# What's the use of breathing?

John Stillwell Schanck

Club paper

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J. S. Schanck

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THE use of breathing! Some will say—Why, breathe—of course we must breathe—we cannot live without breathing. It might as well be asked, What's the use of living? While it is very plain that this is no answer to the question, it is equally plain that the inquiry is a legitimate and proper one, and that an answer ought to lie within the range of our attainments.

Respiration among animals is a universal function. No animal lives that does not constantly continue to breathe from the beginning to the end of life. In man, all the mammalia, and birds, and for the most part, in reptiles, this function is performed by lungs, by alternate inhalation and exhalation, by introducing air within the body so as to bring it in close proximity to the blood, and then expelling it again. In fishes and lower aquatic animals, like crabs and lobsters among articulates, clams and oysters among mollusks, and most radiates, the breathing is performed by gills. The blood in this case is carried out to the surface, so as to meet the air held in solution

in the water in which they live. In still other animals, as insects, a system of interior, open, ramifying tubes, carries air to all parts of the body. Thus respiration continually goes on in all animals. In man seventeen inspirations per minute, from the first gasp of new-born infancy till the closing scene in death. No interruption; no sleep for the function of respiration; day and night it continues; no weariness of respiratory muscles; nine millions of inspirations, and as many expirations per year. Other systems tire and take repose, but no sleep or rest or sense of weariness in the muscles of respiration for threescore years and ten.

Now, if this were to introduce nourishment into the body, one could understand it. Action consumes the body. The body wastes away by living, and food is needed to restore it; but what possible good can come from incessantly blowing in and blowing out again only air. That is not food, or in any sense nourishment.

If a man is well, one would suppose the appropriate advice would be, eat good food and keep well; and if feeble, exhausted, sick, eat nourishing food and be restored; but such is not the popular prescription. Each one deems himself competent to prescribe, and all alike direct, if well, you must get out in the open air or you will be sick, and if sick, you will never get strong and well till you breathe the fresh air. Still air is not food. It is not drink. You breathe in air and breathe air out again; you inhale and exhale mere gas, tasteless, colourless, odourless, and apparently substanceless and useless. What, then, is the use of all this?

Of the three essentials to life, moreover, without which life cannot go on, food, water, and air, such are the providential arrangements of this world that the supply of the latter is the least precarious. Air is furnished to us the most freely, with the least labour or expense. Moreover, it is that one of the three necessaries of life, without the free supply of which death soonest comes. For food to nourish and replenish the body, for drink by which the waste of evaporation and excretion is restored and the blood kept liquid, we wait hours, days if need be, but if deprived of air for three and a half or four minutes only, death is inevitable. Indeed, so great is the care that

this function shall not fail us, that we live submerged in the very midst of a great amospheric ocean. Nor has our Omniscient Organizer been content with this incessant external application of air to our bodies, but, as before alluded to, has organized us for its equally incessant internal application. Alike, through care and negligence, through attention and inattention, through wakefulness and sleep, through labour and repose, bathed externally in air and permeated internally by air, and this not optional, but compelled to live in it, and equally impelled to breathe it; for no man can voluntarily stop breathing if he will. The desire for breath overpowers, controls, and subjugates the most determined will. A man may resolve to do almost anything else and do it, but to resolve to stop breathing is about the most futile of volitions.

Now a function so universal, so imperative, so constant, so guarded on all sides against a moment's interruption, and the object of which, moreover, is so obscure, must have an object, and as students of nature we ought not to rest till we understand something of its object and uses. What then is the use of breathing?

It is probably impossible to answer this question satisfactorily without including a partial view of certain other functions; and first, a word about nutrition. The body is nourished through the introduction of food, and the food of every animal is organic matter. No animal, however insignificant, lives on mineral matter. That which is food must have previously passed through and been prepared by an organized being, and that being always a plant. We eat animal food, to be sure, but the beef must have previously eaten grass and grain. Popularly, food is vegetable or animal, and these are esteemed very different. Science is not content with such a subdivision. That which is food must have been produced by a growing plant; not that all organic matter produced by plants is food. Strychnine is not food, but food is of vegetable origin only; and whether it has first undergone physical change by passing through an animal or not, chemically it is what the plant made it. It is starch, or sugar, or oily matter, without nitrogen—non-nitrogenized food, on the one hand; or albuminous matter,

gluten, &c., containing nitrogen as prepared by plants, cereals, and other grains; or this, changed in physical properties but not in composition, when it becomes the muscle of beef, fibrin, that is, nitrogenized food, on the other. And observe, in reference to both these classes of food, all food of all animals contains a superabundance of carbon, unoxidized carbon; and as carbon is combustible, all food will burn, if thrown on the fire.

