TO

WILLIAM SELLER, M.D.

CE-PRESIDENT OF THE ROYAL COLLEGE OF PHYSICIANS,
EDINBURGH,

ETC. ETC.

THIS LITTLE BROCHURE

IS INSCRIBED

BY

THE AUTHOR.

NATURAL HISTORY

OF

CREATION.

CHAPTER I.

THE LIVING AND DEAD OCCUPANTS OF THE GLOBE.

ERY one is familiar with the fact, that water arising n springs flows through rivers into the oceans; that these oceans it arises into the atmosphere by evation, and forms clouds; that these clouds pour forth water again upon the earth, and that this water s through the ground to keep up the supply that the s derive from the springs. The same water is con- ally in circulation from the springs to the seas, and again from the seas to the springs. This has often very justly been dwelt upon, not only as a very striking nce of design, but also as an illustration of how the rent phenomena witnessed in this world are made to end upon one another. And when we come to examine the operations both of living and dead matter, we find at *they* are ALL bound up to one another by ties as close as exist between the different forms of water in the s the sea, and the atmosphere. To understand even little of the actions of living bodies that this work to teach, it is necessary to have a general idea of whole natural history of the world.

The first great truth that it seems necessary to state that we have every reason to believe that from the ti the earth came out of the hands of its great Maker, fresh matter has been created in it, and none destroy This last statement may seem strange; but the seemi destruction of matter, in burning, in putrefaction, or like, is only apparent, and not real. There is merely little change in the manner in which the elements co posing masses of matter are combined together, and waste. Thus, when we throw a log of wood upon fire, it is not that the heat and blaze render what something, nothing; but the compact wood is changed i ash, and into gas that goes up the chimney, and wh gas will, in all probability, soon form part of anot piece of wood. In like manner, when man was ma it was not that he was formed from nothing, but " sprang out of the dust;" and when the time has co for the spark of life to depart, and for the frame decompose, it is not that its elements disappear from world, but "they return to the dust." Constant chan but never destruction, is the universal rule.

The researches of modern science enable us to h a pretty accurate knowledge of the various success changes that have taken place upon the world since it w first launched into space. At this early day, if any being besides Him whose word made it from emptiness wer connected with it, they were incorporeal spirits, free from matter. The globe had neither animals, nor verdure, nor soil; and yet it contained within itself every bit of matter that was to form the whole substance of all the soil that has ever been, of all the plants that have ever grown, and of all the innumerable generations of animals that have ever lived. The surface of the earth was in all probability a mass of bare rock, rivers, oceans, avalanches, and volcanoes. There is something almost terrible in the picture we are led to form of the world at this date, sullenly rolling on through its allotted space, with none of the associations that we now connect with it save sounds, and those sublime and terrible ones,—the hissing of the water as the volcano ejected its vast and molten mass, the roaring of the cataract down the naked rocks, the booming of the uninhabited ocean, and the crash of the falling avalanche.

Having stated that every atom of matter now present in the world, as it exists at present, with its inhabitants, its animals, its plants, its soil, and everything underneath its soil, was present from the beginning, it seems proper to add what is ascertained regarding this matter. It is found that all the substances present in the creation that can be examined by man (that is, the air, and the substances on and near the surface of the earth), notwithstanding they are so very numerous, and apparently so very different, nevertheless consist of different combinations of a very few elementary substances. An elementary substance, of course, implies one that cannot be separated into two. Thus, by a little management, water, long regarded, and very naturally, as one of the elements, can be divided into two bodies, to which chemists have agre to apply the names of oxygen and hydrogen. Do, ho ever, what the chemists like, they cannot separate eith of these two latter into anything more. It is therefo usual to call them, and others which, like them, cannot separated into two, elements or elementary bodies.

The number of substances usually regarded by chemi as elementary in their nature, is about five and fifty. these, many occur so rarely that they are of no consequer to any save the professed chemist. Of the remaind several are of comparatively little importance; and to t general student, particularly to one principally bent up knowing a little regarding the past and present state of t globe, only some thirteen require to be taken into accou The greater part by far of the surface of the primit world was made up of them and their combinations; a so likewise of them the surface of the present world, a the structure of the animals and plants formed out of are composed. We can do no more here than indicate names of these elements.

Oxygen is the most important of them. It constit more than a fifth of the air that surrounds the glo eight-tenths of all the water, fresh and salt; an immer proportion of the substance of man, animals, and plan and at least one-third of the soil and subsoil as fa we are able to go. Yet it rarely or never exists a but always combined with some one of the other elem When combined with one other element, it is calle oxide, if not sour; but, if sour, an acid. But it freq combines with two or more other elements, and such pounds often receive an arbitrary name, as starch, win

Carbon is, perhaps, the element next in importance to xygen. It entirely composes the diamond, is the main ngredient in coal, and is present in the extensive chalk ills that so often constitute the geology of a country. But it is in the air, and in the substance of man, animals, nd plants, that it most preponderates. And, although t is anticipating, we may mention that there is little loubt but that the air of the early world contained much nore carbon than the air of the present one, and that this arly air parted with its carbon to the animals and plants, is these latter began to multiply, and was, indeed, the nain means of building up their structures.

Oxygen and carbon are very much disposed to combine together. When they do so just by their two selves, they usually form the compound called carbonic acid. This is, in an uncombined state, a gas, and is always found when fuel (fuel is always a substance rich in carbon) is burned in air (which, as we said, contains oxygen). Carbonic acid, in its turn, combines with other substances, as lime, oda, and so forth (substances immediately to be noticed); and such compounds are called carbonates, as, for example, arbonate of lime, or carbonate of soda.

Hydrogen is a third and abundantly occurring element. It constitutes a considerable portion of most animal and vegetable substances, and is one of the two elements of hat, to us, all-important fluid, water.

This compound, water, is composed of equal equivalents (a chemical word of no matter to us just now) of oxygen and hydrogen. Its appearance and common properties re familiar to everybody.

Nitrogen, or azote as it used to be called, is another element, but by no means so abundant as the other thr[ee] we have named. It exists in large quantities in th[e] atmosphere, is present in the crust of the earth, and i[s] essentially present in most animal structures, and in [a] great many vegetable ones.

Nitrogen is very much inclined to unite with hydrogen and the compound so formed is well known by the nam[e] of ammonia. Whenever substances containing these tw[o] elements of nitrogen and hydrogen (as is the case wit[h] most animal and vegetable structures) become subject to putrefaction, this ammonia is invariably produced. Oxygen is another element for which nitrogen has a strong affinity; and the commonest and most important compound of these is nitric acid, or aquafortis. This compound is very fond of forming other compounds with various substances, and chemists have agreed to give to such the name of nitrates.

We say nitric acid is the most important chemical compound of nitrogen and oxygen. This may seem strange when we recollect that the atmosphere so essential to our being is composed of these two; but it is generally supposed that they are in a state of mixture, that is, mechanically united only. Every hundred parts of pure air contain twenty-one parts of oxygen, and seventy-nine of nitrogen. But, in point of fact, air never is thus pure. It always contains a considerable quantity of carbonic acid; and it is believed, with great probability, that this proportion was, in the world's younger days, much greater than it is now, or indeed has been for a long time. Air, too, always contains some watery vapour, and now-a-days always some ammonia, which has escaped into it from decomposing animal and vegetable matters. But, of course, if we are correct in saying, that, in the early periods of the world's history, neither animals nor plants had a being, originally the earth's atmosphere would contain no ammonia.

Another elementary body is sulphur, or brimstone as it is commonly called. It exists pretty extensively in nature. With oxygen it forms the compound known as sulphuric acid, or oil of vitriol. The compounds which this sulphuric acid form are called sulphates.

Phosphorus is another body which is always considered as an element. With oxygen, it forms phosphoric acid; and the compounds of phosphoric acid are called phosphates. Other elements are potassium, whose compound with oxygen is called potash; sodium, which by uniting with oxygen affords us soda; calcium, the oxide of which is lime; aluminum, which by joining with oxygen, &c. gives us clay; silicon, whose acid or oxide is called sand; iron; and chlorine, the compounds of which last are called chlorides.

Such were the elements of which the atmosphere surrounding, and the surface and crust of, the primitive world mainly consisted. With the exception of a little native iron, none of them, or scarcely any of them, were in an uncombined state. The rocks that formed the surface were composed probably of sulphates, nitrates, phosphates, and chlorides of lime, soda, potash, magnesia, and alum. Very probably they were at first in a condition that would present a hard surface to the atmosphere. Just in fact such a surface as we see now-a-days in the face of a newly-cut quarry. But it is found that, when such a surface is exposed to the air and to moisture (particularly, too, when carbonic acid is present, as we have reason to believe was the case in the earth's early atmosphere), it gradually becomes disintegrated, and crumbles down into a powder. When this was first done to the surface of this world, the first step was made to the formation of a *soil.* Had at this period of the globe's history a spirit, wonderful even for its intelligence, inspected the surface, it would scarcely have been able to conjecture that, out of that apparently insignificant crumbling mass, the great Designer intended to form millions of generations of myriads of living plants, and living and sensitive animals.

It is proper to consider what would be the chemical constitution of this fragmentary covering of the hitherto previously naked rocks. It was, doubtless, various compounds of sulphur, phosphorus, potassium, sodium, aluminum, calcium, silicon, chlorine, and iron. It would have moisture mixed with it, which moisture would consist of oxygen and hydrogen. The atmosphere immediately surrounding it would furnish plenty of nitrogen and carbon.

The creation of an immaterial spirit is so above our comprehension, that we cannot understand anything regarding it. This we are told was the first creation, — the creation of Mind. Then we come to that great, and to us equally incomprehensible act, — the creation of Matter. In this period of our consideration of the world's history, we arrive at another great and miraculous creation, — the creation of Life.

We cannot define spirit, we cannot define matter, nor can we define life. We can only look at certain results and properties. The greater part of the matter of this world is, as it once all was, subject to the laws of chemistry; a portion of it now is subject to other laws,—the laws of life,—which oppose, detract from, and add to the laws of chemistry. Matter, in this state, is said to compose the living kingdom of nature; and the objects of this kingdom are well known by the names of plants and animals.

The first created living material being, belonged, it is believed, to that class of plants called cellular, and of which lichens and mosses are familiar examples. In all probability it was a lichen or a moss that first inhabited this earth. Whichever it was, its creation, as well as the subsequent creation of every new kind of plant or animal, must be considered as a miracle. The creation of life was as wonderful, and as impossible to proceed from nothing, as it was for matter to spontaneously arise from nothing.

The difference in the habits of lichens and mosses, as compared with most other plants, is, that they require to have very little hold for their roots, and that they are nearly all leaf, or at any rate something corresponding to leaf. Now the function of the leaves is to take carbonic acid, to separate its elements, and to add the carbon to its structure, returning the oxygen to the air. The lichen would do this, abstract carbon from the air around it (which air contained an excess of carbonic acid), and fix it in its structure. From the soil, or rudimentary soil, it would obtain sulphur, phosphorus, silicon, potassium, sodium, calcium, chlorine, and iron. From water and air, it would obtain oxygen, nitrogen, and hydrogen.

In a word, it would procure a supply of its twelve component elements, which it would convert into its own structure.

After it had obtained so much of all these, and attained so great a size, in obedience to a law soon to be alluded to, it would perish, and its structure rot. All the elements it had obtained from the ground, it would now restore to it. It would also, most probably, during its putrefaction, give ammonia to the ground, and its carbon, oxygen, and hydrogen would unite to form a substance now-a-days called humus.

Now, when the surface of the earth is covered with a crumbling mass containing sulphur, phosphorus, potassium, sodium, calcium, aluminum, iron, and chlorine, or rather compounds of these with one another, and also ammonia and humus, we have what we call soil, and that kind of soil which a farmer would say will grow anything.

There is every probability that other species of plants were afterwards created; first, those belonging to the endogenous division of botanists, of which we may instance as members the grasses; and afterwards those belonging to the more complex exogenous one, such as oaks and so forth. But there is no evidence, but the contrary, that a cellular plant was ever transformed, or, to use the fashionable word, developed, into an endogenous one, or an endogenous into an exogenous. On the contrary, the only deduction that sound philosophy warrants us in drawing is, that the commencement of every species was produced by an act of the Divine Will—that is, was miraculous. All species of plants have the power of perpetuating their kind; and they would gradually increase and multiply, and more and more of the structure of the earth, that a little before had been bare rock, would pass into the vital world. Moreover, as every year additional plants would be there to die, and become rotten, more humus (and probably more ammonia) would be added to the soil, which would thus become more and more fertile, and this fertility would become increased by the addition of fresh sulphur, phosphorus, potash, &c., from the gradual decomposition of the subsoil.

When a sufficient quantity of forage had been formed, we have a right to conclude that animals would be created. Geologists have been enabled to point out even more details regarding the history of the globe. The surface of the earth, they have discovered, is composed of various formations, as they are called, that have been deposited one after the other. Three of the earliest of these are called the gneiss, the mica-slate, and clay-slate beds. In these no remains of either plants or animals are found, and the time of their formation must be referred to that period that we have described as the first formation of most of the soil by the disintegration of the rock. Next to these come what are often called the transition formations, — coal measure, and red sandstones. These all contain remains of living beings, both animals and plants. The vegetable fossils are those of trees and other plants of large size, all of which are now quite extinct. The animal fossils are shell-fish, zoophytes, crustaceous animals, and a few fish, but no amphibious animals, birds, or quadrupeds. The next formation, in order of time, is the oolite. In this we first find amphibia. Twenty-nine species of these, all now extinct, are known to have dwelt in this formation — among whom are the ichthyosaurus, the pterodactylus, &c. It is probable that the vegetables had not yet cleared the air of its original excess of carbonic acid; and to this day the amphibious animals are characterised by being enabled to live in such an atmosphere. We also find in this formation the remains of a quadruped of the opossum tribe.

The appearance of this opossum animal is an anomaly; for in the next formation, to wit, the chalk, we find no quadrupeds. But in those over the chalk, and which are sometimes called the *tertiary*, there are plenty of remains of both birds and quadrupeds. Then we come to the formation at present going on, called the alluvial; and in it of course we find remains of our own species, man, just as our descendants will find our remains.

Two things should be observed. The structure of the first created animals must have been derived from the vegetables that had obtained theirs from the soil. Afterwards, the carnivorous animals would derive theirs from vegetable-feeding animals. But, ultimately, both carnivorous and vegetable-feeding animals return their structure to the soil. Thus the chemical elements forming the crust of the earth are in a constant state of transition from soil to plant, from plant to animal, and back again from animal to the soil: and thus the expressions, formerly so obscure, that "out of the dust man was formed, and to the dust he returns;" and "all flesh is grass," are intelligible. Farther, as the number of vegetables and of animals is constantly increasing, dead matters obtained from the subsoil are daily becoming vitalised and entering into living structures. It will also be observed, that spirituality and life are two quite different affairs: first (of course we are speaking only as far as this globe is concerned), we have the creation of matter, then of life; but not until man is made is there added, to the union of matter with life, Spirituality.

A few more general principles must be cursorily noticed. All living bodies differ from dead ones (*i. e.* the chemical elements under the control of the laws of vitality differ from those identical elements when under the control of the laws of chemistry and mechanics) in some very important particulars. In the first place, dead matter (as a stone, a piece of mud, ammonia formed from the decomposition of flesh once alive, but now dead) presents a homogeneous structure. On the contrary, all living bodies possess organs, each of these organs performing certain functions; as the heart driving the blood, the root taking in food, and the like. Then, every living being, whether an animal or plant, springs from its parent; obtains its structure by appropriating and assimilating surrounding matter; and, finally, every one of them, invariably, after a time, dies, and then their structures return to the dead or inorganic world.

As long as this vitality exists in an animal or plant, it is necessary that certain conditions be present. First and foremost, it is essential that every animal and plant have a nutritious fluid, which is called sap in plants, blood in animals; and this nutritious fluid parts with its substance, and adds it to the structures of the frame of the being to which it belongs. This, of course, implies a constant diminution of this nourishing fluid, and this waste must be made up by a constant supply of matter from without. This matter is commonly called food. Then, the nourishing fluid must be regularly exposed to the air at the lungs, gills, leaves, &c., and be acted upon by the air in a manner to be afterwards explained. Heat and light are also necessary to the continuance of vital action.

The great difference between animals and plants is, that the former have a nervous system, and therefore feel, and usually they also have the power of locomotion. The food of plants, too, must be derived from the inorganic world, while that of animals must be previously organised matter. Thus, if we give a dog a pound of beef it nourishes him; but it would afford no nourishment to a turnip plant. But if we let this same piece of beef become quite dead and changed into inorganic ammonia, and give this to the dog, it does not nourish him at all; but if we put the same to the turnip, it makes it grow exceedingly. The immense importance of this principle will, in the course of the following pages, become very apparent to us.

CHAP. II.

THE WAY THE BLOOD IS CIRCULATED.

The ancients were ignorant of the true courses taken by the blood through the human body. Their opinion regarding it was, that the fluid moved backwards and forwards through the veins; while they thought that the arteries were filled with air, or some imaginary subtle aëriform fluid. It was Harvey, in 1616, at London, who first found out and taught the real circulation of the blood. This is from the heart to the arteries, through these to the capillaries, hence to the veins, and from the veins back to the heart, and again to the arteries, and so on. In man there are two circulations—one for the purpose of sending the blood to all and every part of the body, to part with its own substance to nourish the body, and called the greater; and the other for the purpose of exposing the blood to the air at the lungs, and called the lesser. In reality, these are nearly independent of one another; but, as the organs performing both are as a matter of convenience in the human subject joined together, it is almost impossible to describe them separately. It is this that renders the whole subject of the circulation sometimes difficult to beginners; but if our readers will endeavour to keep in mind the fact that there are *two* circulations carried on in the body, we do not despair to render the whole sufficiently clear.

The blood, or fluid circulated, first, however, demands our attention.

The sap, or nutriment fluid of plants, has for its basis either sugar or starch. The blood of animals has for its, albumen, or the same substance of which the white of egg is composed. With the appearance of freshly drawn blood (blood in the body is the same) every one is familiar. It is a clear red fluid, much warmer than the surrounding air, and a good deal heavier than water. After it has been abstracted a little time from the body, it separates into two parts, one a watery, called a serum, the other a clot, to which the name of crassamentum is given.

As before mentioned, the basis, as it were, of blood, is a compound substance, on which the name of albumen is conferred. It is composed as follows:—

Carbon	53
Oxygen	23
Nitrogen	15
Hydrogen	7
	98

The blood, in virtue of its containing these four elements, can supply them to the body; and, as by far the greater part of the body is composed of these four, we can understand that albumen should be the base of the blood. But while these elements preponderate in our structures, our bodies likewise contain potassium, sodium, calcium, magnesium, iron, sulphur, phosphorus, and chlorine. Our system can only get these from the blood; and we would, if otherwise ignorant, have inferred their presence in this fluid. But we now know by direct analysis that they are every one of them present; and we shall afterwards see how the blood receives a daily fresh supply of them.

