Prize Questions.

THE Committee appointed by the Corporation of *Harvard University*, to carry into effect the laudable purposes of WARD NICHOLAS BOYLESTON, Esq. do hereby engage to deliver to the author of the best dissertation on each of the following subjects respectively, a Gold Medal of the value of thirty-three dollars, or that sum of money, at the option of any such author:—

1. On the medicinal use of carbonic acid gas.

2. On the criteria by which to determine when the use of mercurials in cases of syphilis, should be discontinued.

3. On the reciprocal changes which take place in the blood and in the air, in the process of respiration.

Each dissertation must be transmitted (post paid) to LEMUEL HAYWARD, Esq. M. D. in *Boston* on or before the 20th day of December, 1813. Each Dissertation must be accompanied by a sealed packet, on the outside of which should be written some device or sentence, and on the inside the author's name and place of residence. The same device or sentence must be written on the dissertation to which the packet is attached.—No dissertation can be received which has the author's name affixed.

Unsuccessful dissertations shall be returned, if desired, with the sealed packet unopened; otherwise the packet shall be destroyed, without breaking the seal.

Lemuel Hayward,
David Townsend,
John Warren,
Thomas Welch,
John Brooks,
Aaron Dexter,
Josiah Bartlett,
Wm. Spooner,
James Jackson

Boston, April 24, 1813.

☞ The printers of newspapers in this and the neighboring states, are requested, for the benefit of medical science, to publish the above for three weeks in their respective papers. 3w.

Dr Warner
Dr Dutton

Left at the Post Office
agreeably to direction

"God breathed into his nostrils, the breath of life, & he became a
living soul. "

A Dissertation on the reciprocal changes, which take place in the blood; and in the air, in the process of respiration.

"And the Lord God formed man out of the dust of the ground; and "breathed into his nostrils the breath of life; and man became a living soul."

Genesis IIdd Chap: V IIIth verse.

This question has been proposed, under differ-ent forms, ever since the first establishment of the Boylston Prize Questions; but from the difficulty of its solution has been left to this time without being crowned with the approbation of the Committee. — Being aware of the difficulty of the subject, we shall, to render it as simple, as may be, treat the matter "ab Ovo."

It appears from the dissection of the gravid uterus, that the human body, at its first formation, is very small; appearing like a seed, or rather like the egg of the tadpole, which grows up to the frog. — It appears, that the human Embryo encreases gradually in size by accretion, & by evolution, very much like that of a plant. —

In a month from conception the Embryo is about an inch long; at which time, the bones appear like fine threads. — Among them, the ribs are distinguishable, disposed on each side the spine, but as soft as a jelly. — In two months, it is so far grown, that the ossifications are perceivable in the arms, thighs, & point of the chin; and the umbilical vessels, which before went side by side, now appear twisted like a rope, one over another, so as to encrease the length of the vein & the artery, & to break the impelling force of the latter. — In four months, the nails appear on the fingers & toes; & soon after the stomach, & Intestines seem to perform their functions of receiving & digesting; for in the stomach is found a liquor similar to that in which it swims; & in the larger intestines an excrementitious substance. —

Ch Obs. —

The head of the embryo appears to be first formed; & then the spinal marrow is seen to stretch along the back bone from the brain. — At length heart is seen to beat. — By & by the Liver with its gall bladder is formed; & last of all the Lungs. —

As soon as the Embryo begins to grow, the womb, of course begins to grow also in size; — but, what is rather surprising, it encreases in thickness, as it extends its bulk. — After the seventh month, the embryo changes its name to that of Foetus, which is now seen to be close wrapped around by two membranes, the chorion, & amnios, & thus furnished, it floats in a transparent fluid; — & taking the whole together, it very nearly resembles the chick in its egg-shell. as has been finely illustrated by the immortal Harvey. —

The umbilical vessels, consisting of a vein, two arteries, & a nerve, issue from the navel of the Foetus, & branch out upon the Placenta, & seem to form its chief substance. — By means of this navel-string, the child adheres, & grows to its mother, just as the apples adheres & grows by its stalk to its parent tree. — The Placenta serves here, the same use as the two large umbilical vessels bud-leaves, subserve, that of the Embryo plant, — viz: — to oxigenate its vital fluid. —

The child never breathes in its mothers womb; because it swims in the water of the uterus. — The Lungs of the Foetus remains, as quiet, as its liver & never moves untill the child passes from its watery habitation into the atmos-phere; — nevertheless the blood passes through the heart of the child in the womb; but then it obliges a particular contrivance, which is a wide open passage, from the right auricle to the left, called the Foramen Ovale; it however passes much slower, than it does, after the child has once breathed; which fact, it would be well to bear in mind, in this discussion. —

The child then recieves its nourishment, while in the womb, from its mother; in the same way, that a growing fruit recieves its nourishment, & consequent growth from its parent stock; which again recieves its nourishment, verdure, & beauty, from nutriment drawn from the Earth, by its rootlets, — {* Wood}

or roots; & from the air, the Oxygen, & the Light of the Sun. — But the child, while in the womb of its mother, must recieve something more than mere sanguineous nourishment. — Its blood must be oxygenated, & possessed of that vital something, which imparts to it, the bright vermillion colour; for without possessing that splendid colour, the foetus dies. — We cannot suppose, that the breathing of the mother can oxygenate the blood of her foetus, shut up as it is, in the thick uterus, like the chick in its egg-shell. — We could not suppose this, even if we admitt the strange idea, that the air inspired by the mother, penetrates the fruit of her womb, like the inhalation of air in birds in the action of flying. — How then is this oxygenation of the blood in the foetus in utero effected? — Let us examine it; & adore the Divine hand, that framed & fashioned us in the Womb. —

We have every reason for believing, that the Placenta, is the Organ by which the blood of the Embryo, is oxygenated. — If we examine its structure, we shall find, that it has a nearer resemblance to the Lungs, than any other in the body. — There even appears a structure resembling the air-cells of the Lungs; but whether, there has ever been observed an inflation of this structure, in the Cæsarian operation, we know not. — It is worthy of notice that it was conjectured, more than a century ago, that the Placenta was a respiratory-organ; or what would be called with more propriety now, an oxygenating Organ; but the too scanty time allowed for composing these prize questions, does not admitt of searching out the precise place in the works of a Latin author. — We say however generally, that Harvey, & Malpighius, were not satisfyed, that the placenta conveyed only a stream of red blood & lymph. — Both these philosophers, saw the necessity for the imbibition of the vital air, thro' the shell of the hens-egg; & by parity of reason, they concluded, that the foetus in utero, must derive the same benefit thro' some unknown organ or apparatus; & no other presented, but the Placenta. —

We learn from the Anatomists*, that the two umbilical arteries, arise from the internal iliacs of the foetus; that they ramify all over the Placenta, & their

