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ANIMAL AND VEGETABLE LIFE;

THEIR

DEPENDANCE ON THE ATMOSPHERE,

AND

CONNEXION WITH EACH OTHER,

IN RELATION TO THE

FUNCTIONS OF HEALTH AND DISEASE.

BY

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MEMBER OF THE ROYAL COLLEGE OF PHYSICIANS OF LONDON,
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BACON. *Novum Organum.*

Man, as the agent and interpreter of nature, is limited in act and understanding by his observations of the order of nature: neither his knowledge nor his power extends farther.

DEDICATION.

It is gratifying to all engaged in any kind of labour, to reap the fruit of their exertion; but it must be acknowledged to be peculiarly grateful to the feelings of any medical practitioner, at all aware of his responsibility, to be conscious, that he has been in any measure successful, either in relieving the sufferings or prolonging the lives of his fellow-creatures.

I do not arrogate to myself any unusual success in practice; but earnestly desiring that my past efforts and present motives, may be properly appreciated by those who have hitherto honoured me with their confidence; I beg now courteously to request they will allow this Essay to be dedicated to them; in the hope that they may be able to glean from it some of the *principles* dictating the past treatment of them in the hour of sickness; and that, by a careful perusal of its pages, they may render themselves less liable to require, and more able to estimate, when absolutely necessary, the professional responsibilities of

Their devoted,

And faithful Servant,

E. J. SHEARMAN.

Rotherham, May 3, 1845.

PREFACE.

SOME time ago I wrote a short paper on the subject of this Essay, for the purpose of introducing it to the notice of my son, and of inducing him carefully to consult the whole of the sciences bearing upon it, preparatory to his commencing his studies in medicine. At that time I had not even a thought of my views being introduced to the public; had such, indeed, then occurred, I feel convinced this Essay would never have appeared. The *natural* anxiety of a father to facilitate the progress of his son, would, I verily believe, have been overcome, by a strong repugnance to brave the perils and cavils, too often attendant on professional authorship.

As the work proceeded, the interest of the subject, and the variety of its parts, severally and in harmonious combination, so forced themselves on my attention, that I felt *compelled* to look still deeper into it than I had ever done before; and in order that I might more clearly observe for myself, and more distinctly develope this interesting subject to him, for whose use it was intended, I found it necessary to divide it into several heads.

The present Essay is the result. On showing it to a valued professional—perhaps *too partial*—friend, it so won his approval, as to induce him to press me to risk the publication of it. I have done so; and, as it has often before been the case, that gratifying the partial friendship of one, has called forth the hostility of many; so it may be in the present instance. I trust I shall know how to meet it.

My views are now open to the remarks and criticisms, kindly or *keen*, not only of the profession, but also of the public at large. To the greater number, to whom severe criticism appears so witty, and is so *agreeable*, I would observe, that my little experience has taught me to bear testimony, with many before me, that it is much easier to criticise a book than to write one.

Few human hearts can venture a treasure to the winds and waves without trembling apprehensions for its safety. It would be an ample and exceedingly rich reward, could I hope that some of my gentle readers would thus estimate my humble labours. But conscious as I am of the imperfections which abound in these pages; to me, such painful apprehensions cannot extend. As the argosy is not rare, so would not the wreck be fatal. I cannot, however, apprehend general and severe condemnation, as I know there are many who will at least look through these pages with a feeling "more in sorrow than in anger." Should, however, this Essay be condemned by any one who really understands, and has patiently and impartially considered the subject; to the fiat of such a competent tribunal I shall bow with submission.

But, as I am not aware that the whole wide range of this interesting subject has been so closely linked together before; and, as in such respect, I have ventured to estimate it as a perfectly new arrangement; I have to ask, that in this, my first attempt, some indulgence may be extended to me, if I have advanced opinions which do not appear to be fully borne out. And it may be some extenuation, that these sheets have been written, after sustaining that daily fatigue and excitement, which is necessarily attendant on extensive professional practice, when the mind and body require relaxation and repose, rather than close study and renewed toil.

This Essay is principally addressed to general readers of both sexes, and to the junior members of the medical profession. By those who have grown old in this arduous service, and who will therefore be able deeply and practically to consider the merits of such an elementary outline, it is hoped, its claim as such to their candid attention will be recognised.

Should this volume be received in a friendly manner by the public, it may be followed by another, in the same style, carrying out the subject to the operation of the brain and nervous system, organs of sense, and reproduction: having already some notes written on the subject.

In the appendix, I have taken the liberty of copying from the works of various authors, their scientific manner of proving the constituent parts of the various animal and vegetable substances treated of in this Essay, which I have duly acknowledged. But I have particularly to acknowledge, with gratitude, the great assistance I have derived from the perusal of the works of Billing, Bird, Bronguiart, Carpenter, Dumas, Johnson, Liebig, Müller, and Mulder, authors whose works will live long after this Essay has mouldered away in oblivion.

E. J. SHEARMAN.

May 3, 1845.

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PART I.

ON VEGETATION.

Introduction—Composition of the Atmosphere—Soil—Use of Soil—Growth and Food of Plants—Light and Heat—Organic Products of Vegetables—Fibrine, Albumen, and Caseine—Their approach to animal matter.

It has often occurred to me, when replying to questions put by my patients that, if they would give themselves a little trouble, and take time to examine into those general laws which God has given animal and vegetable creation, they would not only be more tractable and patient under sickness, but would be less liable to be affected by disease; because they would be able to avoid those general causes which constantly produce it.

These laws are so few, so uniform in their action, and so simple; that should the perusal of this little essay be of no other use to its readers, it must have the tendency to exalt the admiration of that Supreme Being, whose transcendent skill is so far above that of man, as to be able to keep up animal and vegetable life in so easy a manner.

My object in the following pages will be, to show, as briefly as is consistent with clear explanation, in plain language, devoid of technicalities, *what animals and vegetables are*, and *how* they live. And, as I do not pretend to be writing for professional readers, I hope, by avoiding any observations which might be considered by any one personal, to escape that criticism which I am well aware this Essay will be justly exposed to from purely scientific persons.

As animals live on vegetables, I will first endeavour to describe what *vegetables* are composed of, and how they are supplied with nourishment. But, to understand this, it is necessary to become acquainted with the composition of our *atmosphere*.

The *atmosphere* consists of seventy-seven volumes, or parts, of *nitrogen*, twenty-one of *oxygen*, one and a half of *watery vapour*, and about half a volume of *carbonic acid gas*. You will naturally ask, What is *nitrogen?* It is that substance of which the principal part of animals is composed; existing in the atmosphere as a gas, in nitric acid as a fluid, and in nitre, or saltpetre, as a crystal. *Oxygen* is the supporter of animal life and combustion, existing in the atmosphere as a gas chemically combined with caloric, or heat, and is the acidifying principle in nature. *Water* is composed of two volumes of hydrogen gas and one of oxygen; hydrogen gas being the lightest body in nature, —used for filling balloons. *Carbonic acid gas* is simply charcoal combined with caloric, or heat, and oxygen.

These four bodies, composing the atmosphere, you will find, as we proceed, act a very prominent part in supporting both vegetable and animal life. I do not go into the physical properties of the atmosphere, as that is foreign to our subject.

That portion of the earth in which plants grow is principally composed of what Liebig calls *humus*, or *mould*, which is the product of decayed vegetable matter; but there is clay, coal, charcoal, potash, soda, ammonia, magnesia, phosphorus, sulphur, silica, lime, and iron combined with it: all of which substances are necessary for the growth of plants generally; each family of plants selecting that which is natural to itself.

The soil does not afford that real nourishment for the growth of plants that is generally supposed. It merely supports them in the situation in which they are placed, and allows the air and water to permeate through it to the roots, and absorb the salts which are in a state of solution in the soil, particularly ammonia, lime, potash, and soda.

Plants are composed of carbon, hydrogen and oxygen, with a portion of nitrogen. They possess absorbent vessels, which have the power of *fixing*, or *secreting*, certain parts of gases; much in the same way as the blood-vessels of animals: and they live entirely on gas or air. This is absorbed by the roots in the mould, and the leaves in the atmosphere.

Plants feed upon *carbonic acid gas*, *water*, and *ammonia*. Carbonic acid gas, which we shall afterwards find principally proceeds from animals, is taken up by the absorbents, which fix the carbon in the plant, and give out, or exhale, the oxygen gas, which is the great supporter of animal life. They also take up water, decompose it, fix the hydrogen in the plant, and give out part of the oxygen. And they absorb ammonia, (which is composed of three volumes of hydrogen and one of nitrogen,) that they meet with in the soil as well as the air, and fix both its hydrogen and nitrogen.

Lignin, or that part of plants which constitute wood, hemp, flax, &c.; and the sugar, gum, starch, oil, &c., of plants in general, contain no nitrogen, but are altogether composed of carbon and water. But wheat, beans, peas, grapes, &c., are composed of nitrogen and carbon, with the elements of water.

Light and heat are necessary for the perfection of these functions in plants; consequently they go on better in summer and by daylight, than in winter and by night. Without the sun, vegetation would cease to exist. During the night, vegetables merely absorb the gases through their vessels; and, for want of light, neither fix the carbon, hydrogen, or nitrogen, but may be considered to be dormant, or at rest. Consequently, plants improve the atmosphere in houses by day, by absorbing carbonic acid gas, and giving out oxygen, but deteriorate it by night.

We thus see that the vegetable kingdom is the great producer of organic matter. Plants live on the air; and from the air, not only form organic vegetable matter capable of giving nourishment to animals, by supplying them with carbon for *respiration* and *fat*, and also with nitrogen to construct their muscles and other tissues; but constantly give out that sort of gas which enables animals to breathe and live.

The various products of the vegetable kingdom are so numerous that it would almost fill a volume of this size to enumerate them. For instance, sugar, starch, gum, vegetable acids, oil, wax, resin, &c., are all composed of oxygen, hydrogen, and carbon only; but, by a re-arrangement of their atoms, and combining with nitrogen and small quantities of various salts, they are changed into gluten, or fibrine, and albumen, and become the most nutritious aliments for both man and herbivorous animals; suited to all climates, species and ages; from the delicious pine and grape, which is the luxury of the rich, to the common grass, which is the natural food of the lowest of the herbivora.

It is not my intention to go so minutely into the physiology of vegetables as that of animals. What I wish to impress upon the reader is, the simple and beautiful mode in which God has ordained that vegetables should grow, for the purpose not only of supplying animals with food and air, but with medicine, adapted to relieve the diseases produced by the wear and tear, and accidents of the organs of the animal system.

All the products of vegetation, rich in nitrogen, necessary for the nourishment of animals, resolve themselves into three substances,—viz., *vegetable fibrine, or gluten,* found in greatest quantity in wheat and the juice of grapes, and being almost identical with the fibrine of the blood: *vegetable albumen,* found principally in seeds, and is similar to the white of eggs and serum of the blood, coagulable by heat; and *vegetable caseine,* found in peas and beans in abundance, like the curd of milk.

The rest of the nitrogenous products of vegetation are principally poisonous, and are rejected by herbivorous animals. But they are found of immense value in stopping the progress of disease, or in assisting nature to repair the consequences of its ravages, and doubtless were originally ordained for that purpose.

PART II.

ON DIGESTION, THE CIRCULATION OF THE BLOOD, AND ANIMAL HEAT.

Nature of Food—Process of Digestion—Mechanism and action of the Heart—Lungs—Nature of Chyle—Union of Chyle with the Venous Blood in the right side of the Heart—Composition of Blood—Influence of the Brain—The Mind—Passage of Venous Blood from the Heart into the Lungs—Action of the air on the Blood in the Lungs—Cause of animal heat in the Lungs—Passage of Arterial Blood from the Lungs to the left side of the Heart—Circulation of Blood in the Arteries—Capillaries—Generation of animal heat all over the Body—Return of Venous Blood to the right side of the Heart—Theory of the Circulation—Various sounds in the Heart and Lungs taken as signs of Disease, and their utility.

THE animals that feed on vegetables exclusively are called herbivorous, and are destined for the food of man and carnivorous animals. As the food of man (an omnivorous animal) contains every variety of animal and vegetable substance, it will be the easiest mode of explaining the process by which all animals live, if we take man as the specimen.

Our aliment is composed of carbon, hydrogen, nitrogen, and oxygen, with small quantities of soda, potash, lime, magnesia, phosphorus, sulphur, and iron; together forming animal and vegetable *albumen*, *fibrine*, and *caseine*.

After mixing with the animal secretions of the mouth by mastication, the food goes through the œsophagus, or gullet, into the stomach, where it chemically combines with the gastric juice, and then assumes the name of *chyme;* it then is urged through the pyloric extremity of the stomach (which is composed of a great number of glands, supposed to be necessary to perfect digestion) into the duodenum, or beginning of the small intestines, where it meets with the bile from the liver, and pancreatic juice from the pancreas. These fluids intimately mix with the chyme, and have such an effect upon it, as to prepare those soluble parts of it for being absorbed into the blood. This is called *chyle ;* it is a white, homogeneous fluid, principally composed of albumen and fibrine.

As the digested matter is forced through the small intestines by their peristaltic motion, the chyle is absorbed by the lacteals, taken through a set of glands called mesenteric ; and from thence they all join in one vessel called *receptaculum chyli,* which carries the chyle into the veins, just before they enter into the right side of the heart ; thus keeping up a constant supply of chyle for the purpose of being converted into blood.