It is, we should observe, believed, that the albumen of the blood is not at once converted into animal tissue; but that it is first converted into another compound of the four elements carbon, oxygen, nitrogen, and hydrogen, but in somewhat different proportions, called fibrine. The blood also contains ready-made oil or fat, the uses of which will afterwards be considered. The blood, then, contains albumen, fibrine, oil, and different compounds of the dozen elements we have so often enumerated.

If we examine the blood immediately after it has been taken from the body with a microscope, we find that it consists of a clear fluid, with a number of globules suspended in it. These globules are improperly so named, because, so far from being round, they are flattened disks.

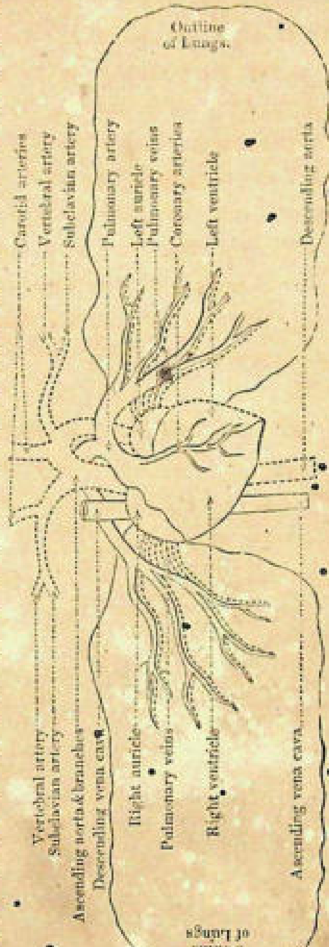
Their diameter varies from the one three-thousandth to the one four-thousandth of an inch. They are remarkable for their flexibility and elasticity, and can pass through a channel less than themselves, and subsequently regain their proper shape. The proportion that these globules bear to the rest of the blood varies in different individuals,—being usually greater in males than in females, and in stout, robust people than in delicate and weakly ones. It also varies in different individuals at different times, according to the state of the health. A deficiency of globules is indicated by lassitude, weakness, and a remarkable degree of pallor in the countenance. The iron in the blood is contained in the globules; and it is found that this deficiency of globules in the blood is cured, at least very often, by administering some preparation of iron.

The coagulation of the blood depends upon the fibrin separating from the serum, and the globules attaching themselves to it. It is by virtue of this power of coagulation that we do not bleed to death every time we receive a cut. When such an accident happens, the blood that is adhering to the edge of the wound gradually stiffens and forms a plug, which hinders any more bleeding. The rationale of putting on a bandage is, to prevent the plug of coagulated blood from being washed away by the pressure of the current of blood from behind. There is a diseased condition, fortunately not common, in which the blood either does not coagulate, or does so very imperfectly. Strangely enough, this seems to be hereditary; and one instance of it is on record in which, in one family, four of one generation and three of the succeeding died from bleeding after trivial injuries.

This property of coagulation of the blood depends upon the blood's vitality, and is not found in cases where the death of an individual has been very sudden. Thus, when a person dies of any ordinary disease, the blood is found coagulated in the heart and great vessels; but if life has been extinguished by something very violent, as in cases of death produced by a stroke of lightning, or extreme mental emotion, it is found to remain quite fluid.

Having now obtained some general notion of the nature and properties of the blood in general, we may proceed to state, that in the human body two varieties of blood are always present, to which the names of arterial and venous are given. The arterial blood is the more perfect of the two, and is just in the act of going to the different parts of the body for the purpose of nourishing them. The venous is the somewhat exhausted blood, that is returning from nourishing the different parts of the body, and going to the lungs, to be there exposed to the air to get a supply of oxygen. Arterial blood is scarlet, contains more oxygen and less carbonic acid, has more fibrin and crassamentum, and coagulates much more strongly than venous blood. Venous blood is of the colour called by painters Modena red. There is nearly three times as much venous blood in the body as there is arterial.

Then, with regard to the circulation of the blood in the human body: first, we may observe that the organs of circulation in man are the same as those of sheep, pigs, &c., and any one can obtain a perfectly accurate idea of the anatomy of the human organs of circulation by examining those of these animals. These organs may be divided into the heart, the arteries, the veins, and the capillaries. The annexed diagram gives a correct representation of the heart, great arteries, and veins, and an ideal one of the capillaries.



The heart is about the size of the closed fist, and is situated between the lungs, at the left side of the chest. It is a hollow muscle, with four chambers or cavities; or, to speak more correctly, it is two hollow muscles (each with two chambers) joined together; that at the left side is for the purpose of propelling the blood in the greater circulation, while that lying more to the right aids in propelling the blood to the lungs in the lesser circulation. These chambers are called auricles and ventricles, and the communication between each auricle and its respective ventricle is defended by a valve, which, while it allows any fluid to pass from auricle to ventricle, effectually prevents any flow in the opposite direction. From the auricles and ventricles the great vessels will be seen to proceed.

Foremost among these great vessels are the arteries, which, with the exception of the coronary artery, are all branches and sub-branches of the aorta. They are flexible, elastic, and cylindrical strong tubes; they penetrate to every part of the body, and the smaller branches anastomose very freely with one another. These latter terminate in—

Capillaries, or hair-like tubes, so called from their extreme minuteness. It is in these that the nutrition of the textures takes place. They form a network that envelopes, as it were, every part of the body. So numerous, indeed, are they, that we cannot run the finest needle into any part of our frames without breaking some of them and causing them to bleed.

As the smaller arteries terminate in capillaries, so the smaller veins may be said to originate in them. Like the arteries, the veins are elastic and cylindrical tubes. The smaller ones freely anastomose together, and gradually unite so as to form larger ones, until the whole are centred in the two venæ cavæ. The veins are provided with valves that prevent any regurgitation of the blood back from the veins into the capillaries.

We can now understand the true course of the blood. We will begin with it in the arterial capillaries. Here the blood is arterial, and in every respect qualified to nourish the body. In these capillaries it parts with as much of its fibrin and other constituents as the part it is at may stand in need of. During this process it becomes a little debilitated and spoilt, and gets charged with carbonic acid (where the carbonic acid comes from will be afterwards explained). It then passes on to the smaller veins, and going gradually along them gets into the two venæ cavæ. From these it passes into the right auricle, and from it to the right ventricle. The right ventricle sends it along the pulmonary artery, which, by its branches and subdivisions, carries it to the capillaries of the lungs. Here it meets with the air, gives off its carbon, and takes in oxygen, and becomes arterial blood once more. It then passes by the pulmonary veins to the left auricle, from this to the left ventricle, and from this to the aorta, which, by its subdivisions, carries it to the arterial capillaries, where we commenced with it.

Whenever the blood enters into any of the chambers of the heart, the cavity contracts, and of course squeezes the blood out of it. All these chambers are provided with valves, which prevent the blood from flowing in any other direction than the one we have described, and consequently each contraction of these cavities propels the blood forward. The contractions of the cavities of the heart serve to tilt its apex forward, and cause it to strike underneath the sixth rib. It is popularly called a beat. About sixty or seventy of these beats take place in a minute. Each time the left ventricle contracts, it drives into the aorta about four table-spoonsful of blood. The force exercised is calculated at about fifty pounds, and the velocity of the blood leaving the heart is supposed to be about a hundred and fifty feet a minute. In the larger animals the velocity of the circulation has a magnitude that we can scarcely conceive. Paley says that the aorta of a whale is larger than the main-pipe of the water-works that then were at London Bridge, and that the blood rushes through it with greater impetus than the water rushed through that pipe.

The heart has little or no sensation. In cases of injury or disease, it has been so exposed as to allow people to handle it, and the touch of the hand upon it is not felt. But, strange as it may seem, it is a familiar fact to all of us that it is powerfully affected by strong mental emotion. Indeed, it is affected by almost every change in the body, and doctors, by ascertaining its state, which they do by feeling the pulse, can often obtain a very good idea of the state and condition of other organs. The pulse, we should state, is produced by the column of blood propelled onward by each contraction of the ventricle striking against the elastic artery.

That the account we have given of the course of the blood is the true one, is very certain. Among the proofs of it we may mention, that in cases of injury the auricles, ventricles, and great vessels have been observed to contract in the order stated. In the translucent animals the blood may be clearly enough seen to pass from the arteries to the capillaries, and from these into the veins. Again, if we tie a ligature around an artery, the artery becomes distended with blood upon the side nearest to the heart. But if, on the other hand, we tie one around a vein, the swelling takes place upon the side farthest from the heart. Lastly, the valves of the heart freely permit the blood to flow in the order stated, but effectually prevent it in any other. It was the observation of this fact that first put Harvey upon the right track regarding the circulation of the blood.

The main cause of the motion of the blood is the contraction of the heart. Other causes, however, that we need not here enter into, influence the circulation. As an example of other causes affecting the local circulation, however, we may instance the phenomenon of blushing.

In this a mental cause produces an increased circulation of the capillaries of the face.

The vigour with which the circulation is carried on, and the facility with which it is excited, vary very much in different individuals. In some, all the actions of the heart are performed very forcibly, and a very slight cause greatly increases the rapidity with which the blood is made to rush through the body. Individuals so situated, when they have light hair, have many characters in common both of mind and body, and are said to have a sanguine temperament. If, however, their hair be black, their temperament is named the choleric. On the other hand, in some the functions of the circulation are very feebly performed, and roused with difficulty. When this is combined with light hair, we have the phlegmatic temperament, and when with dark hair the melancholic. Formerly much more attention was paid to this subject of temperaments than now. Still, the theory is based upon truth, and the reader will have no difficulty in understanding the corporeal and mental characteristics, and finding instances of the sanguine, the choleric, the phlegmatic, and the melancholic temperaments.

CHAP. III.

THE WAY THE BLOOD FORMS THE BODY.

The most striking illustration of the property of nutrition is, perhaps, the growth of the body from the size of the infant to that of a full-grown man. All this increased matter has of course been derived from without, and there is no doubt but that this matter from without is first added to the blood, and that the blood then parts with it to the different portions of the frame. But even in the full-grown man every part is continually receiving nourishment, for every part of it is continually wasting. Wonderful as it may seem, the startling phrase "we die daily," as applied to our physical frames, is scientifically true.

We have seen that the dead matter of the ground passes into the plant, and then into the animal, and that this matter then ceases to be under the influence of the laws of mechanics and chemistry, and becomes subject to those of life. We have also seen that the time comes when every living being, animal or plant, must die. These laws of life are necessarily transitory, and after death those of mechanics and chemistry again assert their sway. But, in animals, the matter composing their structure cannot maintain its vitality for the duration, or anything like it, that it has pleased Him who made us to assign. Were there no provision made for the gradual death, and separation of the dead matter, there is not one of us, perhaps, could live three weeks. The finger of the young man of twenty has probably in that short time been renewed several successive times. It is supposed that the whole body is changed about once in three years, and many parts of it are cast off and renewed much oftener. Should this change, from disease, not be made, the matter retained acts as a deadly poison, and very speedily kills.

In man the whole frame (or nearly so) is permeated by little vessels called absorbents, whose duty it is to take up every particle of matter that has become too old. All these effete matters are poured into the blood, and the blood gets rid of them at various organs. The lungs cast away used-up carbon, the kidneys nitrogen, sulphur, potassium, &c., the liver more carbon and iron; and the skin and other organs likewise assist.

Now, all this continued absorption, and the body never becoming any less, implies continual nutrition. The blood is able to afford a new supply of these elements, because it, as we shall see in Chapter V., is itself daily getting fresh stock of them by the food. It is believed that all the tissues and secretions of the whole body are formed in the blood, and separated by the vital power in the capillaries of the part that wants them. It is supposed, for instance, that the blood parts with a piece of bone at the growing bone, with bile at the liver, with flesh among the muscles, and so on.

Two simple elements never unite together to form an animal proximate principle or tissue. There must be at least three, and usually there are more. These original proximate principles unite together and form organs. Thus, phosphorus, oxygen, and calcium unite together, and form bone; other elements are made to unite together to form albumen, fat, and several others, and these being joined together make a hand. It will be useful here to consider the composition and properties, first, of the more important proximate principles, which are the products of nutrition from the blood; and then those of the principal compound textures and secretions formed out of the blood.

All the proximate animal principles admit of a very convenient and philosophical arrangement into three divisions. The first one is called the saccharine; and the members composing it consist of carbon, oxygen, and hydrogen, and the two latter are in the same proportions that they are in water. The second one is named the oleaginous; and the compounds included in it likewise consist of carbon, oxygen, and hydrogen, but the two last-mentioned elements are *not* joined together in the same proportions as they are in water. The third class is the albuminous; the objects composing it contain carbon, oxygen, hydrogen, and about fifteen per cent. of nitrogen, and usually some phosphorus, sulphur, sodium, &c. &c.

When we have to consider the subject of food, we shall have occasion to notice that the principles formed by plants out of the sap may also be divided into three groups; and that, indeed, a great many of the proximate principles are common to both animals and plants.

While plants, however, have many instances of saccharine proximate principles, animals have only one, and that, too, only exists in milk,—sugar. Sugar of milk is not exactly identical in composition with cane sugar. It is composed of

Carbon - - - - -	45
Hydrogen - - - -	6
Oxygen - - - - -	48
	99

In the state that it exists in milk it is not susceptible of fermentation, but the action of acid upon it renders it capable of undergoing this process. The Tartars, who cultivate no crops, and consequently who have neither wine nor beer, make themselves an intoxicating drink by allowing the milk of their mares to become sour. Sugar of milk has by no means the sweet taste of cane sugar, and hence probably it is that the homœopathists use it for composing the substances of the greater part of homœopathic globules.

The oleaginous group comprehends all animal fats and oils. They, properly speaking, consist of two nearly identical principles,—margarine or stearine, and oleine. The following is their composition:—

	Margarine.	Oleine.
Carbon - - -	37	39
Hydrogen - -	37	36
Oxygen - - -	4	5

Margarine is solid, oleine fluid; in other respects they are almost identical. The solidity of the compound fats is pretty dependent upon the proportion they contain of these two principles. Thus, mutton suet contains about ten per cent. less oleine than olive oil does. The uses of fat are to preserve symmetry and obviate the effects of pressure. But another important purpose that they are put to is, to furnish a supply of food to keep the body warm, as will be explained by-and-by.

Among the albuminous proximate principles we will first mention albumen itself, the one that gives a name to the division. The best example of it is to be found in the white of an egg, which is nearly entirely composed of it. Whenever albumen is heated up to 180°, it coagulates. We have an example of this in the solidification of the white of an egg when the egg has been boiled. Certain acids produce a similar effect upon it, and by means of these two tests we may always distinguish albumen. The following is the chemical composition of albumen:—

Carbon - - - - -	55
Oxygen - - - -	21
Nitrogen - - - -	15
Hydrogen - - - -	7

Casein is another albuminous proximate principle, very similar to albumen. Like that substance, it coagulates when certain acids are added to it. When so coagulated, and properly prepared, it is called cheese. Its composition has been stated as follows:—

Carbon	59
Oxygen	11
Nitrogen*	21
Hydrogen	7

Fibrin is an albuminous proximate principle, formed out of albumen for the purpose of forming the animal tissues, of most of which it forms the basis, or skeleton, as it were. It is thus composed:—

Carbon	52
Oxygen	23
Nitrogen	16
Hydrogen	7

The remaining albuminous proximate principle is called gelatine. Of this, glue is an impure example. It is characterised by its ready solubility in hot water, by its forming a tremulous mass when cold, and by its uniting, with a vegetable principle called tannin, to compose leather. Its composition is this:—

Carbon	47
Oxygen	27
Nitrogen	16
Hydrogen	7

Having now obtained a notion, first of the simple elements that enter into the composition of the human

* The proportion of nitrogen is probably overstated.

body, and next of the compounds that they first of all make, we must go on to consider the still more complex compounds that the farther union of these compounds with one another give rise to. We will begin with

Bone. — This hard dense substance constitutes what is called the skeleton. This skeleton is the foundation, as it were, of our structures; it gives the general form to the body, and serves to afford points of attachment to the muscles, tendons, &c. It likewise protects delicate internal organs from the effects of pressure or external injuries.

The bones of a healthy adult contain thirty-three per cent. of fibrin, albumen, and gelatine. The other sixty-seven per cent. is composed of more than fifty per cent. of phosphate of lime, about ten of carbonate of the same substance, and smaller quantities of magnesia, chlorine, iron, and silicon. In youth, however, the proportion of fibrin, albumen, and gelatine is greater, and in old age less, than this. The structure of the bones, like that of the rest of the body, is constantly changing; the vessels near it taking away effête matter, and the arterial capillaries depositing new osseous substance wherever it is required. If any of our bones be broken, and we can keep them unmoved so as to prevent irritation, the deposition of fresh osseous matter at the broken parts soon makes them unite together again.

The inside of some of the bones is lined with marrow. This substance scarcely seems to be vital. It is oleaginous, and composed of a mixture of stearine and oleine.

Cartilage, or *gristle*, only differs from bone in containing a much greater proportion of fibrin, albumen, and gelatine, and less of the other ingredients just stated to form part of bone.

Cellular tissue, and *fat*, are very common. The former lies underneath the skin, between muscles, surrounds the blood-vessels, and in fact finds its way nearly everywhere. It is composed of cells, which, however, freely communicate with one another; and it is always lubricated with a little serous fluid. It is strong, but soft and flexible; and it is intended to hold those parts of the body together that would be injured by strong constraint. It contains gelatine; and the fluid that keeps it moist is the same as the serum of the blood.

Whenever, as is the case in a great many parts of the body, the cells of cellular tissue are filled with animal oil, we have adipose tissue, or fat.

Fibrous and *serous membranes* contain albumen and gelatine. The former is very strong, and connects bones and joints together. The latter envelopes all the internal organs.

Mucous membrane is another important texture. It lines the mouth, stomach, &c., and secretes a fluid called mucus, that serves to shield the membrane from the injurious effects of acrimonious substances. Mucous membrane and mucus contain a great many substances.

Glands and *their secretions* next demand our attention, and are a very important subject. We have seen that it is in the capillaries that the blood parts with its contents. When this nutrient fluid is merely separating from itself the elements necessary for keeping up the structure of the frame, no particular arrangement of the vessels is necessary. But when the matter secreted is either to serve a farther purpose in the economy, or to be excreted as a poison, the blood-vessels destined to do ether of these are packed together in various ways. Now the name given to such packed vessels is glands.

There are in the human body a great many different kinds of glands. Some of these secrete substances which are intended to serve a purpose in the living body. Among these we may enumerate the wax-glands of the ear, which secrete wax to keep insects from creeping into this delicate organ; those that secrete tears to moisten the eyeball; those that secrete the saliva, the gastric juice, &c. On the other hand, there are some glands at which the effete elements of the body are separated, and which effete elements are afterwards removed from the system. The most important of these are the two kidneys, which separate the used-up nitrogen, potassium, sodium, phosphorus, calcium, magnesium, silicon, sulphur, and chlorine. The liver secretes the excretion called bile. Bile contains a peculiar principle composed as follows: —

Carbon - - - - -	54
Oxygen - - - - -	43
Hydrogen - - - -	1

This analysis instructs us in the fact, that one use of the secretion of bile is to remove decayed carbon.* Bile also excretes effete iron from the constitution. It likewise excretes, but in small quantity, some of the other elements that enter into the composition of the body.