* See Haenyus & Haller. —

their branches inoculate together in its substance, & the smallest extremities are lost in that part of the membrane, called chorion, which is interpo=sed between the Placenta & Uterus. — We learn from the same source, — that the origin of the umbilical ~~vessels~~ vein, is from small venous tubuli, arising from the chorion, where the small twigs of the arteries are lost, which uniting & forming larger & larger branches, at length run all into one large trunk, en=tering the umbilicus of the foetus; & then it goes to the Liver, & opens into the sinus of the Vena Portarum, from which sinus, there arises, in the foetus, an particular large trunk, called the venous duct, opening directly into the Vena Cava, which transmits the blood to the heart, where, without entering or in any degree moving the lungs of the foetus, it passes thro' the heart = by an organical-hole, which is compleatly closed up, after the child has = breathed. —

From this history it appears, that the arteries of the Uterus bring the blood to the Placenta, which being taken up, by the begining of the veins of the Placenta, is transmitted to the foetus, thro" the umbilical vein, into the Vena portarum; & from thence into the Vena Cava, & so into, & thro" the heart; the lungs of the child remaining quiescent. — On the other hand, the two umbilical arteries in the foetus, being continued from the aorta, carry the blood to the Placenta; which blood at the adhesion of the placenta to the Uterus, is taken up by the ~~lungs~~ begin=nings of the Uterine Vessels, & transmitted to the cava & the heart of the mother, — & thus the blood flows from the mother to the child, & from the child to the mother again; — & what was arterial blood in the one, becomes venous in the other alternately* — But in this alternation, for we hardly dare call it circulation, we can discern no process by which the blood of the foetus is oxygenated. — We must therefore refer it, to the lung=like structure, of that temporary organ, the Placenta, without pretending to explain its "modus"

* See Hewson & Haller. — "operandi. —

"But suppose we should not be able to explain satisfactorily; nor even conjecture with probability, concerning the cause of vitality, it is no more, than what happens to the oldest physician & philosopher every day, in his enquires into the works of nature. — We find inexplicable difficulties in the inanimate world; what wonder then if in the human body, a system so curious, so subtle, & compounded, we should meet with things, which we cannot account for? — Every step we take, convinces us of our ignorance; & how little we know of the works of Him, who made us, & all things! — " As thou knowest not, what are the ways of the spirit," "nor how the bones do grow in the womb of her, that is with child; even" "so, thou knowest not, the works of God, who maketh all." —

(Eccles.s Chap. XI: Verse 5.th. —

Chapter III:[a] —

From observations made, ever since the birth of the children of Adam & Eve, we learn, that the human body grows up from a small particle, or egg, in the womb, during the space of nine months. — Even in the last period of its existence in that receptacle, it appears, that its sensations are very few & very obtuse. — It nevertheless seems by its quiet, & afterwards by its motions, to sleep & to wake. — How the foetus comes to be marked & maimed by shocking sights, & very strong impressions of the mother, we know not. — The fact we admitt, because it is testified by all nations, savage as well as civelized, in all ages, & parts of the world. — "~~[illegible]~~

The foetus in utero, even in the last period of its existence; does not appear to possess any feelings above the foetus of any other ~~animal~~ quadrupede. — The commencement of the living state of all animals, is, as far as we can discover, on a level with that of man. — They have the like imbecility, & are equally unconscious of their existence. — If it might not be used to evil purposes, we should say, that there is no one fact attending the human foetus, — anterior to its breathing, that would allow us rationally to conclude, that it possessed a Soul; or the conscious principle, in contradistinction to the anima, vitality, or simple life, equally enjoyed by the brute. — Our opinion is, that the infant does not possess a Soul untill it breathes the vital air of the atmosphere; & in this we are countenanced by the opinion of all ages the wise in all ages; & we are supported in it by the Sacred scripture, which says, that God first formed man, as in the womb; & afterwards "breathed into" "his nostrils, the breath of life; & the consequence was, he became a living soul." — We therefore think, we are justified by reason, & countenanced by Holy writ, in the opinion, that the human foetus, is devoid of a soul, untill the moment of its first inspiration, & that it quits it, at its last expiration, & "returns to God, who gave it;" — & that this is the language of reason & revelation. —

The

The doctrine we wish to maintain, is explicitly this; that breathing & animation, are two terms, for the same state or condition of man; & that the state & condition of the "foetus in utero", previously to its first inspiration of Atmos=-phereal air, was, in the scale of vitality, little more than vegetation. —

Let us now, take up, the state & circumstances of the child in the womb, which was at the latter end of the ninth month. — At the termi=-nation of the about 40: weeks from conception, the infant gives its mother painful proofs of its existance; for now the stalk of the fruit is beginning (if we may so speak), to separate from the parent tree; & the head of the child falls down to the oppertare of the womb, which organ becomes uneasy, & strives instinctively to be freed from its too heavy burden. — Both these causes co-oper=-ating, the infant at length issues into life. — Now let us attend, to the impor=-tant change, which at this momentious period takes place. — As soon as the child issues into light, the atmospherical air rushes into its nostrils; & the Lungs, that had till this time been inactive, first begin their functions. — This rushing in of air, thro' the nostrils, seems to occasion pain, which the in=-fant expresses by a shriek. — It then appears, that when the child is wholly disengaged from the uterus & placenta of its mother, it depends in future upon the operation of its own organs, instead of the organs of its parent; & that in order, that it may live, it must be allowed the free use of the atmospherical air. —

When a child issues into light, or is born, that is to say when it passeth from its watery habitation into the atmosphere, it becomes dependent on a new principle for the continuance of it existence. — A new determination now takes place in all its organs; & instead of receiving life from its mother, as heretofore thro' the umbilical cord, the common air becomes ever after, the fountain of its heat, & the main=-spring of all its actions, & functions, both corporeal, & intellectual. — No sooner does the infant inspire the atmospherical air, than the Lungs are, for the first time, expanded;

and

and the great volume of blood, which had hitherto passed only thro" the heart, now takes a wider circuit, & the foraman Ovale, or hole thro" the heart closes forever. — The Lungs now first begin their functions; & they cease not their action so long as life continues. — What a complicated, interrolving, simultaneous, & alternate revolution is here, in the tender, & delicate frame of the infant! — —

The strict order of our disquisition, compells us to concentrate our attention on the function or process of Respiration. —

Beside the Bronchial artery & vein, which nourish the Lungs, as an Organ, there is another & a larger set of vessels pervading them, which contain blood; & another set of ves-sels, which contain Air. — The air in the Lungs, as well as in the blood in the pulmo-nary artery, is in constant motion; for either that portion of air, which is at present, contained in the cells, is passing thro" the wind-pipe, into the atmosphere; or else a fresh parcel is paping from the external atmosphere, thro" the wind-pipe into those cells. — The whole of this compound motion is very aptly termed Respiration. —

