbach, one of the most strenuous

*These are the principal differences between living and dead matter, pointed out by Professor Caldwell, in his lectures on Physiology.

champions against the life of the blood, allows to possess vitality.

Now the observations of Harvey and others teach us that the "punctum saliens" is the heart, which is seen pulsating long before any vestige of brain or spinal marrow can be traced. Indeed, correct views of the physiology of animals ought to have made us acquainted with this fact, independent of experiment. For however divided we may be in our opinions with regard to the source of the power of the heart, we must all agree in ascribing the action of the brain to the impulse and vital influence of the blood upon its fibres. How could nervous action go on, then, previous to the development of the sanguiferous system?

Let us, with Dr. Rush, imagine to ourselves a perfectly formed and well organized man, with heart, blood vessels, brain, nerves, lungs, and in short, all the organs, with which we are invested. Let us also imagine that as yet, the wheels of his machine are not put into activity and motion; not a passion or emotion has impressed its lineament, a death like paleness is spread over his whole system. But now the pervasive, kindling and animating principle of life is infused into every fibre of the system. What part would first manifest the presence of the congenial influence? Assuredly not the brain or spinal marrow, because we have just seen the heart is the prime cause of all motion, in these organs. The nervous system cannot communicate activity to the sanguiferous, because it has it not to communicate. The heart first feels the vivifying spark, it leaps, it bounds, the blood rushes to the brain, the brain puts in motion the muscles of respiration and volition, the whole animal and organic life is completely established.

It is worthy of remark that what Bichat calls the organic functions, in contradistinction to the animal, are performed with strength and regularity, in the fœtus, many months before the animal, viz. the brain and spinal marrow. As soon as these last, together with the voluntary muscles are developed or evolved, the fœtus gives us the information by exercising them. This motion of the fœtus in,utero,is distinguished in obstetrical writings, by the term *quickening*,and never occurs until the fourth or fifth month of gestation. There is, then,in the growth of the fœtus, a considerable period of time, when reason and observation inform us that the heart is active, while we cannot,by the most powerful microscope,discover any appearance of a nervous system. Whence does the heart derive its power of action during this state of things? Certainlynot from the nervous system,for as yet it does not exist—and if the heart can perform its functions several days, and even months,without the influence of the brain or spinal marrow, why may it not for life? It is unphilosophical and, we had almost added, preposterous to say it cannot.

2. Supposing irritability and sensibility to be identically the same principles, an increase or decrease of either should be accompanied by a corresponding augmentation or diminution of the other. Now notwithstanding this is often the case, it is well known to medical men that the converse frequently happens; that in health and disease, there is a destruction of this equilibrium in many instances, not only in a part, but even in the whole system; not to mention that the most irritable organ in the body, viz, the heart, is the least sensible.

Doctor Rush,* in his observations on the Tetanus, re

*Vid. Medical Observations and Inquiries,vol. 1 page324

marks, "The negroes in the West-Indies are more subject to this disease than white people. This has been ascribed to the greater irritability of their muscular systems, which constitutes a part of its predisposing cause. *It is remarkable that their sensibility lessens with the increase of their irritability;* and hence, Dr. Mosely says, they bear surgical operations much better than white people." That disease itself consists in a broken balance or loss of equilibrium in the irritability and sensibility, or in the excitability and circulation, is a doctrine which, under the auspices of the learned and ingenious professor of the theory and practice of medicine, in this university, is daily gaining ground, and promises to be of eminent utility, in unfolding the pathology, and improving the treatment of disease. Were it necessary, on the present occasion, we might examine in detail the history of apoplexy, paralysis, delirium, mania, and numerous other diseases, and show that in all these cases, the most remarkable circumstance that occurs, is the great inequilibrium of sensibility and irritability: but such particularity is useless, because it is only necessary to advert to the fact, in order to gain the assent of every intelligent observer of diseases.

Some experiments of Dr. Philip, "on the manner in which opium and tobacco act on the living animal body," (detailed in the third appendix to the second volume of his Treatise on Febrile diseases, page 476) clearly and satisfactorily establish the fact, that sensibility may be almost entirely exhausted, and the motions, dependent on irritability, continue as vigorous as ever. This excellent physician and accurate experimenter found that by removing the cranium of rabbits, and injecting a strong solution of opium into the brain, the animal was

thrown into the most violent convulsions, terminating in complete paralysis: and still on opening the thorax the action of the heart was observed to be "strong and regular."

In his comment on this experiment, the Doctor remarks, "It is a curious circumstance, that at the time the animals, used in this experiment, were thrown into convulsions by the slightest touch," (which evidently showed that their irritability was not at all diminished) "their sensibility was so much impaired, that on running a knife through the foot of one of them, it manifested no signs of pain."

This experiment was repeated on frogs, with this difference, that by exposing the brain and the whole of the spinal marrow to the contact of the solution, the animal was deprived of all sense and voluntary motion, and the action of the heart continued "as vigorous as it is in healthy frogs."

It appears, then, that irritability may remain unimpaired and even be increased, while there is a deficiency and even a total extinction of sensibility. Nor, in order to satisfy ourselves of this fact, need we have recourse to disease or experiment; such a state is not incompatible with perfect health.

In what is called the sanguineous temperament, there is an equilibrium between irritability and sensibility. But when persons of this temperament devote themselves to such pursuits as require uncommon muscular exertion, what is called by Dr. Rush the muscular temperament is superinduced. In the formation of this temperament, nature seems to forget the production of sensibility, and to concentrate all her powers to furnish the

muscular system with irritability proportioned to its increased exigency.