That part of the food which is insoluble, and not absorbed as chyle, is carried forward through the small intestines ; from thence into the colon and rectum ; and discharged as fæces.

Having traced the chyle to the venous blood, we will now endeavour to pursue it through its course in the circulation ; for the purpose of ascertaining what becomes of it. But, to understand this subject, it will be necessary to know something of the mechanism of the heart and lungs.

The heart is a double-actioned force pump, composed of a very powerful muscle ; so strong, as to be capable of forcing fluid through it seventy times in a minute for seventy years in succession, without being deranged. But when its mechanism is perfectly understood, its diseases are comparatively easy of detection, although difficult of cure.

It is composed of two sides: the right and the left: in fact you may call them two hearts; as the right side has no connexion with the left after the animal breathes, except through the lungs. Each side is composed of an auricle and a ventricle: a vein to bring the blood into each auricle, and an artery to carry it out of each ventricle; there is also a strong valve between each auricle and ventricle: and three valves, acting together as one, at the mouth of each artery where the ventricle terminates.

The *lungs* are principally composed of the minute ramifications of the artery that carries the blood out of the right ventricle, and the vein which brings the blood back into the left auricle of the heart; together with the minute subdivisions of the bronchial tubes, ending in the *air cells.* This is formed in so beautiful a manner, that it becomes a sort of spongy tissue, capable of allowing all the blood which goes through the right side of the heart to be freely exposed, through a very fine membrane, to the action of the atmospheric air: and, after being so exposed, to return back to the left side of the heart, from whence it is thrown all over the body in the arteries. These arteries terminate in very minute vessels called *capillaries:* and these capillaries terminate in the veins again, which end in the right auricle of the heart.

We left off in describing the process of digestion where the *chyle* was just mixed with the venous blood. We have seen that chyle is composed of albumen and fibrine, with some salts, phosphorus, sulphur, lime, and iron. *Blood* is also composed of albumen and fibrine, with the same kind of salts. And this albumen and fibrine, with the water of the blood, consist of these four simple chemical substances: *carbon*, *nitrogen*, *hydrogen*, and *oxygen*.

The colour of the blood is owing to its globules, which are composed of what Leibig calls *proteine*, combined with iron in a certain state of oxidation. Proteine being merely the chemical term for the animal combination above-mentioned in the blood.

Venous blood is a *dark red* colour; and its globules are very minute *transparent double convex lenses*. *Arterial blood* is a *light florid colour*, and its globules are *semi-opaque double concave* *lenses*. These are easily seen through a powerful achromatic microscope.

It is an established fact in natural philosophy that transparent convex lenses, absorb; and opaque concave lenses, reflect, the rays of light.

Having thus shortly explained the mechanical parts concerned in the circulation, it is necessary to observe that every animal has a *nervous system*, consisting of a *brain* and *spinal marrow;* from which nervous filaments proceed, as from a galvanic battery; carrying sensation from the brain, and motion from the spine. This nervous system, as we shall find further on, is kept in order by the absorption of the chyle, in the same way as our muscles and vital organs are nourished; and, of course, is a principal part of every animal body.

But, as it would lengthen this essay too much to enter fully into the explanation of the brain and nerves, I will merely say here, that the *brain* is the organ of the *mind*, and is dependent upon animal matter for its supply in the human species, in the same way as in all other animals. The only difference between the brain of man and animals is, that of man is more highly organized, and capable of cultivation to any extent.

The *mind* and the *soul* are not identical. Animals have minds, which are called instinct. The *soul* is that part of man which is indestructible—and lives for ever. But the mind of man evidently depends upon the organization of the brain; and, when the organs cease to act—in death; the brain, and consequently the mind, is, as will be discovered as we proceed, converted gradually into gas; to supply the wants of vegetable matter, in the same way as the rest of the animal creation.

The two great veins, called by anatomists superior and inferior venæ cavæ, enter the heart at the right auricle, together with the chyle: the auricle admits of its being gradually filled. But, at this instant, the right ventricle, having contracted, and sent its blood into the lungs, relaxes, and admits the venous blood through the tricuspid valve, into the cavity of the ventricle, which it fills, and stimulates to immediate contraction; the tricuspid valve closing and preventing the blood returning back into the auricle. The contraction of the ventricle is sufficient to send the blood through the valves of the pulmonary artery, into the lungs, which it fills with blood; and the three semi-lunar valves of the pulmonary artery immediately close, and prevent the blood returning into the ventricle. The mode in which the venous blood gets to the right auricle of the heart will be explained hereafter, on the hydrostatic principle of fluid in bent tubes finding its level.

The blood is now in the *lungs*. Let us see what it is composed of; and what it meets with in the lungs. You are now aware that it is composed of carbon, nitrogen, hydrogen, and oxygen, with small quantities of soda, potash, lime, magnesia, sulphur, phosphorus, and iron, and the double convex venous blood discs; forming *water*, *albumen*, and *fibrine*. It meets with the atmospheric air in the lungs.

Every time we inspire, we take in about twenty cubic inches of atmospheric air, which is a mixture of oxygen gas and nitrogen gas. Oxygen gas being composed of oxygen and caloric or heat. And every time the right ventricle of the heart contracts, it sends into the lungs between two and three ounces of blood. The whole quantity of blood in an adult man being about twenty-five pounds, or one-fifth part of the weight of the whole body.

It is an established chemical fact, that whenever carbon or iron are exposed to oxygen gas at the temperature of 50° or upwards, a chemical decomposition, or combustion, takes place: the carbon combines with the oxygen of the gas, and is converted into carbonic acid gas—liberating a very large quantity of caloric or heat. The iron combines with a portion of oxygen, and becomes an oxide of iron, and also liberates heat; and whenever hydrogen and oxygen meet in the chemical laboratory, under the influence of galvanic action, they are decomposed; water is formed, and heat set free. The nerves supplying the lungs sufficiently account for the galvanic battery.

There is much more carbon than nitrogen in the venous blood. It is composed of minute *double convex transparent globules* of *proteine;* which, in other words, consist of carbon, hydrogen, nitrogen, and oxygen, with hydrated *prot*-oxide of iron, or iron combined with one proportion of oxygen; and this peculiar oxide of iron, together with the transparent convex globules of the blood, which *absorb light,* is pretty well established as the cause of the dark colour of venous blood.

These globules are immediately exposed to the action of the oxygen gas of the atmosphere; a chemical decomposition takes place; the carbon unites with the oxygen of the oxygen gas; combustion ensues; carbonic acid gas is formed and exhaled; and heat given out.

Some of the hydrogen unites with another portion of oxygen gas; water is formed, which is exhaled as watery vapour, and heat is liberated.

Another portion of the oxygen gas combines with the hydrated *prot*-oxide of iron; the oxygen converts the *prot*-oxide into *per*-oxide; or, in plain terms, gives it an additional quantity of oxygen: changes the dark colour of the iron into a *bright red;* and changes the *double convex* form of the blood discs, into *semi-opaque double concave reflecting lenses;* which, instead of absorbing light, as in venous blood, reflects the light, and gives the blood in the arteries that vivid bright scarlet colour which denotes arterial blood.

These three chemical actions going on together in the lungs, give out so much heat, as to satisfactorily account for the animal heat of the lungs.

It is calculated that thirteen ounces and a-half of carbon are daily consumed by an adult man, and converted into carbonic acid gas, causing as much heat as would raise 370 pounds of water from 32° to the temperature of the blood.

Some years ago Dr. Black made some very interesting experiments to discover the mode in which animal heat is kept up all over the body; and his theory was, that arterial blood had a greater capacity for heat than venous:—holding it in a latent state; and that when the arterial changed into venous blood in the capillaries, the latent heat was made sensible, in consequence of the incapability of the venous blood to take it up. This theory is now quite exploded. It did not account for the necessary supply of nourishment to those tissues which are constantly wearing out in all animals. But the present theory, originating with Liebig and Mulder, not only accounts for the degree of heat being the same all over the body, but very satisfactorily explains the process by which the supply is kept up.

Having accounted for the animal heat in

the lungs, let us now consider what becomes of the blood after it has mixed with the oxygen gas of the air in the lungs.

We find the globules of blood are changed from *convex transparent absorbing lenses*, to *semi-opaque double concave reflecting lenses*, merely by *combining with oxygen*. This blood, called arterial, is brought back to the *left auricle* of the heart by the *pulmonary veins ;* and the *left ventricle*, having just before contracted and sent out its blood, relaxes; and the arterial blood from the left auricle flows through the *mitral valve*, fills the left ventricle, and excites it to contraction; the mitral valve closing, and preventing the blood returning to the lungs. From thence the blood is sent through the three *semi-lunar valves*, to the *aorta*, which distributes it all over the body; being prevented from returning by the valves of the aorta immediately closing. The blood now is conveyed, through the arteries, to the capillaries, which are found all over the body; and it goes from them into the veins, which end in the right side of the heart.

The blood flows quietly through the arteries the division of them, from large to small, adding; to its free circulation. But when it gets to the *capillaries*, which are such fine vessels as not to be larger than a hair, it meets with the carbon, nitrogen, and hydrogen of those tissues of the different organs and muscles of the body which have been used, or decayed; and the oxygen of which has been expended.

The oxygen of the hydrated *per*-oxide of iron now combines with the carbon and hydrogen of the decayed tissues, and converts them into carbonic acid and water, just as it did in the capillaries of the lungs before. Heat is given out by this chemical combination or combustion; and thus accounts for the animal heat of the whole body.

The fibrine and albumen (proteine) of the blood, is deposited to supply the waste, just in the same proportion as the disintegrated tissue is taken away by the veins. The blood-discs are again, by losing their oxygen, changed from *semi-opaque reflecting double concave lenses*, to *transparent convex absorbing lenses*, and the iron, by losing its oxygen, is changed from *per*-oxide, which is *bright*, to *prot*-oxide, which is *dark red*. In fact, the blood is again converted into venous. The *supply to the system* is kept up, and the *animal heat* is kept up.

Let us now endeavour to account for the easy mode in which the blood is thrown out from the heart, and returns again to it without any difficulty: notwithstanding the animal body is constantly changing its position.

The heart *contracts* and *relaxes* alternately. The *contraction* of the ventricles is owing to the natural stimulus of the blood. The *relaxation* is the state of rest or sleep. The contraction of the ventricles keeps up a regular stream, constantly flowing, similar to the constant current of air issuing from the bellows of a smith's forge.

It is an established fact in hydrostatics, that *a fluid in a bent tube will return to its own level.* The left ventricle of the heart need not exert itself very much to throw the blood down the body; for fluids always run down hill easily: its principal effort being required to throw it upright and horizontal into the head,—which it has sufficient muscular power to do. The blood runs down hill in the veins from the head and neck, to the heart; and the simple hydrostatic principle of a fluid in a bent tube finding its own level, brings the blood up from the feet into the right auricle of the heart. The natural relaxation of the ventricles allows the blood to fill them while they are reposing after each contraction, and the natural stimulus of the blood excites them to contraction shortly after they are filled.

How simple and beautiful is this mechanism of our circulation! The ordinary laws of hydrostatics, which we observe unheeded, every day of our lives, accounts satisfactorily for one of those processes of animal life which, at one period seemed to elude the discovery of man.

Every time we breathe and move; each time our heart throws out its blood; every action of our lives—tends to wear us away! Our tissues and muscles are made of the same animal matter as those of other animals, and are continually wearing out. This is proved by the quantity of excretions constantly coming away from us, in the forms of perspiration, expiration, urine and fæces. Everything in nature has a tendency to decay. When we clean our teeth, we wear out our teeth as well as our tooth-brush. But, by conveying albumen and fibrine again into our blood, we keep up the necessary supply. In youth, we complete our growth, by taking in a much larger quantity of carbon and nitrogen than we require; and, in adult age, are enabled to prevent the wear and tear of the system necessarily connected with our occupations.

It will be readily seen that this process, simple and beautiful as it is, cannot go on, if the organs through which it has to pass are out of order; any more than a watch or a steam-engine can act steadily when their mechanism is broken. This is not the place to enter into the nature of the diseases of these organs; but it may be useful shortly to examine into the methods by which we can distinctly and positively detect the various changes which disease brings on in the organs of the circulation.

Every motion in nature produces a certain sound. We hear the wind whistle and the torrent roar: the flute and the trumpet give their natural tones. The air enters the lungs by the bronchial tubes, which are branches from the wind-pipe, and goes from them into the air-cells, producing a certain natural sound which is called *vesicular*. The lungs, being filled with air, ought to sound on percussion, hollow, like an empty barrel, the ribs being its hoops. And, in the healthy condition, the vocal resonance is of a peculiar muffled character; such as you would expect to hear in a person speaking to you through a large sponge filled with air.

If the bronchial tubes become inflamed, the inner membrane not only becomes thickened, but a secretion of an adhesive substance remains in them, which immediately alters the sound, according to the degree of the inflammatory action. Or, if spasmodic action of these tubes exist, preventing the air from entering the lung, no sound can be heard. Or, in inflammation of the lungs, the very fine vessels become half clogged up by a tenacious fluid; and the air, rushing in through this fluid in them, gives a peculiar crepitating sound, decisive of the state of the organ.