To breathe & to live are terms synonimous. — All animated nature & the vegitable breathe. also. — "The breathing leaf" is a phrase not merely poetical. — The large leaves of equatic plants have a breathing structure, that is easily to be traced, constituting an appa-ratus resembling the gills, or breathing apparatus of fishes. — The insect breaths; the rep-tile, that lives under a stone, & the animal that burrows in the bottom of ships, breathe, & so do sponges & polipi, that adhere to crusteceous habitations. — They all in a greater, or less degree, pant after the vital principle in the Atmosphere. — Nay farther, the seed, if planted too deep in the ground, perishes for want of the vital principle in the Atmosphere. —

The question now is, — What is that vital Principle? —

Some persons of circumscribed views, & confined reading, have imagined, that the wise men of Antiquity, were entirely ignorant of this vivifying ~~principle~~ something in the air; but it is a mistake. — Aristotle had an idea, that a vivifying something was absorbed from the air; & he imagined, that it underwent some change in the Lungs-

thing

David
King says in 104th Psalm "- Thou sendest forth thy spirit, & they are created; thou"
"takest away their breath, & they die." - This finely expressed the effects of inspi-
-ration, & expiration, which phrases were then, as they are now, synonomous
with living & dying, all of which depended on the function of Respiration. -

Modern Physiologists, enlightened by the discoveries of the recent
chemists, have said, that the process of respiration, may be aptly compared to a
slow combustion; - for as in combustion, the oxygen of the atmosphere unites
with some inflamable body, & forms an acid, as in the production of vitriolic
acid from sulpher; or carbonic acid from charcoal, which gives out, at the same time,
a quantity of the matter of heat; so in Respiration, the oxygen of the air unites
with the phlogistic part of the blood & changes the colour of it, from a dark to a bright
red. -*

* Darwin

The ancients had a similar idea. - They supposed there was an internal
combustion; & that by the action of respiration, it assisted in the expulsion of a noxious,
fuliginous, or poisonous vapour, which was continually passing out from the centre
of the body, thro' the wind-pipe into the air, which was of so destructive a
quality, as to convert good & wholesome air, in a short time, into poison. - And their
reasoning on these facts marks their sagacity. - Their theory was explicitly this, -
They supposed from the heat of the blood, that there resided in the heart, a
flame or vital spark; & it seems they were confirmed in this notion, by observing
the appearance of smoke in our breath, in a very cold day. - They were still fur-
-ther confirmed in their theory, by noticing, that fire was extinguished when
deprived of air; hence they concluded, that the process of respiration was to fan
or blow up, this internal flame, & to keep the original, vital spark from going out;
& at the same time to ventilate & moderate the heat of the blood in the arteries
of the Lungs, & in the heart. - All this was very natural & consistent. - They
saw, that the flame was extinguished, if you prevented the entrance of the air
into the lungs; & that if you obstructed the exit of the foul or fuliginous matter, -
the

the patient was thereby poisoned, by the retention of that mephitic vapours which ought to have been expelled. — We meet with few theories more natural or consistent. They were however far from being agreed as to the "modus operandi" of this vital— process. — Some more negatious than the rest, as Aristotle, supposed that a certain vivifying principle, was absorbed from the air, to which they gave the name of "pab= "ulum vitae, or provender of life. —

In the 17th century Lower in England, & Borelli in Italy, paid great attention to the functions of the heart & lungs; they observed, that those animals, which respire the most & quickest, have the warmest bloods, such as men; & some smaller animals; while those, that respire the least, have the coldest, as the Turtle; & some other amphibia, & fishes. — They proved, that the air lost something by coming in contact with their Lungs. — Dr Mayo, a learned & ingenious physician in the reigns of King Charles the IIst — of England, shewed, that this something was contained in Salt= petre. — This was first observed by those, who were employed, in the manufacturing this article; they said, that there was something powerful in nitre, that was absorbed from the atmosphere; & it was left for the great Dr Priestly to shew, what that — something was. —

If we turn to the writings of the great Boerhaave, we shall find, that he was not ignorant of this acidifying principle, or as some call it, "nitrous acid" of the air. — The upper surface of the blood, when exposed to the air, is, says Boerhaave of a light, "of a bright scarlet, while in every other part, which the air does not come at, grows" "as black as the blood of the cuttle fish; & yet as soon as this black part is laid" "open to the air, the black colour is immediately changed into scarlet. — This" "vivifying principle in air, so necessary to life the support of life, & of flame, as well" "as animal & vegitable life, seems by every phenomenon, to be that of an universal acid," "which is distributed thro" the entire atmosphere, in a certain proportion, insomuch" that no proportion of air seems to be without it. — By this acid the calx of vitriol, of alum, & of the Earth, from which salt= petre is procured, are again replenished, in such

"in such a manner, as to be capable of producing acid spirits afresh. — There is reason"
"says Boerhaave to suspect that Flowers are indebted to this acid of the air, for their"
"beautiful colours; All concerned in dying observe, that a cloudy, moist air interferes"
"with the beauty & vividness of their colours; & that a serene sky exalts them, & makes them"
"more elegant. — And then, this ornament of the medical world, adds, — "This acid of the"
"air, finds some way of mixing with the blood; & it is believed, that, this grand operation"
"is performed in the Lungs; & that the blood acquires a scarlet colour". —

We may remark on this passage, that if we here substitute the term of the new nomenclator, Oxygen, for that of the acidifying principle, we have a pretty correct idea of the modern doctrine of the oxygenation of the blood, as we shall see hereafter, — for it seems, that Boerhaave, a century ago, was not ignorant of this vivifying agent. — We every day see, old doctrines & discoveries brought into fashion under new names. — Boer= =haave, Boyle & Newton, had an indistinct view, of this principle in nature; but neither of them a correct one. — They knew; that the common air, was impregnated with a certain vivifying ~~principle~~ spirit, which was necessary to continue the life of animals; & that, this in a gallon of air, was sufficient for one man during the space of a minute, & not much longer. — They knew, that this spirit in the air, was destroyed by passing thro" the Lungs; & also by passing thro" fire; particularly thro" charcoal fire; or the flame of sulpher. — They knew likewise, that air which had lost this spirit, deadened fire, extinguished flame, & destroyed life. — They = knew full well, that this thin transparent, elastic fluid, which encompases the whole earth, to a certain height, & which we breathe," was to us "the breath of life; & that it was at the same time, the very spirit of fire or flame; but they knew not, what this spirit was; & how to detect it, & exhibit it "per se". — Boer= =haave spoke of it, as we have related; & the immortal Newton spoke of a "materia subtilis", which he supposed to be so subtle & refined a nature, as to be void of gra= =vity; & of the other properties of common matter. —