* In so rudimentary a little book as this, any allusion to other supposed uses of the bile would be out of place. Whether true or not, they are not generally received.

But although the liver rids the system of some spoiled carbon, the glands that, in the human adult, discharge from the body by far the greater quantity of it are the lungs. When we examine the lower animals, we find that the development and the activity of the lungs and of the liver stand in an inverse ratio to one another. Insects have not, indeed, any lungs like ours, but they have an amazingly large and active respiratory system, and scarcely any liver at all. On the other hand, in molluscous animals, we find the respiration by lungs carried on in a very imperfect kind of way, and they have most enormous livers.

When we come to speak of the way people breathe, we shall have occasion to give an outlined account of the lungs. Here we only desire to state the nature of the excretion that takes place from them. Every time we breathe, we send a stream of gas and vapour into the air. The gas is carbonic acid, and the vapour that of water. A full-grown man in this way gets rid of about ten cubic feet of carbonic acid, containing about five and a half ounces of solid carbon, in the course of a day. This carbonic acid is poisonous; but it is removed from the atmosphere by plants, and by them converted into starch and sugar. Animals eat these, and convert the carbon that they contain into their structure; and when this carbon can no longer remain vitalised, it is cast out to again afford nutrition to plants. And thus does the same carbon go on being circulated, from air to plants, from plants to animals, and from animals back again to the air.

Another excreting organ is the *skin*. The skin consists of two layers; the cuticle, which is outside, and the true skin. A third layer was formerly stated to be between the two, of a dark hue, and which is highly developed in men of colour; but it is now ascertained that the colouring matter is situated in the true skin, or rather in pigment cells scattered up and down in the true skin.

The cuticle is easily separated from the true skin by a blister. It is scarcely anything but condensed albumen, and has no sensibility. The function of the cuticle is to restrain the sensitiveness of the true skin. Its thickness, therefore, varies very much according as to whether the part is to be endowed with extreme sensibility, or to be protected from strong impressions. Thus, on the tips of the fingers, which are meant to feel, the cuticle is very thin; on the palms of the hands, that are intended to grasp, it is thicker; and upon the soles of the feet, which are destined to support the weight of the whole body, it is densest of all.

The true skin lies underneath, and is composed of a vast number of fibres, interlacing in all directions with one another; and these fibres are traversed by an immense number of blood-vessels and nerves. It is owing to the great number of these latter that the skin is by far the most sensitive organ that we possess. Besides, the skin contains an immense number of little glands, with canals leading from them to the cuticle, and conveying the excretion of the skin—the perspiration. This perspiration contains water, nitrogen, and some other substances. Of all the excreting organs, the skin is the one that is most liable to perform its functions imperfectly; and the matters thus retained in the system, that ought to be excreted, prove very injurious to the health. A new system of therapeutics, called hydropathy, has of late become fashionable, the intention of which is to restore the healthy action of the skin. But it may reasonably be doubted if a little regular domestic hydropathy would not enable us to dispense with its public performance on a large scale.

Muscles play an important part in the animal economy, and constitute the bulk of the body. They compose what is popularly known as flesh, and they consist of a number of fibres bound together. These fibres have the power of contracting, the result of such contraction being a shortening of the muscle. In this manner, a muscle that has one extremity fixed to one bone, and the other to another, with a joint between, can, by contracting, flex or bend the joint. It is to an extension of this principle that locomotion, and the power of moving the different parts of the body, are owing.

All muscles are well supplied with blood-vessels and nerves.

Muscles are composed of fibrin, albumen, gelatine, potash, phosphorus, and other compounds of the elementary bodies, and a peculiar principle called kreatin, to which the sapid taste of meat is owing. The art of cooking mainly consists in coagulating the albumen by heat. Heat, too, has the power of developing the sapid taste and odour of the kreatin.

Nervous matter is another and very important texture, formed out of the blood. The nervous system of man may be divided into the brain, enclosed in the skull; the spinal cord, enclosed in the hollow of the backbone; and the nerves, distributed all over the body. Each of these demands a little separate notice.

The brain is enclosed and protected from injury by the bony casing named the skull. It is composed of a peculiar substance (or rather two peculiar substances), called nervous matter. In its composition it is mainly distinguished from most other parts of the body by containing an excess of sulphur and phosphorus. In appearance it is soft and firm, and a good deal resembles blancmange. It contains three distinct and important divisions: the cerebrum, the largest and the one lying forward and uppermost; the cerebellum, or little brain, situated lower down and behind; and the medulla oblongata, placed at the base of the brain, where the backbone joins, and communicating with the spinal cord. It is believed, that it is by means of the cerebrum that we understand the impressions made upon our organs of sight, hearing, touch, smell, and other sensations, and that the cerebrum is also the seat of the mental acts. The cerebellum has unquestionably a connection with the function of motion. The endowments of the medulla oblongata will be better understood when we have acquired a knowledge of those of the spinal cord.

The spinal cord is a mass of nervous matter filling the space or hollow in the centre of the backbones. From it, opposite to each backbone, two nerves, an anterior and a posterior, arise. These, however, soon unite; and from branches of these every part concerned in voluntary motion, and every part that can feel pain, is supplied. If the anterior nerve of these backbone nerves be destroyed, the power of motion is altogether lost in the parts that it supplies. If, on the other hand, it is the posterior that is so injured, then the power of sensation is lost. When we lay our hand upon a rough surface, the sensation of roughness is transmitted along the filaments that proceed from the posterior nerve of one of the backbone nerves in our neck to the spinal column up to the cerebrum, and it is when it has got to this last place that we are conscious of the roughness of the object. When we wish to grasp anything with our hands, we have first the will to do so in the cerebrum; this is transmitted through the spinal cord to the nerves of the fingers, which nerves have come from the anterior root, and then the necessary muscular contraction is made, and the thing desired is grasped.

The medulla oblongata, in like manner, sends off nerves with two roots, one destined for sensation, the other for motion. It is the medulla oblongata that supplies the organs of respiration. Whenever the lungs are filled with the venous blood, the posterior nerve conveys to the medulla oblongata the sensation of suffocation; and this sensation causes us, with our knowledge indeed, but not merely in obedience to the will, to make the muscular movements that take in air to the venous blood at the lungs. The impulse to do this is transmitted, from the medulla oblongata, through the anterior nerves.

Whenever the cerebrum receives sensations, wills, or thinks, it is very probable that some change takes place among the particles of nervous matter. Now, it is very likely that sometimes an internal cause produces the same change in the nervous substance of the brain, and therefore conveys the same mental impression as some particular external object does. Thus, in fever, there is often great disturbance in the brain, and a similar change may take place in it as would be produced by seeing a particular individual. In such a case, the fevered man talks as if that individual were present. In the same manner may many of the delusions of insanity be produced. But, in a state of mental sanity and freedom from fever or any violent disease, some derangement of the brain may produce an arrangement of its particles that will give to the mind the idea of internal objects. Thus it is that Spectres are formed. These have occasionally happened to strong-minded and intelligent individuals, and the accounts they have given of them are very interesting. We may give two cases of these spectral appearances; one occurring in a state of fever, and the other to a gentleman otherwise in good health.

The first case occurred to a physician. "Some circumstances had occurred," he says, "to render me anxious and dispirited; of these I took an exaggerated and gloomy view. I had been studying during several months with unusual severity. One day, in the cold weather of January, after having been occupied many hours in the practical duties of my profession, I returned home fatigued. Great as was my bodily exhaustion, the depression of my mind was still more remarkable. My head ached; and, unable to study or to attend to my professional engagements, I laid on the sofa and attempted to read: chance having thrown in my way the American novel called the 'Water Witch,' I became interested in the story; but, the pain and confusion in my head increasing, I requested a friend to read to me, my own eye constantly wandering from the page. The progress of the fever was rapid; its chief force fell upon the organ that had been over excited—the brain, and delirium came on early and somewhat suddenly. Immediately before I became decidedly delirious, I received an invitation to the soirées given by the Duke of Sussex to the members of the Royal Society. The friend whom I asked to return an answer, expressive of my regret that I should be unable to attend on account of illness, used, as I conceived, an expression not strictly correct; this verbal inaccuracy, I thought, was construed into wilful falsehood: the matter was brought before this assemblage of learned men, who unanimously declared that it ought to exclude me from the society of honourable men, and that I should no more be admitted among them. The announcement was brought me from the palace, accompanied with martial music, but of a more solemn and impressive kind than I had ever heard before, in which was predominant the sound of bells, soft and as if of a silvery tone. Remonstrance was vain; the decision, of which I succeeded in obtaining a reconsideration, was confirmed: this confirmation was brought to me in the same manner as the first announcement, accompanied with the same kind of music, only still more solemn and impressive. I saw no persons forming the band of musicians, but occasionally I heard very distinctly their measured step. I now thought myself an abandoned and lost being; and the apprehension that every one about me hated me, and sought occasion to destroy me, took possession of my mind. My physicians, my nurses, my dearest friends, were in league with a malignant spirit, which assumed the shape of the demon of the 'Water Witch.' By an object of my tender affection, who was anxiously watching over me, but in whom I now saw only the willing agent of the demon, I was betrayed, and through this treachery the malignant spirit obtained entire possession of me. No sooner was I in the power of the demon, than she began to suggest to me the commission of crimes abhorrent to my nature; and, at last, there fixed upon my mind the impression that I had really been guilty of the crimes by the vivid picture of which my imagination had been disturbed. I pass over the hurricanes and storms I encountered, evidently suggested by the descriptions in the novel I had just been reading. On the sudden subsidence of these, I thought I stood before an invisible tribunal. I felt a solemn consciousness that an all-seeing eye was upon me, while there was visible to me only a portion of the deck of the 'Water Witch,' and, very obscurely, the shadow of my malignant accuser. Not the crimes falsely laid to my charge, but the actual events of my life,—even the scenes of childhood and of youth long forgotten,—were now called up to me with extraordinary vividness; all the circumstances of place, person, dress, language, and attitude, such as had actually accompanied them, being revived. Of each of these events I was compelled to give a true account, an invisible hand recording every syllable that fell from my lips, and a secret power obliging me to utter the words which expressed the exact truth. During this ordeal I saw the countenances of dear friends, and of secret and of open enemies,—those that had long been dead, and those that were still living; the former cheering me by their attitudes and words, the latter scouting upon me and assuming menacing postures, but uttering no sound. And now, again, I felt myself under the influence of the demon, by whose uncontrollable agency I was compelled to accuse myself of the crimes of her own suggesting; and, while suffering the bitter anguish of self-reproach, and expecting some fearful punishment, I again saw my dearest friends, with their innocent and happy countenances, engaged in occupations with which associations of a highly pleasurable nature had been formed in my mind, but whom I could not make sensible of my presence, and with whom I was doomed to hold affectionate intercourse no more. After this, I have no remembrance of anything that passed until conscious of the nature of some obscure and vague recollections. I had the impression that some calamity had befallen me, but I felt as if a soft and refreshing breeze was blowing gently upon me; and soon I found myself in a vast ocean, in a beautifully constructed vessel, with a fresh and invigorating breeze, sailing rapidly along a coast presenting the most magnificent and lovely scenery, and at length the vessel entered gallantly a port unknown to me, but the strand was crowded with human beings with happy faces, and still happier voices. I had returned from a long voyage, but I could not make out where I had been; I felt hungry and fatigued; and now, for the first time, I recognised individuals of my family, after having been violently delirious upwards of a fortnight, during the last three days of which time I lay in a state of total insensibility, my physicians and friends expecting every moment to be my last."

The other instance is that of Nicolai, the German publisher. His spectres were, as will be seen, by no means the result of delirium; on the contrary, he always knew them to be phantoms. "In a state of mind," he writes, "completely sound, and after the first terror was over, I saw with perfect calmness for nearly two months, almost constantly and involuntarily, a vast number of human and other forms, and even heard their voices.

"My wife and another person came into my apartment in the morning, in order to console me; but I was too much agitated by a series of incidents which had most powerfully affected my moral feeling, to be capable of attending to them. On a sudden I perceived, at about the distance of ten steps, a form like that of a deceased person. I pointed at it, asking my wife if she did not see it? It was but natural that she should not see anything; my question, therefore, alarmed her very much, and she immediately sent for a physician. The phantom continued for about eight minutes. I grew, at length, more calm, and, being extremely exhausted, fell into a restless sleep, which lasted about half-an-hour. The physician ascribed the phantom to a violent mental emotion, and hoped there would be no return; but the violent agitation of my mind had in some way disordered my nerves, and produced further consequences, which deserve a minute description.

"At four in the afternoon, the form which I had seen in the morning reappeared. I was by myself when this happened, and, being rather uneasy at the incident, went to my wife's apartment; but there, likewise, I was persecuted by the apparition, which, however, at intervals, disappeared, and always presented itself in a standing posture. About six there appeared, also, several walking figures, which had no connection with the first. After the first day, the form of the deceased person no more appeared, but its place was taken by many other phantoms, sometimes representing acquaintances, but mostly strangers: those whom I knew were composed of living and deceased persons; but the number of the latter was comparatively small. I observed that the persons with whom I daily conversed did not appear as phantoms, these representing chiefly persons who lived at some distance from me.

"These phantasms seemed equally clear and distinct at all times, and under all circumstances, both when I was by myself, and when I was in company, and as well in the day as the night, and as well in my own house as abroad. They were, however, less frequent when I was in the house of a friend, and rarely appeared to me in the street. When I shut my eyes, these phantoms would sometimes vanish entirely, though there were instances when I beheld them with my eyes closed; yet, when they disappeared on such occasions, they generally returned when I opened my eyes. I conversed sometimes with my wife and my physician of the phantoms which at the moment surrounded me; they appeared more frequently walking than at rest, nor were they constantly present. They frequently did not come for some time; but always reappeared, for a longer or shorter period, either singly or in company; the latter, however, being most frequently the case. I usually saw human forms of both sexes: but they generally seemed not to take the smallest notice of one another, moving as in a market-place, where all are eager to press through the crowd; at times, however, they seemed to be transacting business with each other. I also several times saw people on horseback, dogs, and birds. All these phantoms appeared to me in their natural size, and as distinct as if alive, exhibiting different shades of carnation in the uncovered parts, as well as different colours and fashions in their dresses, though the colours seemed somewhat paler than in real nature. None of the figures appeared particularly terrible, comical, or disgusting, most of them being of an indifferent shape, and some presenting a pleasing aspect.

"The longer these phantoms continued to visit me, the more frequently did they return; while, at the same time, they increased in number about four weeks after they had first appeared. I also began to hear them talk; they sometimes conversed among themselves, but more frequently addressed their discourse to me. Their speeches were commonly short, and never of an unpleasant turn. At different times there appeared to me both dear and sensible friends, of both sexes, whose addresses served to appease my grief, which had not yet wholly subsided. Their consolatory speeches were usually addressed to me when alone. Sometimes, however, I was visited by these consoling friends while I was engaged in company, and not unfrequently while real persons were speaking to me."

At another period, the same Nicolai was troubled by spectres, but of a different description. "In the year 1778," he writes, "I was afflicted with a bilious fever, which at times, though seldom, grew so high as to produce delirium. Every day, towards evening, the fever came on, and, if I happened to shut my eyes at that time, I could perceive that the cold fit of the fever was beginning even before the sensation of cold was observable. This I knew by the distinct appearance of coloured pictures, of less than half their natural size, which looked as in frames. They were a set of landscapes, composed of rocks, trees, and other objects. If I kept my eyes shut every minute, some change took place in the representation; some figures vanished, and some appeared. But if I opened my eyes all was gone; if I shut them I had a different landscape.

In the cold fit of the fever I sometimes opened and shut my eyes every second, for the purpose of observation, and every time a different picture appeared, replete with various objects, and which had not the slightest resemblance to those that appeared before. These pictures presented themselves, without interruption, as long as the cold fit of the fever lasted. They became fainter as soon as I began to grow warm; and, when I was perfectly so, all were gone. When the cold fit of the fever was entirely past, no more pictures appeared; but if, on the next day, I could again see pictures when my eyes were shut, it was a certain sign that the cold fit was coming on."

CHAP. IV.

THE WAY WE BREATHE AND KEEP OURSELVES WARM.

We have said that it is necessary for the continuance of life that the blood be exposed to the air. This, in man, as in the higher animals also, is very frequently done at the lungs. Here the venous blood obtains oxygen to qualify it, or to aid in qualifying it to again become arterial blood. Here, too, the venous blood discharges the effete carbon, in the shape of carbonic acid. The process of respiration is likewise subservient to the means provided for keeping the body warm.

It is not known whether heat is a substance itself, or merely a property of matter. It is unnecessary here to consider its laws regarding transmission, &c. We may content ourselves with saying that, unless a certain amount, and in man a very considerable one, be present, life comes to an end. The sources of heat become an important question: one great source is, as every one knows, the sun; and man, by art, has acquired another, artificial combustion. Then, during almost all chemical changes, heat is developed. A very striking instance of this may be got by mixing together a little sulphuric acid and water. When this takes place, a very considerable amount of heat is generated. But the chemical combination that produces the most heat is that of carbon with oxygen. When this is done, the heat produced is very great, and the result is the formation of carbonic acid. A common fire, or a burning candle, is nothing more than the rapid union of the carbon of the coal or tallow with the oxygen of the air.

Now, so necessary is the presence of heat to all vital action, that no living being—no, not the most insignificant moss-plant—is left dependent upon external sources for heat, although, as supplemental, such are necessary. All living beings are provided with means of raising their own temperature. The temperature thus maintained by the human race is about 100° of Fahrenheit. It is produced by the effete carbon of the body uniting with the oxygen taken into the blood at the lungs. Thus, in every crevice of our frame is a kind of languid fire, or slow combustion, going on. Of course, we must frequently obtain a supply of carbon from without, just as a fire, if we intend it to go on burning, must continually receive fresh supplies of carbon. When we consider our food, we shall see that we daily take in a quantity of carbonised food, in the shape of wine, starch, sugar, fat, &c. Were this not so taken in, we should as infallibly go out as the wick of a lamp without oil would do.

The absorption of oxygen by venous blood seems a purely mechanical process. If we take a little of such venous blood and enclose it in a bladder, the portion near the surface soon indicates by its change of colour that the air has passed through the pores of the bladder, and parted with some of its oxygen. Now the lungs are essentially a collection of very little bladders, around which the blood flows; their popular name is derived from their buoyancy, and is lights. They may be said to begin with the windpipe, which communicates with the back of the nose. This gives off bronchi, or air-tubes, and these latter divide and subdivide until they end in the little bladders, or air-vessels, of which the mass of the lungs consists, and to which these organs owe their low specific gravity. These vessels are very minute; not more, probably, than the hundredth part of an inch in diameter. The bronchi and vessels are lined by a mucous membrane, and the lungs are enveloped by a serous one, called the pleura. The lungs, heart, and vessels entirely occupy the cavity of the chest. A strong muscle, called the diaphragm, or midriff, divides the chest from the abdomen, and we can make this come higher in the chest by an act of will, and *vice versâ*. By means of this, and by raising or depressing the ribs, we can alter the capacity of the chest, and thus either expel or take in gaseous matter.