Again, all states of inflammation, and nearly all diseases of the lungs, produce that sort of condition which thickens, or consolidates, their fine spongy texture. And then the voice assumes a very different sound: being conducted better to the ear of the listener. And the sound on percussion, instead of being hollow and resonant, is flat and solid.

In the very beginning of tubercular consumption, long before there is any cough, debility, or any other visible symptom, it is a very easy task to a person well acquainted with the nature and cause of the different sounds of the breathing, voice, and resonance of the lungs, to discover, by their physical signs alone, the commencement of that incurable and unmerciful disease: and, of course, to adopt proper precautions, before the complaint has made so much progress as to be too late to repair. Whereas if such knowledge is not applied to a case of this description, it is left alone until cough and difficult breathing make their appearance; which symptoms are too often treated as inflammatory. The unfortunate sufferer is lowered by a weakening system of treatment, and soon brought into that condition which renders all human assistance unavailable. These remarks might be continued to an almost indefinite extent; but enough has been named to secure the attention of the reader.

We will now go to the circulation of the blood through the heart. By referring back, it will be found there are four valves to the heart; every one of which must be in action every time the blood goes through it. In ordinary circulation there are two natural sounds of the heart constantly heard, caused by the action of the ventricles and valves. By carefully studying the circulation of the blood through the heart, it becomes very easy to discover, by the different sounds elicited, at the proper spot, and at the proper time, *where* any disease in the heart exists.

For instance, if at the place where the valve exists between the right auricle and ventricle, you have a peculiar grating sound just at the time the ventricle contracts to send the blood into the lungs through the pulmonary artery; and, at the same time you see the jugular veins pulsate in the neck, you may be certain there is such a state of disease in that valve, as to allow some of the venous blood to rush back into the large veins every time the right ventricle contracts. And what will be the consequence? The lungs are imperfectly supplied with blood; there is less arterial blood circulating in the brain, and the system at large; the supply of nourishment and nervous power to the system is less; the patient grows weaker on that account; and the blood accumulates in the veins, producing dropsy. This is not so common a case as the following.

A peculiar murmur is heard at the spot where the mitral valve exists, between the left auricle and ventricle, just when the ventricle contracts and sends the blood into the arteries. This shows that some of the blood goes back into the lungs at each contraction of that ventricle. The lungs are constantly gorged; blood will be coughed up frequently; and less arterial blood being sent into the arteries, the supply of the waste of the system cannot go on to any extent; and the lungs, being constantly congested, prevents even the blood that goes through them being properly arterialised. There is a blue colour of the skin, but no dropsy. Every other derangement of the heart is as easily understood as those just described, and from the same unerring rules.

But it is not the physical signs alone, of disease, which are discovered from a correct knowledge of these simple laws of nature. The origin, progress, and ultimate consequences of most diseases of the heart and lungs, can be thus easily and clearly explained.

To return to a case of consumption—which I take as a specimen, because of its frequency of occurrence aud great mortality. It commences in a habit predisposed to that imperfect state of assimilation, digestion, and circulation, closely allied to scrofula. There is a deficiency of fibrine in the blood, and of energy in the muscular system. The first effect of the disease is to prevent free circulation of the blood through the capillary vessels of the lungs, and of the air through the fine bronchial tubes. This can be discovered by listening to the respiration. It gradually produces *congestion* (fulness) of those vessels; which increases, owing to the constant effort of breathing. The tubercles, which are very small particles of almost inorganic matter, then become inflamed, and increase the irritation by exciting the secretion of mucus around them, which must be coughed up. This cough adds to the irritation. At length, a part of the lungs becomes almost solidified, and admits the air with such difficulty that the sound of expiration is louder than that of inspiration. The tuberculous matter, being incapable of absorption, *softens*; and, acting as a foreign body in the lungs, brings on ulceration, until it reaches a bronchial vessel large enough to admit of its being coughed up through it. The tuberculous matter is thus expectorated: the part from which it proceeds is in some degree emptied; an effort is made by nature to repair the ravages of disease; but the consequence is, there is a *cavity* formed in the lungs, which constantly secretes *pus* or matter, and eventually this cavity becomes lined with a sort of membrane sufficiently dense to give to the voice so peculiar a sound, as to make this a special physical sign of such a cavity. At this period, every time the blood goes through the heart and lungs, there is less arterial blood formed; and that of a description not capable of repairing the ravages of the disease. By-and-bye, pus is continually secreted from the blood in the lungs, and this is often in large quantities in such cavities; part of this is coughed up, but a great deal is absorbed into the blood, and circulated as a poison in the system. This is proved by discovering the pus globules by the microscope in the urine. Hectic fever, the consequence of the circulation of pus, gradually decreases the quantity of blood in the body, proved by the hectic sweats and copious expectoration. The poor sufferer becomes more and more emaciated! And, under such circumstances, how can we expect to find a cure? No; it is only by discovering this disease in the *very first stage*, and by a generous diet, and tonic course of medicine, to increase the quantity of fibrine in the blood, and energy in the system; and a regulated temperature, to prevent as much as possible, the alterations in the respiratory movements, and the effect of atmospheric changes on the vessels of the skin, that any real lasting good effect can be produced.

The physical examination of the chest is called *percussion* and *auscultation*. *Percussion* denotes the resonance of the chest; and *auscultation* conveys to the ear the different breath-sounds in the lungs, and muscular and valve sounds in the heart. These are all best heard through a *stethoscope*, because it conveys sound better to the ear than air does. But that instrument is of no use in discovering the seat of disease, or what the disease is, unless the listener is fully acquainted, not only with the natural sounds, but the mechanism and physiology of the parts in health; and the pathology of them under disease.

The following table of temperature, pulse and respiration, in different animals, will be found useful.

	Mean temperature by Fahrenheit.	Of the pulse in the minute.	Of the inspiration in the minute.
In Birds	106° to 117°	110 to 200	21 to 34.
Guinea pig	100°	140	36.
Dog	99°	90	28.
Cat	101°	100	24.
Goat	102°	84	24.
Hare	100°	120	36.
Horse	98°	56	16.
Man	98°	72	18.
Child	102°	120	24.

PART III.

THE SECRETIONS AND EXCRETIONS OF ANIMALS.

Mode of Secretion—Division of Subject—Gastric Juice—How secreted—Contents—Digestion—Spleen—Hunger—Animal and Vegetable Food—Bile—How secreted—Contents—from Carbon of decayed Tissues—Taurine—Chylification—Absorption of Chyle—Rejection of Fæces—Pancreatic Fluid—Urine—What it is, and how secreted—Contents of Urine—Urea, Uric Acid, and Water—Quantity—Urine of different Animals—Carbonate of Ammonia—Effect of disease on Urine—The Brain—Lungs—Liver—Kidneys the safety valves—Perspiration—Quantity of Water and Nitrogen perspired—Effect of Exercise—Evaporation cools the body—Heat in Fevers—Absorption by the Skin—Impossibility of curing diseases by acting solely on the Skin—Milk—Properties—Butter—Cheese—Sugar—Mode of nourishing the Infant—Substitute for Milk—Properties of Sheep, Goat, and Asses' Milk—Mode of feeding Cows to produce either Butter or Cheese.

The various secretions which enable us to digest our food—as saliva, gastric and pancreatic juices, and bile: and those which enable our organs to move easily—as the synovia in the joints, the serum in the bag of the heart and between the ribs and the lungs in what is called by anatomists the pleura, &c.; the milk to nourish the young; and the urine, which removes the decayed tissue away; are all formed from the blood.

The arteries, when supplied with proper nerves, have the power of secreting that peculiar kind of fluid from the blood, which the various organs require. The real cause of this principally depends upon that peculiar galvanic power which the nervous system has over the various organs: and, to fully explain, would take up too much room, and carry the reader beyond the intention of such a treatise as this.

But there are a few secretions so necessary for the healthy condition of the animal organism, that it will be proper shortly to examine into their nature: viz. gastric juice, bile, pancreatic fluid, urine, perspiration, and milk.

GASTRIC JUICE.

The gastric juice is secreted by a great number of arteries which supply the stomach. It looks like saliva; is acid to the taste: and contains much free muriatic, and some acetic acid (vinegar). The muriatic acid proceeds from the common salt which is taken into the blood with the food: and the acetic acid is the product of a decomposition of part of the saccharine matter of the food. It also contains muriates and phosphates of potash, soda, magnesia, and lime.

Gastric juice has the property of chemically dissolving all animal and vegetable food, after they have been well masticated and mixed with the saliva; and it is pretty well acknowledged that digestion is a purely chemical process. It requires the temperature of 100° to allow this process to go on uninterruptedly: and therefore the practice of drinking iced water, wines, &c., during dinner, and taking iced creams afterwards, is very injurious.

When the stomach has no aliment in it, the blood which is usually sent to it for the purpose of forming the gastric fluid, is conveyed to the spleen—which acts as a sort of reservoir to the stomach. This prevents the feeling of hunger coming on during the necessary period of time between meals.

The sensation of hunger is caused by the action of the gastric juice upon the mucous membrane of the stomach, when it contains no aliment capable of being dissolved by it.

The kind of animal food which is easiest of digestion is the flesh of wild animals; then mutton, beef, venison, turkey, chicken, pork, and lastly, veal. All these are more digestible roasted than boiled. The reason why fat bacon is found so useful in cases where too much bile is secreted is, that in the bile, which then gets into the stomach, there is a great deal of alcali (soda), which combines with the fat of the bacon, and is converted into a nutritious kind of soap, of an aperient quality.

The digestible vegetables come in the following order: viz. asparagus, sea-cale, cauliflower, celery, artichokes, white bread two days old, brown bread without too much bran, turnips, mealy potatoes, parsnips, salad dressed with oil, red and white cabbage, beet root, onions, leeks. carrots, radishes. But all vegetables are more digestible when cooked.

To facilitate the action of the gastric juice, salt, spices, mustard, horse-radish, capers, wine and spirits, sugar, and bitter vegetable infusions, in small quantities, are found very useful in the generality of habits.

BILE.

The bile is an exception to the general rule of secretions. This fluid is secreted by the veins: every other secretion comes from the arteries. There must be some good reason for this; which we shall find out as we proceed. In describing the process necessary for the liberation of animal heat, it was particularly mentioned that our food consisted of more carbon than anything else; and it was shown how a great deal of carbon was used in respiration, forming carbonic acid gas in the lungs, which was constantly expired, with the nitrogen of the atmospheric air. Bile is principally composed of carbon and soda; is a necessary fluid for the process of digestion: indeed, digestion cannot go on without it: too little, too much, or an unhealthy state of bile, soon brings on what is called indigestion, with all its accompanying symptoms of debility.

From whence does this bile arise? The arterial blood, we have seen, supplies the waste of the system by filling up, in the capillaries, what the veins take back again to the heart. But, if the heart was again charged with all the disintegrated carbon which exists in the decayed tissues, the lungs would become overloaded with carbon, and the blood could not be arterialized.

Nature has provided a remedy for this. The venous blood from all the abdominal viscera, except the kidneys, bladder and uterus, join; and form one large vein, called by anatomists, vena portæ; which immediately goes to the liver; and from which the carbon and soda, which forms the bile, is secreted. The liver is kept alive by the arteries which supply it—like all other organs; but the bile is derived from the veins, which come from a very large proportion of the body.

This, then, is one mode which nature has adopted to rid the animal system of the principal part of the carbon of those organs which have been labouring. The nitrogenous part of the bile is called taurine: and we shall see, in a future part of this essay, that this principle finds its way into the liver, from the use of the agreeable beverages of tea and coffee.

After the bile is secreted in the liver, it is poured out of it by a small bile-duct, which goes immediately to the lower part of the stomach, where it becomes intestine—called the duodenum. There is also a reservoir for the bile, (the gall-bladder,) where it lodges and accumulates, when the process of digestion is not requiring a supply.

Every time food is introduced into the stomach, after the gastric juice has dissolved it, and formed it into chyme, the peristaltic motion of the intestines urges it through the pyloric orifice of the stomach, where it mixes with the secretion from its glands; and from thence it goes to the duodenum, where the bile mixes with it in large quantities, and the pancreatic juice (also coming in a duct from the pancreas) joins it.

The united effect of these two fluids upon the chyme is to separate it into soluble chyle, which is absorbed into the blood, as explained before; and insoluble excrement, which is gradually expelled through the anus. The excrement or fæces consists of the insoluble salts and carbonaceous matters of the chyme and bile; substances which are of no use to the animal organism; and if not voided, would produce disease. They are not really of that value as a manure which they have generally been considered to be; because they contain scarcely any nitrogen: the whole of the decayed nitrogen going off through the kidneys in healthy animals except in birds.

Those who are well acquainted with this process, can readily detect, from the symptoms, when there is a deficiency, redundance, or unhealthy secretion of the bile: but it will be readily admitted that remedies directed to the liver alone, could not in all cases have any chance of restoring this organ to its healthy condition.

PANCREATIC FLUID.

The pancreatic fluid is secreted from the arteries distributed to the pancreas, much in the same way as the gastric juice is. This fluid resembles the saliva in its appearance; it is slightly acidified by acetic acid, and contains phosphate of lime and soda, chlorides of sodium and potassium, and lactates of soda and potash. Its use has been described in connexion with the bile.

URINE.