If O represents an atom or equivalent of oxygen, H one of hydrogen, C one of carbon, and N one of nitrogen, then H O will mean water, C $O_2$ carbonic acid, N $H_3$ ammonia, $C_2 H_4 N_2 O_2$ urea; and the principal ingredients of food will stand thus:

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| Non-nitrogenized food. | Sugar, . . . | $C_{12} H_{11} O_{11}$ |
| | Starch, . . . | $C_{12} H_{10} O_{10}$ |
| | Oil, . . . | $C_{11} H_{10} O$ ? |
| Nitrogenized food.* | Veg. albumen, Veg. fibrin (gluten), Animal flesh, | $C_{48} H_{36} N_6 O_{14}$ |

Non-nitrogenized food contains only just enough, or less than enough oxygen to convert all its hydrogen into water, and the nitrogenized always less than enough; so that the affinity of the carbon and part of the hydrogen of food can never be satisfied by the supply of oxygen it contains.

Food thus originated by the vegetable kingdom, crushed and softened in the mouth, liquefied in the stomach and intestines, then absorbed and circulated as blood, is deposited and vivified in the tissues as cells, very minute, excessively numerous, and arranged in numbers, constituents, and forms, so as to constitute living organs; but through all this change of form, and function, and vitalization, observe the composition remains. The oil, the starch, the sugar of the plant, continue to be hydro-carbon compounds, still containing unoxidized carbon; and the albumen and fibrin of the cereal, whether it has first

* The reader who is critical in chemical matters will immediately detect the incompleteness of these formulæ, and at the same time will notice that the solid oxides of S, P, &c., which are washed out of the system by water, need not complicate a discussion of the elimination of the gaseous products of the oxidation of the above elements.

become beef or not, is albumen and fibrin still, nitrogenized matter, still containing unoxidized carbon.

Now in order to sustain life, we need and eat about thirty-six ounces, say two-and-a-quarter pounds of such food every day, a mixture being requisite to health; and this two-and-a-quarter pounds is every day used within the body, much of it converted into living cells, vivified muscular, nervous, and fatty or other tissue, and yet the curious fact is true that we are not gaining in weight. Four to six ounces are discharged as excrement, a little more, dissolved in water, escapes in the urine, some through the skin; and yet we take in thirty-six ounces of solid food, provide thus for the exit of a limited portion of it only, and still do not gain in weight, often not an ounce for years together. It may be said that there is a constant waste, and in this way it disappears; but one must define to himself what he means by this. Let us not be cheated by mere words. If he mean that it disappears by becoming nothing, the explanation must be ruled out by the answer, that matter is never destroyed. We can no more make nothing out of something, than we can make something out of nothing. The explanation is however possible; for while the millions of cells constructed daily from the food we eat, the vital principle being the artificer, are born, and enter upon their brief career of life; other millions having accomplished the end for which they lived, die and disappear. But how do they disappear? you say. Certainly, that is the very question. We put into the body two-and-a-quarter pounds of solid food every day; how do we get it out again?

Now let us get back to breathing. We inhale a large quantity of air every day and exhale about an equal bulk, but then it is greatly changed. We inhale a mixture of nitrogen and oxygen, of which one-fifth is free oxygen, (the nitrogen does not concern us now.) In expired air, a considerable part of this oxygen is replaced by carbonic acid and water. The inhaled oxygen is transferred by the blood to the dying hydrocarbon cells, unites with them, and returns as carbonic acid ($C\ O_2$) and water ($H\ O$) to be exhaled. Inspired air has five or six ten thousandths, expired five or six hundredths of $C\ O_2$.

