Respiration.

"Experimentum lubricum, judicium difficile."

Hippocrates.

As we trace the progress of human knowledge, from the first dawning of science to the full sunshine which we now enjoy, we find that what was believed, advanced and supported zealously by learned men, has been since rejected. Their erroneous ideas have been confuted, and most then have sunk into oblivion and those which have not, now float upon the surface on account of their lightness, futility and absurdity. Thus as time rolls over our heads & those of our posterity, the theories which are sound doctrine with us, will give way to those which have their foundation in our present knowledge and that which will be accumulated by the industry & perseverance of others.

Since Sir Francis Bacon Science and Phylosophy have undergone a compleat reform, and the era of experimenting has commenced. Scienes have been originated. The active and aspiring mind of man has soared into regions, the limit of whose existence, would not many years since have been considered the heighth of theoretical enthusiasm and madness. Who would have believed that one man, in wooden ships, with so small an index as the mariners needle, would have circumnavigated this globe? Who would not then have started with superstitious horror at the idea of a Franklin, guiding with his rod, the red lightenings of Jupiter harmless to the ground.

who would then have believed that 70 suns, each perhaps the centre of a planetary system like our own would have been discovered by the Telescope? a Herschel within the constellation of Pleiades. who would have believed that the waters of the vast ocean were composed of the most inflammable substances which can be brought together? who but would have laughed at the idea of navigating the Mississippi, against wind & tide & currents, by the mighty power of steam alone Now we laugh at those who know them not. Vaccination

Medicine has received as many improvements as any other Art of Science and they have been for the most part such as have been great advantage to the world in improving its condition; for the researches have been made with an earnest & Philanthropic desire of alleviating human sufferings. The discovery of the circulation of the blood, although great, as a discovery yet it presented a field vast and extensive to the curious & speculative mind, & by without enlarging the sphere of the Philanthropists action. The changes which the air undergoes in respiration is a subject which promises little more, but as the Phthysis Pulmonalis is a disease which annually takes from our country many of the most promising of the young of both sexes, we conceive it a subject of Physiology worthy on that account, only of our most accurate observation. The ideas of Philosophers upon this subject have been vague and indeterminate and are now vacillating.

The ancients so famous for acuteness and discernment supposed that as they saw smoke issuing from their mouths in winter that there was a spark within them which required to be perpetually fanned by the breath, or it would go out. It was a natural conclusion because they saw, that if a burning torch was deprived of air, it went out, & if this natural bellows was stopt, the man ceased to live. They also found that when an animal ceased to inspire, cold commenced at the extremities & soon pervaded the whole body, finally the thorax*. From this

* a patient who died on Sept. 1813. of fever remained hot about the thorax untill 16 hours had elapsed.

idea they introduced ~~that~~ beautiful figure "the spark of life". When a man was sinking under disease, or when the animal machine was almost worn out by the continual action of life, they said that the lamp had almost burnt out; that the candle had burnt into its socket; that is, that the "pabulum vitae", like the inflammables used for lights was near exhausted. When a man died they said that the vital spark was extinguished; that is, that he had expired, or could no longer inspire, or fan that spark.

We are not assured that this notion was erroneous. In the first periods of civilization from the poverty of language, men expressed themselves in metaphor, and these metaphors are a reflection on the similarity of those things for which they have no ~~——~~ words to express, to those things for which they had, and the ancients not having that perplexing profusion of mental pleasures created for them by their anxiety, ~~which~~ as have the moderns ~~have~~, had more time for this sort of reflection of course their tropes, metaphors, similes and allegories were the more natural. In figurative language then they might have dressed their knowledge of animal respiration.

Later Philosophers supposed that the action of life or the friction of this complicated animal machine, the pivots, axles & boxes of which were in the thorax & near the heart, produced heat & that by the means of the lungs air charged with frigorific particles was introduced to the machinery and cooled them. Those of a still later date, held that heat was communicated to the exhaled air & expelled with it in expiration.