This spirit in the air could not escape the penetrating eye of

Newton,

Newton who says, "That there is an unknown something, which remains behind when the "air is taken away, as appears from certain effects, which we see produced in vacuo", (in the air pump). — Heat is communicated thro' a vacuum", almost as readily as thro "air". — And this great philosopher, subjoins, "that this communication of heat, cannot be without some interjacent body, to act as a medium; & that such a body must be subtle enough to penetrate the pores of glass; as a glass recipel is that part of the air-pump, where the vacuum, as it regards air, is made. — If this subtle, unknown, something, or spirit of the air, penetrates glass, we may it is said, well conclude, that it penetrates the pores of all other bodies, & consequently is diffused thro" all the parts of space. — —

Newton supposes this subtle æther to be rarer in the pores of bodies, than in open spaces; & even rarer in small pores & dense bodies, than in large pores & rare bodies. — He also supposes, that its density increases in receeding from gross matter, so as to be greater, for example, at $\frac{1}{100}^{th}$ of an inch from the surface of any body, than at the surface. — He further more infers, that this aetherial medium, is not only rarer, & more fluid than air, but exceedingly more elastic & active; in virtue of which properties, he shews, that a great part of the phenomena of nature, may be produced by it. — He ascribed to it, the elastic force of the air, & the nervous energy of the living fibre, & nervous system; the phenomena of light, as well as the effects, of the communications of heat, together with sensation & muscular motion. —

It is not for me, who am but a collector, arranger, & comparer of facts, widely scattered, to attempt to draw the line, (if a line can be drawn), between this principle or element, & that of oxygen. — That task must be left to this learned Committee. —

We however, draw a line between this spirit in the air & that igneous fluid, or matter of heat, which the vulgar call Fire, & the philosopher, Calorie, by which term, they mean that exquisitely elastic fluid, which causes heat. — —

Over & above these, there is a third grand agent, viz: Light, — but whether light be a modification of caloric; or if caloric be a modification of light, we leave to others older than ourselves, to determine; & close this chapter by saying in the words of the celebrated Lavoisier. — "Organisation, sensation, spontaneous motion" "& all the operations of life, exist only at the surface of the Earth; & in places exposed" "to the influence of light. — Without Light, (& its concomitant heat) — nature itself" "would be lifeless, & inanimate. — By means of Light, the benevolence of the Deity" "hath filled the surface of the Earth with Organisation, Sensation, & Intelligence!!"*

* How sublime & beautiful is that expression of scripture, which calls our great Creator; the Father of Light! —

Chapter^o VIII:^d

Having discussed the wonderfull economy of the Gravid Uterus, in our first chapter; & of certain principles, or agents in the Economy of the atmosphere; let us now try to make an application of them, with a view to ex=plain, "the reciprocal changes, which take place in the blood; & in the air, in the proces^s of respiration." —

The atmosphere is a chaos; for in it float, all the attenuated particles, of all terrestial substances; — In it are the seeds of life; & the causes of death; — yet from this mixture of all things, nature takes the elements of the composition of bodies, which when they decay, by decomposition, return the same principles, which were before extracted from it. — This great solution or mixture of all things, is continually operating upon itself; & it would seem, that the salubrity of the air, is owing to the variety of its mixture; for the predominance of any one vapour, from any body however wholesome in itself, soon becomes deleterious. —

The mathematical physicians of the last century, endeavoured to make the world believe, that respiration, was only the mechanical dilatation of the air vessels of the lungs, by an elastic fluid. — More modern physiologists, have entertained almost as narrow ideas of this important function, when they tell us, that the object of respiration is confined merely to the reception, & emission of a fluid. — The truth is, the Lungs is a digestive organ; for while the stomach is digesting solid food; the lungs is digesting air. — The Lungs, is an organ, which is nourished by the air; — & in digesting that, which is presented to it, it retains what is beneficial, & rejects — what is noxious. — And as the stomach is liable to receive articles, that are pernicious, so is the lungs constantly exposed to the inhalation of noxious particles. — The — stomach rejects unwholsome materials by vomiting, & by diarrhoea (the intestines); & the Lungs by ~~coughing~~ coughing. — The stomach can bear for a little while, a poison; so can the Lungs endure a very short time, the hydrogen gas. —

The ancients —

The ancients had pretty correct ideas of respiration. — Hippocrates knew, that the air contained a principle, or pabulum vitæ, to nourish & support life. — He says, spiritus "etiam alimentumest". — His simple & just ideas has been made to give way from time to time, to theories void of all foundation. — Borelli in his essays, de "motu animalium", built a theory of respiration on the dilatation & contraction of the Lungs in inspiration, & expiration. — Jurin adopted the same ideas. — Lower Savage looked no farther than this mechanical theory; nor did Bernoilli; & Borghave & Haller wasted much mathematical theory knowledge in their vain attempts to subject the vital function of respiration, to the laws of mathematical & mechanical philosophy. — Vitality, or the vis vitæ, cannot be explained on mechanical principles; nor even on chemical ones; not but what chemistry has now dispelled the clouds of hypothesis, & let in the dawn of truth. —

In the course of our researches, we have found no writers, who have treated the subject of respiration more clearly, or shewn the connection of life with this function, in a manner more satisfactory, than Dr. Edmund Goodwyn, "on the effects of submersion & Strangulation, & of noxious airs upon animals." —

If this ingenious physician has not added greatly to our stock of facts, he has arranged them in so clear & satisfactory a manner, that we shall avail ourselves of his industry; for we presume, that the Committee, who sit in judgement on these prize questions, expect from us, the young worshipers in the temple of Appollo, an offering, that we have collected & sifted, & prepared for his altar, instead of the mere smoak & vapor of hypothesis, that shall leave nothing — but a "caput mortuum" behind. — —

Dr. Godwyn tells us, that as the result of experience, that when an animal is plunged under the surface of water, his pulse becomes weak & frequent, with anxiety about his breast, which he struggles to relieve, & in these struggles, rises towards the surface of the water, & throws out a ~~more air from his lungs~~, quantity of air from his lungs. — after this, his

anxiety

anxiety encreases, his pulse becomes weaker, the strugglies are renewed with more vehemence; — he rises towards the surface again, throws out more lungs air from his lungs & makes several efforts to inspire; & in some of these efforts, a quantity of water commonly passes into his mouth. — His skin then becomes blue, particularly, about the surface of lips; his pulse gradually ceases; — the sphincters, — are relaxed; & he falls down without any sensation, & without motion. — If the body be immediately opened, it has the following appearances: —

" I: — — — The external surface of the brain, is of so a darker colour, than usual; but the vessels are not turgid with blood, nor are there any marks of extravasation about them. —