Whenever, as we had before occasion to state, venous blood is present in the air-vessels, a sensation, the feeling of impending suffocation, is produced. This is transmitted along a nerve to the medulla oblongata; and, whenever this sensation is felt, a will is transmitted along the nerves of motion to the diaphragm and muscles of the ribs, which causes them so to act as to enlarge the cavity of the chest. When this is done of course a vacuum is formed, to supply which a quantity of air rushes down the windpipe into the lungs; from which the blood abstracts the oxygen, and gives off from itself carbonic acid. The various muscles are then made to act so as to contract the chest; this drives the carbonic acid and the nitrogen of the breathed air into the air, through the windpipe. These processes of inspiration and expiration, as they are called, are performed some fifteen or sixteen times in a minute.

That there is no difficulty in the blood abstracting a sufficient quantity of oxygen from the air in its rapid passage through the lungs, will be seen when we learn that an adult receives into, and expels from, his lungs every day about 4000 gallons of air, and that the surface of the air-vessels is supposed to be 20,000 square inches.

We can also understand how necessary a due supply of pure air is. Supposing impurities are present sufficient to hinder a due quantity of pure oxygen from being taken into the system, nearly immediate death is the consequence. The most fearful example of this on record occurred in the Black Hole, as it is called, at Calcutta. In this horrible dungeon, only eighteen feet square, and with but two small windows, both on the same side, 146 of our unfortunate countrymen were immured. In six hours ninety-six were dead; and in the morning, for it was not until then that the doors were opened, only twenty-three were found alive.

But when the quantity of carbonic acid is not so great as to produce immediate suffocation, it still produces a very injurious effect upon the system; and when, in addition to carbonic acid, the air that is breathed contains putrefactive miasmata, the effect produced upon the health is very injurious. And when we consider the quantity of carbonic acid perpetually poured into the air from the lungs of man and the innumerable millions of animals, and also the additional quantity which the atmosphere receives from every fire and candle that is lighted, with our necessity for living in closed houses, we can believe that a very great amount of disease is thus induced. To amend this, a proper system of ventilation should be a *sine quâ non* with every one having the control of a household. We are by far too much afraid of drafts of air: a choked atmosphere is more injurious than all the currents of air in the world.

The quantity of oxygen taken in varies in the different classes of animals, in proportion to the muscular exertion that they have to make. Of all muscular exertions flight is the most severe; and hence we find that the respiration is quicker, i. e. a greater supply of oxygen is needed and afforded, and the animal heat is greater, in birds than in animals of any other class. Consequently, we see the evil effects of a vitiated atmosphere sooner in birds than in any other created beings. Almost every one is aware that, if a thin handkerchief be thrown over the cage of a canary, so as to impede the rapid passing away of the breathed air, and access of fresh, it very soon dies. And yet the animal temperature of the swallow, one of the hottest of birds, is only twelve degrees more than that of the human species. In all probability, pestilence and the other great devastators of the human race do not destroy nearly so many men as bad ventilation does in its own silent manner.

The length of time during which respiration may be suspended varies not only in different classes of animals, but in the same animal in different conditions. If a warm-blooded animal, or a man in an ordinary state of health, be submerged under water, and thus prevented from breathing for a few minutes, death is the result. A reptile, whose respiration is much less intense, can be kept under water with impunity for a much longer time. There is a peculiar state witnessed in some of the higher animals, and which used, perhaps, to exist in many more, called hybernation. Of this there are various degrees; some animals lay up a store of food in the autumn, and pass the winter almost entirely in a state of sleepy insensibility, but occasionally awake, and take a little to eat; but others, as the marmot, sleep during the whole of the cold weather. During this state of sleep the respiration is performed very feebly; and it is found that hybernating animals may, during their winter insensibility, be kept under water without being killed for many minutes, although, if they were so immersed during summer, when breathing naturally, they would speedily perish. Although man never hybernates, strong impressions made upon his nervous system produce a similar state of insensibility; such as, a violent blow upon the head, or even an extreme fright. Hence, human beings who have fallen into the water may be, and occasionally are, recovered after they have been submerged for an hour or more. In these instances, the individuals fell into the water in a state of insensibility, either from striking against something when falling in, or from the state of fear they were in. The practical deduction to be drawn from this is, to persevere for a long time in attempting to restore sensibility to apparently drowned people.

While upon this topic, we may state that the reptiles and cold-blooded animals inhabiting the land not only hybernate, but do something more. When the temperature is low, they fall into a state of insensibility, from which they recover when the temperature becomes warmer. But they can remain in this dormant state not only for one winter, but apparently for any given length of time. Thus, frogs have been kept in this state in an icehouse for three years, and snails for a much longer period. This power of vitality of remaining dormant for a length of time, and, when the proper stimulus is applied, reviving again, is a very curious one. It is seen more distinctly and powerfully in seeds and eggs than in perfect plants and animals. Seeds, in particular, retain their vitality for a long time. Gardeners, we believe, prefer their cucumber seeds to be twenty years old. And we frequently see, when the subsoil is turned up, vegetation immediately spring from it. In many of these instances, which are of every day occurrence, the seeds from which these plants proceeded must have been in a dormant state in the subsoil for many years. Wonderful tales are told about wheat found in mummies sprouting, but these are probably fables. A small example of this power of life becoming dormant is seen in man in the case of an ordinary fainting fit. In such a case the fainting individual is in a state of perfect insensibility, and the respiration is very imperfectly performed. Fainting fits are always produced by a sudden impression made upon the nervous system, either through the medium of the mind or by abstracting suddenly a quantity of blood from the brain. There is a diseased state of the nervous system, recognised by pathologists, in which there is prolonged insensibility with very trifling activity of respiration, and to which the name of trance is given. That most cases of trance are cases of imposition, is unquestionable; but still the disease really appears to have an existence.

Somewhat, at least apparently, connected with the subject of animal heat is that of animal luminousness. That many of the lower animals have the power of emitting light, is a familiar fact. The ocean is sometimes lit up for miles, and our own country affords us an example of animal light in the glow-worm. But it is not generally known that sometimes, a little before death, our own bodies emit light. As before mentioned, our structure essentially contains phosphorus. When this substance is subject to chemical laws, it combines with oxygen, and luminousness is produced. When the powers of life have become weakened, it is quite possible that the phosphorus is disposed to obey the laws of chemistry. In this manner, perhaps, the instances that have been witnessed of "death lights," as they have been called, may be explained. The following is an instance of one of these cases, not generally known. The individual alluded to was about seventy years of age, and the lights were seen by five persons. We extract the following account from a medical journal: — "About eight o'clock in the evening of the 30th of September, 1836 (two days before her death), two persons attending her, and leaning on her bed, looked to each other and exclaimed, 'What is that?' The exclamation was caused by the appearance of a pale flame about a foot in length, and an inch and a half in breadth, slightly curved and pointed at the ends, moving slowly between the pillow, on which one of her hands happened to be lying, and the board at the head of the bed. The flame was sometimes bright and sometimes faint, and gave a pale yellow colour to the lighter part of the print-hangings of the bed. At times the inside of the bed seemed lighted as by a lantern; and more than once the pillow on which her head lay, and her cap and face, became quite white. She did not seem aware of the light herself, as on one occasion, when she raised her luminous hand towards her eyes, one of the attendants interposed her hand to shade her eyes from the light, when she immediately put it down. She disliked light excessively, and the room was all this time kept as dark as possible. There was a stone wall on two sides of her bed. On one occasion one of her attendants tied her cap, when the nail of the thumb became luminous. There were also dots of light observed on the pillow, face, and cap."

Besides the lungs and heart, the chest contains at the top of the bronchus the larynx or organ of speech; and the air that we breathe is one of the essentials to the production of the sounds of the voice. In order to understand even the elements of the very beautiful provisions made for the production of animal sound, it is necessary to have a general idea of the nature of sound itself.

Sounds are produced by bodies in a certain state of vibration. These vibrations are communicated to the air, and produce in it a number of waves or undulations, which make a definite impression upon the organs of hearing, and are called tones. These tones are compound in their nature, being made up of a succession of shocks, occurring one after the other with such rapidity that the ear cannot discriminate an interval. Tones differ from one another, according to the rapidity with which the shocks or vibrations succeed one another, the name given to this difference being the *pitch*. Thus, if we tie a string by its two ends of such a length that when we strike it it vibrates sixteen times in a second, we have the lowest note appreciable to our senses,—we have the lowest C of our musical scale: when thirty-two times, lowest D, and so on. Some very acute ears can discriminate the sound produced by 24,000 vibrations in a second. This would be four octaves above the highest F in the piano. All the tones between these two are multiples of, or proportions to thirty-two; and, when they follow one another in accordance with certain well-known rules, we have harmony, and, when the reverse, discord.

Sounds likewise differ in their quality or *timbre*, as it is called. Thus, when we sound middle E on a clarionet and on a violin, we have the same note, the same number of vibrations in each, and we recognise them as the same, but still there is a difference in timbre or quality. What is the cause of their difference is not known.

We can, of course, produce every sound in the musical scale from the same string. This we do by altering its tension or tightness, the highest sounds being produced when the string is tightest.

Now, the sounds of the human voice are produced by our making the air strike against two little strings, called the vocal ligaments, situated in the larynx. By means of certain muscles, we can tighten or relax these in a great variety of ways; and, when we have learned to do this, we have acquired the art of producing all the sounds of which the human voice is capable. And yet these two little ligaments are amazingly small. When at rest, their average length in a man is $\frac{73}{100}$ of an inch. When they are stretched as far as we can make them stretch, their length is $\frac{93}{100}$ of one, the difference being just the fifth of an inch. In the female, the size is much smaller; and the difference between repose and the greatest tension only the eighth of an inch. The compass of the human voice is usually about a couple of octaves, or twenty-four semitones. A good singer can make ten intervals in a semitone; consequently, a good singer can produce two hundred and forty different states of tension of the vocal ligaments, and all this within the range of one-fifth of an inch. Miraculous as this may seem, many singers have a voice of much greater compass than two octaves.

The vocal ligaments of boys are short, like those of females. Hence boys, as well as women, sing treble. Men, with ligaments of the ordinary length, sing about an octave lower, or tenor; while those who have very long ligaments sing lower still, or bass.

A great many varieties of sounds are produced by different animals. Snakes are only capable of making one, — a hiss, which they do by drawing the air from their lungs through the windpipe. As their lungs are very capacious, and contain much air, this hiss is often very prolonged. Most animals have different sounds; some indicating terror, some pleasure, and some hunger, &c. Thus, the roar of a bull is very different from his low, the purr of a lion very opposite to his roar. The cries of some animals, as the neighing of horses, or the braying of asses, are certainly sociable. When we come to birds, we have the production of musical notes; some of these are instinctive, but some are undoubtedly acquired by hearing other birds sing. In man, we have this power of producing musical notes altogether acquired; the faculty of making instinctive cries; and in addition, what is peculiar to him, the faculty of language, by means of which one individual can communicate to another what is passing in his own mind.

It is not owing to any peculiarity of the organs that man can speak, inasmuch as other animals may be taught to articulate words, and even sentences. But, in such cases, no idea is connected with the expression. The peculiarity of human language consists in its being a perfect medium of communication between mind and mind. There is nothing that the mind can conceive that the voice cannot utter. The higher animals, as dogs, horses, &c., have a certain but very limited means of communicating with each other; but it rarely happens, although occasionally with dogs it does appear to happen, that anything like an idea is so communicated. The neighing of a horse is probably a mere instinctive acknowledgment of the vicinity of another horse.

Spoken language consists of a number of elementary sounds, some of which are grouped together to compose a syllable. One or more syllables make a word, and a number of words a sentence, which sentence contains one or more ideas. From about twenty sounds, as many combinations may be made as to express all human knowledge, thoughts, and feelings. At a very early period in human history, man would desire to make language intelligible to the eye as well as to the ear. It is extremely probable that hieroglyphics were first used for this purpose. If a man wished, for instance, to communicate the idea of a cow to the mind of another, through the medium of the other's eyes, he drew a representation of such an animal. It is believed that the hieroglyphic characters gradually wore away until they lost their original shape, and became representations of phonetic sounds; first, perhaps, syllables, and afterwards letters.

Accordingly, in a perfect language, each one of the twenty sounds, or of whatever number of sounds the language is to consist, should have its corresponding letter, and no more. But no language is so perfect, and our own in particular is very deficient: for we have many simple sounds that we cannot express by one letter; and, on the other hand, a single letter sometimes represents a compound sound. Thus, the sound expressed by *th* is perfectly simple, and our *i* is a compound sound, being formed in the act of transition from *a*, as sounded in *ah*, to *e* as sounded in *theme*. This is the reason why *i* cannot be sung in a loud note, as it invariably runs either into the *a* or the *e*.

The letters, or vocal sounds, are divided into vowels and consonants. The characteristic of the former is, that they are continuous tones, while, when we utter consonants, we produce an interruption to the breath. This is the reason that we can prolong the utterance of a vowel as long as we please, while the sound of a consonant is very momentary. The difference between one vowel and another depends upon the shape we put our mouth and lips into when the sound is coming out. Of the consonants, some are more momentary in their pronunciation than others. The most so are called explosive ones, and require us, when we say them, to altogether stop our breath. The explosive consonants are *b, d, p, t, k*, and *g*, when hard. The others are more continuous, and do not require such a thorough and immediate stoppage of the breath. Their peculiarities depend upon the sound being modified by the lips, palate, tongue, and teeth; and they are often named accordingly—labials, gutturals, dentals.

Although all these sounds are easily enough acquired by children, yet adults find the greatest possible difficulty in doing so; and hence it is that a man rarely acquires the pronunciation of a language, not his natural one, so perfectly as not to be immediately detected as a foreigner. The inhabitants, too, of many localities are characterised by vicious pronunciation; *i. e.* by peculiar sounds, that they do not seem able to amend. The Northumbrians are famous for the ringing sound of their *r*: many nations substitute a *l* for our *r*, others *d* for our *th*, as dat for that: the Welsh have long been noted for substituting *f* for *v*, and *p* for *b*—"Fery goot," says Sir Evans; "I will make a *p*rief of it in my note-*p*ook:" others, again, are too prone to employ the labial sounds, and are, in common language, said to lisp. But, perhaps, the most distressing difficulty regarding speaking is that of stammerers or manters*; i.e. of those who do not possess the proper and necessary control over the muscles concerned in articulation. Generally speaking, the articulating muscles of such individuals are more or less subject to involuntary spasmodic contractions.

CHAP. V.

THE WAY THE FOOD IS DIGESTED.

CHILDREN, and growing animals, are continually adding to their structure; and adults are daily parting with portions of their frames. The formation of the body, and the keeping it up, is, as we have seen, performed by the blood. This fluid, however, does not in health become diminished in quantity. Had we no other evidence, we should know from this that the blood received constant supplies from without. And as we have seen that the blood is always expending oxygen, carbon, nitrogen, hydrogen, sulphur, phosphorus, potassium, sodium, calcium, magnesium, silicon, iron, and chlorine, we should infer that these supplies from without were composed of these different elements. But, in point of fact, we see supplies daily added to the system in the shape of food, and the

* To mant, is, in Scotland, the common expression indicating to stammer.

eye of science as clearly sees in this food every one of the above enumerated elements. Farther, we have seen that, besides the elements necessary for maintaining its integrity, the body requires a good deal of carbon to burn, in order to keep up the necessary animal heat. This, too, is added to the system in the form of food.

The subject of digestion naturally divides itself into two heads, — the manner in which the food is taken into the system, and there acted upon, and the nature and varieties of food. We begin with the former.

When the blood is becoming exhausted of its elements, a peculiar sensation — hunger — is experienced; and, if it be becoming deficient in fluid likewise, there is also the sensation of thirst. In a proper state of health these sensations are exactly indicative of the wants of the body. The cause of thirst is simply dryness of the coats of the stomach (an organ immediately to be noticed). The sense of thirst is felt about the mouth and top of the throat; but that its true seat is the stomach has been made clear from cases of wounded throat, in which it has been relieved by pouring water into the stomach, through the orifice in the neck. The feeling of hunger is believed to be owing to a distention of the blood-vessels of the stomach, these blood-vessels having become so distended, in order to secrete gastric juice. Whenever this distension is done away with, by the gastric juice having been secreted, the hunger is at an end. The natural way in which this is brought about is by eating; but any substance that comes into contact with the distended vessels, even although it contain no nourishment, causes at least a partial secretion and relief of the hunger. This is well known by many savage nations, who, when they cannot get food, swallow earth, and other indigestible matter.

When, however, hunger is felt, there is a desire for eating nutritious food that has an agreeable and sapid taste. It is found that sapidity is increased, in many instances, by the action of fire; and hence almost every nation, in all time, has practised the art of cookery. When hunger is felt, and these agreeable articles of food are present, they are placed in the mouth to be divided into bits, and crushed by the action of the teeth.

These organs, the teeth, are, as is well known, situated in the two jaws; the upper jaw being fixed, but the lower allowing of motion both upwards and downwards, and also from side to side. Three kinds of teeth are found in the human species: those in the front, called incisors, which are furnished with a thin cutting edge, and whose office is to divide or slice the food; next to these come the canine or dog teeth, larger, and with a sharper point, calculated to tear asunder the food; and lastly, and most in the rear, come the molars or grinders, furnished with an extended and flattened surface, and which are calculated to grind or comminute the food in the same manner as two millstones, one placed above the other, and moving round, crush corn into flour and meal.

When the food is introduced into the mouth, by moving the jaws up and down we cut it into bits with the canine and incisor teeth, and then, pushing it backwards with the tongue, it goes between the two sets of molars; and the lower jaw, by moving from side to side, soon reduces it to a soft mass. At the same time that this is done, two glands underneath the tongue, and four at the back of the mouth, secrete a fluid called the saliva, which is well mixed with the food in the act of chewing. This saliva consists mainly of water, with a little saline matter. It is produced whenever sapid fluid is introduced into the mouth; and sometimes it is secreted at the mere thought of such food. Thus, memories of bye-gone feasts, or anticipations of future ones, are said to make people's "mouths water." The use of the saliva would appear to be principally to communicate the necessary degree of pulpiness to the mass.

When the food is chewed, and mixed with the saliva, it is made up into balls, and, by the action of the tongue and muscles of the back of the mouth, pitched into the œsophagus, or tube leading from the mouth into the stomach. When it has reached the œsophagus, it is no longer under the control of the will, nor are we conscious what is taking place in it.