The first idea was a good one, and we have already said might have been figurative, as it so well agrees with what was long entertained by the first Chemists the world ever saw. Except it is no ways likely that their ideas were then so precise-

The immortal Harvey discovered that the blood passed from the Vena cava into the right auricle, which by the irritability of its internal coats forced the blood into the right ventricle, and the ven-

ventricle by the same power impells the blood thro' the pulmonary artery into every part of the lungs & was returned thence by the veins into the left auricle, thence driven into the left ventricle, which by a stronger muscular power forces the blood into each and every part of the body, to the ultimate ramification of the arteries, from which by as many and as minute orgin'ations it was received by the veins & returned thro' the Vena cavae into the right auricle again, and so on, in the same continued circumvolgyration.

After this grand discovery a question arose, what was the use of the lungs, what the final cause of, and their function respiration; and the very natural conclusion was that as the air which came out of the lungs was warmer than it entered, was intended by the all wise Creator to cool the blood. But when that Era of Chemistry commenced, which dehnolished all former theories & reduced to order the confused nomenclature. when the Genius & industry of Priestley & Lavoisier discovered the causes of combustion, respiration began to be more understood The changes which the air underwent during combustion was proved, as they then thought incontrovertibly, to be precisely the same as during respiration. These two operations explained by the sagacity of this great man laid the foundation was the precursor of all those changes in Chemistry which we have alluded. That part which is called Pneumatic Chemistry owes its origin almost entirely to the hitherto unobserved analogy between these two operations. It was left for the Genius and the detracting mind of Lavoisier to apply to all these important facts.

Later and more accurate observations however have proved that the analogy is more correct than they themselves imagined. They knew before that as Stahl termed it, the air was phlogisticated, but that was not the only change produced. These Philosophers found that a new principle unknown to them predecessors disappeared in both cases. This was oxygen. They also knew that in the combustion of metals, that no new substance was evolved In the combustion of woods they also observed the evolution of gases and highly attenuated parts of vegetables forced off by the intensity of heat They supposed also that the air expired was only phlogisticated. but

later Chemists have found that this was not true. Lavoisier and the Physiologists contemporary Phlogistonists and those who have lived since the important period of his existence, believed that oxygen was absorbed by the blood thro' the thin membranes of the lungs and condensed as they found it, as they found it to be in the red oxyde of mercury and that this condensation of oxygen must produce heat by the evolution of the specific calorie necessary to its existence as gases.

This accounted for the heat, and the oxygen they said was necessary to the welfare of the system and was by the blood carried into every part of the body. So sure were they that oxygen was indispensably necessary to the welfare of the system that they supposed the placenta in utero served beside, being a medium of nutrition, to oxygenate the blood; but of no facts that prove its necessary introduction into any part of the system, excepting as a constituent of the blood. The Umbilical arteries bring the blood, which has passed thro' the circulation of the foetus, to the placenta, and ramifying thro' it and exposed the foetal blood to the arterial blood of the mother to which the dark carbon is imparted. The Umbilical veins then return it to the foetal heart. The carbonized blood in the mother take that from every part of the body returns by the uterine veins & discharges the superabounding carbon thro' the lungs.

Later Chemists commencing with these highly important discoveries have found that the same quantity of air was expired as was inspired, but that a portion of it was materially altered, not negatively as to its effects, but positively, becoming deleterious on the human system. They found this to be Carbonic acid gas. Still the Lavoisian theory held its own, few presumptuously daring to question its truth, for the devotees to this theory were enthusiastic and its friends increasing. But the idea of the absorption of all the oxygen into the circulation was incorrect.

Priestly found that if venous blood was introduced into a bladder the dark scarlet colour was altered to a beautiful vermilion. This alteration was produced by its phlogistication, or in the Lavoisian language it was oxygenated. We shall soon see that Priestly, Lavoisier, was not less erroneous as others in his ideas on this subject.