" II: The cavity of the Lungs contains a considerable quantity of frothy fluid; & the pulmonary arteries & veins are filled with black blood thro' their whole extent. — —

" III: The right auricle & ventrical of the heart were filled with blackish blood, & the of the heart, are still contracting & dilating; the left sinus venous & auricle more feebly; but the left ventrical, is at rest. —

" IV: The right auricle & ventricle are filled with black blood, & the left sinous venous & left auricle also; — but the left ventricle is only about half filled with the same coloured blood also. "

Dr: Goodwyn afterwards proves, by a set of judicious experiments, — that the water produces all the changes, that take place in drowning, by excluding the atmospherecical air, from the lungs; & not by its entering directly into that organ. —

He proves also by experiments, that the dilation of the Lungs, is not the final cause of Respiration, as Borelli, Hales, Jurin, Savage, Bernoulli & Haller believed. — Dr: Goodwin therefore turns his attention to the changes, which the air, & the blood undergo in the process of respiration. — In order to determine this, he first states the constituent parts of the atmospherical air, as ascertained by analisys, with the well known

chemical

chemical tests; & which he finds composed of Azote. — Oxygenous gas. — and Carbonic acid gas. — The relative proportions are generally these in a given quantity; two thirds azote; one third oxygenous gas; & a very small quantity of carbonic acid gas. —

With these data Dr. Goodwyn attempts to shew the changes, which the atmospher-ical air undergoes in the proofs of respiration; — & he says, — if one 100: parts of analized atmospherical air be inspired, & expired again into a reciever, it is found to have under-gone a change in the proportion of its constituent parts, viz: — the quantity of oxygenous — gas, is diminished; the quantity of carbonic acid gas, is encreased; & the azotic remains the same. —

The celebrated Lavoisier, proposed to ascertain the change, which these airs undergo, by a single respiration, which means one inspiration & one expiration. — Dr. Goodwine tried the experiment on himself, to ascertain the degree of those changes, in 12: cubic inches of atmospheric air. — He first ascertained the proportion of these airs in 12: inches of Atmospherecic air; then he inspired an equal volume of the same air; & expired it into a glass: reciever, & then analyzed the whole quantity, & the medium result, after several trials, was as follows. — —

The volume of air taken into the Lungs, at a single inspiration, contained of — Azote, 80: parts
Oxygen-gas 18:
Carbonic acid gas 2
100

The volume of air expelled from the Lungs by the next succeeding expiration, contained. —
Azote 80: parts —
Oxygen gas 5:
Carbonic acid gas. 13
95
From whence it appears, that the diminution of the oxygen gas, & the encrease of carbonic acid gas, is considerable. — It appears by Lowers Tractus de Corde, published 150: years ago, that he knew, that the blood acquired its scarlet colour, in passing thro' the Lungs, & that this was produced by the chemical action of the air. —

But the grand question is, which of these three component parts of the atmospheric air, is it, that produces this change of colour? — Does it arise from the addition of the carbonic acid gas, separated from the blood? — Or does it arise from the chemical action of the azotic gas? — Or from the chemical action of the oxygenous gas? —

It is found by experience, that if you confine fresh drawn blood from with carbonic acid gas, it does not become black. — If you confine black blood, — fresh drawn with the azotic gas, it suffers no change whatever of colour whatever. — But it is found, that if black blood be confined with the oxygenous gas, it directly becomes of a bright florid or scarlet colour. —

Dr Priestly knew this fact, & so did Boerhaave before him. — Priestly found, that air would change the colour of blood, from black to scarlet, even when enclosed in a bladder. — Can we then wonder, that it changes the colour of blood thro' the more delicate & living coats of the blood vessels of the Lungs? —

But by what means, the air is applied to the blood in respiration, is a subtle & curious question. — Some suppose it by means of the absorbents; others, that it is by the influence of chemical attraction. — We are doubtfull, if it be either. — Compara-tive Anatomy, or rather comparative natural history, teaches us, that nature works different ways, in the respiration of animals of different classes. — Tho' no animal can live without air, or vegitable either, yet we find, that they require air of a different degree of purity. — Birds require the purest; & in those, that fly high, there is a structure & economy, by which the air penetrates their bodies, even to their feathers; which is kept in circulation by the motion of the wings; while their Lungs in the action of flying, are in a great measure, collapsed. — Next to birds, man requires the purest air; but can accomodate himself by degrees, to air of al-most any state of impurity & yet live. — Some, as the class of vermes, live in the earth, have & recieve the benefit of the air in a way peculiar to them; those who naturally have no red blood, but instead of it a colorless fluid. —

amphibious —

Amphibious animals can live in the air & out of it; & this by a peculiar structure & economy.—# The whale, the porpoise, the aligator, the tortoise, can, at will, collapse their lungs, & open their "foramen ovale"; in which place the blood passes direct thro' from one side of the heart to the other, without passing thro" the Lungs; in which case they are exactly in the state of the "foetus in utero;" but they cannot remain in this state very long.— They must of necessity come up to the surface of the water to inspire the vital air of our atmosphere, or in other words to oxygenate their blood, & change it from a black to a scarlet colour; so that we see, that it is possible to drown a whale or allegator.— The greater part of fishes have not lungs in their thorax, like the whale or porpois, but in their heads, together with an air-bladder, containing, as Fourcroy assures us nitrogen gas, or azote.—

Insects have a structure & a breathing apparatus still more remote from ours; & approaching the respiratory economy of plants, which apparatus pervades all parts of their bodies.— Insects, like plants, are nourished by atmospherical mephitis.— These facts are mentioned to shew the resources of nature; & how wonderfully means, are adapted to ends; & to remind us, that our mode of breathing, is not the standard by which we are to judge exclusively of this vital function, for we find, that one animal, will live in an air, in which another has died.— Returning from this digression, let us pursue our enquiry relative to the reciprocal changes in the air, & in the blood, by the process of respiration.—

We learn from various sources, that the vapour or gas, emitted by expiration, is a mixture of azote, carbonic acid, & oxygenous gas; for if the air, which issues from the lungs passes thro" lime water, it renders it turbid; if it be received thro" tincture of turn-sole, it reddens; & a pure alkali causes it to effervesce.— We learn also, that when carbonic acid has been absorbed by the foregoing process, the remainder of this air consits of azote, & oxygen gas; the presence of the latter, is demonstrated

The heart of an amphibious animal, has only one auricle & ventricle; the pulmonary artery, is a small branch from the aorta; & the pulmonary vein proportionably small, empties itself into the sinus venosus.—

demonstrated by means of nitrous air. — We also know, that the a ~~portion~~ portion of the air, is absorbed in respiration. — —

The first effect, which the air appears to produce upon the blood, is that of giving it a scarlet or bright vermillion colour. — Hewson found, that by injecting a portion of a vein, between two ligatures, he rendered the blood of a brighter colour. — Blood, that had been confined in a vacuum remained black; but no sooner was it exposed to the open air, than it assumed the most beautiful vermillion colour. — Dr. Priestly filled a bladder with blood, & exposed it to pure air; when that portion of it, which touched the surface of the bladder became red, while the internal part remained black. —

All these experiments, & many more that* can be adduced, demonstrate, that the bright scar-let, or vermillion colour assumed by the blood in the Lungs, is owing to the pure air inspi-red; while air, which has remained in contact with blood, extinguishes a candle, & precipitates lime-water. — These are precious facts.