Drinking is performed partly by holding the mouth a little back, and pouring the fluid in, and partly by sucking; i. e. forming a vacuum in the mouth, and holding the glass containing the fluid to our lips. The pressure of the external air thus forces the fluid into the mouth, in the same manner as it does into a pump.

When the food, liquid and solid, has got into the œsophagus, it is transmitted into the stomach. This is a large membranous bag lying underneath the chest. Its office is partly to secrete gastric juice, and also, inasmuch as from our habits of locomotion we cannot, like plants, be always eating, to serve as a kind of larder for us, and thus enable us to dispense with the necessity of too frequently receiving food. The proportional size of the stomach varies very much in the different classes of animals, being very large in those animals which, like oxen, are intended to live upon food in which the nutriment is not concentrated, and small in those which, like a tiger, are intended to subsist upon very concentrated aliment. In man, who is meant to live on a mixed diet, it is of a medium size.

When the food has reached the stomach, a quantity of gastric juice is poured upon it. The stomach, by its contractions, moves the whole mass about; and in time, usually in from two to four hours, the whole forms a homogeneous thin pulp, to which the name of chyme is given. Gastric juice consists of muriatic acid, which dissolves the food, and a particular principle called pepsin, which has probably the power of inducing albumen to turn into fibrin, in the same manner as yeast induces sugar and water to turn into beer.

The chyme passes from the stomach into the intestines, where it is mixed with bile. It then separates into two portions, one of which is called chyle, which is another name for incipient blood, and which contains albumen, fibrin, serum, and other compounds of the elements of which the body is composed; and another, which is the non-nutritious part of the food. The chyle is taken up by a series of vessels called lacteals, that terminate in a large vessel called the thoracic duct. This thoracic duct pours its contents into the circulating system just where the jugular and subclavian veins unite. Thus, although the blood is every second parting with its elements, it never becomes less in quantity, because it is every moment receiving fresh supplies of these very same elements by the thoracic duct, and which elements are obtained from without in the shape of food. The blood, also, as we saw, receives continually supplies of oxygen from the air.

As every one knows, this process of digestion, although under the control of organic life, and in no respect under the control of voluntary acts of the mind, is very much influenced by mental sensations and emotions; and, in particular, it is deranged by depressing emotions. When this is the case, the chyle is imperfectly formed, the blood imperfectly recruited, and therefore the body imperfectly nourished. The ultimate result of all this is disease or death.

If solid food be abstained from, but water drank, a person may live as long as forty days; but if both solid and liquid matters be not taken, the individual dies in less than half this time.

We now come to our second topic, the nature and varieties of food. As we before had occasion to remark, the food of animals must consist of matter that has previously existed in an organised state, i. e. must consist of either animal or vegetable substances. Like the animal structures, the vegetable are composed of saccharine, oleaginous, and albuminous proximate principles. It will be proper to enumerate the more important of these.

a. *Saccharine proximate Principles in Vegetables used as Food.*

Foremost amongst these is sugar; it exists abundantly in many plants, as the sugar-cane, the maple, beet-root, grass, &c. The composition of sugar has been stated before.

Starch is another very important alimentary principle, of which we consume a great deal. It is composed of—

Carbon	36
Oxygen	40
Hydrogen	5

It is extremely abundant in potatoes, rice, all kinds of grain, turnips, apples, and other fruits. Sago, tapioca, arrow-root, and the like, are entirely composed of it. The following table will indicate the proportion per cent. of saccharine proximate principles contained in some commonly-eaten vegetables:—

	In 100 lbs.
Wheat flour	55 lbs.
Barley flour	60
Oat flour	60
Rye flour	60
Indian corn	70
Rice	75
Bran meal	40
Pea meal	50
Potatoes	18
Mangold wurzel	11
Turnips	9

We ought to include in the list of saccharine proximate principles one not found in nature, but produced by art, and greatly taken as aliment. We refer to alcohol, the product of the fermentation of sugar, and known under the various forms of cider, beer, wine, and distilled spirit.

There can be little doubt but that the use of these saccharine proximate principles is to supply the body with carbon, to be expended in keeping up its temperature.

b. *Oleaginous proximate Principles in Vegetables used for Food.*

Like the animal oleaginous proximate principles, the vegetable essentially consists of oleine and stearine. In a pure state the olive and poppy oils are extensively used as food; but of late years it has been ascertained that all our common articles of vegetable food essentially contain a considerable quantity of oil or oleaginous principle. The adjoined table will indicate the proportion contained in the common articles of diet used by man, or the animals upon whose flesh man feeds, namely :—

	In 100 lbs.
Fine wheat flour - - -	2½ lbs.
Bran - - - - -	3½
Barley flour - - - -	2½
Oat flour - - - -	4½
Indian corn - - - -	5½
Beans and peas - - -	2½
Potatoes and turnips - - -	0¼
Wheat straw - - - -	2½
Oat straw - - - -	4
Clover hay - - - -	3½
Meadow hay - - - -	2½

The use of the oleaginous proximate principles of vegetation is the same as that of the saccharine; to wit, to furnish carbon. Whenever men are prevented by accident from obtaining a due supply of saccharine proximate principles, they instinctively eat a large quantity of oleaginous, derived either from an animal or vegetable source. Thus the natives of polar regions, whose climate prevents them raising saccharine corn crops, consume an immense quantity of blubber, train oil, &c.

c. *Albuminous proximate Principles in Vegetables used for Food.*

Like the albuminous proximate principles of animals, these are composed of carbon, oxygen, hydrogen, and something like fifteen per cent. of nitrogen; and it is likewise very probable that the sulphur, phosphorus, and other necessary constituents of the human body are united with them.

One of the most important of them is gluten, which bears a great resemblance to animal fibrine. It is composed as follows; i.e. the proportion of the four following elements are in it as follows:—

Carbon - - - -	55
Oxygen - - - -	21
Nitrogen - - - -	15
Hydrogen - - - -	17

Albumen and casein, identical in composition, and therefore in nutritious properties, with animal albumen and casein, are likewise common constituents of most of the vegetables that, under the guidance of instinct or experience, we have used for food. The table we here quote will show the proportion per cent. of albuminous compounds contained in the vegetables that we usually consume:—

	Per Cent.
Wheat flour - - -	10—19
Bran - - - -	16
Barley - - - -	12—15
Oats - - - -	14—19
Rye - - - -	10—15
Indian corn - - -	12
Rice - - - -	7
Beans - - - -	24—28
Peas - - - -	24
Potatoes - - - -	2
Turnips - - - -	1½

The use of the albuminous proximate principles, when taken as food, is not to furnish carbon for fuel, but to afford to the body all those elements of which it is composed, and of which by its constant wasting it is always needing a supply.

It will be seen, by a reference to the above table, that oats contain more real nutriment than any other kind of food that we derive from the vegetable kingdom.

The composition of the different articles of diet that we take from the animal world may be taken from the account of the composition of the animal structures, of which we gave an outline in Chapter III. No saccharine principle is obtained from animals, excepting the sugar contained in milk; but flesh affords plenty of oleaginous and albuminous ones, usually much concentrated. If man subsist upon either animal or vegetable food exclusively, he is apt to fall out of health. This probably arises from the digestive organs being too large for a purely carnivorous, and too small for a purely herbivorous, diet. The proper rule is to employ a varied diet, drawn from both kingdoms.

CHAP. VI.

THE WAY WE MOVE, AND THE INFLUENCE OF THE MIND UPON THE BODY.

The faculty of locomotion is one of the characteristics of the animal creation; and its exercise, indeed, is indispensable for its existence. Very beautiful contrivances are provided in the different classes of animals for its due and facile performance. In all, except some of the very lowest, the great agent in locomotion is muscle; which, by contracting in obedience to the will, makes the two points to which it is attached come nearer to each other. The simplest method of locomotion is, perhaps, to be found in animals of the worm and leech tribe. These creatures have two sets of muscles, one running along their bodies, and the other passing round them in rings. When they contract the former, they draw their heads and tails together, so as to shorten their bodies; when the latter, they diminish their diameter, and consequently lengthen their bodies. By performing these two actions alternately they get along.

The higher animals, however, besides muscles, are furnished with a hard substance, to which the muscles of locomotion may be attached. This is called a skeleton. In insects, crabs, &c., this skeleton is on the outside; but in all the animals that have a backbone, and therefore in the human race, it is internal, and composed of a number of distinct bones articulated to one another by ligaments. All these articulations or joints admit of more or less freedom of motion. In order to facilitate this motion, the joints are kept well lubricated by a fluid secreted for the purpose. How the contractions of the muscles make these joints move may be easily perceived. Supposing, for example, that a muscle went from the palm of the hand to be fastened into the middle of the lowest bone of the fore finger: when, by an act of the will, this were made to contract, the result, of course, of the contraction would be to draw the fore-finger towards the palm of the hand. If, on the other hand, a muscle went from the back of the hand to be inserted in the middle of the back of the lowest bone of the forefinger, and if this muscle were made to contract, the result would be that the finger would be straightened, — made to point, in fact.

To make intelligible the different bones, joints, and muscles of the human body, would occupy by far too much space; nor, indeed, could it be done at all without numerous illustrations. And it will, perhaps, be as interesting to describe the various attitudes of the body, and the various kinds of locomotion witnessed in the vertebrated animals.

A very few of the vertebrated animals, as the serpents, lean upon their whole body, which altogether rests upon the ground; but by far the greater number are supported upon extremities or limbs: and when an animal rests upon its limbs, it is said to stand. The muscles in this act of standing are by no means passive; on the contrary, those whose business it is to stretch out or extend the limbs must be in continual action. Hence standing is more fatiguing than walking, inasmuch as during the latter the extending muscles only contract alternately with the bending ones, and therefore both get a rest, and only do half as much work as when standing.

In standing, however, something more is necessary than keeping the extending muscles contracted. The body must also be kept balanced. It is clear that this will be more easily done by an animal that has four limbs to stand upon than by one that has only two. To compensate for this, animals that have to stand on two extremities only have always their feet very large, so as to afford a greater base of support. The difference between the feet of a man and those of a horse, or those of a duck and a cat, in this respect is very striking. The smallness of the extremities of quadrupeds is one reason why they cannot maintain an upright position when placed upon their hind legs.

It is not, however, quite correct to say that quadrupeds cannot stand upon their hind legs, for some can. Monkeys and bears are examples of this; dogs and horses can also be taught to do so for a little. But this habit of standing upon the hind legs in quadrupeds, whether acquired or natural, is very imperfectly performed. Even monkeys seldom use it when walking; and the ourang-outang itself, when standing, likes to avail himself of a long stick.

Sitting is a much less fatiguing attitude than standing, as the extending muscles of the neck and body only are in action. In lying, no muscular contraction of any kind is necessary; and hence this attitude is the one chosen for reposing from fatigue.

The various kinds of motion are performed by alternately contracting and expanding the limbs. When a man walks he is continually performing the evolution of standing upon one leg, and then putting the other forwards; he then stands upon the latter, and moves the one he did stand on forwards. A quadruped goes upon the same plan, only he stands upon a pair of limbs at a time, and then moves the other pair, and so on. Running is managed somewhat differently, and the body altogether quits the ground at intervals; and a running man springs through the air, rests on his right leg, springs through the air, rests on his left leg, and so on. Of all two-legged animals the ostrich is the swiftest. "Their speed," says a naturalist, writing regarding them, "is great; the swiftest greyhound cannot overtake them; and even the Arabian and his horse are obliged to have recourse to cunning as well as speed to close the chase, by throwing a stick dexterously between the legs, or otherwise to disable it. In its flight it spurns the pebbles behind it like shot against the pursuer. Nor is this its only mode of annoyance. Dr. Shaw, who gives a pretty account of the airs which the ostrich plays off in a domesticated state, fanning itself with its expanded wings, and seeming to admire its own shadow, states, that though tame and tractable to those familiar with them, these birds were often very fierce to strangers, especially those of the poorer sort, whom they would try to run down and attack with their feet. They are capable of striking with great force, and the same author gives a melancholy account of a person who was ripped up by a stroke of the pointed and angular claw."

Another form of motion is found in quadrupeds, and is named the amble. This pace is natural only to the giraffe, but horses can be made to acquire it. It is a fast kind of walk, the two legs of one side being moved together, while the animal rests upon the other two. We believe that ambling horses are liable to lose their balance and tumble down. Trotting is a much superior pace, and is performed as follows: the fore foot of the right side and the hind foot of the left are raised and advanced, and when these are set down, the fore foot of the left side and the hind foot of the right are raised and advanced. A gallop is performed in the same manner, but faster. In cantering, a horse first puts down its left hind foot, then its right hind foot, next its left fore foot, and then its right fore foot.

In leaping, the extremities are suddenly contracted, the force of the contraction being to drive the body into the air. The distance that a man can leap is comparatively little, but that of some of the other animals is very great. In the kangaroo, for example, the muscles of the hind extremities are wonderfully large and strong; in fact, the animal looks all hind legs together, and it can jump a very long way; indeed, its mode of progression is by a series of jumps. We, too, in this country have jumping animals, of which the squirrel is the best example. The rabbit, also, has very strong hind legs, and when it is moving along it jumps with them like a kangaroo, although it walks with its fore pair.

Swimming and flying are two other modes of locomotion. All animals, save man, can swim naturally, and man himself can acquire the art. Some animals, as ducks and others, are intended to spend much time in the water; and in order that they may bring a greater extent of surface to paddle with, their toes are joined together by a web. Some water-dogs are also web-footed; but when the extremities of an animal are intended solely for swimming, they are considerably modified. All quadrupeds have an arm, a fore arm, and a hand, or parts corresponding to these. In the case of the animals in question, the arm and hand are little developed, but the bones of the hand are made very large, and to extend over a wide space; the hind legs, on the other hand, almost disappear. Thus, in examining the skeleton of a whale, we can scarcely perceive that lower extremities exist. In swimming, whales and seals scull themselves with their tails. In the fishes, the action of the tail is also predominant; but they are assisted by the fins, of which the side fins may be taken as representatives of the hands and legs. A man in swimming propels himself by his hands and legs, which he uses something like oars.

Several quadrupeds possess a *quasi* power of flying; that is to say, they can go through the air a considerable distance, being helped by what look like wings: but in the instances to which we refer no propelling power is given by the wings; the impulse is all taken from a spring or bound, and the organs that look like wings act merely as parachutes. There is a species of squirrel called the flying squirrel, the members of which have a web of skin extending from the fore extremities to the hind ones and to the tail. This membrane supports the animal in the long jumps it takes from tree to tree. The bat possesses the perfect power of flying, although this animal, being a mammal, has no true wings. In it the bones that should be the fingers are wonderfully developed; and what we call the wing of the bat is the web that extends between the fingers. Every one has heard of the flying fish, as they are called: these sometimes skim along the air for a hundred yards, and are often so high above their native element as to clear the deck of a ship.

When we come to birds (insects we are purposely leaving out of the question), we arrive at true wings. These consist of feathers attached to strong muscles belonging to the arm, fore arm, and breast. These are all so arranged that the air is struck with greater force during the down-stroke than during the up-stroke. But even with this contrivance the amount of force expended in any living structure propelling itself through the air is most amazing, far greater than that expended in the severest draught or the strongest exercise. It is supposed that a swallow, when merely sustaining itself in the air, exercises a force to prevent falling equivalent to what would raise its own weight to a height of twenty-six feet in a second. When we consider that it takes so much simply to maintain it where it is, what must it require to raise and propel it? And yet what a distance some birds fly in a short space! A hawk, for example, can traverse the air at the rate of a hundred and fifty miles an hour, and many swallows probably fly a thousand miles in the course of a day.

It is this enormous amount of muscular exertion that is necessary for flying that renders any attempt of man so to travel quite out of the question. We extract Dr. Carpenter's calculations regarding this point:—"It is impossible," writes this physiologist, "for a man to sustain himself in the air by means of his muscular strength alone in any manner that he is capable of applying it. It is calculated that a man of ordinary strength can raise $13\frac{1}{4}$ lbs. to a height of $3\frac{1}{4}$ feet per second, and can continue this exertion for eight hours in the day. He will then exert a force capable of raising ($13\frac{1}{4} \times 60 \times 60 \times 8$) 381,600 lbs. to a height of $3\frac{1}{4}$ feet, or one-eighth of that amount, namely, 47,700 lbs., to the height of 26 feet, which, as we have seen, is that to which the bird would raise itself in one second by the force it is obliged to exert in order to sustain itself in the air. Now if we suppose it possible that a man could by any means concentrate the whole muscular power required for such a day's labour into as short a period as the accomplishment of this object requires, we might find the time during which it would support him in the air by simply dividing this amount by his weight, which we may take to be 150 lbs.; the quotient is 318, which is the number of *seconds* during which the expenditure of a force that would raise 47,700 lbs. to a height of 26 feet will keep his body supported in the air, and this is but little more than five minutes. There is no possible means, however, by which a man could thus concentrate the force of eight hours' labour into the short interval in which he would have to expend it when supporting himself in the air."

All these muscular movements are produced by acts of the will. Their rapidity is sometimes very great. Thus, some men are able to pronounce 1500 letters in a minute. This implies 1500 distinct movements, and 1500 distinct acts of the will.* It is calculated by Haller, that a dog, when running, will exert as many distinct volitions, or acts of will, in a second, as 200. All this is very wonderful; and it is not surprising that young animals perform these voluntary movements very imperfectly at first, and that it is not until after repeated trials, and repeated failures, that they acquire the proper method of doing them.

In this latter respect, these voluntary movements differ very strikingly from what are called instinctive actions, or those actions of which the performer is conscious, but which he performs whether he wills or not. These are done from the very first as accurately as afterwards; and a child, for example, sucks the moment it is born quite easily. So also does it swallow with ease from the first. Besides these actions of sucking and swallowing, few of the movements performed by the human species are instinctive. Perhaps

* Alison.

throwing the hand before us when we fall, and winking when an object approaches the eye, are the only other examples. But among the lower animals very striking illustrations of very complex instinctive movements are to be seen. One or two of these may be interesting.