Considerable quantities of water in the state of vapour was expired & this was supposed to have been secreted by the lungs. This idea has ~~was~~ been called in question by some who contend that the hydrogen is secreted in the lungs & that uniting with atmospheric oxygen forms the water which every one knows is expired.- Here we must question the possibility of an union between the two gases oxygen & hydrogen, when we know that it requires the most powerfull chemical reagents to effect it, which the ingenuity of man has ever been able to control & apply to use. The most intense heat is required, such as never can be applied to them in the lungs. Pressure has not yet combined them, and certain that to which they have been exposed in the lungs, is trifling. I think it by no means an absurd idea, and as it has been advanced and believed by those far better skilled in chemical changes & combinations than ourselves, we ought to examine its claims and try them impartially before our contemporaries. Hydrogen which is a constituent both of the animal solids & fluids, and exist in them as a fluid and as a solid also may be secreted from the termination of the arteries by follicles or yet unobserved glands in a condensed solid or fluid form and in this state being brought into contact with the oxygen of the atmosphere may unite with it & thus form water. But still while the pulmonary mucous excretories throw out vast quantities of fluids, why should we expect a generation of water; and why should we seek to make natures simple operations more complex. Still it may be possible and the idea reflects honor on the invention of the first promulgators of it; but it seems entering the fields of hypothesis, for none yet know just the manner of union between the pulmonary arteries & veins and conjecture supplies place of fact in our reasoning even upon the access of air to the bloodvessels, in the air cells, which most of us believe to exist not being eye witness to its truth. Much less can we be expected to unravel the glands, the function of which ~~is not yet known proved to the necessary~~ so far from being demonstrable, is not yet even proved to be necessary.

The excretions from mucous membranes, pass thro' such small ducts that fluids are so minutely divided, that the particles are almost out of the sphere of each others attraction and are consequently evolved in a vesicles, or a gaseous form or perhaps in a form between a fluid & gas.

the heat of the lungs or that which is rendered sensible in the lungs by the chemical changes there produced, willbe amply sufficient to convert it into vapour. This being the case I can see no reason for supposing but that the moisture of the breath arises from the mucous pound out by the proper function of the pulmonary exhalants. Perhaps this is as hypothetical as the other, and as ~~unworthy~~ deserving of [illegible] attention. I do not mean that they are my own ideas, but I mean to give the opinion which I now entertain, as collected from various sources.

Thus we think we have accounted for the ~~change~~ moisture in the air expired & next it will be necessary to take notice of the other changes, which have been long observed.

5th The air loses its power of supporting life and the great question is, what is the change by which it loses this power? The atmospheric air consist is composed of 22 of oxygen & 77 of nitrogen in the 100 parts. The quantity of ~~Oxygen~~ nitrogen in expired air is precisely what it was when inspired, but the two other ingredients hold not their proportions. The oxygen disappears & the carbonic acid gas is increased in proportion to the diminution of the oxygen Quicksilver becomes red by combining with a maximum of oxygen. so does iron, copper, manganese & chrome when united with some thing other substances. The blood changes from a dark ~~scarlet~~ to a beautiful vermilion colour by exposure to air, and the presumption was that as the change was the same what and-ever was the cause was the same, but we ought not to take any thing for granted, which is not a mere assertion as this deportation will prove, & Perhaps its impropriety here will be more palpable than we now imagine

Let us examine this question & see how it will agree with the products of expired air. The oxygen disappears & carbonic acid gas is generated as we find by breathing thro' lime water. Carbon is a constituent of the blood, but we have no proof of its existence in the animal form as carbonic acid. The carbon must therefore have absorbed the oxygen, united with it and been thrown out again, thus