This then is what goes on. Plants absorb carbonic acid, water, and a little ammonia, and through the influence of plant life, or the vegetable vital principle, always, however, requiring in addition sunlight, or that chemical ray which accompanies the sunbeam, they are able to construct living vegetable tissue—organized matter. They deoxidize water and carbonic acid, deliver the oxygen into the atmosphere, and detain the deoxidized hydro-carbon as vegetable tissue, the proper and only food for animals; while animals, having consumed as food these organic compounds formed by plants, reoxidize them by the process of respiration, degrading tissues back to mineral matter, and delivering them again to the atmosphere as carbonic acid and water. Thus, in order ourselves to live, we steadily destroy organic matter, and while millions of cells begin in us to live to-day, as many millions die, and their carcasses are removed from the interior of the body by the simple act of breathing. If breathing stops, death ensues, because, if for no other reason, the putrid carcasses of dead and dying cells poison us. Thus inhaled oxygen, while it prematurely attacks and kills the cells of which our bodies are made up, immediately removes the carcasses of those dead, and respiration becomes the scavenger of the body to remove the debris of matter which has lived through its brief career, performed its part in the world of vitality, and dead, is thus swept away into the great ocean of the atmosphere whence it originally came. Thus then it happens that without two-and-a-quarter pounds of solid food each day we cannot live, and with two-and-a-quarter pounds introduced every day, we must immediately die, unless an equal amount of effete dead and dying organs are every day removed.

This two-and-a-quarter pounds of organic solid matter, daily introduced, is a very varying mixture of the nitrogenized and non-nitrogenized articles of food. Both are necessary to the continuance of life, but the proportions of the mixture may vary much with the varying circumstances of life. Always however, food contains less oxygen than is sufficient to convert its carbon and hydrogen into carbonic acid and water, and expressed in free carbon, not less than seven or eight ounces must be expelled from the lungs every twenty-four hours.

Often it is asked how frequently during life the body changes. Popularly it is believed to be renewed every seven years; hence that vaccination runs out, and certain diseases are liable to recur at such interval. In the light of what has been said, it is easy to see that an amount of matter equal to the weight of the body is introduced, used, dies and escapes in as many days as two-and-a-quarter is contained in the number of pounds the body weighs; that is, through a man of one hundred and fifty pounds, there flows his entire weight of solid food every sixty-six days. But the entire composition of the body is not changed in quite so brief a period as this, for a part of the food we eat is used in us without ever actually becoming living tissue at all. Moreover, the rapidity of change varies very much in different tissues; for while muscles, brain, and nerves change their constituents with extreme rapidity, bones, cartilage, &c., may be years in being replaced by new material.

This then is the use of breathing. We must eat two-and-a-quarter pounds of organizable matter every day or we die. The same amount having lived its brief career within us, dies, and must be carried out of the system every day or we immediately die. Breathing results in the oxidation and elimination of this effete material. The inhaled oxygen aids in killing and destroying tissue, and then immediately removes it from the body. We are constantly living, constantly dying. We cannot live without dying, because motion involves death and destruction of tissue, and the two-and-a-quarter pounds of matter cannot die within us, and we yet live, without the incessant purifying process of respiration. It is not a nourishing, a vivifying, a building up, an organizing and life-giving function, but a killing, a destroying, a disintegrating, a reducing process. Plants make organic matter, animals, through respiration, consume it.

A second point is worthy of our attention. No fact in science is better established, than that whenever carbon unites with oxygen to form carbonic acid, heat is evolved. This may or may not be attended by light also. If the carbon of the vegetable kingdom, a plant or a tree, be rapidly burned in a stove, heat and light are both emitted. If the same plant lie exposed to the air without ignition, it slowly disappears, it rots