The ant lion, a little insect that feeds upon ants, affords a good example of curious instinctive acts. It moves slowly, and is not able to catch its prey unless it can entrap them. To do this, it digs a pit in the sand about twenty inches deep and thirty across. This pit it so constructs, that the sides gradually slope from the top to the bottom. The ant lion conceals itself at the bottom of this pit, and when an ant slips over the sides, casts a quantity of sand upon it, which insures its rolling to the bottom. The unfortunate ants, in falling, frequently destroy the side of the pit a little; but the ant lion invariably restores it to its proper angle of slanting. In all this there is no reason to believe that the animal reasons; but in all probability it does it all in obedience to a blind instinct. There is a spider called a Mygale, that constructs a very curious house for itself to live in, lines it with a silky substance, and puts in it a door with a hinge; and if any person approach and try to open the door, the insect tries to keep it shut by holding on to the door opposite the hinge, and fixing its legs into some holes, or staples, that it has made. There is an insect of the wasp species, called a Pomphilus. This insect lives upon flowers, but its larva is carnivorous in its diet. Now before a pomphilus lays her eggs she goes and kills a spider or a caterpillar, and places it beside the egg, so that when the young is hatched it may have a due supply of food. This insect, however, cannot know what it is doing this for. The ingenuity that birds display in building their nests must suggest examples of instinct that are very wonderful. But perhaps one of the most complicated instinctive acts is afforded by the manner in which beavers build their huts. In the summer, these animals live alone in country quarters, but as winter approaches they congregate together to construct a winter residence. About two or three hundred unite, and select a river or lake, preferring the former. Their first work is to insure the water being kept at a uniform height, by means of a dam. This dam they construct of branches of trees interlaced into one another, the intervals being well filled with stones and mud. Now if the dam go across running water, it is convex towards the current,—the very form that gives greatest stability. But if the water be still, the dam is made straight. When this dam is finished, the beavers of the colony divide themselves into a number of groups or families, and the animals employ themselves in building houses. The material that they use is wood, which they cut down with their strong incisors, and cast into the river above their locality, so that the stream may float it down. They daub over their walls a coating of mud, which, when the cold weather comes on, freezes and forms a hard and solid casement; and it has been noticed that they perform this operation late in the season, so as to insure frost.

All this—and had we space we might narrate much more—looks like the result of reasoning; but there can be no doubt but that it is all pure instinct, i. e. that these actions are performed, not on account of observation and reflection, in the manner that man does, but in obedience to impulses of which the animal knows nothing, save that he feels them. Thus, when a beaver is placed in circumstances where he can have no possible motive, and secure no possible end in building, he still builds. Of this we have a rather remarkable instance. It relates to a pet beaver belonging to Mr. Broderick, who thus narrates: "The animal arrived in this country in the winter of 1825, very young, being small and woolly, and without the covering of long hair that marks the adult beaver. It was the sole survivor of five or six which were shipped at the same time, and it was in a very pitiable condition. Good treatment quickly restored it to health, and kindness soon made it familiar. When called by its name — Binny — it generally answered with a little cry, and came to its owner. The hearthrug was its favourite haunt, and thereon it would be stretched out, sometimes on its back, sometimes flat on its side, sometimes stretched out on its belly; but always near its master. The building instinct showed itself immediately it was let out of its cage, and materials were placed in its way, and this before it had been a week in its new quarters. Its strength, even before it was half grown, was very great. It would drag along a large warming-pan, or a sweeping-brush, grasping the handle with its teeth, so that the load came over its shoulder, and advancing in an oblique direction till it arrived at the point where it wished to place it. The long and large materials were always taken first; and two of the longest were generally laid crosswise, with one of the ends of each touching the wall, and the other ends projecting out into the room.

The area formed by the cross brushes and the wall he would fill up with hard brushes, rush baskets, books, boots, sticks, cloths, dried turf, or anything portable. As the work grew high, he supported himself on his tail, which propped him up admirably; and he would often, after laying on one of his building materials, sit up over against it, appearing to consider his work, or, as the country people say, to 'judge' it. This pause was sometimes followed by changing the position of the material 'judged;' and sometimes it was left in its place. After he had piled up his materials in one part of the room — for he generally chose the same place — he proceeded to wall up the space between the feet of a chest of drawers, which stood at a little distance from it, high enough in its legs to make the bottom a roof for him, using for this purpose dried sticks and turf, which he laid very even, and filling up the interstices with bits of coal, hay, cloth, or any thing he could pick up. This last place he seemed to appropriate for a dwelling; the former seemed to be intended for a dam. When he had walled up the space between the feet of the chest of drawers, he proceeded to carry in sticks, cotton, hay, &c., and to make a nest."

There is, however, one instance on record where a beaver seems to have modified his building propensities to meet a present emergency. One was confined in the menagerie at Paris. The season was winter, the cold was intense, and his cage door shut very imperfectly. It was the custom of his attendant to supply him with apples, and other vegetables, to eat, and with branches to amuse him with pulling to pieces. One night there came on a fierce snow-storm, and some of the snow was blown into his domicile. The poor animal took his boughs, and interlaced them through the bars of his cage, and filled up the vacant place with his apples, carrots, &c. He then covered the whole with snow, which the frost soon stiffened, and thus formed an effectual shelter for himself.

Besides these voluntary muscular movements, performed in obedience to the will, and the instinctive ones that we have just considered, the muscular system is also often involuntarily affected by the mind. Thus the feeling of the ridiculous excites those complex movements of the muscles of the face that we call laughing. In like manner grief induces weeping. The muscles of the face are even slightly affected by nearly every mental act; and as each man has a peculiar mental identity, so do these mental acts produce a little difference, which soon becomes permanent, in the relative contraction of the individual faces. To discover by these appearances of the face the mental character, is the business of the physiognomist.

Some violent mental emotions sometimes affect the whole muscular system quite without our willing it. Thus great fear often produces trembling of the whole muscles, and the sensation of horror occasionally brings on writhings, as they are called. Thus, some mental emotions have actually the power of strengthening, and frequently do so strengthen, to a very remarkable extent, the force of the muscular contractions. Of this nature are anger, military enthusiasm, fanaticism, &c. On the other hand, grief; and particularly despair, diminish the muscular strength, and the latter sometimes temporarily altogether paralyses it.

The mind powerfully affects other parts of the system besides the muscles. The following is a summary of some of the more striking of such.

The exciting emotions that act permanently, but without violent agitation, such, for instance, as the "emotion of pleasure that attends any occupation which interests and occupies the mind,—the emotion of hope from the prospect of lasting enjoyment or of returning health,—the emotion of benevolence which attends the conferring, or that of gratitude which follows the receiving, of benefits; even the excitement produced by a certain degree of the feeling of indignation," have several very decided effects upon the system. They cause a permanent glow upon the face; they increase the secretion of the eye, and thereby augment its glistening; they render the skin far less liable to feel the sensation of cold; they are said to increase the quantity of carbonic acid thrown off at the lungs; they unquestionably promote the digestive powers; and they fortify the body to a most remarkable degree against the effects of contagion and malaria.

But if any of these exciting emotions act very suddenly and violently, none of these beneficial effects are to be seen. On the contrary, the heart's action is usually much excited, and a temporary fever produced. So fearfully has the heart's action sometimes been increased, by anger for instance, that immediate death has resulted. The local effects of some of the sudden exciting passions are extraordinary enough. Thus surprise causes the blood to congeal in the internal organs, and to desert the skin, and thus to render it pale and constricted; while shame produces the opposite effect, making the blood gorge in the skin of the face and neck, or causes blushing. Then sorrow causes the secretion of tears.

On the other hand, the depressing emotions, when they act permanently and without violent agitation, such as the feeling of ennui from want of occupation, the feeling of depression from continued disappointment and hope deferred, or the reproaches of a conscience ill at ease, produce just the opposite effects from the exciting passions. Thus they render the face pale—who does not remember the pale face of sorrow?—the eye dull, the skin readily chilled; they also diminish the excretion of carbonic acid from the lungs, impair the digestion, and in a very marked degree render the body prone to yield to contagion and malaria.

The depressing emotions, when they act suddenly and violently, as extreme horror or grief, tend to produce stoppage of the heart's action, which stoppage is sometimes fatal; and others belonging to this class produce strange local effects. Thus, fear acts on the skin, anxiety stops the secretion of mucus about the mouth, &c.

Besides producing involuntary motions, and influencing the organic functions of the body, emotions sometimes produce sensations. Thus fear brings on a peculiar sensation of chilliness and a constriction of the skin, and horror brings on nausea. Also, various emotions excited in the mind bring on various and sometimes very anomalous sensations. We may cite, as instances of this, the strange sensations experienced by individuals when touched by metallic tractors, and which were just as vivid and intense when fictitious ones made of painted wood were used; and when subjected to the manipulations, &c. of Animal Magnetism.

Not only has the mind an involuntary action upon the body, as exemplified by involuntary muscular movements, and the influence of the emotions, but *sensations* produce effects upon the system that may easily be perceived. Thus the sensation of pain tends to produce weeping, and that of tickling laughter; the sensation of weariness or listlessness produces yawning—a pretty complex operation; and other sensations bring on coughing, sneezing, hiccupping, &c. A peculiar idiosyncrasy often exists in individuals as to the effect of sensations; and what has no effect upon one person, as, for example, various odours, may excite nausea or fainting in another.

It is a very singular fact that all the involuntary actions of the mind upon the body are instinctively interpreted by a spectator. No sooner does an emotion or a sensation produce its effect upon the countenance, and its appropriate gesture, attitude, &c., than a bystander at once understands the nature of that emotion. We say that they are instinctively interpreted, i. e. that the interpretation is not the result of reasoning, for they are very easily understood by young children, moreover they affect us more powerfully than words can do; and, indeed, the expression of the countenance, the sound of the voice, and the whole appearance of an unaffected person under the influence of strong excitement, express more meaning and more shades than words can express or experience learn.

Every body can understand the external effects of emotion and sensations, but a few only of us can successfully imitate them, particularly when these effects are not present before us. To do this, constitutes the art of Acting.

But every one has to a certain extent, when he witnesses these changes in the body produced by emotions, an instinctive desire to imitate them. Thus children almost invariably acquire the gestures, &c. of their companions. The catching nature of yawning, laughing, and crying, is a matter of notoriety. But more striking illustrations of this may be seen in the case of the rougher passions; and very decided imitations of these may be witnessed. The degree to which this imitation is carried depends a good deal upon age and sex, and also upon the nervous temperament of an individual. But, perhaps, the most powerful predisposing cause of all to imitate these expressions is the presence of numbers. In this manner is not only to be explained the rapid propagation of nervous diseases in schools and the like, but also many absurdities of religious fanatiscism, violences of party politicians, and the extreme excitement of courage or depression of panic amongst soldiers.

CHAP. VII.

THE CAUSES OF DISEASE.

MEDICINE, perhaps, knows more about the causes of diseases and their prevention than about any other subject that comes under her province: and were circumstances such that it were possible she could enforce her rules upon this subject, there can be no doubt but that human life would be very much extended, and much suffering and sickness avoided. We have an instance of what has been done in this respect in the prevention of small-pox. Save in remote districts in the Highlands, where vaccination is either not known or will not be submitted to, this loathsome and fatal scourge of the human race is almost annihilated. But, excepting in this case, the medical men have it rarely in their power to prescribe for the prevention of disease; and their advice is only sought when the malady is formed, too often, indeed, when it has taken too deep root. It is, then, of the greatest consequence that the general public should know something of the causes of diseases, in order that they may avoid and counteract them.

A dozen men, we will suppose, are out shooting together. A storm comes on, and they have to walk home in the rain, which thoroughly drenches them all. Next morning eleven may be none the worse, but one may be laid up with inflammation of his lungs. A dozen men may, habitually, take every day too much wine and butcher's meat; eleven may not take the gout in consequence, but one may become a martyr to it. Twelve men may walk into a fever ward, and only one catch the infection.

That is to say, there are two kinds of causes of disease, existing and predisposing; and that to set up a disease, both must be present. The one in the twelve in whom cold excited the inflammation was predisposed to the disease, the one in the twelve who took gout had probably a hereditary tendency to it, and the one in whom contagion set up fever had the predisposing causes of fever in his constitution. It is often quite impossible to avoid both the predisposing and existing causes of disease; but in a great majority of cases it is possible to avoid one set, and this is quite sufficient for the purpose.

Among the predisposing causes of disease, a foremost place must be given to the hereditary tendency; that is to say, the tendency to particular diseases which is transmitted from parents to children. This is only part of a general law that the offspring inherit the peculiarities of those from whom they are descended. Of this many illustrations must occur to every one. The thick lip of the Austrian dynasty is to be observed in all the portraits of members of the family. The ladies of the Duke of St. Alban's family are said to be striking resemblances to their beautiful ancestress, Nell Gwynne. The members of our own royal family have for generations preserved the same cast of feature. Perhaps the most striking illustration of such hereditary transmission occurs in those cases where something unusual is present in the conformation of some part of the body. Thus the American calculating boy Zerah Colburn had six fingers and six toes, instead of the proper number, and so had a number of his kin; all having derived this peculiarity from a common ancestor four generations back. Haller describes a web-footed family who had inherited the peculiarity from a mother; and Dr. Watson knows a musician whose father, grandfather, and great-grandfather were web-footed.

The diseases, a hereditary tendency to which is transmitted from one generation to another, are insanity, gout, scrofula, and asthma, and, but less certainly, a few other diseases.

Now, if both parents have a hereditary predisposition to the same disease, this predisposition becomes so strong in the offspring that the slightest exciting cause is sufficient to set it up. It is owing to this that marriages between two near relations, i. e. between two individuals with probably the same predisposing tendencies, is so very objectionable.

Any individual with a predisposing cause to any disease will, of course, if he is wise, take great precautions against being exposed to the exciting cause or causes of it.

Another predisposing cause of disease is a state of too great plethora, as it is called. This is caused by too high living and too little exercise. The diseases to which it most predisposes are apoplexy and the inflammations. Its means of prevention are obvious; a diminution of food and drink, and an increase of exercise.

A cause, or rather a set of causes, of a different nature from the above, and which produce deficiency of the circulation, and increase the susceptibility of the nervous system, predispose very extensively to disease, and especially to fevers. These causes are, deficient nutriment, a deficient supply of pure air, long-continued depressing passions of the mind, and excessive and too long continued exertion. Thus it is that we see those fatal epidemics of fever, &c. commit their ravages among the poor inhabitants of our large towns, by far the most wretched class in the community, and not among the same class in the country, the members of which are not exposed to the above predisposing causes: thus they attack the very poor, and scarcely ever the rich; beaten armies, and not victorious ones; distressed and broken-hearted men, and not more fortunate ones, &c.

This cause, or set of causes, is probably the source of more disease than any other in this country, particularly in large towns. Every epidemic of fever that we have had for many years past has been clearly preceded by a state of unusual poverty; and there never has been a state of unusual poverty, but it has been followed by an epidemic and fever.

That in isolated cases, a depressed circulation and susceptible nervous system are the predisposing cause of fever, has been witnessed hundreds of thousands of times. The same has been nearly as often observed in cases of intermittent fever or ague. Thus, soldiers that have been exposed to the exciting cause of it have kept free from the disease when strong, but have taken it after having been weakened by exertion and fatigue. Dr. Gregory used to tell a case in point. His brother-in-law commanded a battalion in the West Indies. He was a strong active man, and did not take fever, although those around him were suffering severely from it. At length he received a wound, and, against the advice of the regimental surgeon, insisted upon resuming his military duties before his strength was restored. The consequence was, that he took so violent an attack of fever, that his life was despaired of.

That a certain amount of suffering, both of mind and body, must be endured in this world, is undoubted; but it may be believed that philanthropy could relieve so much of it as to lessen the mortality at present produced by the cause of disease just mentioned.

Then certain causes predispose to particular diseases, as long-continued exposure to heat, to liver affections and dysentery, — mental emotion to heart complaints, —

mental exertions to diseases of the brain,—and long-continued damp to the formation of tubercles.

Another predisposing cause of disease is previous disease. Whenever a person has had a disease (with some exception, as small-pox, measles, hooping-cough, &c.), he is always more liable to take it over again.

The above may serve as an outline of the predisposing causes of disease. The exciting ones are very numerous. To use the words of Dr. Watson: "Whatever ministers to life, health, or enjoyment, may become the medium, under changing circumstances, of pain, disease, or death. The atmosphere in which we are constantly immersed is full of dangers. Both the organic and the inorganic world of matter around us abound in poisons; they lurk in our very food, which becomes pernicious when taken in excess, or when it consists of certain substances, or certain admixture of substances; so that there really was much truth, as well as some humour, in the startling motto to Mr. Accum's book on Adulterations, 'There is death in the pot.' Our passions and emotions also, nay, even some of our better impulses, when strained or prevented, tend to our physical destruction. The seeds of our decay are within as well as around us."

The following is a list of the most important exciting causes of disease. After enumerating them, we will comment on some of them. First, mechanical and chemical injuries produce disease. Then there are atmospherical changes and conditions,—extreme heat, extreme cold, excessive moisture, excessive dryness, sudden variations, different electrical conditions, different states of the barometer, and too little light. Further, the atmosphere often contains impurities that have the power of exciting disease: these are the matter of malaria, inducing ague; contagion, causing various fevers, &c.; and noxious gases. Excess in eating and drinking are fertile sources of maladies. Various trades and professions have their peculiar sicknesses. Too little exercise sets up disease, and so does too much, as also too little sleep. To the list we must add violent and unrestrained passions, over-solicitude, and excessive mental exertion. Of these, the most important, and those regarding which most is known, are the effects of heat and cold, some dietetic errors, and the action of malaria and the matter of contagions. All these demand a little expatiating upon. We begin with the effects of heat and cold.

The human species can live, and be in health, under a wide range of temperature. In some parts of India, where, too, the white man can exist, the temperature is as high as 120° of Fahrenheit, and during the winter of the Polar regions it has been known to sink to 50° below zero. A little beyond either of these two extremes life is probably impossible. But, for a *short* time, a much higher degree of heat may be borne with apparent impunity. The famous Fahrenheit, whose scale of the thermometer is in common use in this country, was one of the first who experimented upon this subject. He shut up a sparrow, a cat, and a dog in a sugar-baker's stove, of which the temperature was 146°. The sparrow died in less than seven minutes, the cat in fifteen, and the dog in twenty-eight. But, in all probability, the animals did not die from the heat, but were suffocated by the impure air of the stove. The truth upon the point came out by accident. Nearly a century ago, in Angoumais, in France, the corn was found to be consumed by an insect, and Duhamel and Tillet were appointed to investigate the subject, with the view of discovering a remedy. They found that they effected this object by exposing the grain to a sufficient degree of heat to kill the insect, but not sufficiently intense to injure the grain. When they were heating some of the corn in an oven they introduced a thermometer at the end of a long shovel, to find out the exact temperature. This was found to be more than 212°. But Tillet perceived that as the thermometer was coming towards the mouth of the oven the mercury fell. While he was endeavouring to fall upon some plan of determining the real temperature in the centre, a young woman who waited upon the oven offered to go in and mark the height of the mercury with a pencil. She did so, and found it to be 280°. She declared that she felt no inconvenience, and stayed in the oven ten minutes, at the end of which time the mercury was found to be at 288°; that is, 76° hotter than boiling water. Emboldened by finding no bad effect result from her boldness, she ventured into the oven again, and remained there for five minutes, when the thermometer indicated a temperature of no less than 325° of Fahrenheit.

This experiment was published, and various scientific men made further trials with their own persons. One of the most conclusive of these was made by Drs. Fordyce and Blagden. They exposed themselves to a temperature of about 260° without experiencing any inconvenience; and yet this temperature was such as to make their watch-chains so hot that they could scarcely be touched;

and eggs were roasted and beefsteaks cooked by their sides. Their animal heat was not materially affected; and a thermometer placed under their tongues did not indicate much above 100°. Accordingly, when they breathed upon their fingers, it cooled them. In all their trials, however, they found the pulse much accelerated, being sometimes doubled in frequency.