becoming a gas & requiring a certain definite quantity of caloric to become latent in & sustain it as a gas. But as it is a denser gas it will require a less quantity of latent caloric. According to Davy 100 cubic inches of Oxygen weighs 35.09 grains at 53° Fahrenheit & 34.70 at 60° Fahrenheit & 30 inches the Barometer and according to Allen & Pepys. 33.82. Ther. Fah. 60° Bar 30 in. According to Davy 100 cubic inches of carbonic acid weighs 47.5 grs. Ther Fah. 55°. Bar. 30 inches and 47. Ther. same pressure 47.11. According to Allen & Pepys 47.26 grs. Ther 60° Bar. 30 inches. Thus by calculation we shall have an average difference of 13.03 grs. nearly; and as the capacity of any body for caloric or its specific latent caloric is inversely as its density nearly, the union of the carbon of the blood with oxygen will extricate a portion of the latent caloric & make it sensible - as the average difference between the carbonic acid gas and oxygen 13.03 nearly is to the average quantity of oxygen 34.53 so is the caloric evolved to the quantity of oxygen which has disappeared.

Here we account for the oxygen disappearing & the generation of carbonic acid gas, and likewise shew that caloric must be evolved, since it is well ascertained that the augmentation of temperature of the blood by a passage thro' the lungs is only one degree, which must have been greater, were there not some other way by which the heat should be carried off. The branchiæ are replete with mucous follicles, whose office is to lubricate the lungs. Some would say that this is reabsorbed. Grant that it may, but as we think we have proved that the water expired is not generated, we believe it excreted by the lungs & as it is minutely divided by passing thro' the secreting vessels, that it appears in a halitus & thro' the means of this rendered imperceptible by the condensation of the two gases it is carried off. caloric, ~~is evolved~~. To convert water into the form of vapour, & consustain it in this new form would require a vast quantity of caloric. During this process the blood receives the warmth by the tendency, which caloric has to diffuse itself thro' surrounding bodies.

The next question is where does the carbon come from from. It is a constituent of the blood. Is the blood then decomposed, so that it yields its elements to the atmospheric oxygen? — No! The arteries carry the blood into the capillaries, where a portion of it has been assimilated, or

a part secreted & converted into Carny fibre. This is taking place
in every part of the body. Not a point, which is round, can be found
where this process is not going forward. By this process a portion of
carbon is separated from the other part of the blood & mixing with it
at the extremities of the arteries & commencement of the veins is col-
lected by the veins from every part of the body & brought to the lungs
of a dark scarlet colour, where the carbon unites with the dimospheric
oxygen & passes off leaving the blood of the proper scarlet vermilion colour -

But how does this atmospheric oxygen come in contact with
the carbon in the lungs? Physiologists generally suppose that the
air vessels were pervious to oxygen & that it really passed thro' the
coats of the vessels. Must we believe that it passes thro' & then comes
out again in the form of carbonic acid gas? Who has demonstrated the
vessels or pores which absorb or exhale these substances? We will
not declare that this is not true, but is it not more natural to sup-
pose that the carbon is secreted by the proper vessels in the
lungs. May not the artery terminate in a duct, which empties
into the air cells, & from which the veins take their origin, just like
the exhalants. This may be called a glandular structure & may
meet the ideas of the gentleman who has written so elaborately upon
the subject.

Thus we have accounted for every alteration which takes
place in the air & the blood by its passage thro' the lungs. One thing
which is important, and which I have only hinted will not become
an interesting disquisition, that is a production of animal heat. The
ancients supposed that there was fire in them, which gave heat
to the animal frame, and was the motive principle of all its functions.
Others supposed, among which was the illustrious Boerhaave, that
it was the friction of the blood against the various blood vessels.
Others that it arose from the fermentation of ingesta in the stomach,
some said it was produced by the action of the muscles; the friction of the
tendons, and by the various degrees & kinds of friction in every part of
the body, whether natural indispensible or accidental. As we
have already hinted, some thought the lungs appropriated to cooling
the body. Others contended that they were organs almost exclusively