we say, its carbon is oxidized, and it becomes carbonic acid, and in so doing evolves just as much heat as if burned rapidly in the stove, but occupying months or years, the evolved heat is diffused through the atmosphere and is unnoticed. Heat is always generated when carbon becomes carbonic acid. But carbon is constantly becoming carbonic acid in our bodies, through the process of breathing. Does that develope heat? Does breathing not only kill us, but burn us up while we live? Are we furnaces in which combustion is constantly going on? Well, the evidence is that we live in a medium whose temperature is 60°, in winter often 0°, and somehow our bodies continue at the temperature of 98°. We are radiating heat constantly to other objects, and yet we remain 40°, 80°, 100°, hotter than they. A stove may do that, but only while combustion continues. If its carbon ceases to be oxidized, it cools. Nay, if well supplied with carbonaceous food, and with free respiration to burn it, we remain at 98°, when everything around us is frozen. Kane was comfortable with his body at 98°, when the air around him was nearly or quite —98°, the air or other surrounding bodies 180° or 190° colder than he. What a rapid radiation from his person must have occurred, notwithstanding the impediment that furs could offer; and whence this development of heat, but from the furnace within him, the oxidation of his own tissues by breathing. And this throws light upon what is obscure about food. Observe we live upon two kinds of food. Only one of these can furnish material for the construction of our bodies. Our organs are built up of nitrogenized food only, of albumen, fibrin, the gluten of wheat and other grains; while sugar, starch, and fatty matters can never make muscle, brain, or other tissues. These tissues must have nitrogen, while they contain none. They are more largely consumed by us than the former, digested and circulate as part of the blood, and in the capillaries are burned with the oxygen of respiration to sustain our animal heat, when our tissues are consumed too slowly to keep us warm; and if too much of this highly carbonaceous food is taken, that is, more than is needed for immediate combustion, it is stored as fat, a fuel for combustion at some future time. Hence the philosophy of fattening animals is easily understood. Food is of two kinds, tissue-

making and heat-making. If the ox is to be worked, that is, to consume his muscles in dragging the cart or the plough, grain and other nitrogenized food must be furnished to supply his muscular waste; but if he is to be fattened, he must be fed on starch, and oily matters, hay, potatoes, turnips, and corn or flax-seed meal, which are converted into fat, and he must be kept still in the stall, so as not to hurry respiration, and thus consume his stored fat, and kept warm, so as not to need a hurried respiration to keep up his normal temperature.

So too we see why the indolent, inert, inhabitant of the tropic, breathing slowly, and a rarefied air, may sprawl in the shade, and live on fruits which are little else than flavoured water. He needs but little fuel, and but a languid respiration, because the medium in which he lives is nearly 98°; and if compelled to work, and to increase his breathing and his combustion, his temperature is moderated by a copious gush of perspiration, thus carrying off his superabundant heat in a latent state, in vapour. Fatty food is his abomination, while the Arctic inhabitant freezes without it, and asks no choicer meal than blubber, with tallow-candles for dessert. Even when the supply of food-fuel is arrested, respiratory combustion still goes on.

The melancholy doom of the shipwrecked man is sad in the extreme. If he cannot float, if he be submerged, he cannot breathe; he dies for want of oxygen, he is poisoned by retained carbonic acid. We say he is drowned. But if he float and breathe, oxidation goes on, and heat is developed, but not sufficient to prevent the gradual reduction of the temperature of his body in a medium which conducts away heat so well as sea-water. In a few hours, notwithstanding his internal combustion, he is benumbed, then cooled below the temperature compatible with life (about 80°), he dies. But if he be of the favoured few who gain the life-boat, what then? Breathing still goes on, oxidation of his body by degrees; first his fat is attacked, stored among his organs for this very purpose. It burns away for several days; it keeps him warm, and saves his muscles from attack; he becomes lean. This gone, the oxygen of breathing attacks his muscular system, the nitrogenized constituents of his body; he fails in strength, because his muscles

soften and are consumed. Mere skin and bone is his appearance, scarcely strength to move a finger is his condition. Then the oxygen of respiration invades, attacks, and steadily consumes his nervous system, his brain; delirium, perfect exhaustion and death soon ensue. Starvation we call this. The body has been consumed, burned up, converted into carbonic acid and water, just as surely as if it had been in successive pieces thrown into the fire, and just as much heat liberated. A mere skeleton is left, and that nearly all incombustible. If food could have been reached, life would have been spared; but the fuel exhausted, the fire goes out. Cellular death and combustion go on for days, to preserve the life of the body; but the cell fuel exhausted, respiratory combustion ceases, and somatic death is the immediate and inevitable result.

The identity of the body is thus easily understood. Living implies death. If the body lives, it can only be at the expense of the incessant death of its component cells. Identity of form and features may persist for years, but not identity of substance. Appearance may be constant, but the substance of a man is not the same for any two consecutive moments. A steady stream flows through him, of food, water, and oxygen, not less than a ton and a half per year. Man's body is like a gas flame; it seems the same this moment as the last; it is a ceaseless onward flow of combustion, but neither is the combustible nor the supporter of combustion identical now with that of any former moment.