In these trials the exposure to the heat was of short duration. Some cases have occurred which go to prove that a considerable degree of heat, although nothing approaching to the above, may be borne with impunity for a considerable length of time. Thus Sir James M'Gregor, in his account of the passage of our army from India to Egypt, states that although the heat was uniform, and the temperature of the tents kept at 118°, the men were healthy.

But, in general, long exposure to excessive heat produces disease. Of this we witness but too many examples in what happens to our countrymen who have to reside in India and other very warm countries. Three distinct diseases are produced in them by the heat. The enormously additional work thrown upon the skin produces disease of that organ; and every griffin, or new comer to India, has to submit to an eruption of pimples, attended with excessive tickling, and which goes by the name of the *prickly heat*. Then the action of excessive heat is sometimes to produce a concussion and paralysis of the brain. This is called a sun-stroke. But it is upon the liver that the bad effects of heat are most conspicuously visible. The secretion of bile is not only increased in quantity, but vitiated in quality; and various violent and often fatal disorders of the stomach and bowels are the result. The great congestion thus brought about in the liver also predisposes it to various inflammatory affections, which often end in becoming chronic. So extensively are hepatic diseases produced by heat, that few Europeans settled in hot countries escape them.

In considering the effects of *cold* upon the human body, it is necessary to bear in mind whether the cold air is in a state of motion or quiescence. When it is still, so bad a conductor of the heat (produced by the body) is air, that a very low degree of temperature of it may be suffered without inconvenience; but if it be in motion, of course every particle of it that passes over our frames takes away its portion, and its bad effects become very manifest. As an instance of the accuracy of this, we may quote Captain Parry: "With the thermometer," says this distinguished officer, "at −55° (*i. e.* 87° *below the freezing point*), and no wind stirring, the hands may remain uncovered for ten minutes or a quarter of an hour without inconvenience; while with a fresh breeze, and the thermometer nearly as high as zero, few people can keep them exposed so long without considerable pain."

The result of the application of excessive cold is to cause the extremities, and ears, nose, &c., to become frostbitten, i. e. their vitality is destroyed, and they fall off. Cold, likewise, produces general effects. There is obtuseness of the senses, and often a strong tendency to sleep. If this tendency be indulged in, the obtuseness becomes greater and greater, and the individual at length expires. The adventure of Sir Joseph Banks and Dr. Solander is a classical illustration of this: and at the risk of being liable to the imputation of repeating a thrice-told tale, we subjoin an abstract of it.

Sir Joseph, then Mr., Banks and Dr. Solander, a Swedish physician and naturalist, accompanied by some servants, including two men of colour, went botanizing among the dreary hills of Terra del Fuego. They were returning from the interior towards the coast to rejoin their ship, and were much wearied, having been compelled to travel through swamps for a considerable way. As ill-luck would have it, the weather became very bad and cold, and snow began to fall. A swamp intervened between them and a fir-wood, to which latter it was deemed the best plan to push, for the purpose of erecting a hut to shelter them and kindling a fire. Mr. Banks undertook to bring up the rear, and Dr. Solander, having had experience of the effects of extreme cold in his native country, conjured the company that if they felt drowsiness creeping over them, on no account to yield to it, but to keep moving, concluding his warning with the emphatic expression, "Whoever sits down will sleep, and whoever sleeps will wake no more." Thus admonished, the party proceeded. The cold became still more intense, and the accuracy of Dr. Solander's prediction became manifest. He himself was the first to succumb, and he insisted upon lying down. Mr. Banks entreated and remonstrated in vain; Dr. Solander laid down upon the snow. His friend, however, succeeded in keeping him awake. One of the men of colour named Richmond was the next to succumb; and, in answer to all the reasonings of the others, declared that he wished for nothing but to lie down and die. The rest of the party attempted to carry the doctor and the black man, but found it impossible to do so. They accordingly laid down in some bushes, where they fell into profound sleep. They had been in this state for about five minutes, when one of the advanced party returned with the welcome news that a fire was lighted about a quarter of a mile on. Upon this they attempted to arouse the two sleepers. With Dr. Solander they succeeded, but their exertions on behalf of poor Richmond were useless.

It has been observed by Dr. Watson that many of the cases of supposed drunkenness in poor wretches picked up in the streets by the police are often, probably, instances of stupefaction produced by cold. He quotes an anecdote related by Captain Parry that bears upon this point. This officer, we should observe, had sent a party in search of a missing seaman, who was found, quite benumbed, in the snow: — "The effect which exposure to severe frost has in benumbing the mental as well as the corporeal faculties was very striking in this man, as well as in two of the young gentlemen who returned after dark, and of whom we were anxious to make inquiries respecting Pearson. When I sent for them to my cabin they looked wild, and spoke thick and indistinctly; and it was impossible to draw from them a rational answer to any of our questions. After being on board for a short time, the mental faculties appeared gradually to return with the returning circulation; and it was not till then that a looker-on could easily persuade himself that they had not been drinking too freely. To those who have been much accustomed to cold countries, this will be no new remark; and I cannot help thinking, and it is with this view that I speak of it, that many a man may have been punished for intoxication who was only suffering from the benumbing effect of frost; for I have more than once seen our people in a state so exactly resembling that of the most stupid intoxication, that I should certainly have charged them with the offence had I not been quite sure that no possible means were afforded them on Melville Island to procure anything stronger than snow-water."

The above extreme effects of excessive heat and cold are, however, rarely seen in this country. We have, it is true, derangement of the abdominal organs during summer, produced by the action of heat upon the liver; but these are seldom of much consequence. In the winter, too, in the pastoral districts of Scotland, and occasionally in the cases of vagrants, we see or hear of the fatal results of exposure to excessive cold. But such instances are so rare as to have no effect worth noticing upon the general mortality or amount of sickness. Nevertheless, the influence of the temperature in causing disease in this country, and indeed in all countries, is very great.

Now it is found that a great many diseases are liable to be produced, or excited, in the human constitution if the body, having been hot, is, *while cooling*, or after having been cooled, exposed to cold. Upon this action of cold, however, two erroneous opinions are prevalent.

One of these is, that this action of cold in producing disease is most prevalent in cold or temperate countries like our own. This is quite erroneous. It does not matter whether the temperature be high or low, to begin with: if it fall some ten degrees or so, the sensation of cold is experienced; and if the body be cooling, it is liable to the effects of cold. And, indeed, more disease and more death are induced in tropical countries from this very cause than in Great Britain. Thus, Dr. Johnstone, in his work on the diseases of tropical countries, in speaking of the coast of Coromandel, says, that although the temperature of the day is uniform, and that of the night, as indicated by the thermometer, high, yet the soldiers and sailors are eternally exposing themselves, when tired, to an open port, &c., to enjoy the coolness of the night breeze; and that this exposure is frequently bringing on inflammation of the liver; the liver being the organ attacked, because, from the heat, it is predisposed to disease. In all probability the night breeze, that thus on the Coromandel Coast feels cool, and produces the effects of cold, is 80° of Fahrenheit,—a temperature that would be considered very warm indeed here. In like manner, Dr. Walsh states that after the crew had been for some time accustomed to a temperature of 72°, they happened, as they were sailing along the coast of Brazil, to meet with a strong breeze that brought down the temperature to 61°,—a temperature which we, in this country, regard as very comfortable in our houses. "But," says the Doctor, "the sense of cold from the sudden transition of temperature was quite painful. After bearing it for some time, shivering upon deck, it became intolerable; and we all went below, put on warm clothing and dreadnoughts, and again appeared with thick woollen jackets and trowsers, as if we had been entering Baffin's Bay, and not a harbour under one of the tropics."

Similar results are experienced when the case is reversed. Thus, when a person, after having been for long in a very low temperature, comes into one which is not quiet so cold, but which we would regard as excessively frigid, he feels too warm. Captain Parry gives us an illustration of this. He was in the Polar regions on the 21st of October, during the night of which the temperature fell to 13° below zero. "The wind," writes this distinguished officer, "veering to the south-east on the 24th and 25th, the thermometer gradually rose to 23° (i.e. 9° lower than freezing point). I may possibly incur the charge of affectation in stating that this temperature was much too high to be agreeable to us; but it was, nevertheless, the fact that every body felt and complained of the change. We had often before remarked that considerable alterations of the temperature of the atmosphere are as sensibly felt by the human frame at a very low part of the scale as in the higher. The difference consists only in this, that a change from $-40°$ upwards to about zero is usually a very welcome one; while from zero upwards to the freezing point, as in the instance just alluded to, it becomes to persons in our situation rather an inconvenience than otherwise."

The second erroneous opinion is, that any sudden change from heat to cold is injurious, and that it is to the application of cold to the body when it is much heated that the bad effects known to proceed from cold are to be attributed. This opinion would appear to be altogether unfounded. As is well-known, cold is applied to the heated surface in fever, not only with impunity, but with advantage. The Russians are in the constant habit of rushing from the extreme heat of the vapour-bath to cold water, or even a bath of snow, and are never the worse for it. Captain Scoresby tells us that he often went from his cabin, which had a temperature of 60°, to the mast-head, where the temperature was only 19°, without any additional clothing, save his cap, and felt no injury. In the experiments of Dr. Blagden, before noticed, both he and his co-experimenters came from a temperature of 260° to a cold room without any precaution and without any injury. Innumerable other instances might be multiplied. As long as the body is strong, and generating heat from recent exercise, &c., no harm follows an exposure to a lower degree of temperature; but it is when the hot body is, from weariness or other causes, incapable of maintaining its temperature that disease is induced by the application of cold. Thus, if a person walk in a hot summer's day to a river to bathe, and become heated by his walk, he will, if he immediately take off his clothes and plunge into the stream, sustain no injury; whereas, if he wait to cool, and then go into the water, he very likely will.

The application of cold either to the skin or to the mucous membrane of the stomach, as in the case of a draught of cold water, is injurious, not when applied to a hot body, but to a body, as before stated, either cooling or cooled. The dangerous effect of cold thus applied may unfortunately be witnessed every day. We may give an instance of death or severe disease being induced by a person, having been hot, and being weary and cool, drinking cold water.

Dr. Currie relates a case that fell under his own observation. A young man, who had violently heated himself by playing a game at fives, sat resting himself upon the ground, covered with perspiration. He ordered a servant to bring him a pitcher of cold water from an adjoining pump. The servant did. He took a long draught; he then laid his head on his shoulder, his countenance became pale, his breathing difficult, and in a few minutes he was dead. Quintus Curtius relates that Alexander's army reached the river Oxus, wearied, perspiring, and thirsty, after a march of forty-six miles across the torrid desert. The soldiers rushed to the stream and drank, and the consequence was, he says, that more died from that cause than ever fell in one of his battles.

But the usual effect of the application of cold to the cooling body is not to produce immediate death, but inflammation of some internal organ. Which of the internal organs it shall be, depends upon which is predisposed or congested. In hot countries, as we have seen, the liver is oftener so inflamed than any other. Here, the respiratory organs are, perhaps, the most constant sufferers; but every internal organ of the frame may have inflammation set up in it from this cause.

Dr. Watson, in his lectures to his pupils, advises them how to direct their patients in this respect. His observations,— like, indeed, every thing he says,— are so sound and so impressively worded, that we extract them. "Thus," he says, "you may tell the sportsman that wet feet or a wet skin need cause him no apprehensions, so that he continue in active exercise, and changes his clothes, and avoids all further application of cold as soon as his exercise ends. You may admonish the bather, that, after walking in a hot day to the river's side, he had better *not* wait to cool himself a little before he plunges into the stream; and, in like manner, you may venture to counsel the young lady, who has heated herself with dancing, not to linger in the entrance-hall till the glow has somewhat subsided, but to make the best of her way to her carriage and thence to her bed; and you may tell your male friends, who happen to be similarly circumstanced, that the best thing they can do is to walk briskly home in their great coats. The main points to be remembered are, that the heat which is preternaturally accumulated by exercise is held with little tenacity, is dissipated by profuse perspiration, and is speedily lost when to this perspiration is added a state of rest after fatigue; and that in these circumstances the application of cold is apt to be prejudicial."

Hence it is that anything that weakens the body makes it far more liable to take inflammation after exposure to cold. Among the causes that facilitate the evil effects of cold may be enumerated sleep, long study, excess in wine, great fatigue, and the like. Children have far less power of generating heat than adults; and hence it is that an amount of cold that a grown-up person scarcely perceives is often sufficient to produce fatal pneumonia or some mortal inflammation in them. Then, for a reason before stated, cold is much more prone to become injurious when it is accompanied by a wind or draft; and if to the draft moisture be added, then is it most injurious of all. In fact, an individual exposed to wet, cold, and fatigue, is almost sure, unless he can contrive to keep up his natural heat by exercise or stimulants, to suffer.

Several circumstances render the frame less liable to suffer from the effects of cold. We will only mention the force of habit, as it is called. This means, that by custom the body can become, to a great extent, fortified against the injurious effects of cold, and even against feeling the sensation of cold. Perhaps we cannot take a better instance of it than this: if we men, who wear cravats, went for a single day with our neck and the upper part of our bosom uncovered, we should feel very uncomfortable, and, perhaps, catch cold; while many delicate young women can do it with impunity, and without experiencing any disagreeable sensation in consequence.

Now advantage may be taken of this fact, both in the physical education of children and in the physical management of adults also, to harden and fortify the body against the effects of cold. To do so requires great management and skill; but it may be done. It never should be tried upon any body not in perfect, nay, even pretty vigorous health. It consists in habitual exposure to cold, taking care that those conditions that render cold injurious — fatigue, or anything weakening the body — are absent. The two most effectual means of thus fortifying the system are, plenty of out-door exercise, and taking the cold bath at that hour of the day when the body is most rested from fatigue, namely, upon getting out of bed in the morning. If, after the cold bath, however, any chilliness be felt, it must be taken as a clear indication that the system is not able to stand this hardening process. Sometimes when the cold bath, particularly the cold shower bath, cannot be borne, a tepid one can, and can also produce good results.

That a deficiency of pure air is a very powerful predisposing cause to disease, is very evident from the greater amount of disease in large towns as compared with the country, and from the recovery from disease that so often follows removal from the impure atmosphere of the town to the purer of the village. It is probable, too, that impure air aids in exciting scrofulous diseases; although there must, for this end, be conjoined with it hereditary tendency and dampness. Of late it has been decidedly maintained that bad air can *excite* typhus fever. Those who believe that typhus fever always originates in contagion, as the writer of this, in common with almost all who received their education in the Edinburgh school, do, regard this impure air as a powerfully *predisposing* cause to the disease in question. So that, practically, both are anxious to see the bad air of large towns, the dwellings of the poor, workshops, &c., as well ventilated as possible.

Before proceeding to attempt a popular outline of what is known regarding contagion, we will offer a few remarks regarding malaria, the undoubted cause of ague or intermittent fever. This malaria is a certain invisible emanation from the earth, or rather from particular portions of the earth, whose existence we recognise on account of the effects we see. It is necessary to discriminate between this malaria and merely foul or impure air.

Now in order that this malaria may be produced, a certain amount of temperature is necessary. In the Arctic regions it is never found at all; nor, indeed, farther north than the fifty-sixth degree of north latitude. Even in these temperate countries it is not generated during the winter's cold; and it is believed to require a continuous temperature of sixty degrees. As we get nearer the equator, not only does its quantity increase, but so likewise does its virulence; and those of us who live at home can form little idea of the dreadful scourge that intermittent and remittent fevers are in high latitudes.

Besides a certain amount of heat being necessary to the formation of malaria, there must also be moisture. In this country ague is never known excepting in the immediate neighbourhood of undrained fens and bogs; and when these fens are drained, the ague goes away with the water. Draining, moreover, has diminished the mortality of this island on a large scale. The neighbourhood of London used to be very marshy; and ague, and death from ague, were, in consequence, very common. James I. and Oliver Cromwell, for instance, both died in the English metropolis of ague. Now-a-days, the disease is almost unknown in London; and the few cases that do, from time to time, occur, are probably of foreign origin.

Land, also, is necessary for its production. However hot it may be, sailors at sea never suffer from it, although, when they get to land in these low latitudes, they often do so most severely.

Now when heat, moisture, and earth were seen to be necessary for the production of malaria, and also that when these meet together there is usually excessive vegetation, and much decomposition of vegetable matter, it was very natural to conclude that malaria proceeded from decomposing vegetable matter. But this conclusion has been arrived at too rapidly, and is not true; and the decomposition of vegetable matter, although it frequently accompanies the malaria, is only an accidental, and not a necessary companion. We might have suspected this, had we considered that every summer we see vegetable decomposition going on, with moisture and heat, and yet no production of malaria follows. But the merit of proving the unsoundness of the opinion, and of proving that malaria can be produced without any vegetation at all, is due to Dr. Ferguson, whose service with our army gave him ample means of making observations upon malaria.

He found that for the production of malaria a surface capable of absorbing moisture was necessary; also that this surface should be well soaked, and very rapidly dried under considerable heat; and he could not find that anything else was necessary. This chapter is already getting so long, that we cannot do more than quote one of his illustrations. In the year 1809, several of our regiments, then in Spain, encamped in a hilly ravine that had been a water-course. Although the stream had ceased, many pools of water remained, whose contents were so pure, that the men desired to bivouac close to them that they might have their water handy. Before the next morning many were attacked with ague. "Till then," says Dr. Ferguson, "it had always been believed among us, that vegetable putrefaction (the humid decay of vegetables) was essential to the production of pestiferous miasmata; but in the instance of the half-dried ravine before us,—from the stony bed of which, as soil never could lie for the torrents, the very existence even of vegetation was impossible,—it proved as pestiferous as the bed of a fen."

After an individual predisposed to take ague is exposed to malaria, he may take the disease at once, or the poison may remain lurking in his constitution for some time. That this should be so, seems strange; but the fact is undoubted. Another most remarkable fact regarding the malaria is, that it appears to have no influence whatever over men of colour. White men, indeed, sometimes become acclimatised, as it were, to it, but such are invariably sickly and short livers; but a black man not only does not take the disease, but, in the midst of the greatest malignity of it, remains sound in health and long-lived.

Then various and repeated observations have established certain properties of the malaria. One of these is, that it is much more malignant by night than by day. The reason of this, perhaps, is, that the bodily functions are more feebly performed at night, owing to the fatigue of the day, and that the system is thus more predisposed. Whatever may be the cause, the fact is certain. We have but space for one illustration. It has often been noticed, that sailors on a malaria shore may visit it by day with impunity, but not so at night. The "Phœnix" man-of-war was off the coast of St. Thomas, in the Gulf of Guinea, close upon the equator. Of her crew, 280 went on shore, in parties, every day, diverted themselves with shooting, and so forth, and at night returned to sleep in the ship. All these remained in good health. But the whole crew, numbered 296, and the remaining sixteen slept on shore. Of these sixteen, the whole took the ague; and thirteen of them were killed by it. Next year the same ship returned to this island, and the crew again visited it, returning at night to the ship. All remained healthy save ten, who imprudently remained on shore; and of these ten, eight died of ague.