adapted to the production of the heat so necessary to the prese
action of life and I have told you that heat is really evolved &
likewise how it is carried off without affecting much the tem-
perature of the blood. This last is the opinion we generally en-
tertained but we differ from them all. We will never be-
lieve that either of these modes of explanation are true, until
they are proved & simply they cannot be. Strange it has
long appeared to us, that men should have such a inclination
or propensity & I had almost said passion to explain effects com-
plicated and intricate, by one simple cause. That the production
of animal heat should be explained by anyone of these causes
is to us preposterous & absurd. My language is tinctured with
the ardor of youth, & also with its presumption. It is foolish
to tax the learned of all ages with ideas preposterous & absurd
particularly for ignorance & youth, but I will not conceal it
left & should appear to have less warmth than usually
falls to the share of a young man.

My opinion is that all these causes conspire to
produce the grand effect; to produce the motion which upon
which life rests. Heat is the principle which gives the first
pulsation to the heart of the embryon, that evolves its parts,
that keeps the machine in motion & gives it power to live
& move spontaneously. It is that principle which acts upon
organization and makes it living. Can it then have one
cause or exciting cause. Heat is an essential constituent
of all animal bodies, whatever the medium they inhabit
and of every thing that is about us, & all that is necessary
is, that it should be made sensible, and this we contend is
done by the joint operation of all the animal functions, & by
all the accidents & circumstances before above mentioned, and by
many more which may not now be apparent.

One however I am surprized ~~but~~ not to have seen noticed
among the theories. I will not ~~say~~ be certain that it has not
been long ago refuted among the many preposterous ideas

with which our science has been replete (is encumbered). I know not how often it has been proposed lately I have never heard it opposed and have never read it, which I wonder at since so many men has been so busy in framing hypotheses in explanation of what is of no use to him. — I believe with Boerhaave that friction produces heat or expresses it. The very contraction of that powerful muscle the heart, the friction of the blood with itself, and against the internal coats of the cavities, and in its coronary arteries; the friction of the blood in the pulmonary arteries; its passage thro' the lungs, the action of the respiratory muscles, the secretion of mucous renders the latent heat sensible & produces animal heat. It is also extricated by the condensation of oxygen in its union with carbon to form carbonic acid, the whole action of respiration, the motion of the blood in the pulmonary veins, and the powerful action of the left ventricle in forcing the blood thro' the arteries producing a friction on their sides. The contraction of the arteries thro' their whole extent, compressing the blood, particularly the smaller ramifications, unite in producing the same effect. We now have come to an idea, which I have never heard advanced. Blood is a fluid, and in the cappilary or extreme vessels a secretion is performed, by which this fluid becomes solid, and to constitute a fluid, requires more heat than if it was a solid. Now the animalization or secretion of animal solids is progressing in every part of the body and this heat is extricated in every part, of course, and it's continually kept up in every part of the body. But there is an objection to this. Is this secretion or animalization a condensation of fluids in to a solid, or is it a mere seperation. I believe it to be a condensation. Coagulable lymph is not effused, in the same form as we find it upon the meninges of the brain, in persons dying of violent fevers, on the surface of the Abdomen, in Pleuretis or upon the surface of the heart We will not deny that the term secretion is not improperly

applied, but not entirely so for we believe in a seperation of carbon in the blood at this time. The carbon giving the dark colour to the blood, after its having passed the process of Arterialization.

All the secretions performed by the subordinate systems evince a just in the support of this heat altho' some of the secreted a more fluid substance, than the blood itself, yet the action of the vessels, independent of their functions, will more than compensate for the change of capacity. Besides its only the seperation of the thicker from the thinner. Hence tho no increased capacity for calorie, there is no diminution of sensible heat.

The process of digestion may & probably does aid in a small degree the continual extrication of calorie necessary to the facility of life's functions. After a full meal a slight fever commences. The mere stimulus of food would have little effect, because one or two pulsation more the Artc. would not increase the heat perceptibly. We would bring in all those circumstances that may in any degree assist in rendering that sensible, which is always tending to equalize itself by diffusion thro surrounding bodies, for we do contend the animal heat is the product of all the animal functions conjointly, some only aiding in a very small degree, yet all deserving our consideration as co-adjutors.