It appears then that two important purposes are served by the function of respiration. It serves to purify the body, to eliminate from it the effete, dead, and dying portions which otherwise would collect, circulate, and poison it; and at the same time, in the act of removal, produces new and inoffensive compounds, and generates the animal heat necessary to continued life.

But while respiration destroys and consumes organic matter and developes heat, it must not be supposed that no other end is accomplished by breathing. If we stop at this point, the uses of breathing are but imperfectly found and stated. A steam-engine consumes organic matter and developes heat, but remember heat is an energy, a phase of mechanical power, an

embodiment of work, and just as the chief office of the combustion of the fuel of the engine is not to keep the engineer warm, but to do work, so the combustion of the animal body, while it keeps us warm enough, generates that *power* by which the body is enabled to perform its part in the work of life; by which it carries about and executes the mandates of the soul. Let no man suppose that he is the creator of the power he is able to exert, any more than that he is the creator of the matter of which his body is composed. His power lies dormant, latent in the structure of his unburned body, and is only liberated when his combustible tissues are burned. As well suppose that the will of the engineer is the source of the power of the locomotive, as that the will, the mind, or the vital force of the man, is the source of his power to do mechanical work. Heat is an equivalent of, and is convertible into mechanical power; and combustion, that is, oxidation of fuel, is the source of our artificial heat. Fuel then is our great reservoir of manageable power, and is the same whether it be our enormous deposits of coal, our contemporaneous vegetation, or the bodies of animals, and oxidation in either case immediately yields us the mechanical work. Nor does it matter much whether our vegetation be oxidized under the engine boiler, and thus do work; or be eaten by the ox and then oxidized as muscle in him, and thus do work; or his muscle yet unoxidized be eaten as beef by us, and then, as man-muscle, oxidized in us by breathing, and thus do work; or, carried still further as lifeless animal-muscle and fat, be burned under the engine boiler, still combustion is the means, and heat, or its equivalent power, the end attained. Whenever or wherever a hydro-carbon compound is oxidized, there heat or mechanical energy, or both, are eliminated, and may be applied and used by man; and it is by power so generated in us that we are able to pick ourselves up and carry our bodies about, or execute any of those muscular movements by which the business of the world is carried on. The reasons are abundant for the conviction that our bodies can perform no act, produce no motion, exert no force, without the oxidation and death of muscular fibre, and this is the direct result of breathing. It is interesting fully to apprehend the thought that in this world I not only can perform no

bodily labour, but I can convey no thought to you, without the death and destruction, that is the combustion, through respiration, of some portion of my muscular system. If I speak, or write, or gesture, or nod, or smile, or frown, it is all the same. No idea can be conveyed by me to you without the contraction and accompanying death and oxidation of some muscular fibre; and it is highly probable that on your part, your mind can receive no impression made by me without a corresponding oxidation of some portion of your nervous structure. Muscle and nerve constitute, in this world, the only bridge over which thought can travel between one mind and another, and a part of the bridge must be destroyed every time a thought passes over.

It is easy now to understand the need of two kinds of food. The fibrin and albumen of meat and the gluten of the cereals are the tissue-producing food, and respiratory combustion of these is mainly the source of our ability to do work; while the starch, sugar, and oil of vegetables, and the fat of animals are the calefacient constituents of our bodies, and by their respiratory combustion they mainly contribute to the production of our animal heat.

Thus then the answer to our quere lies before us. While a whole catalogue of other functions, in both plants and animals, conspire to build up the embodiment of that splendid conception, an animated being, respiration is ever busy tearing the structure down again, and removing the rubbish, destroying organized matter, killing us while we live, and enabling us to live while we are continually, piece by piece, dying. Moreover, through its influence we are kept at a comfortable temperature, not only here and now, but enabled to resist the fiercest arctic cold ever found on earth; and lastly, through breathing only are we able to produce those motions and generate that immense power of animals and men, without which both would be more helpless than new-born babes.

How far respiration contributes to preserve a uniform composition of the atmosphere; how far to furnish food for plants; how far it is related to our own choice of food and clothing; how far to the ventilation of our dwellings and churches; how far it is instrumental in enabling us to produce those sounds,

which, modulated into language and vocal music, contribute so largely to our free communion with each other, and to aid us in our approaches to Him who planned the whole, he can know who chooses to press further the inquiry, and seek yet a fuller answer to the question—What's the use of breathing?