It is to persons, possessing this constitution of body, that we are to look, when we wish to select one equal to every daring and hazardous enterprise; when we need the assistance of the

> "Son of the howling mountain wave!
> Where thunders roll, and lightnings flash,
> Where loud the vext tornadoes rave,
> And spars descend and timbers crash."

The great irritability and corporeal strength, which exist in this temperament, admirably qualify the possessor for enduring every inclemency of weather and privation of comfort, while the insensibility, both of body and mind, allows no qualms of conscience to interfere with the execution of the most bold and sanguinary schemes. Of this description of character was that prodigy of nature, Charles XII of Sweden.

From the account of his stature and appearance, furnished by his biographer, and the high latitude of his country, I have no doubt he naturally possessed the sanguineous temperament. Subsequent activity and unparalleled exertion, produced in him the muscular temperament. He was the most extraordinary example the world ever afforded, of the great diminution and almost complete extinction of sensibility, by a preternatural determination of life and blood to the muscular system.

It was this happy provision of nature, which enabled him to sustain the accumulated distresses and sad reverses of fortune, which characterized his life; which banished fear from his soul when Russia, Poland and Denmark leagued against him; which prevented despair amidst all his misfortunes in the Ukraine, and empowered him to

perform miracles, while a wandering Prince in Turkey; which encouraged him to oppose the "shafts of destiny," by a last desperate effort in Pomerania, and gloriously to die in the siege of Frederickshall.

Shakspeare was not ignorant of the accumulation of irritability in the muscular system, consequent on the inactivity and insensibility of the nervous. Hence, after having represented the fair and beautiful Ophelia as deprived of sensibility, by the excess of her grief for the murder of her beloved father, he makes her exhibit the most extravagant and apparently unfeeling *actions*.

From a candid and impartial consideration of the subject, then, we have every reason to believe, that the action of the sanguiferous is not directly dependent on the nervous system, Dr. Johnson's* opinion that such a conclusion is "vain philosophy," to the contrary notwithstanding.

If irritability is not dependent on nervous influence, it may be asked from whence is it derived? We answer, from the blood, which we have already endeavoured to show is endowed with vitality. This important fluid, this "pars primogenia" of animals, is distributed by means of the circulation to the most minute and distant parts of the system, and, fraught with life and nourishment, preserves and vitalizes the whole.

The matter of life, as well as the grosser matter, which is destined alone for the increment of our bodies, is fatigued, worn out and exhausted by the actions of the machine, of which it constitutes the spring. There must, therefore, be some organ in the system, specifically ap-

*Vid. his Treatise on Derangements of the Liver, Internal Organs and Nervous System. p. 166.

propriated to the reparation of this continual expenditure, and we coincide with Professor Caldwell in ascribing this vital function to the lungs, which receive the Materia vitæ from the atmosphere, and impart it to the blood of the pulmonary artery, in its innumerable ramifications on the bronchial cells.

The limits of this dissertation, which, we fear, have already been transgressed, will not allow us to enter into a laboured defence of this hypothesis; we shall, therefore, merely observe that if universality can afford any argument in favour of the importance of any function, respiration is certainly one of the most important in the economy of living matter. For there is no description of living matter, whether animal or vegetable, simple or complex in its organization, whose existence is not inseparably connected with the atmosphere, through the medium of respiration of some kind.

> 'Leaves, Lungs and Gills the vital ether breathe,
> On earth's green surface, or the waves beneath.'

Now the following are the inferences which Messrs. Allen and Pepys deduced from an extensive and accurate series of experiments, which Mr. Ellis has confirmed, and in which physiologists now generally, if not unanimously acquiesce.

1st. The inspired air imparts none of its oxygen or nitrogen to the blood.

2. The blood loses a principle, viz. carbon, which by its union with the oxygen of the inhaled air, forms carbonic acid gas.

3. The watery vapour, found in expired air, is the serous discharge from the bronchial tubes.

4. The blood derives heat from the decomposition of

the inspired air; all the latent heat of oxygen gas not being necessary to the formation of carbonic acid gas.

5. The dark colour of the venous blood is owing to its being surcharged with carbon; and the bright scarlet color of the arterial blood to its parting with carbon in the process of breathing.

From this it appears, that no oxygen is communicated to the blood in respiration, as was at one time very generally believed; but that the quantity of oxygen consumed is no more than what is employed, in the formation of the carbonic acid gas exhaled. Now the mere separation and elimination of a little carbon from the blood cannot be the great object and final cause of the universally distributed function of respiration; for any other organ in the body might have performed this office, as we know the liver and the skin may and do, vicariously when any cause impedes the function of the lungs.* No: breath or air and life are synonymous terms, and indissolubly connected, because the principle of animation itself exists in the atmosphere, and vitalizes our systems through the medium of respiration.

It would seem that the ancients entertained some such view as this, with regard to the origin of life. Hence, Homer represents Sarpedon as almost expiring under the wound inflicted by the lance of Tlepolemus, but he is immediately resuscitated by a gale of air pregnant with vitality.

> "The fainting soul stood ready wing'd for flight,
> And o'er his eye balls swam the shades of night,
> But *Boreas*, rising fresh with gentle breath,
> Recall'd his spirit from the gates of death.

*Vid. Observations on certain causes which influence the decarbonizing function of the lungs, by Charles E Pierson M. D. in the transactions of the Physico-Medical Society of New York.