And by the experiments instituted by Dr. Goodwine, it ap-peared, that the contractions of the heart were diminished in frequency, in proportion as the blood from the Lungs became dark-coloured; & that they were excited again, when it became florid; but that when, it was quite black, the contractions ceased en-tirely; whence it clearly appears, that something, whatever it be, that gives the blood a scar-let or bright vermillion colour; imparts fresh life and animation. — It appears from a train of experiments, that the quality of blood, influences the action of the heart, even when the quantity is fully sufficient for the purposes of circulation. — And it also ap-pears, from what has been advanced, that if the blood does not acquire its florid ap-parence in the Lungs, its stimulus is insufficient to excite the heart to action. — And hence says Dr. Goodwyne, it follows. — "That the chemical change, which "the blood undergoes in the Lungs by respiration, gives it a stimulating, by which it is fitted "to excite the left auricle & ventricle to contraction. — And from all his experiments, he "draws the following conclusions"; —

I: "A quantity of —

* Chaptal.

I: "A quantity of oxygenous gas, is ~~evaporated~~ separated from the atmospheric air in the Lungs by respiration; & a quantity of carbonic acid, is added to it." —

II.d "The oxygenous gas exerts a chemical action on the pulmonary blood, in consequence of which, it acquires a florid colour." —

III.d In ordinary respiration this florid colour is seen distinctly as the blood passes into the left auricle; * & the heart contracts then, with its natural force & frequency. —

IV.th "When respiration is obstructed, the florid colour is gradually diminished, & the contractions of the left auricle & ventricle soon cease." —

V.th The cessation of contraction arises from a defect of a stimulating quality in the blood itself! — and hence it follows, —

"That the chemical quality, which the blood acquires in passing thro' the ~~lungs~~ Lungs, is necessary to keep up the action of the heart, & consequently the health of the body." —

The deductions from Dr. Goodwynes experiments are these, viz: — that in proportion as the colour of the blood, passing thro' the Lungs, is darker, the contractions of the left auricle & ventricle, & the corresponding pulsations of the arteries become weaker, & the current of the blood slower; & whilst the blood moves slowly in the larger trunks, it begins to stagnate in the smaller branches of the arteries & veins; when the pulmonary blood is no longer fitted to excite the sinus venosus & auricle to contraction, they receive it into their cavity & remain at rest. — As soon as they cease to contract, & propel the blood to the head, all the intellectual operations cease, sensation, & voluntary motion are suspended & the external signs of life disappear; & the black blood remaining at rest in the arteries, & particularly in the smaller branches upon of the arteries & veins, occasions, that blue colour observable upon different parts of the body. —"

And if this state continue many minutes, death ensues. —

* In dogs, toads & frogs, subjected to this experiment &c.

Chapter 4:th

It appears from what has been said in the first part of this dissertation, that before a child is born, its lungs are quiescent, and entirely useless, the child depending on its mother for life & nourishment, as much so as the apple deppends on the parent tree for nourishment, & life growth. — The existence of the child depends on the warmth & life of the mother; & on a partial circulation of its blood thro" a temporary opening in the heart, without ever passing thro" the Lungs; which opening is closed for ever, after the child has once breathed the vital air. —

When a child is entirely disengaged from the uterus & placenta of its mother, it depends, in future on the operation of its own organs for its existence; & in order, that it may live, it must be allowed the free use of the atmospheric air; — which is drawn into, & alternately expelled from the Lungs; which compound action is called respiration. — *

When a child is born, it becomes dependent on a new principle for the continuance of its existance; for when it passes from it watery habitation into the atmosphere, a new determination takes place; & instead of receiving its life & growth, as heretofore, by the navel-string from its mother, the common atmospherical air becomes the main-spring of all its actions & functions. — When the air rushes into its nostrils, the child opens its mouth & cries, and the Lungs are expanded; & that action closes up forever, the foramen ovale. — The blood, which had hitherto passed thro" this opening, now takes a wider circuit; & the Lungs, which had (till) this time been inactive, now first begin their functions; — & they cease not their motions as long as life continues. — They begin their motion by inspiration, & they cease their motion by Expiration. —

But in order, that an infant should grow in size, as well as receive a vital principle from the air, to oxygenate its blood & animate its frame, it must have like-wise —

* Hence appears the pernicious custom of swrapping up the hands of new born babes in blankets. — —

likewise a supply of more solid food; which being received into its stomach from the breast of its mother, in the form of milk, is therefore prepared for its nourishment by digestion; — taken up from thence by absorption, distributed by circulation assimulated to its nature by the wonderfull procefs of nutrition; & all its various fluids & juices perfected by secretion; while the whole is kept up by Respiration; which being free & easy requires neither conscious exertion, nor even a thought; but carries on the circulation at ~~about~~ the rate of about 105: pulsations in a minute; when duly modulated by perspiration. —

The growth of the young animal depends on the extension of the arterial system; & this depends upon the quantity of fluids accumulated in it from the organs of digestion; & upon the force of the heart being such, as to keep the arteries constantly in a state of ~~digestion~~ distention. — This depends on the "vis contractilis insita"; which depends on the conjoint energy of the digestive & respiratory ~~organs~~ functions. —

Dr: Priestly has thrown out an idea, that ~~physiologists~~ phlogiston, was attracted by plants in their growth; & that it became more fixed in their substance; & that when plants were taken into the stomach & there decomposed by digestion, the phlogiston, or inflamatory principle, (& after answering its vivifying purposes) recovered its fluidity & was thrown out again by means of the blood in the Lungs, by which operation it vitiated, or as he called it, 'it phlogisticated the air expired. — Priestly conceived, that the chyle, which is incessantly entering our systems, beside distending the vessels, & conveying fresh supply of matter to repair the daily waste of body the body, — conveyed also a portion of that subtle fiery principle, which the ancients, called the pabulum vitae, the flame or provender of life; or in other words, a portion of that expensive fire, or anima mundi, which gives motion to the Universe, & life to nature. — This idea does honor to Dr. Priestly, who tho' not a medical man, was a philosopher of the very first class. —

To conclude; our ideas ~~on this subject~~, respecting" the reciprocal changes of the blood & of the air in the process of respiration are these,"—