Urine is the secretion destined to remove from the animal system any excess of fluid; any mal-assimilated food; and the whole of the nitrogen, with a portion of carbon returned into the veins from the decayed tissues. It is therefore both a secretion and an excretion; and is of the greatest importance to the animal organism.

If, from any cause, the secretion of urine is prevented, the decayed nitrogen is absorbed into the venous blood again, carried through the lungs, and circulated as an animal poison in the arteries; producing very serious disease.

The nitrogen and carbon from the decayed tissues which are given off in the urine appear chiefly in the forms of urea and uric acid;

which combine with the different salts they meet with in the urine, forming urates of ammonia, soda, &c. They are composed of nitrogen, carbon, hydrogen, and oxygen; and are formed by the re-arrangement of the atoms of water, nitrogen, and carbon, sent to the kidneys by the renal arteries.

After the blood has been injected from the left ventricle into the arteries, a very large quantity is sent to the kidneys by the renal arteries; which separate that portion of nitrogen which has been given off in the capillaries from the disintegrated tissues in the form of urea and uric acid; together with a large quantity of water.

The amount of tissue metamorphosed or used in a given time, may always be measured by the quantity of nitrogen (uric acid or urates) in the urine. And that condition of the body which is called health, involves the conception of an equilibrium among all the causes of waste and supply.

In addition to urea and uric acid, healthy urine generally contains small quantities of hippuric acid, phosphates of soda, ammonia, lime, and magnesia; salts of potash; chloride of sodium: sometimes sulphates; and colouring matter.

A healthy adult voids from thirty to forty ounces of acid urine, of the specific gravity of 1·020; containing about eight grains of uric acid, two hundred and fifty-five of urea, one hundred and thirty-eight of fixed salts, and one hundred and sixty of other organic matters, in twenty-four hours; and is of a pale amber colour.

The urine of herbivorous animals is always alcaline, and contains a large quantity of hippuric acid. The urine of carnivorous animals is always acid, and contains principally uric acid. But the urine of omnivorous animals, as man, is acid; unless when fed exclusively on vegetable diet; when it becomes alcaline.

It always contains more water, and is lighter, after drinking freely of water; and contains less, and is heavier, after copious perspiration and in hot weather.

The vessels of the skin are intimately connected with the kidneys; for, if that part of the nitrogen which ought to pass through the skin, is prevented, by checked perspiration, intense cold, or any other cause; it is always found that the urine is immediately more loaded with urea or urates, in some form or other.

When urine is left to itself, it is converted into a solution of carbonate of ammonia. The carbon of the urea combines with the oxygen of the water, and is converted into carbonic acid: the nitrogen combines with the hydrogen of the water, and becomes ammonia. Heat is, of course, generated and given out.

This carbonate of ammonia, we shall find, as we proceed, is the very best food for plants; and in this country has, hitherto, been completely lost to the agriculturist. In some parts of the continent, the whole of the urine of large cities is saved and collected every day, and used as tillage for wheat; by which means the crops are so abundant that they are enabled to compete with their neighbours to great advantage.

Whenever there is disorder or disease in any of the organs essential to life, whether in the brain, chest, or abdomen, the nature and contents of the urine always show such derangement.

Every substance in nature is composed of atoms; and every salt assumes a certain form of crystal; from the common salt which we eat every day with our food, to the mineral arsenic which is the most deadly poison. Under all circumstances, and in all situations, this law of nature exists.

This crystalline form of all salts aids us very much in discovering the various changes which the urine undergoes in disease. With the aid of a powerful achromatic microscope, we may, in a short time, distinguish between the rhomboid or square crystal of uric acid, which is a healthy salt, and the splendid octohedral crystal of oxalate of lime, which is the product of disease. And this knowledge, connected with the chemical analysis of the urine, is found of immense importance in detecting obscure diseases.

For instance; it is well ascertained that the brain differs from other organized parts of man, by containing phosphorus and phosphates in great abundance. A person excites his mental faculties to a very great extent in a hot debate in parliament, or in any other way; without, at the same time taking sufficient walking exercise. Or, a poor curate, who reads the service and preaches three or four times on a Sunday for a small salary; and in order to support a large family, is obliged to keep a school, to which he attends closely and conscientiously every day in the week, at length becomes debilitated, and unfit for his accustomed duties. There may be no regular disease discoverable. But, on examining his urine, there are abundant phosphates of ammonia and magnesia found, in prismatic or foliacious crystals, which are accounted for in consequence of the extra wear of the phosphates of the brain, which are absorbed by the veins, and brought by the renal arteries to the kidneys to be excreted.

Or, a patient presents himself in great debility, with cough and heavy expectoration, loss of flesh, night sweats, rapid pulse and respiration. I need not go into the signs which may be discovered by listening to the sounds of the chest, &c. Examine his urine, and there will be found a great excess of urea and urate of ammonia, with globules of pus. The tissue of the lung has given way from disease: nitrogen is absorbed into the veins in great quantity, along with the pus secreted by the inflamed capillaries in the lungs; the circulation generally is weak, rapid, and unable to secrete pure urea; it therefore is converted into carbonate of ammonia, as it would be out of the body; the uric acid combines with the ammonia, forming urate of ammonia in very large quantities; and the pus globules are seen under the microscope.

This is found in all cases of pulmonary consumption.

Take a case of inflammation of the liver—where the carbon, which ought to be taken from the venous blood returning from the abdominal viscera through the liver, fails to be secreted from it. It is an established fact, that in all cases of inflammation of an organ, healthy secretion is suspended. What is the consequence? We find hippuric acid in the urine, which is principally composed of carbon, and fat in the blood: nature being able to convert the carbon of the bile, by an additional quantity of oxygen which it meets with in the capillaries, into fat.

We therefore see clearly, that the kidneys are safety valves to other secreting organs of the animal economy. While they remain healthy, and act freely, the human body will bear, for a length of time, an immense quantity of disease; but, let them once cease to act, and, in organic disease, all is soon over.

This subject might be carried much farther. But this is not a treatise on disease; but one, more especially directed to healthy organs. Cases have been selected from the brain, the lungs, and the abdomen, merely to convince the reader of the importance of the knowledge of this secretion to the medical practitioner: who, however skilful and observing—however long in practice—is constantly meeting with cases of disease difficult to detect the origin of; and, until that can be done, his treatment of them must be empirical.

The knowledge which the chemical contents of the urine gives in such cases, is as invaluable and certain, as auscultation and percussion is to the detection of diseases of the lungs and heart.

PERSPIRATION.

The perspiration in human beings is a subject of much importance. The skin is the same kind of continuous mucous membrane which lines the mouth, alimentary canal, &c. It also lines the secreting surface of the kidneys. It is plentifully supplied with capillary blood-vessels, absorbents, and veins. It therefore possesses a secreting and excreting, as well as an absorbing surface.

It is ascertained, that about thirteen ounces of watery fluid is excreted from the skin of a healthy adult, in the form of insensible perspiration every twenty-four hours; and this is loaded with the nitrogen which is taken into the stomach with the food, in the form of nitrogen gas of the air.

The skin absorbs oxygen; which combines with some of the hydrogen of the decayed tissues, and forms water. This is supposed by some physiologists to be the sole origin of the insensible perspiration.

But the skin has the power of excreting a large quantity, not only of fluid, but of nitrogen. Eleven grains of matter are exhaled from the skin per minute: or thirty-three ounces in twenty-four hours; and of this, eighty-eight per cent. is solid:—principally nitrogen.

When we take violent exercise, particularly walking, we wear out a great deal of tissue; and the consequence is, that the skin is stimulated to increased action; the oxygen of the air combines with the hydrogen of the decayed organs in the capillaries of the skin, and forms water; which becomes impregnated with nitrogen in some degree from the disintegrated tissues; and we then excrete by perspiration, a great deal of the hydrogen and nitrogen which we are destroying by our exertion.

The respiration is always increased in speed by exertion; we take deeper inspirations for the purpose of inhaling more oxygen; which, by combining with the carbon of the tissues we are destroying by our exercise, is exhaled in the form of carbonic acid gas, in the manner before explained.

By perspiration, then, we see how quickly we lose that portion of our decayed tissue, which, if absorbed into the blood, would become an animal poison.

The function of perspiration also acts by evaporation, and keeps the body from becoming too hot. In the winter, the external heat is not sufficient to produce evaporation: and the skin therefore retains its heat longer, as there is less perspiration. But the generation of animal heat, accompanied by the heat of the atmosphere in summer and hot climates, would be too oppressive, if it were not for the evaporation which is constantly going on from all parts of the skin, in the form of insensible perspiration.

To convert water at 98° into vapour, requires the constant supply of a large quantity of caloric or heat. When the water, formed by the union of oxygen and hydrogen gases, is generated in the skin, it must combine with this quantity of caloric, before it can be driven off by evaporation. This process keeps the skin cool.

And this is the cause of the animal heat becoming so great in fevers. The functions of the skin are suspended, and no evaporation takes place. The animal heat cannot get away by its usual channel; and the hydrogen and nitrogen, which ought to be driven off by the skin, is absorbed into the circulating system. Our organs become overloaded; we require no supply, and therefore nature takes away our appetite.

But the skin also absorbs. Various poisons can be easily introduced into the blood, by applying them to the skin. And water, and other fluids, impregnated with various substances, are absorbed very rapidly, when the whole skin of the body is exposed to its influence in a bath.

It is evident that the functions of the skin have great influence over the health; and it should always be kept in a healthy condition. But it must also be evident, that the carbon of the decayed tissue cannot go off through the pores of the skin; the proper function for that excretion being the respiration from the lungs. And, although it has been suspected, but scarcely proved, that a small quantity of carbonic acid gas is occasionally exhaled from the skin; yet, this is the exception, and not the rule.

It is well known, that the largest proportion of our food consists of carbon: and that in disorder, or disease of any of the animal functions, there is a great accumulation of carbon in the blood—causing various dangerous symptoms. How then can we expect, by exciting the functions of the skin only, to deprive the blood of this surcharge of carbon? And I would ask, how do those persons who say the application of cold or hot water to the skin, in various forms, is the only and infallible cure for disease, account for their miraculous statement of cures?

MILK.

Milk is the only remaining secretion which will be here examined. And this is noticed particularly, because every part of the animal body is originally formed from it, in all the family of the Mammalia. It is needless to say this is an animal fluid secreted by those glands called breasts.

Milk consists of caseine, butter, sugar of milk, and lime, phosphorus, potash, soda, magnesia, and iron.

The butter (fat) and sugar, are composed of carbon and the elements of water (oxygen and hydrogen): and are required for the performance of respiration in the young animal. But the caseine is composed of the elements of the blood—fibrine and albumen; which, together with the salts, &c., are quite sufficient, as it were, to build up the young animal system.

On exposure to the atmosphere, the least dense part of milk separates from the rest, and rises to the top, where it becomes oxidized by combining with the oxygen of the air. This is cream: and is composed principally of fat globules, mixed with milk and a little caseine. The principal quantity of the caseine and sugar remaining in the milk.

By agitating this cream, the oil globules are destroyed; and the effect is, the whole of the fat is formed into butter; leaving the caseine and sugar in the butter-milk. This accounts for butter-milk being found so nutritious and easy of digestion, and explains why it is recommended in diseases accompanied by great debility.

The caseine is very easily coagulated by lactic or any other acid. The inner membrane of the calf's stomach, called rennet, contains this acid. And cheese is the caseine and fat of the milk, pressed together and dried, and contains fibrine and albumen, the elements of the blood. The whey which remains contains all the sugar, and most of the salts of the milk; and in some countries, a particular kind of sugar is made from it, by evaporating and crystallizing the whey. This is so far nutritious as to supply the blood with carbon for the oxygen of the air to combine with in the lungs, and form carbonic acid gas.

Before the young animal breathes, he is nourished and heated by the arterial blood of the mother, which is sent to him through peculiar blood-vessels, which it would be foreign to our present purpose to enter into. He, at that time, swims in a fluid, secreted by the mother from a serous membrane. But as soon as the animal is divided from his mother, respiration, animal heat, waste and supply, go on just as they do in his mother; and it is from the caseine of the milk that his tissues, bones, and brain are formed; and from the butter and sugar of the milk that he breathes.

As it has been stated that the milk of the mother is the most nutritious food for forming the organs, muscles, and bones of the young animal; it becomes a question, when, in the human species, the mother of the infant is unable to supply her offspring with milk, what is the best substitute for it?

There is much more butter and sugar, and less caseine, in human milk, than in that of the cow; and, experience has determined, that the nearest approach to human milk is, to take the cream of cow's milk, and half the milk from which it proceeds, mixed up with an equal quantity of very thin groat gruel, and sweetened with lump-sugar. It is better to use rather more groat gruel, where the infant is very young, and decrease the quantity as its age increases. This supplies fibrine, albumen, and all the salts and iron necessary for the growth of the infant, but is certainly inferior to good human milk; although many children grow up as well under its use as could be expected if they obtained their food from a healthy woman. It should be given at blood heat. The animals whose milk approaches nearest the human milk in quality, are the goat and sheep; but even in those there is more caseine than the human infant requires. Where there is a deficiency of muscle and bone, the milk of these animals is useful.