Of course, any one in the neighbourhood of malaria should avoid being out at night.

Another thing ascertained regarding malaria is, that it is very superficial in its action, and has no bad effect whatever a little way from the ground. Those occupying the upper flat of a house situated in a malarious district have often been known to keep their health, while those living below have caught the disease. At Spanish Town, Jamaica, for example, we have, or had, two barracks, one situated higher than the other; and the soldiers living in the low barracks were far more liable to ague than the others.

Still the malaria is borne from one part of the surface to another by means of winds; and a knowledge of this fact may sometimes be of much use to those who have to select the site of encampments, &c. in malarious countries, where trade winds, and the like, often blow for a long time in one direction.

Still greater advantage may often be taken of two other well-ascertained facts regarding it,—that it is neutralised by passing over water (1000 yards of water between the source and a ship have often been known to be sufficient), and that it is absorbed by trees. We have a very striking example of the truth of the latter, in what is done by the inhabitants of New Amsterdam, in Berbice (six degrees from the line). This place is situated on the banks of a swampy forest, to remain in which, at night, would be death to an European. But a strong trade wind blows there day and night. The town is situated on the lee side of the malaria source, and the trees at the edge quite protect the residents.

The last peculiarity of malaria that remains to be noticed is very well ascertained, but quite inexplicable. If, in a malarious country, the soil previously lying waste be cultivated, the ague generally disappears; and, on the other hand, if the country again go out of cultivation, the ague comes back again. Thus, for instance, when East Lothian was but partially cultivated, the disease was common there, to such an extent, indeed, that the reapers of such harvest as there was took an attack of it as a matter of course, while now, in the same district, we suppose, there has not been a single case for twenty years. Now-a-days, the district of the Marumna, in the Papal States, is almost, or nearly, uninhabitable from malaria; and this is believed to have been caused by its depopulation from plague about three centuries ago. We have an instance of a country becoming malarious from depopulation, narrated by Bishop Heber. He says, "At the foot of the lowest hills, a long black level line extends,—so black and level, that it might seem to have been drawn with ink and a ruler. This is the forest from which we are still removed several coss, though the country already begins to partake of its insalubrity. It is remarkable that this insalubrity is said to have greatly increased in the last fifteen years. Before that time, Ruderpoor, where now the servants of the Police Thanna die off so fast, that they can scarcely keep up the establishment, was a large and wealthy place, inhabited all the year through without danger or disease. The unfavourable change is imputed by the natives themselves to depopulation. The depopulation of these countries arose from the invasion of Meer Khan, in 1805. He then laid waste all these Pergunnahs; and the population, once so checked, has never recovered itself."

As the exciting cause of intermittent fever is a peculiar substance to which the name of malaria is given, so the exciting cause of continued, or typhus, fever is a particular principle called contagion, which does not emanate from the earth, but from the body of a fevered person. This is taken in usually at the lungs, and is supposed to undergo a process similar to what yeast does in fermentation, whereby its quantity is much increased.

The evidence of a disease being thus contagious lies in this, that when we investigate the history of cases of fever, we find that the majority have been in close and continued intercourse with people sick with fever, and that others living in the same place, and otherwise precisely similarly circumstanced, but who have not held such intercourse, escape.

With regard to this being the case with fever, appears so plain and manifest, that it seems incredible that any person should deny it. The writer of these pages was for long clerk in two fever wards in the Edinburgh Infirmary. During that time, of every twenty fever patients that came in, nineteen stated that they had held communication with individuals suffering from fever; and even the twentieth had often, to his, i. e. the writer's, own knowledge, been so exposed; but, from an unwillingness to allow himself to believe that he was taking so mortal a malady, determined not to admit it.

Upon this head, however, we extract some most conclusive evidence from Dr. Alison. "During this epidemic," (he is speaking of the one in 1828), he writes, "as well as in that of 1817–19, many of the clerks and nurses employed in the Royal Infirmary have taken fever. Since November last, six of the clerks employed in the clinical wards, four of those employed in the ordinary wards, and twenty-five nurses or servants, have taken fever. All these persons had necessarily frequent and close intercourse with the fever patients in the house, having been employed more or less constantly in the fever wards, excepting only four of the servants. Of these four, two had been employed in the laundry, where the linen from the fever wards was washed; one was a porter employed at the gate, who would of course have communication with the fever patients at their entrance or dismissal, as well as with their relations coming to visit them; and one was a nurse employed in the servants' ward, but who was in the habit of visiting the fever ward." So much for positive evidence in favour of contagion. Then comes the reverse side of the picture. He continues: "In this very place and season those of its inhabitants that have *not* had intercourse with fever patients have almost uniformly escaped the disease. Of the inhabitants of the ground floor of the house, none but those already mentioned as having washed the linen from the fever wards, and the barber who shaved the heads of the fever patients, have taken the disease. No one of the nurses whose duty has confined them to the medical and surgical wards, where no fever patients are admitted, has taken fever, with the single exception of the woman in the servants' ward above mentioned. And of the numerous *patients* in these ordinary wards, the only one who has taken the fever within my knowledge during the present year was a patient in the man's clinical ward, who lay in the bed next the door that communicates with the clinical fever ward."

Then, in another place, the same eminent physician says: "Some years ago, at a time when there was no great number of fever cases in Edinburgh, I met with a case in the son of a shoemaker, who was lying in a room in which the father and two apprentices were at work. I could not prevail upon the father to remove his son to the hospital, although I stated the danger of the apprentices being affected. Within two or three weeks after, I found that the two apprentices were lying ill of fever in their own houses; one of them two hundred yards, the other half a mile, distant from the workshop, and widely distant from each other. These young men, likewise, lay at home during the fever, and each of their cases was speedily followed by a succession of others in the inhabitants of the rooms that they occupied, and of those immediately adjoining, who had never been at the workshop. In one of these houses seven, and in the other twelve, were so affected. Now, on the supposition of the fever being contagious, all this was to be expected, and all corresponded to the predictions which were hazarded on that belief. But on the supposition of such succession of fever cases depending on miasmata (those who deny the cause of fever to be contagion affirm that it is miasmata from putrid matter, foul air, &c.), there must have been two, more probably three, separate and accidentally consuming miasmata to explain the phenomena here observed,—one at the workshop, and one at each of the houses of the apprentices; and there must have been this extraordinary coincidence, that at each of these last the malaria sprang up just at a time when a patient was lying ill there of fever, which he had apparently contracted elsewhere. Further, the three houses in which these succession of fever cases were observed are in situations very different from one another; and all of them have been, to my knowledge, perfectly free from fever for years together, both before and since that time, notwithstanding that fever has been much more generally prevalent, and that they have been inhabited by successive families. What probability is there that three separate miasmata should have arisen in these three houses just at the time when their presence was required in order to produce an effect which had been foretold as the consequences of another cause undeniably operating on all."

Besides the contagion of fever, there are other contagions that excite respectively the plague, small-pox, measles, scarlatina, and influenza. The following observations apply partly to the diffusion, &c. of all these, but more especially to that of continued fever.

The matter of contagion is diffused amongst air, and when much diluted with it, loses its poisonous properties. Thus air about thirty yards distant from a fever patient is harmless. Then it unquestionably attaches itself to clothes, furniture, &c.; and may there retain its malignant influence for a long space of time. A temperature of 120° effectually destroys it; and this is perhaps the reason why continued fever is unknown in tropical countries. It appears to have much less influence over a person who has had fever than over one that has not; and in the case of small-pox, measles, and scarlet fever, one attack renders the person safe from another. The very curious discovery that immunity from small-pox was obtained not only by having that disease, but the very trifling one of chicken-pox has saved the lives of thousands.

Then, among other exciting causes of disease, errors in diet occupy a prominent place. Deprivation of fresh vegetables for a length of time excites scurvy, too much meat and wine, gout; and intemperance, disease of the brain and other organs. Further, not taking a due mixture of albuminous, saccharine, and oleaginous principles for a continuance, produces different states of the system that induce disease. But we have dwelt so long upon the causes of disease, that we must here close this interesting and very important subject.

CHAP. VIII.

THE WAY PEOPLE DIE.

As we before mentioned, all individual vital action is essentially temporary in its nature; and every living thing, whether a simple moss, an oak, a worm, or a man, must die. The material elements that form our structure lose their power of exercising those peculiar vital actions that characterised them, yield to putrefaction, and serve to furnish food for plants. We also stated that two general conditions were essentially necessary to be present in order that life may be continued in an individual,—the circulation of the blood, and the exposure of the same blood to the air. Now it is evidently one of the intentions of Nature, that by diseases, or by that rare malady, old age, obstacles should be put to this circulation of the blood and its aëration. It is these stoppages that terminate our existence in this world. They are the causes of that which we instinctively dread, which we drive so from our thoughts, and which we strive so to avert: they are the causes of Death.

The aim and end of the art of the physician is to combat this death; and accordingly the exact nature of the different ways in which these stoppages to the two important functions of circulation and respiration take place have been much investigated. We here present a very rapid summary of them.

There are three ways in which people die: when the blood will not circulate,—and this way of dying is called fainting or syncope; when the air cannot get to the lungs, —and this is called choking or asphyxia; and when we do not know that we ought to try to breathe,—and this is called stupor or coma. Each of these three ways in which people die demands a little separate attention.*

One of the most striking illustrations of death by syncope is to be seen in cases where a very large blood-vessel is wounded, and when, to use the popular phrase, "the person bleeds to death." The blood does not circulate, for the very best of all reasons, there is none left to circulate in the body. The appearances witnessed in a death of this kind are paleness of the face, cold sweat

* Perhaps the ways in which people die would be more intelligible, if the reader would re-peruse chapters II. and IV., on The Way the Blood is Moved, and the Way we Breathe.

on the brow, a weak pulse, a feeble breathing, a sigh, a gasp, a convulsion or two, and all is over. The sensations felt are, probably, a singing in the ears, a flash of light before the eyes, followed by dimness of vision, and then a placid insensibility.

But the blood may cease to exist in the blood-vessels from another cause than from the blood being taken out by a wound. We have seen that the body is always abstracting from the blood. If, then, the daily supply of new materials to the blood be cut off, the blood diminishes in quantity, and by-and-by death by syncope comes on. The most perfect example of a death brought on in this manner is in a case of death by starvation. But when, as in many diseases, the digestive organs cannot assimilate a sufficient quantity of food to keep up the normal quantity of the blood, death is produced in this way.

Further, if the quantity abstracted daily from the blood be greater than the digestive organs can, even if acting pretty well, make up for, although death is not, as in the case of bleeding to death, sudden and instant, it is as certain, and brought about in the same manner. In this way, people often die in cases of dysentery, and other exhausting and lingering disorders.

Again, certain violent concussions of the nervous system, and pain in the abdomen, have a powerful depressing effect upon the circulation, and sometimes bring it to a stand. People do not very often die from the first of these causes; but in cases of fatal inflammation of the bowels, and of cholera, the circulation is thus brought to a stand, and thus death is produced. When death takes place from lightning, or intense mental emotion, it is owing to, in part at least, the violent concussion upon the nervous system.

The simplest illustration of death, in the way of choking or asphyxia, is witnessed when a mechanical obstacle around or in the windpipe obstructs the passage of air to the lungs. When this is done suddenly, the symptoms witnessed are tremendous attempts to move the midriff or diaphragm, and violent clutching with the hands; the eyes seem as if they would protrude from the head: these symptoms, in a very little time, cease; then there is insensibility and convulsions; then irregular tremors of the muscles; and, lastly, the scene closes. The sensations, for a moment or so at first, are extremely painful, —absolute agony; but this soon ceases, and the feeling becomes, it is believed, not painful at all: then there is vertigo, and this is followed by total unconsciousness. If, however, the obstruction to the air getting at the lungs comes on by degrees, none of the above violent and distressing symptoms are to be seen.

In cases of disease, the obstruction to the breathing is rarely brought on with sufficient rapidity, so as to produce the violent symptoms; although, in cases of inflammation of and rapid effusion in the windpipe, &c., it sometimes is. But death in the way of asphyxia, but produced in a slower manner, is common. Many diseases of the lungs, as inflammation, consumption, &c., render these organs quite unable to perform their functions, and induce death in this way.

The last way in which people die is by coma, or stupor. We have before said that the reason we inspire, or breathe, is because the venous blood in the lungs gives rise to a sensation which is transmitted to the medulla oblongata by means of nerves; and that whenever this sensation is experienced, the movements that take a supply of air into the lungs are made. If, from the medulla oblongata being diseased, this impression is imperfectly felt, only imperfect attempts at breathing are made; and if this impression be not felt at all, no attempts whatever are made to breathe. When such is the case, the individual so affected is said to die in the way of coma.

The symptoms witnessed in a case of this kind are slow and irregular acts of inspiration; and the individual so affected with such imperfect breathing snores: there is complete insensibility to all external impressions, or internal acts of the mind; the breathing becomes slower and slower, and at length no blood becomes arterialized, and the man dies. No painful sensations, or, indeed, sensations of any kind, are felt.

In water in the head, apoplexy, and fatal cases of diseases of the brain, the death is usually in the way of coma.

We possess means which, in a great many cases, are able to obviate these fatal tendencies in diseases to death in the way of syncope, asphyxia, and coma; and it is in finding out, in each individual case, and sometimes in long foreseeing, the particular fatal tendency, and in administering the proper remedies against it, that the skill of the physician is based; and upon this depends the safety of the patient.

through the nervous system, and improve the digestion and appetite.

Many more classes of remedies might be enumerated; but our object is to show the principle upon which therapeutics, or the art of treating disease, should be based. The value of experience in it is owing to it giving a facility of seeing long beforehand the changes that will take place in disease; and in being able, when one class of remedies is wanted, to pick out the individual member of that class most suited for a particular case.

We have now completed the task we assigned to ourselves in compiling this little book. We meant to give, in popular language, an account of creation, not merely as it was, but as it is going on daily around us. We take the first creation, or formation of the world, as the first creation of each plant and animal, to be the result of miraculous power. We have seen that probably the world was first made without life upon it, and only gradually prepared for life, at first of a very humble nature, to dwell upon it. We have also endeavoured to trace the wanderings of the same particles of matter from the inorganic world to the vegetable; and from that to the animal, and then back again. We have then considered the more important functions of animal life, and likewise enumerated the causes of disease in man, also not only the certainty, but the modes of death in him, and the action of remedies upon his frame. With two remarks we now close this essay.

Although we have of necessity been very brief, we believe that we have given a tolerably faithful account of the most recent discoveries of physical science, upon the topics of which we have treated. This physical science has too often been, and even yet too often is, considered as teaching something different to, and opposite from, the truths contained in the Sacred Writings. To those who have said this, it has been remarked, and with great propriety, that the object of the Sacred Writings was to teach religious truths and moral duties, not principles of science. But in many cases, the supposed discrepancy between Scripture language and scientific deductions has been discovered to be no discrepancy at all. Now, without assigning too much value to it, we may point out that many expressions used in the Bible, some of which were thought metaphorical, and some of which were unintelligible, express, in a manner at once clear and emphatic, the very scientific principles we have attempted to explain. Thus we may instance: "In the beginning God created the earth;" "The Lord God made man out of the dust of the earth, and breathed into his nostrils the breath of life; and man became a living soul;" "In the sweat of thy face shalt thou eat bread till thou return to the ground; for out of it wast thou taken: for dust thou art, and unto dust thou shalt return;" "The blood is the life;" "We die daily."

Our second remark is this. We have seen that every living being inevitably ends in death; and that every one of us is carrying within him, and causing to germinate, the seeds of his own destruction. Nor is this constant change going on only in the living world: the very ground on which we dwell is in a state of eternal transmutation. As our elements are always being replaced, and our appearances altered, so also is the globe always undergoing revolutions. This land on which we live once formed the bottom of an ocean; and where the wild waves of the Southern Ocean roll along in their vast expanse was once probably a huge continent. And causes are, perhaps now at work, tending to again submerge this northern end of the globe, and once more to drive the ocean from the south. As everything is evidently formed on one great and uniform plan, as the operations going on in the framework of the earth, and in the living bodies upon its surface, have so many strong analogies, and as all these living bodies end in death, is it not probable, it may be asked, that the time will come when the globe itself will come to an end? And if it be so, can science detect the provision that is possibly made for this consummation of all things?

We have seen that the atmosphere has for long been undergoing a change; that, at a very early period, it was charged with carbonic acid, the carbon of which now forms part of animal and vegetable structures. We saw, also, that at first it contained no ammonia. But since vegetation and decomposition began, the nitrogen that existed in the nitrates of the earth, and some of the nitrogen of the atmosphere, have been gradually entering into new combinations, and forming ammonia, — and the quantity of ammonia, a substance at first non-existent, has gradually increased; and as it is volatile, the atmosphere now always contains some of it. The quantity has now become so great in it, that it can always be ed by chemical analysis. There is an evident ten- of it to increase in the atmosphere. Now sup- it to go increasing up to a certain point; it forms air a mixture that, upon the application of fire, is tly explosive. An atmosphere charged with am- is liable to explode whenever a flash of lightning through it. And such an explosion would doubt- stroy, perhaps without leaving traces of, the present of things. Do any expressions of Revelation seem er to such an end of the present creation? We , in a popular book, to quote too much from the Writings; but we may, perhaps, be allowed to t the following detached passages:—

nd there came down fire from God out of heaven; saw a great white throne, and him that sat on it, whose face the earth and the heaven fled away: and the dead, small and great, stand before God, and were judged every man according to their works: and a new heaven and a new earth, for the first heaven he first earth were passed away, and there was no sea. And he that sat upon the throne said, 'Be- I make all things new.'"

THE END.

"My wife and another person came into my apartment in the morning, in order to console me; but I was too much agitated by a series of incidents which had most powerfully affected my moral feeling, to be capable of attending to them. On a sudden I perceived, at about the distance of ten steps, a form like that of a deceased person. I pointed at it, asking my wife if she did not see it? It was but natural that she should not see anything; my question, therefore, alarmed her very much, and she immediately sent for a physician. The phantom continued for about eight minutes. I grew, at length, more calm, and, being extremely exhausted, fell into a restless sleep, which lasted about half-an-hour. The physician ascribed the phantom to a violent mental emotion, and hoped there would be no return; but the violent agitation of my mind had in some way disordered my nerves, and produced further consequences, which deserve a minute description.

"At four in the afternoon, the form which I had seen in the morning reappeared. I was by myself when this happened, and, being rather uneasy at the incident, went to my wife's apartment; but there, likewise, I was persecuted by the apparition, which, however, at intervals, disappeared, and always presented itself in a standing posture. About six there appeared, also, several walking figures, which had no connection with the first. After the first day, the form of the deceased person no more appeared, but its place was taken by many other phantoms, sometimes representing acquaintances, but mostly strangers: those whom I knew were composed of living and deceased persons; but the number of the latter was comparatively small. I observed that the persons with whom I daily