There are within us, two important organs, performing, at the same time, two different kinds of digestion, viz: — the stomach, & the Lungs; for while the former is digesting solid substances, the latter is digesting air. — The digestion of solid sub=stances by the stomach, is the conversion of food into chyle; & of chyle into blood. — A regular supply of this milky fluid is necessary to recruit & repair those parts of the animal machine, that are incessantly wearing down, & passing off by the very actions requisite to life. — When this function is impaired, & much deranged, the patient languishes, becomes emaciated, faints, & at length dies. — If digestion be well performed; that is completed within three or four hours, the chyle is proper, be the food ever so various: — The blood formed from this chyle, is natural; the secre=tions, & excretions are regular, & health, strength, activity & cheerfulness ensue. — But if the function of digestion languish, the contrary of all this will happen, be the food whatever it may. — *

There is however a remarkable sympathy between the func=tion of digestion & the function of respiration. — When we inhale atmospheric air, the Lungs in the action of breathing, separate a portion of that inspired mass, called oxy=genous gas, (or vital air, or empyreal air, or dephlogisticated air, for all those terms have been used to designate, that spirit of the air, so often mentioned), which entering the blood, — vivifies & animates the whole frame, giving that fluid a bright vermilion colour; which oxygen, actually becomes, one of the constituent principles of our bodies. — Between this oxygenation of the blood from the air, thro" the Lungs, & the digestion of the more solid food by the stomach, there exists an inseparable sympathy. — When the stomach the stomach is loaded with superabundance of food, we labour for breath; best when we breathe the oxygenated air from the mountains; or the equally oxygenated air of the open & deepest —

* Dr. Waterhouse's printed lecture, — On the evil tendency of the use of Tobacco in young persons &c. &c. —

& deepest ocean, we feel not merely an encreased alacrity & a keener appetite, but a greater proportion of food than ordinary can be digested, without any oppression of the stomach, or labour of the Lungs. *

Respiration, beside occasioning an equable continuation of animal heat, is a most powerfull agent in the circulation of the blood. — Azotic air, or the fumes of burning sulpher, will stop respiration; & the heart will cease to beat, unless you allow your patient immediately to inspire the pure atmospheric air, when he will directly revive, & his heart beat as before. — This is not owing to the mechanical distention of the Lungs, but to the oxygen in the air. —

This Law in our natures affords a very important practical rule to the physician in forming his judgement from the pulse, where he should always take into consideration, the state of the air, the patient breathes. If a sick man, in a confined place, recieve the respiratic or azotic air of his own foul body, his pulse becomes depressed, & fluttering; its beatings become slower & slower; the cause continuing, by degrees, all his vital functions labour, & at length appear to be suspended; the artery is nearly ceasing its motion, & death appears fast approaching. In this alarming state, if you allow your expiring patient, to inspire the oxygen gas, properly diluted with common air, his pulse will begin to tremble, & then beat; — he will fetch a deep sigh, which effort serves to heave round, if we may so speak, the wheel of life, & his pulse will beat as before; when warmth, sensation & cogitation will again return. — And this resuscitation is effected by the simple inspiration of that prin=ciple in the air, which turns the black, venal blood to a bright vermillion colour! —

This wonderfull principle, which some have called, the universal acid; others impyreal air; others plogiston, & which the French chemists have called oxygen; when in combination with caloric, or the fluid matter of heat, is the grand, efficacious, & necessary instrument, which nature principally makes use of, in all her operations. — The fishes in the depths of the Ocean, cannot exist, if deprived of it. — So neces=sary is this vital air to the existence of every animal & of every vegetable, that

* ibid.

the

that the eggs of animals, & even the seeds of vegetables, be they ever so ripe & perfect, will never remain inactive & die, if cut off from this vivifying principle. — Of what importance, this doctrine of oxygen & azotic air must be in asthmatic & consumptive disorders; — physicians of more experience than myself can best determine. —

From what has been said, it appears, that during respiration, the blood imbibes the vital part of the air, called, oxygen, thro' the membranes of the vessels of the Lungs; & hence the resemblance between this function & combustion. — How this is performed we know not. — The conjecture, oppressed with fewest difficulties, is that, which supposes, that something from the inspired air, pervades the coats of the pulmonary vessels, by the power of chemical attraction. — It is not to be expected, that we should give an opinion in the tone of decission. — Nothing but probability can be expected, in our present state of knowledge. — Some future Franklin, Priestly, Lavoisier, or Davy, may unfold this mystery of nature, so long hidden from the prying eyes of philosophers. — It has been conjectured, that the oxygen of the air, unites with the inflamible, or phlogistic part of the blood, producing animal, or phosphoric acid; & that, it is this, which changes, the colour of the blood, from black, to a bright vermillion, or scarlet; & that caloric was, at the same time, thrown out from the system, thro' the Lungs. —

It should be constantly born in mind, in all our disquisitions, on the vital functions, that the Lungs, is by far the most complicated organ; & performs the most compounded function of all the others in animal nature. — Beside circulation & respiration, the Lungs is a sanguifying, or blood perfecting organ. — It is the origin of the pulmonary vein, (where the blood is perfected & prepared & fitted to answer the purposes of nourishment,) that the "punctum saliens" of the blood exists; & it is at the extremity of the pulmonary artery, where it parts with its azotic, or carbonaceous properties, after it has gone thro' the course of the system, which constitutes the punctum ultimum of the whole. * We then see, that, there is a set of vessels in the Lungs, that recieves the blood, in its purest state, & another, that returns it, in its worst. —

* See Summary. —

That portion of the blood, which is returned brought back by the returning veins, from all parts of the body, cans answer no purpose in the system, for which, blood is intended; as it constitutes the residuary matter only, or refuse of the whole, being too grofs, & too azotic, to afford nourishment for dying parts; & too impure to be acted upon by the living. — Its impurity is marked by its blackness; & its corrected state, by a bright vermil-ion, or scarlet coulour. — Its blackish state carbonates, or azotifies the inspired air; while the oxygen received, animates & perfects the blood, by the process of oxygenation.