Asses' milk contains very little caseine and fat, and a great deal of sugar; on which account it is found serviceable, where it is a point to keep up the circulation and animal heat without overstimulating the digestive organs. In infants recovering from inflammation of the lungs or bronchia, or any other dangerous disease, and in various affections of the skin, this milk is found exceedingly useful. And in consumptive habits, where the digestive organs are deranged, asses' milk, by supplying sufficient carbon for respiration, in the form of sugar of milk, is an excellent article of diet.

Mental anxiety, or great fatigue of body, has a tendency to prevent the natural secretion of milk in a healthy woman; and the milk is deteriorated in quality when any organic disease exists. The choice of a wet nurse for a delicate infant requires much discrimination.

It is not generally known, that the infant should be allowed to suck as soon after birth as possible. By this means the milk is prevented being absorbed into the blood, or kept so long in the milk vessels, as to bring on fever and inflammation of the breast. The infant is also kept in a healthy state by this plan being adopted.

Some medicine acts on the mother without being absorbed into the milk; while others impregnate the milk sufficiently to cure the infant of any disease which it may be born with. A correct knowledge of this circumstance is very useful in the treatment of the diseases of women and children.

Dr. Playfair has lately proved that cows may be fed and exercised in such a manner, as to increase the quantity of either butter or caseine in their milk. By keeping cows still, in a warm place, and feeding them with oily food, the quantity of butter is very materially increased, because respiration goes on slower; and the fat is not used in such quantities for the elimination of carbonic acid gas and water, as it would be if the cows were running about in a large field exposed to the cold atmosphere; whereas, in the latter case, there is always a deficiency of cream, but an increase of caseine. When farmers want milk, they should keep their cows up; but when they want cheese, they should let them run in large pastures, exposed as much as possible to currents of air.

PART IV.

ON COMBUSTION, FERMENTATION, PUTREFACTION, AND DECAY, IN VEGETABLE, AND ANIMAL MATTER.

Theory of combustion—Products of combustion—May be reproduced—Common gas—Carbonic acid given off to the atmosphere—Oxidation of Metals—Fermentation—Alcohol—Three kinds of Fermentation—Vinous, Acetous, Putrefaction—Preserving wine in casks—Cause of wine becoming sour—Use of fermented liquors—Putrefactive substances contain nitrogen—Carburetted, sulphuretted, and phosphuretted hydrogen gases—Ammonia—Cyanic acid—Fermentation of vegetable juices—Eremacausis or decay—Humus—Common effect of oxygen and hydrogen on humus—Draining—Gases supplied to the air—Manure—Mode of managing—Moist animal matter—Nitric acid—Nitre—Church-yard emanations.

COMBUSTION.

All bodies in nature are either combustible or incombustible; that is, either inflammable or uninflammable; and there is one great supporter of combustion—oxygen.

In all cases of combustion oxygen is consumed; and carbonic acid, water, heat and light are evolved.

As this process is constantly going on all over the world, not only in the fires and lights within our own dwellings; but to an enormous extent in manufacturing districts, and in the neighbourhood of volcanoes; besides that process which silently proceeds in animals and vegetables, it may be useful shortly to inquire into its theory.

By burning a body, many persons think it is destroyed; nothing can be further from the truth. Matter is indestructible. Combustion merely alters its form, and the combustible body enters into new combinations. The combustible body, and the supporter of combustion, although rendered invisible, remain in the atmosphere; and may, by chemical operations, be reduced to their original condition.

In a common fire, the coal of which consists principally of carbon and hydrogen; the oxygen gas of the atmosphere, which consists of oxygen and caloric or heat, chemically combines with these two substances; and, exactly as was explained in the process of animal respiration, the oxygen combines with the carbon and hydrogen, forming carbonic acid gas and water; which, in the case of a fire, is converted into steam; and so much heat and light are liberated by this process as is quite sufficient to warm and cheer us in the coldest day of winter.

The carbonic acid gas and water, in consequence of the draft and rarefaction of the air by the heat, is carried up the chimney, where it mixes with the atmosphere. But exactly the same quantity of carbon and hydrogen may be obtained from what we call the smoke, as was contained in the quantity of coal burnt.

The common gas which is burnt in houses for light, is a mixture of carbon and hydrogen—carburetted hydrogen gas. When ignited, it is converted into carbonic acid gas and water; and, if not carried away, as the smoke is from our fires, always fills the room with a disagreeable air, which is very oppressive to respiration. In fact, when gas has been burning some hours in a room, the atmosphere is so filled with carbonic acid gas and water, as be insufficient to support animal life. And, in counting houses, banks, &c., where a number of persons are exposed to this atmosphere for many hours a day, they almost invariably become diseased. To prove that a great deal of water is given out, we need only notice the rust on any steel articles which are in the way.

In the foregoing instances of combustion, it is evident there is always carbonic acid gas and water given off to the atmosphere, as well as the nitrogen of that part of the atmosphere which has been used.

But there is another great source of combustion always going on in the different volcanoes in the world, which ceaselessly pour out immense volumes of carbonic acid gas.

When metals rust, they combine with oxygen, and become converted into oxides; and this oxygen is obtained either from air or water. When from the air, the nitrogen of the air is given out in proportion as the oxygen combines with the metal; when from the water, the hydrogen of the water is given off in proportion as the oxygen is used; and heat also is evolved in both instances, although the process goes on so slowly that it is almost imperceptible.

In almost all chemical decompositions, where air or water is decomposed, one of the gases is evolved; and this is another mode of supplying the atmosphere.

FERMENTATION.

Vegetable substances composed of carbon, hydrogen and oxygen, when combined with water, and exposed to the temperature of from 70° to 80°, go into that state which is called fermentation, particularly when any particle of that peculiar glutinous substance called yeast, is mixed with them.

The simplest form of fermentation is the conversion of sugar into alcohol, which we will endeavour to describe.

Sugar is composed of twelve equivalents of carbon, ten of oxygen, and ten of hydrogen. This combines with water, which is composed of eight parts ~~equivalents~~ of oxygen, and one of hydrogen. The oxygen of the water combines with some of the carbon, and two-thirds of the oxygen of the sugar, and is driven off in the form of carbonic acid gas. While the rest of the oxygen of the sugar unites with all the hydrogen of the sugar and of the decomposed water, and the rest of the carbon of the sugar, and is converted into alcohol.

Alcohol is composed of one equivalent of oxygen, two of carbon, and three of hydrogen.

Fermentation, therefore, changes sugar into alcohol, by driving off some of its carbon and oxygen in the form of carbonic acid gas; and uniting with the hydrogen of the water.

There are three kinds of fermentation. The vinous, the acetous, and the putrefactive.

The vinous fermentation has been already described.

When wine, or a fluid having gone through the vinous fermentation, is exposed to the atmosphere at the temperature of from 70° to 90°, it gradually absorbs oxygen from the air, which combines with part of the hydrogen of the alcohol, and forms water. And the fluid, by losing part of its hydrogen, is gradually converted into vinegar. This is the acetous fermentation.

Acetic acid, or vinegar, is composed of four equivalents of carbon, four of oxygen, and four of hydrogen.

When wine or ale becomes sour, it is always in consequence of the alcohol in it having gradually combined with oxygen, and converted it into acetic acid.

When wine is drawn out of a large cask, gradually, for some time, without being bottled, the best way of preventing it becoming sour is, to introduce into the cask sulphurous acid, which, by combining with the oxygen of the air as it is admitted, prevents its action on the alcohol of the wine.

The purest wine, or that which contains the least gluten, retains the vinous character the longest. The oxygen of the air oxidizes the gluten, which becomes insoluble ; and its oxidation is communicated to the alcohol, which is converted into acetic acid. This is the reason why the common kinds of claret and other wines will not keep ; there is always a sediment in the bottle.

It must be evident now to the reader, that all fermented liquors contain a large quantity of carbon and hydrogen, and these are in such a condition as to be readily absorbed by the lacteals ; conveyed into the venous blood, and exposed, at once, to the oxygen of the air in the lungs.

PUTREFACTION.

Those substances which are the most prone to the putrefactive fermentation, have, without exception, some portion of nitrogen in their composition. In many of these compounds, a transposition of their elements spontaneously occurs, as soon as they cease to form part of either a plant or animal; they cannot exist after losing vitality.

The transformation of wood in marshy soils, where quantities of carburetted, sulphuretted, and phosphuretted hydrogen gases are given off, and which materially deteriorate the atmosphere of the neighbourhood, is one proof of this.

But the principal sources of putrefactive fermentation is in azotized bodies. There is some peculiarity in the nature of nitrogen, which gives its compounds the power of decomposing spontaneously with great facility, when combined with water in any form.

The nitrogen of the body combines with the hydrogen of the water, and is converted into ammonia: the carbon of the body unites with the oxygen of the water, and the hydrogen, sulphur, and phosphorus of the body, and is converted into carbonic acid, carburetted hydrogen, sulphuretted hydrogen, and phosphuretted hydrogen gases. Besides which, some of the carbonic acid gas unites with the ammonia, and forms carbonate of ammonia: a very volatile substance, which is soon dissipated in the air.

Nothing proves the correctness of this mode of decomposition in nitrogenized bodies better than the manner in which cyanic acid and water behave to each other, when mixed. Cyanic acid is composed of nitrogen, hydrogen, and oxygen; the instant it is mixed with a certain quantity of water, the oxygen of the water and of the cyanic acid unite with the carbon of the acid, and form carbonic acid gas; and the hydrogen of the water unites with the nitrogen of the acid, and forms ammonia; which is shewn by a brisk effervescence, and the strong smell of ammonia instantaneously. This decomposition is putrefaction in its simplest and most perfect form: because the new products, carbonic acid and ammonia, are incapable of further transformation.

We may now examine the mode of fermentation of a vegetable juice, which contains not only saccharine matter, but also albumen and gluten—which we know contain nitrogen. When this is mixed with yeast at 70°, it ferments like sugar and water: carbonic acid gas escapes from it with effervescence: and in the liquid alcohol is found, exactly corresponding to the weight of saccharine matter in the juice. But, expose such a fluid to a temperature of from 95° to 105°, with free access of air; and gases, possessing a very offensive smell, are evolved in considerable quantity: and when the liquor is examined, no alcohol exists. The sugar has also disappeared; and with it, all the nitrogenous compounds which were present previous to fermentation. The nitrogen has combined with the hydrogen, carbon, and oxygen, and has been converted into carbonate of ammonia; and a disagreeable acid liquor remains, with an unpleasant smelling glutinous matter deposited.

The principal ultimate elements of animal matter are the same as those of most vegetables: viz. carbon, hydrogen, oxygen, and nitrogen: but nitrogen exists in the greatest abundance: and sulphur and phosphorus are always present. The humidity necessarily accompanying their organization, (they contain three fourths of their weight of water,) and their ultimate compositions are such, as to render them very liable to change, after the loss of vitality; and the very circumstances which render them permanent during life, are, apparently, those which, after death, make them particularly susceptible of decomposition. Their putrefaction is distinguished from that of most vegetables by the disgusting nauseous stench which attend it; arising principally from the sulphur and phosphorus in combination with ammonia.

That kind of general decay which is constantly going on all over the globe very slowly, by the contact of dead vegetable matter with the air, called by Liebig Eremacausis, produces a constant supply of water and carbonic acid gas. Part of the oxygen of the air combines with the hydrogen of the vegetable matter, which, being most easily accomplished, happens first: this liberates the carbon, which combines with another portion of oxygen, producing carbonic acid gas.

But when wood putrefies in marshes not exposed to the air, carbon and oxygen are separated from its elements in the form of carbonic acid gas, and hydrogen in the form of carburetted hydrogen gas.

All putrefying bodies decay when exposed constantly and freely to the air; and all decaying matters, when air is excluded from them, as by being under water, go into putrefaction.

We cannot wonder at oxygen having such

an effect upon the carbon and hydrogen of vegetable matter, if we consider, that at the common temperature of the atmosphere, phosphorus unites so freely with oxygen as to ignite and produce a flame; and that hydrogen, if merely forced upon finely divided platinum, instantly ignites, as in Doebereiner's lamp. Again, we know that alcohol exposed to oxygen is at last converted into carbonic acid.

While this constant decay and putrefaction is going on in order to form humus for plants to grow in, it also produces a gas which is the natural food of plants; unless it contains too much carburetted or phosphuretted hydrogen; and we therefore find that, by draining the land, where it is of such a nature as to hold moisture too long, we get rid of the two latter gases, and confine the decomposition to the carbonic acid gas alone.

This principle of draining is also a great boon to the life of animals. Before various tracts of land in this country were drained, the inhabitants were continually affected with ague and intermittent fevers, and diseases of the spleen and liver; which happily, now, we seldom meet with from such a cause.

We have now seen that not only from the

systems of animal and vegetable life, but from all bodies which ever possessed any organization, there is a continual effort made by them to supply the atmosphere with gases. Animals supply it with carbonic acid and nitrogen: vegetables with oxygen: fermentation with carbonic acid gas: putrefaction with ammonia, carbonic acid, phosphuretted hydrogen, sulphuretted hydrogen, and carburetted hydrogen gases: and the constant decay that is always going on from the influence of the oxygen, with another portion of carbonic acid gas.

There is yet another source of ammonia and carbonic acid, which is of so much interest to the agriculturist, that it may be permitted to be named here; and that is, the common method of treating horse and cattle manure in this country.