The action of the muscles consists in the ~~dilatation~~ shortening of their transverse diameter & an the increase of the conjugate diameters. What this depends upon we know not; but as the busy mind of man must have something to rest upon various hypotheses have been framed, none of which would influence this question, without we could prove that the nervous

energy depended upon some modification of heat, as galvanism, by which heat would be extricated. Muscles are composed of fibres, the smallest of which examined by anatomical eyes, are found to be likewise fibrous. These ~~cylindrical rings~~ fibres are composed of cylindrical rings and these ~~cylinders~~ rings granular. The power which they exert depends on their ability to contract diminish their size. This very action will express latent caloric and make it sensible for muscular force is prodigious

In exercise there is first an acceleration of blood from pressure & friction. The right ventricle is sooner filled and of course sooner contracts. The blood passing thro' the lungs quicker & falls the sooner, and from the pressure of the succeeding column the left ventricle is sooner filled, which as soon as filled contracts and produces a pulsation in the arteries some what sooner than before. This acceleration pervading the body gives by mechanical distention, greater ability for muscular motion, which thus reacted upon, by the same causes effects still further hasten the circulation. Such exercise always gives a general & agreable warmth to the system if moderate. And how? By giving vigor to the whole system increasing all the secretion & excretion and every process in the body. If exercise be great. the body becomes hot & the functions are hurried and soon exhausted. Has this circumstance then no agency in the production animal heat. Let a man contract his muscles and heat will be produced The action compresses the vessels and thus heat expressed. Let a man rub his hands together once, and he will perceive an increased warmth; by continuing friction rapidly sometime the heat will be insupportable*. If this be the case if it be beyond common sense to suppose that every motion assists in the production of the requisite animal heat.

as slipping down a rope

I have here unfolded the opinion which I now entertain upon the changes which the air undergoes during respiration & the collateral circumstances which I have connected with it. I pretend not to original ideas, because few of them are my own. I sincerely give my opinion as gleaned from many authors, and from suggestions of others.

Let no one say that I do not give credit for what I borrow, without considering that to refer the reader to authorities would be doubling the size of my essay. Besides I dislike this pedantic appearance of numerous references ~~to authorities & doubling the size of my essay. Besides I dislike~~. If a man knows a thing and can tell it to another & write it down, without referring to any authorities, it is knowledge, and it is as good to him as if the product of his own mind. Wherein consists knowledge but in the accumulation of the ideas of others? A man of learning is estimated according to the extent of his knowledge of what is known, not what he has found out by dint of his own ingenuity and industry. Invention, discoveries, and novel ideas surely add to the great mans reputation, but first let me know what is known already & let invention & discoveries be secondary & incidental, or sequels to acquired knowledge.

If I have asserted any thing coldly and/or presumptuously, pardon it. I mean only to advance my opinions & I give it with the same freedom & in the same style, as I would in the conversation of a friend, always declaring, what I believe to be true; at the same remaining open to conviction, when any person will take the trouble to shew where I am wrong. Meaning to take nothing for granted, I have endeavoured to give such reasons as will convince others even as I am convinced

With all these pretentions to candour I may however be as dogmatical as any one. It would not be human to be otherwise.

Addenda –

Our theory then is that the oxygen ~~it respires to~~ enters the lungs ~~by~~ combining with the carbon ~~of the~~ with which blood in the pulmonary veins is surcharged. thus taking away that portion of the blood which gives it its ~~dark~~ colour. Colour is given out by the condensation of the two gases oxygen & carbon, that the moisture is derived from the mucous follicles of the bronchia & is evaporized in part by the minute division of the particles & by a portion of caloric evolved. the blood itself acquiring by a small quantity of heat.

moisture is not derived from the chemical process of generating Hydrogen, but that the lungs are supplied like all other delicate organs with water by the exhalent vessels —