The probability, that we are, every moment, recieving a spark of fire, from the "Father of Light," thro' the instrumentality of the air, is an animating thought! —

It is probable, that if our bodies were transparent like glass, so that we might see all that was going forward within us, in the Lungs, & heart, during respiration; & if this transparent body was placed in a room dark room; & the breathing stopped, for a few moments, so as to turn the blood in the Lungs, black, & then allow the air to be inspired, should we not see a flash of fire in the heart & lungs, the very moment, when the pulmonic blood assumed its high scarlet coulour? — It probably should. — That this glow of scarlet, is a flash of fire, (similar to electricity, or galvanism), none can doubt, who have attended to that subject. —

I know not how it strikes others; but I confess, that, the idea of our recieving, every moment, a spark of ~~fire~~ celestial electrical fire to keep up life, — animate our bodies, & light up our souls, has in it, an air of grandeur, inexpressibly impressive, & consoling, while travelling thro' some of the dark & dismal scenes of this world! — And must inspire a veneration, for that Divine power; which — "breathed into mans nostrils, the breath of life;" in consequence of which "he became" — "a living Soul!" —

Appendix

Appendix. —

We did not wish to deviate from the streit road of our discussion into any of the bye-paths of theory; & have therefore thought it best to reserve such desultory matter, for an appendix. —

After Harvey demonstrated the circulation of the blood; this puzzling question forced itself upon the minds of the physiologists. — What is the use of the Lungs? — It was not until a century & an half afterwards, that Priestly, & Lavoisier, revived, by experiments, the ancient idea; that the air in respiration, underwent a change simi-lar, to what it did, in combustion. — It was found; that the same quantity of air inspi-red was expired, as was inspired; but that a portion of it was materially altered; — & that, not negatively, but positively; & becoming absolutely deleterious. — They found, that this greater portion was a of carbonic acid gas. —

As a considerable quantity of water, was obser-ved to be expired in the form of vapour; & this has been attempted to be accounted for, by the hydrogen, secreted from the Lungs, being united with the atmospheric oxy-gen, & so forming water. — But when we consider, that it requires some of the most powerfull reagents, to produce this effect out of the body, we can hardly believe, that an operation, so inconsistent with the simplicity of nature, takes place within us. —

Hydrogen, which is a constituent both of the animal solids & fluids, & exists in them, as a fluid, & as a solid also, may be secreted thro' some organic structure, that is unknown to us, & may be thrown out in a fluid form, & may be brought into contact with the oxygen of the atmosphere, & uniting with it, form water. — But why need we have recourse to this complex operation to account for the water emmitted from the Lungs, in the form of vapour, when it can be explained on the easiest & most palpable operation? — This savours too much of the doctrine of the effervescence of acid & alkalies, & of intestine fermentations of the blood, causing the cold fit & the hot fit of fevers, as taught of Sylvius de la Boe, than of the simplicity of nature. —

This too

It is too much like the mathematical physicians, who imagined they saw, all the mathematical mechanical powers in the human body, not wan excepting the screw. — The works of man are naked, by a very complicated machinery, to produce a simple effect; — but the works of nature (like the obliquity of the axis of the earth) are dignified by a simple contrivance, producing manifold effects & contrivances. —

We know full well; that every circumvoiled cavity in our bodies, is replete with water; which is taken up & modulated by the absorbants; or else is thrown out of the system, as an excrement; as is the case in the urine, in the perspiration, & in the vapours from the Lungs. — This operation is simple & palpable. — Why then have recourse to chemical hypothesis?

As air once respired looses its power of supporting life, the great question, is — what is that change, wherely it looses this power of animation? — Whatever be the comparative proportions of oxygen & azote in the atmospheric air, the quantity of the latter is thought to be the same, when expired, as inspired; but this is not the case, with the two other ingredients, viz: — the oxygen & the carbonic acid. — They are found to vary in their proportions; the oxygen almost entirely disappears, while the carbonic acid gas is encreased in proportion to the diminution of oxygen. — Quicksilver becomes red by combining with a maximum of oxygen; so does iron, copper, manganese & chrome. — The blood changes from a dark coulour to a beautifull bright vermillion, by exposure to the atmospheric air; & the presumption was, that as the changes were analagous, the cause must be the same. —

That the oxygen disappears & the carbonic acid gas, is generated, I me find proved by breathing thro' lime-water. — Carbon is a constituent part of the blood; but we have no proof of its existence in our bodies as carbonic acid. — The carbon therefore must have absorbed the oxygen, & united with it; & been given out again; & thus becomming a gas, & requiring a certain quantity of caloric to sustain it, as a gas. — But as a dense gas, it will require a less quantity of latent calorie. — An 100: cubic inches of ~~calorie~~ oxygen weighs, according to Davy ~~47:5~~ 35: 09: grains of Farenheit; & 34: 70 — at 60:° — Farenheit; & 30: inches of Baron; & according to Allen & Pepy, 33: 82: Thermom: — 60: — Baron: 30. —

An 100: cubic —

An 100: cubic inches of carbonic acid gas weighs, according to Berry 47: 5: grains, Ther: Fanht: 55: Barom: 30. inches, & 47: Ther: — Bar: same pressure. — According to Allen & Pepy's, — 47: 26: grs — Ther: 60: Barom: 30: inches. — Thus by calculation, we have an average difference of 13: 0: grs: nearly; & 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 & oxygen, is 13: 03. — or 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 as disappearing & for the generation of carbonic acid gas; & shew likewise, that caloric must be evolved, since it is ascertained; that the augmentation of the temperature of the blood, by its passage thro' the Lungs, is only one degree; — which must have been greater, were there not some other way & means by which the heat should be carried off. —

The next question is, where does the carbon, which is found in the expired air come from? — We have said, that carbon, was a constituent part of the blood. — Is the blood then, decomposed in the Lungs, so as to yeild its elements to the all powerfull oxygen of our atmosphere? — We suppose, that, that portion of the blood, which is arterialised, or just converting into the living fibre, as well as every live part & point of our bodies, is constantly oxygenating; & that by this process, a portion of carbon, is separated from the blood; & brought successively & alternately to the Lungs; & while it marches out of the Citadel of life, with its dark coulours, the vital principle, or oxygen, marches in, with its scarlet ones. — And we would beg leave to insinuate, by this flourish of coulours, that if we have not compleatly succeeded in our enterprise, we hope it may appear, that we have not quitted the ground we had taken, with dishonor. —

Recapitulation. —

Recapitulation.

Our Theory is explicitly this. — The oxygen in the inspired air enters the membranes of the Lungs, by force of an operation resembling chemical attraction, & combines with that portion of the blood, which is brought virtually in contact with the atmospherical air, by the pulmonary veins, & combines with the carbon, with which these vessels are surcharged. —

This operation takes from the venal blood its black colour; & imparts a scarlet, or intensely high vermillion one; & this is the first effect of the process of respiration. —

The second effect of respiration, is the evolution of caloric, by the condensation of the two gasses, the oxygen & carbonic; & that these compounded operations keep up, the focus of heat in the Lungs; this idea is supported by the fact, that, those who respire, by way of experiment, the oxygenous gas, affirm, that they perceive an encreased heat in the breast, & extending from thence to all the other parts of the body, together with a remarkable elevation of spirits, & energy of mind.

And finally, that the Lungs, in common with every other moistened part, recieves its portion of water, from the exhalent vessels, & not from the formation of hydrogen. —

Finis.