This manure is generally heaped up, either in a field or a farm-yard; the carbon of the manure combines with the oxygen of the water, and produces carbonic acid gas—liberating so much heat, as to drive off the ammonia, which is formed from the nitrogenous part of the manure and the hydrogen of the water; thus is the whole of the real value of farm-yard and stable manure driven into the air.

Now, the rational mode of treating this kind of manure, so as to make it serviceable to the agriculturist, is the following: A sort of large shallow pit should be made, and lined in such a manner as to make it water-tight: this pit should slope from each end downwards into the middle; where a cistern should be fixed to catch the fluid part, which, of course, would be constantly draining into it. A pump should be connected with this cistern. The manure should be laid on the pit at each end as it is generated, and well watered and trodden down; and every few days, either a solution of sulphate of iron, (a very cheap salt,) should be poured all over this manure, or powdered sulphate of lime, (gypsum,) or diluted sulphuric acid, (oil of vitriol): this immediately combines with the ammonia, as it is generated in the manure, converts it into a soluble sulphate of ammonia, which constantly runs into the cistern in the middle, and which should be as constantly poured over the manure again and again. The sulphate of ammonia is not volatile; whereas, if nothing is done to fix the ammonia, the whole of it flies off into the air, before the farmer can have any chance of using it.

It remains to point out another source of nitrogen from decomposition. Where moist animal matter is exposed to the air, ammonia is always liberated; and nitric acid never formed. But, when alcalies or alcaline bases are present, which very commonly happens, a union of the oxygen and nitrogen takes place, and nitrates are formed. When, therefore, any vegetable which contains potash is exposed with animal matter to the putrefactive process, nitrate of potash is formed in abundance.

Whenever ammonia, which is a compound of hydrogen and nitrogen, is exposed to the action of oxygen, the effect is always an oxide of nitrogen, or nitric acid. And this is formed by the decomposition of animal matter continually in warm weather. But where there is a great deal of carbon, as well as hydrogen and nitrogen, and carbonic acid gas is formed first, this prevents the formation of nitric acid.

In the combination of the oxygen of the air with nitrogen and hydrogen, water is formed as well as ammonia: and when the ammonia is oxydized or converted into nitric acid, it combines with the water, and then with any salts within its reach; and thus accounts for the extensive nitrification all over the globe. Animal matter is not the sole cause of nitrification;

it merely finds the ammonia: vegetables produce the salts; and the atmosphere the oxygen.

In the next part of this essay we shall find how valuable this knowledge of the production of ammonia, nitric acid, and nitrates, is to the agriculturist.

It may not be improper to mention in this part of the essay, another source of nitrogen, carbon, hydrogen, sulphur, and phosphorus, which, unfortunately for the living, exist too plentifully in all civilized countries. I mean, the noxious emanations from church-yards.

In many of the most crowded parts of London, and almost all the large cities in the provinces, the quantities of ammoniacal, sulphuretted and phosphuretted hydrogen gases, which arise from this fruitful source of decomposition, in the centre of large and populous districts, is immense.

PART V.

THE FORMATION OF THE ATMOSPHERE.

Original formation of the Atmosphere—Effect of Light and Heat—First Vegetation—First change in Atmosphere—Coal formations—*Third period*—Creation of cold-blooded Vertebrate Animals—Mammalia and Birds—Second Vegetation—Origin of Carbon in the Coal formations—Origin of Carbon in Vegetables of the present day—Origin of the vast Forests—Formation of the present Atmosphere—Account of the Creation in the Bible—Creation of the present race of Animals—Origin of Gases—Carbonic Acid from Animals—Oxygen from Vegetables—Nitrogen from Animals—Fibrine, Albumen and Caseine—From Vegetables to Animals—Animals destroy what Vegetables produce—The Sun—Origin of Nitric Acid, Nitrates, Ammonia, Carburetted, Sulphuretted and Phosphuretted Hydrogen Gases—Volcanoes—Vapour—Equilibrium of the Atmosphere—Duration of the Atmosphere—Perfection of Art shown in Locomotive Steam Engine.

Everything which exists must have had a beginning. Our atmosphere did not exist until when, "In the beginning God created the heavens and the earth," but "the earth was then without form and void: and darkness was upon the face of the deep." At this period it would be easy to prove, scientifically, that the atmosphere around the world was a very different one, as to its constituent parts, from what it now is.

During the time the earth was in a state of chaos, carbonic acid gas was a very large ingredient in the atmosphere; and animals, such as now live on the earth, could not possibly have existed; because they could not have kept up respiration upon an atmosphere, with so large a proportion of carbonic acid gas. Now the proportion is only, at the utmost, half a volume in one ~~hundred~~ thousand volumes of air.

But, when "God said, Let there be light;" then, vegetation in all its glory and beauty broke forth, in consequence of the effect of the light and heat of the sun. Vegetables, then the only things possessing life upon the earth, at once decomposed the carbonic acid gas, fixed its carbon, and poured forth its oxygen and caloric to the atmosphere, which, in due time, supposed to be many centuries, so altered the constitution of the atmosphere—by producing a large supply of oxygen, that it became a fit habitation for a race of animals, which, like toads and frogs, live best in bogs and marshes.

Before any animals were created by God, vegetation had gone on to such a great extent, as to produce several layers of vegetable matter, found now under certain strata of the earth: which, by gradual decomposition and chemical action, has been converted into coal.

This is a subject so beautiful, to treat in that clear way which is the most convincing, that I cannot do better than quote the words of the celebrated French philosopher Bronguiart; whose lucid and eloquent ideas all must admire.

"The study of the metamorphoses undergone by the vegetable kingdom, if I may be allowed to make use of such an expression, during the formation of the crust of the globe, appears to inform us, that the temperature and extent of the ocean have been diminishing incessantly from the first appearance of vegetables upon the earth, to the present epoch.

"The comparison of the successive development of plants and animals is not one of the least remarkable points in the study of fossil organized bodies.

"We know, in fact, that in the strata of older date than, or of the same epoch as, the coal formation, there are no remains of any terrestrial animal; whilst, at this epoch, vegetation had already made great progress: and was composed of plants as remarkable for their forms, as for their gigantic stature. At a later period, terrestrial vegetation loses, in a great measure, the signal vigour which it formerly possessed: and cold-blooded vertebrate animals became extremely numerous. This is what is observed during the third period.

"Subsequently, plants became more varied, more perfect. But the analogies of those that existed originally are reduced to a vastly smaller stature: this is the epoch of the appearance of the most perfect animals; of animals breathing air; of mammalia and birds.

"Is there no means of discovering some cause adequate to explain, in a natural way, this vast development, this vigorous growth of plants breathing air, even from the most remote epochs in the formation of this globe? And, on the other hand, of the appearance of warm-blooded animals, that is to say, of animals whose aërial respiration is most active in the last periods of its formation only? May not this difference in the epoch of the appearance of these two classes of beings depend on the difference of their mode of respiration, and of the circumstances in the state of the atmosphere, calculated to favour the development of one, and to oppose that of the other?

"Under what form, at the epoch of the creation of organized beings did the whole of the carbon exist, which these beings subsequently absorbed, and which is now buried, with their spoils, in the bosom of the earth; or which is still met with, distributed among the infinite multitude of organized beings, that actually cover the surface of the globe?

"It is obvious that animals derive carbon neither from the atmosphere, nor from the soil; but exclusively from their food.

"We cannot conceive how plants could have assimilated this carbon had it been in the solid state: and, moreover, in the formations older than those that include the first remains of vegetables, we can scarcely encounter any traces of carbon.

"This carbon, then, which the vegetables of the primitive world, and those of the subsequent and present world, absorbed, must, necessarily have existed, in a shape, proper to furnish them with nutriment; and we only know of two: *humus*, or vegetable mould; which, resulting itself from the decomposition of other vegetables, would lead us into a vicious circle: and carbonic acid; which, decomposed by the leafage of vegetables under the influence of solar light, and so serves for their growth.

"It appears to me impossible, therefore, to suppose that vegetables can have derived from any other source than the atmosphere, and in the state of carbonic acid, the carbon that is found in all existing species of plants and animals; as well as that which, having served the vast primeval forests for sustenance, has been deposited under the form of coal, lignite, and bitumen, in the different sedimentary strata of the earth.

"If we suppose, then, that the whole of this carbon was diffused through the atmosphere in the shape of carbonic acid prior to the creation of organized beings, we shall see, that the atmosphere, instead of containing less than the one-thousandth part of its bulk in carbonic acid, as at present, must have contained a quantity which it is not easy to estimate exactly: but which was perhaps in the proportion of three, five, six, and even eight per cent.

"We are well assured, by the experiments of M. de Saussure, that carbonic acid, far from proving detrimental to vegetation, is positively favourable to it, when plants are exposed to the sun's light. This highly probable difference in the constitution of the atmosphere may, therefore, be regarded as one of the causes influencing most powerfully the more active, and very remarkable vegetation of the first organic period of our globe.

"But this same circumstance must, on the contrary, have interfered materially with the decomposition of the remains of vegetables and their transformation into soil; for this kind of decomposition is owing essentially to the abstraction of a portion of the carbon of the wood by the oxygen of the air; and if the atmosphere contained less oxygen and more carbonic acid, the decomposition in question must have been, without doubt, both more difficult and slower. Hence the accumulation of vegetable débris in extensive beds, even in circumstances and from vegetables, which, in the actual state of the atmosphere, would give rise to no such layers of combustible matter.

"On the other hand, this difference in the composition of the atmosphere, so favourable to the development, growth, and preservation of vegetable matter, must have proved a bar to the existence of animals, particularly of warm-blooded animals; whose respiration, as it is more active, also requires a purer air. During this first period, consequently, not a single animal breathing air appears to have existed.

"During this period the atmosphere must have been purged of some portion of the excess of carbonic acid which it contained, by vegetables which then existed: these assimilated it first; and subsequently buried it in the state of coal in the bowels of the earth. It is after this first period, in the course of our second and third periods, that this immense variety of monstrous reptiles make their appearance: animals which, by the nature of their respiration, are capable of living in an atmosphere of much less purity than that which warm-blooded animals require; and were the heralds and precursors of these.

" Vegetables continued incessantly to abstract a portion of the carbon of the air, and thus rendered it every day, more pure; but it was not until after the appearance of a vegetation altogether new, abounding in mighty trees, the source and origin of numerous deposits of lignite, a vegetation which seems to have covered the surface of the earth with vast forests, that a great number of mammiferous animals, analogous in all the essential features of their organisation to those that still exist in the world, appeared for the first time upon its surface.

" Would it not be fair to suppose from this, that our atmosphere had now arrived at that degree of purity which could alone comport with the active respiration of warm-blooded animals? and prove alike favourable to the development of plants and animals? Whilst the simultaneous existence of these two orders of beings, and the inverse influence of their respiratory actions, conduce to maintain our atmosphere in a state of stability, which is one of the remarkable characters of the present period?"

The above extract is sufficient to convince those, at all acquainted with scientific pursuits, of the reasonableness of the position, that long before there were any animals in this world, vegetables flourished abundantly: and that the first class of animals differed in their organization completely from the present class: inasmuch as their respiratory organs were such as to allow them to live in an atmosphere which would prevent respiration in all animals of the present race except reptiles and fishes.

We hope it will be distinctly understood that, by declaring this to be our belief, it does not in the slightest degree go to disprove the account which Moses gives of the creation, in the first chapter of Genesis: in fact, it tends to prove the correctness of it. Any unprejudiced person reading the first five verses of the Bible, must feel convinced that the world was created long before "God divided the light from the darkness." Those who are anxious to become more acquainted with this interesting subject, are referred to Buckland's admirable work on geology and mineralogy.

Let us return to our aërial subject. We have endeavoured to show the part which matter plays in the production and growth of organized beings, in the phenomena which are constantly occurring in their daily existence, and in the changes which their bodies undergo after death. It is now necessary to elucidate in what manner this process of living and dying tends to keep up the atmosphere, which supports both animals and vegetables in a proper condition. From whence comes the matter which vegetables, animals, man, contain in their composition? What becomes of it— when death breaks the chain by which its various parts and forms were so closely conjoined?

We shall find as we proceed, that of all the elements of modern chemistry, which are many, organic nature makes use of but four—carbon, nitrogen, hydrogen, and oxygen. We shall find also, that, of those vegetable and animal substances which are now multiplied almost to infinity, general physiology requires no more than ten or twelve species, which have been explained already. And that all the phenomena of life, so complex in appearance, may be referred to so simple a formula, that every thing seems viewed in a moment!

We have found that an animal, in a chemical point of view, constitutes a true apparatus of combustion; where carbonaceous matters are returned to the atmosphere in the shape of carbonic acid gas; where hydrogen burnt, incessantly returns as water; and where nitrogen is ceaselessly exhaled from the lungs, and given off in the state of ammonia in the urine.

From the animal kingdom therefore, as a whole, carbonic acid gas, nitrogen gas, and watery vapours, are continually escaping; simple substances, few in number, but of the utmost consequence to the atmosphere.

We find also, on the other side, that healthy vegetables incessantly decompose carbonic acid, fixing the carbon, and setting free the oxygen; that they decompose water, seize its hydrogen, and liberate its oxygen to the air; and they also absorb ammonia in all its combinations, fix the hydrogen and nitrogen, (as well as the carbon when it exists,) and liberate the oxygen.

Therefore the animal kingdom constitutes an immense apparatus of combustion, while the vegetable kingdom constitutes an immense apparatus of reduction. What one kingdom gives to the atmosphere the other takes away; so quickly, that a constant equilibrium is kept up, and with it, constant circulation of air.

We cannot literally and scientifically say that "dust we are, and unto dust we shall return;" but, we may with the greatest certainty affirm, that we are the offspring of the air, and unto air we shall return!

Vegetables take from the atmosphere the elements which animals exhale into it; carbon, hydrogen, and nitrogen; or rather, carbonic acid gas, water, and ammonia.

But how do animals procure the elements which they give to the atmosphere? Herbivorous animals live entirely upon vegetables; they convert the vegetable fibrine, albumen, and caseine into animal fibrine, albumen, and caseine. Omnivorous animals, such as man, live upon herbivorous animals and vegetables.

During the life of these animals, and after their death, the four organic substances return to the atmosphere from whence they came, just in proportion as they are destroyed.

Vegetables are the only producers of organic life. It is in vegetables that all the organic substances necessary for the support of animals are formed. Animals destroy everything which vegetables produce.

Such is the mysterious circle of organic life. The air contains the oxidized substances required—carbonic acid, water, nitric acid, ammonia. Vegetables seize upon the radicals of these; fashion all the infinite variety of vegetable products, and give off the oxygen. Animals again combine the oxygen with the radicals, and return them to the air as carbonic acid, water, and ammonia.

But, if God were to take away from us the sun, that immense source of light and heat, which is alone possessed of power to bring into play this great and unparalleled apparatus—the vegetable kingdom; what would be the effect?

The great chemist Lavoisier, on speaking upon this subject, says, "Organization, sensation, voluntary motion, life, only exist on the surface of the earth, and in places exposed to light. It might be said, indeed, that the story of Prometheus was the expression of a philosophical truth, which had not escaped the penetration of the ancients. Without light, nature were without life and without soul. A beneficent God, in shedding light over creation, strewed the surface of the earth with organization, with sensation, and with thought."

But we have now to consider how the nitric acid, nitrate of ammonia, carbonate of ammonia, carburetted, sulphuretted, and phosphuretted hydrogen gases, get into the atmosphere in such a manner as to be available to vegetation, and still not to injure animal life?

In the rain of every thunder storm, nitrate of ammonia can be chemically detected. It is supposed, that when two clouds, being in the two opposite states of electricity, approach each other, a discharge takes place, as in the case of a Leyden jar, or an electrical battery; and the effect of the electric action is, to decompose both the water and atmospheric air. The hydrogen of the water unites with the nitrogen of the air, and forms ammonia; and another portion of the hydrogen of the water, and the oxygen of the air, combines with the rest of the nitrogen, and forms nitric acid; together producing nitrate of ammonia.

In those countries where thunder and lightning form almost a daily phenomena, very large quantities of this nitrate of ammonia are formed. But how is it kept in the atmosphere and spread about, from place to place, for the food of plants?

It is first dissolved in the rain water: this goes into the ground; some of it is absorbed by the roots of plants, but the principal part of it is again evaporated with the water into the air, and taken by currents of air, through vast tracts of countries. And, by scientific measures, there can be no doubt but we may, in this country, obtain and fix, in our vegetation, the very nitrate of ammonia which is formed amongst the mountains of Switzerland.

The carbonate of ammonia which we find in the air, is usually the product of the decomposition of urine, or animal and vegetable substances containing nitrogen, as was explained in the last part.

Every healthy man throws off from his system, through his kidneys, at least half an ounce of nitrogen, in the form of urea, every twenty-four hours. This urea consists of two atoms of carbon, two of nitrogen, two of oxygen, and four of hydrogen; by adding two atoms of water to this, we immediately render it capable of being converted into carbonate of ammonia: and that, we constantly smell on going into a stable, or a bed-room, which has not been properly ventilated.

When it is considered how many more animals exist in the world than human beings, and we know that all these excrete large quantities of urea; we are no longer at a loss to account for the carbonate of ammonia. But this ammonia is very volatile; it is evaporated into the air by the slightest generation of caloric, which is, in fact, always going on when urine is being converted into carbonate of ammonia. The air then becomes charged to a certain extent with this gas.

Carburetted, sulphuretted, and phosphuretted hydrogen gases, all arise from the decomposition and putrefaction of animal and vegetable substances, when in a state of decay. This is constantly going on all over the earth; but more so in warm than cold weather. In cold weather vegetation does not require it.

Another very fruitful source of carbonic acid gas is from volcanoes. These, unceasingly, pour out immense volumes of this gas, which very materially assist in furnishing the vegetable system with food.

We see then that ammonia, nitric acid, and nitrate of ammonia, are produced upon a grand scale by the action of those magnificent electric sparks that dart from the storm cloud; and, furrowing vast fields of air, engender these substances in their course. That carbonic acid gas is ceaselessly poured out by these volcanic eruptions, which make both the earth and its inhabitants tremble! and also by all the living beings both on the earth and in the sea.

The watery vapour in the atmosphere arises from two sources; that which is respired by animals—the consequence of the chemical combination of oxygen and hydrogen in the lungs; and the effect of the heat of the sun upon the sea and all other water. Water is converted into vapour which is found at the surface of the ocean and elsewhere, and is impregnated with carbonic acid, nitrate, and carbonate of ammonia; and is continually condensed everywhere in the form of dew or rain; which again is raised into vapour, abandons again its gas, which again becomes dissolved in fresh quantities of water in the form of vapour, and is again deposited on the ground, and on the leaves of plants.

The atmosphere, then, is a mixture of gases. It contains, on an average, two hundred and eight volumes of oxygen gas to seven hundred and ninety-two of nit ~~hy~~drogen gas; but it has always floating in it from four to six ten-thousandth's parts of carbonic acid gas; and a very small proportion of carburetted hydrogen gas, besides an atom of sulphuretted and phosphuretted hydrogen gases.

As animals go on breathing incessantly, and plants only respire under the influence of solar light; as in winter the earth is stripped and naked, while in summer it is clothed with verdure; it may be thought, that these ought to bear witness, in its constitution, to these varying states. The carbonic acid gas should increase at night, and diminish by day; and the oxygen gas diminish by night, and increase by day; or, the carbonic acid gas should be in larger quantity in winter, and oxygen gas increase in summer. This would be found true in a small quantity, undoubtedly; but, when we consider the immense extent and weight of the atmosphere, all these considerations cease.

It is supposed that if the human beings on the earth be computed at 1,000,000,000 of men, and the rest of the animals at 3,000,000,000, it would require 10,000 years before all these animals could produce so much decrease in the quantity of the oxygen gas of the air, to produce any sensible difference, capable of being measured by Volta's endiometer; even supposing vegetable life to be extinct the whole of this time. Such a state as this is impossible ever to take place; for, if vegetation ceased, all animals must soon die.

A long succession of ages would be required to bring into play, and render manifest, any preponderance in either of the two realms of nature, with reference to the composition of the atmosphere. We are therefore very far from experiencing those daily or annual variations which ancient philosophers and the vulgar, were, at one time, alike disposed to regard as equally easy to foresee and overcome.

We know that respiration cannot be kept up by man in an atmosphere containing ten parts of carbonic acid gas in one hundred of atmospheric air.

The air, therefore, is a mighty magazine, where plants may, for a long time, draw all the carbonic acid they require for their wants; and where animals, for a still longer period, will find all the oxygen gas they can consume.

Borrowing the words of Dumas, "Then come animals, consumers of matter, and producers of heat and of force; true instruments of combustion. It is in them, unquestionably, that organized matter acquires, what may be called its highest expression. But it is not without detriment to itself that it becomes the instrument of sensation and of thought. In this new capacity, organized matter is burnt, and in giving out the heat or electricity which constitutes and is a measure of our force; it is destroyed and returned to the atmosphere from whence it had originally come.

"Allow me here, borrowing a simile from modern science, of grandeur somewhat commensurate with these grand phenomena, to liken the vegetable world of the present age, the true storehouses whence animal life is fed, to that other great magazine of carbon, which we possess in our primeval beds of coal; and which, being burnt under the genius of Papin and Watt, produces carbonic acid, water, heat, motion—we might almost add, life and intelligence."

On looking back, we distinctly find that the primitive atmosphere of our globe has formed itself into three great divisions; the first, constituting the atmosphere of the present age; the second represented by plants; and the third, by animals.

PART VI.

OBSERVATIONS AND REFLECTIONS ON AGRICULTURE, ANIMAL LIFE, HEALTH, AND DISEASE.

Utility of the subject—Cultivation of plants—Use of Humus or Mould—Use of Minerals—Use of Gypsum—Starch, Sugar, and Dextrine—Fibrine, Albumen, Caseine, Gluten, Proteine, &c.—Electricity—Plants become animals during flowering—Supply of Carbon and Hydrogen to the Lungs—Effect of labour—Remedied by a supply of Carbon and Hydrogen—Asphyxia from Carbonic Acid Gas—From Sulphuretted Hydrogen Gas—Cyanogen, or Prussic Acid—Effect of breathing an impure atmosphere—Typhus fever—Treatment—Ventilation—Theory of Inflammation—Congestion—Treatment of Inflammation—Effect of Mercury, Antimony, Iodine, Colchicum, &c.—Inflammation of the lungs—Pleurisy—Inflammation of Liver—Treatment—Hydropathy, Homœopathy and Mesmerism—Absurdity of—Benefit of early remedies—Selection of medical attendant—Education of medical men

—Definition of Disease—Indigestion and its effects—Progress of Disease—Tested by the Urine—Disease of Kidneys—Specific remedies—Treatment of Disease—Diet—Tea, Coffee, and Tobacco—Conclusion.

Those who have attentively considered the subjects entered into in the first five parts of this essay, must feel convinced, by this time, that an intimate knowledge of the manner in which vegetable and animal life is kept up by the common laws of nature, must be very useful; not only to the agriculturist and physician, but, to all classes of society. For, exclusive of the agreeable and interesting information it gives to us of the mode in which everything around us exists; it also teaches us that best of all knowledge—"the knowledge of ourselves."

It remains, therefore, to make a few observations of a practical nature on these simple laws of animal and vegetable life, which have been very hastily, and we fear too indefinitely, portrayed; feeling certain that all classes of persons come within their reach, and will benefit from a correct knowledge of their manifestations.

As it is so self-evident that we all depend on vegetation for our existence, it must be conceded by all, that the state of agriculture in every nation and neighbourhood, has much to do, not only with the prosperity, but the health of its inhabitants; and not the least part of the author's intention in writing this essay, is, to induce persons, interested in the progress of agriculture, to carefully examine the laws which have been so imperfectly explained in this treatise, and study them from more elaborate works.

It will be acknowledged by all those who understand the subject, that wheat and the Jerusalem artichoke both contain in their composition, a very large proportion of nitrogen; and, on that account, are both very nutritive articles of diet. Yet, look how these two vegetables grow? Wheat has a long stem, with very little herbage or leaf, and, consequently, not capable of absorbing much nitrogen or ammonia from the atmosphere; whereas, the Jerusalem artichoke has a fine capacious foliage, evidently showing its capability of absorbing food from the atmosphere by its leaves.

Does not such a reflection as this must suggest, show that the proper mode of feeding wheat is through the soil; and the proper mode of feeding the Jerusalem artichoke through the air? But, in general agricultural pursuits, how seldom is this plan of culture taken into consideration? And if these two vegetables, so much alike in their products, and useful to the human family, admit of so great a difference in their mutual mode of culture, is it not most probable that every family of plants has one or other of these peculiarities?

In selecting tillage for these two varieties of plants, no one would think of giving to the wheat a preparation of ammonia, so volatile, that it would, by the heat of the sun, be immediately evaporated into the air. The *roots* of the wheat should be supplied with the food, and the *leaves* of the artichoke.

In a former part of this essay, it has been shown how easily the ammoniacal or nitrogenous parts of stable and yard manure may be collected, fixed, and dissolved in water, so as to be ready for the roots of wheat to imbibe it. But, if you wish to push a crop of Jerusalem artichokes, water your soil every day with a solution of carbonate of ammonia, or what is the same thing, urine.

The mere soil or humus of the ground principally serves to support the plant in the position in which it is placed, and allows it to obtain carbonic acid from the decomposition of the carbon in the soil; and nitrogen and other salts from the rain water which comes in showers, and the dew at night; and which easily permeate the soil, if it is kept in sufficiently open condition.

Every variety of vegetable requires some salt or mineral substance to perfect its formation: such as potash, soda, lime, silica, magnesia, phosphorus, sulphur, iron, &c., besides nitrogen, hydrogen, and oxygen; and the scientific agriculturist will devote his energies to discover if the soil in which he sows such seed contains the very substance which nature has intended it to absorb; if not, he will supply it at the least possible expense. The great advantage of using gypsum (sulphate of lime) as a manure, is, that the ammonia of the carbonate or nitrate of ammonia, combines with the sulphuric acid of the gypsum, and converts it into a soluble sulphate of ammonia, which is dissolved in the rain and dew, and conveyed to the roots; and the carbonic or nitric acid unites with the lime, forming carbonate or nitrate of lime, both of which are soluble by plants.

From carbonic acid and the elements of water, woody fibre, starch or dextrine, and sugar are formed, which compose the general frame-work of vegetables. And from carbon, the elements of water and nitrogen; fibrine, albumen, caseine, gluten, proteine, vitelline, legumine, gelatine, chondrine, and of every other vegetable matter are produced. The mere addition of specific salts and mineral substances, giving the alterations in flavour, colour, consistence, &c.

The cheapest and easiest mode of supplying plants with nitrogen in hot weather, will be found to be through the agency of electricity. Already has this plan been put into execution, and found to answer.

But enough has been said on agriculture. It would be easy to follow the subject up, if these pages were exclusively devoted to this subject. We will now endeavour to throw out some useful hints on the nature of health and disease in animals, a subject more nearly connected with the author's views and intentions, although the cultivation of vegetables is, as must be manifest, most intimately connected with it.

There is a link between vegetables and animals, so close, and so expressive of that common law of combustion, or chemical combination of carbon with oxygen and hydrogen, when carbonic acid and water are produced, that it would not be doing justice to the vegetable world to pass it over unnoticed. We refer to the combustion of sugar, and evolution of heat, carbonic acid and water, at the period of germination. A familiar instance may be named in the sugar-cane. When the flowering and fructification have been accomplished, it is found that the stem from which the flower has proceeded, has lost the whole of its sugar; and during this process, the flower, instead of exhaling or giving out oxygen, gives out carbonic acid gas, water, and heat. In other words, it manifests some of the characters of an animal.

This is exactly what happens in animals. Sugar and starch are composed simply of carbon and water; animals digest and convey them into their blood, not to form their muscles and tissues with—as these are principally composed of nitrogen; but, to combine with the oxygen of the air in their lungs, and produce animal heat, the product of which is carbonic acid and water.

If this constant supply of carbon and hydrogen was not kept up in the venous blood, what would be the consequence? The oxygen of the atmosphere would enter the lungs at each inspiration, and because there was not a ready supply of carbon and hydrogen in the venous blood, the *fat* of the body, which also is composed of carbon and hydrogen only, would become absorbed and carried into the venous blood; and there take the office of the starch and sugar of our food.

We therefore find, that when an animal has been a length of time without food, the whole of the fat of the body is gone; it has been absorbed, and used for the production of animal heat; without which, the animal could not have existed.

Suppose, then, a man has been ploughing or thrashing five or six hours; or if he has been running fast, or working hard in any way; he, during that employment, has breathed much quicker than usual; his inspirations have been deeper, because he wanted a greater supply of oxygen to combine with the tissues which had been worn out or decayed in the capillaries during his increased exertion. The effect of this is, a feeling of great exhaustion. He has been supplying carbon and hydrogen to the blood in his lungs at the expense of his muscles; and if this is carried to a great extent, complete fainting supervenes — nay, actual asphyxia might take place.

What is the natural remedy for such a state? An immediate supply of carbon and hydrogen to the venous blood in the lungs is the rational answer. How can this be best administered? By drinking a glass of good bottled porter; which is carbon and hydrogen prepared for immediate absorption. This, certainly, is the very best remedy for such a state of exhaustion; but there are instances which would lead one to prefer a glass of wine, or even brandy and water; but some kind of fermented liquor, particularly in a state of effervescence, is most undoubtedly the very best, and only, immediate restorative. A glass of champagne is no bad substitute.

It is very far from the author's wish or intention to encourage anything approaching to an improper use of fermented liquors. *Intoxication* is a propensity so debasing to human nature, that the wonder is, any reasonable being will ever allow himself to be so deluded. But, in the present age, the opposite extreme is becoming too much a matter of prejudice, passion, and fashion; and cannot be supported to the extent it is done by many well-intentioned and intelligent individuals, upon scientific principles.

The poor man who works hard the whole

morning, and has worn out much of the carbon and hydrogen of his food of yesterday, feels the want of some gently stimulating liquor for the immediate supply of the vacuum in his lungs; and it is really cruel to prevent him taking that best of all sustenance, which God has provided for him, and, which used temperately, must be a great source of gratification as well as benefit to him.

Instead of encouraging teetotalism to the extent it is now done, let us endeavour to give the minds of those who are deluded by a cheerful cup to "drink too deep" a better bias! Let us instruct them in the real use of this gift of Providence! Make them fully understand *that*; and their mental faculties will no longer be given up to the beastly indulgence of intoxication!

Suppose, instead of having atmospheric air to meet this carbon and hydrogen in the lungs, carbonic acid gas is inhaled; which may happen from various circumstances, as it did in the black hole of Calcutta, in consequence of so many being obliged to breathe the same atmosphere for a great length of time; or from a charcoal-fire being placed in a room, or in a coal-pit or mine, &c.; what would be the consequence? The venous blood could not be changed into arterial; there would be no animal heat generated; venous blood would be circulated in the brain, instead of the naturally stimulating arterial blood; the brain would not receive that energy which it ought to do; the nervous power would not be sent to the heart and lungs, and respiration and circulation must soon cease; the left side of the heart could not be stimulated by the venous blood, and consequently would cease to act; the right side of the heart and the general venous system would, therefore, become congested or gorged, as well as the brain, with black blood, full of carbon. From such a state a person might be recovered by the abstraction of a small quantity of venous blood from the jugular vein or arm, which would relieve the congestion in the brain, and by producing artificial respiration by means of proper apparatus, which it is right for every person to become acquainted with the use of. The external heat of the body should be kept up by warm blankets and friction.

But what would be the effect if an animal attempts to breathe sulphuretted hydrogen gas? Just what it would be, if a solution of protoxide of iron were exposed to a current of sulphuretted hydrogen gas out of the body. It would decompose the oxide of iron of the globules of the venous blood, form a black sulphuret of iron, which could not be again changed to the protoxide of iron by any addition of oxygen; consequently the animal immediately dies, and cannot be recovered.

The same thing happens if an animal breathes cyanogen, or the gas of Prussic acid. The animal cannot be resuscitated.

Imagine, then, what must be the effect of living in an atmosphere contaminated by those gases, within the precincts of one of the notorious churchyards in the middle of London, where an atmosphere consisting of a mixture of sulphuretted, carburetted, and phosphuretted hydrogen gases, with ammonia, is the only one within your reach? This is well described by Mr. Walker, in his "Gatherings from Grave Yards." He says of the burying-ground in Portugal Street, "The soil of this ground is saturated, absolutely saturated, with human putrescence. The effluvia from it at certain periods, are so offensive, that persons living in Clement's Lane are compelled to keep their windows closed. The walls even of the ground which adjoins the yards of these houses, are frequently seen reeking with fluid, which diffuses a most offensive smell. Typhus fever is very prevalent in the neighbourhood, especially in Clement's Lane, which is absolutely surrounded by burying grounds." Of Enon Chapel, he says, "The upper part of this building is devoted to the purpose of public worship. Underneath it is the burying-ground, being separated from it only by a boarded floor. From 10,000 to 12,000 bodies have been placed here since its establishment, in pits, the uppermost of which were covered only by a few inches of earth. Soon after interments were made, a peculiarly long narrow black fly was observed to crawl out of many of the coffins; this insect, the product of the putrefaction of the bodies, was observed in the following season, to be succeeded by another, which had the appearance of a common bug with wings. A Sunday School is held in the chapel." "In St. Clement's Church, Strand, there is a vault called the Rector's Vault, the descent into which is in the aisle of the church near the communion-table, and when opened, the products of decomposition of animal matter are so powerful, that lighted candles, passed through the opening into the vault, are instantly extinguished. The men at different times employed, have not dared to descend into the vault until two or three days had elapsed after it had been opened; during which period, the windows of the church also were opened, to admit the perflation of air from the street to occupy the place of the gas emitted. Thus, a diluted poison is given in exchange, from the dead to the living, in one of the most frequented thoroughfares of the metropolis. There was formerly a well by the side of the church, but the water became so nauseous that it could not be drunk, owing to its becoming impregnated with the putrefying matter with which the ground was charged." "In Buckingham Chapel, very near Buckingham Palace, one of the vaults is underneath two large school-rooms, where some hundreds of boys and girls receive their daily education. The entrance to the vault is through a trap-door in the passage, dividing the school from the chapel. When I visited this place, a body had recently been interred, and the effluvia from it was particularly annoying. The vault is supported on wooden pillars, and there is only one grating, which fronts the street, to admit light and air. The floors of the school-room, whitewashed on the under surface, form the roof or ceiling of the vault. It is no difficult matter to see the children in the lower school-room from this vault, *as there are apertures in the boards sufficiently large to admit the light from above.* This place is spacious, *but very low*. The smell emitted from it is *very offensive.*"

We will not attempt to offer any comment on the facts which have been here detailed. They speak for themselves.

The immediate effect of breathing such an atmosphere as this, in many cases, would be the production of low putrid fever. But, when human beings are habituated to this kind of atmosphere, its effects are only slowly produced.

In the first place, there would be too little oxygen in the air to combine with the carbon and hydrogen of the venous blood, to free it from that quantity which nature requires; and in consequence of that, there will be less animal heat generated both in the lungs and general capillary system; and a larger quantity of carbon continually circulating, than nature is capable of holding. The natural stimulus caused by the circulation of arterial blood in the brain, is not given; the nervous system does not act; galvanic action, as it were, is not generated, and, of course, not distributed or conveyed; by-and-by, the left side of the heart refuses to receive the blood from the lungs, because it is not sufficiently stimulating to excite the contraction of the ventricle. But this makes its approach very slowly: consequently, the venous blood remains in the vessels of the lungs, and produces congestion, with all its accompanying debilitating symptoms. The proper secretions are not formed by the various organs, in consequence of a want of supply of arterial blood, and digestion and chylification are deficiently performed.

All these operations go on at the same time in the human system, from breathing an impure atmosphere; more quickly, according to the degree of the impurity. At length, fever of a low description breaks out: this is soon propagated from one individual to another in the same vicinity, because they are all under the same depressing influence. To prove the correctness of this opinion, we will again quote from Mr. Walker's work.

"In the middle of June, 1825, a woman died of typhus fever in the upper part of the house No. 17, White Horse Yard, Drury Lane; the body, which was buried on the fourth day, was brought down a narrow staircase. Lewis

Swalthey, a shoemaker, then living with his family in the second floor of this house, and now residing at No. 5, Princes Street, Drury Lane, during the time the coffin was placed, for a few minutes, in a transverse position in the doorway of his room, in order that it might pass the more easily into the street, was sensible of the most disgusting odour, which escaped from the coffin. He complained almost immediately afterwards, of a *peculiar coppery taste*, which he described as being situated at the base of the tongue and posterior part of the throat; in a few hours afterwards, he had, at irregular intervals, slight sensations of chilliness, which, before the next sunset, had merged into repeated shiverings of considerable intensity. That evening he was confined to bed. At the expiration of the third week, he was removed to the Fever Hospital: he recovered. He had been in excellent health up to the instant when he was exposed to *this malaria*."

The effect of the gases produced during the extreme stage of putrefaction, are well illustrated by the following case.

"My pupil, Mr. J. H. Sutton, accompanied by an individual for many years occasionally employed in the office of burying the dead, entered the vault of St. ——— Church. A coffin, *cruelly bloated,* as one of the grave-diggers expressed it, was chosen for the purpose of obtaining a portion of its gaseous contents. The body, placed on the top of an immense number of others, had, by the date of the inscription on the plate, been buried upwards of eight years. The instant the small instrument employed had entered the coffin, a most horribly offensive gas issued forth in large quantities. Mr. S., who unfortunately respired a portion of this vapour, would have fallen, but for the support afforded by a pillar in the vault. He was instantly seized with a suffocating difficulty of breathing, as though he had respired an atmosphere impregnated with sulphur. He had giddiness, extreme trembling, and prostration of strength. In attempting to leave the vault, he fell, from debility. Upon reaching the external air, he had nausea, subsequently vomiting, accompanied with frequent flatulent eructations, highly fœtid, and having the same character as the gas inspired. He reached home with difficulty, and was confined to his bed during several days. The pulse, which was scarcely to be recognized at the wrist, although the heart beat so tumultuously that its palpitation might be observed beneath the covering of the bedclothes, ranged between one hundred and ten and one hundred and twenty-five per minute, during the first three days. For many days after this exposure, his gait was very vacillating."

On the 5th of July, 1841, a boat was launched in the canal at Rotherham, crowded with people, principally young, and, unfortunately overturned, and drowned fifty persons; most of whom were interred in the churchyard of the parish, which is in the centre of the town, on the same day of the week. The consequence of opening so many graves in a cemetery which is as full as it can hold, was, that a very unpleasant effluvia arose, which the author took particular notice of; and, in the course of the following week, a great number of cases of typhus fever broke out amongst the inhabitants all around the churchyard. Two of the cases, which came under his own care, were of an exceedingly malignant character.

How are such cases as these to be treated? Are we to pour cold water into them, and cover them with comfortless wet sheets, wrap them in blankets, and sweat out the bad air from their blood? It is to be hoped, by this time, the reader has become sufficiently acquainted with the subject, to be aware, that in the first place *respiration* must be kept up, or the patient could not long exist. This is best accomplished by those ready-made, but abused preparations of carbon and hydrogen, porter and wine, which in such cases are most invaluable remedies. We must support respiration also, by doing all in our power to supply the venous blood with oxygen. A pure atmosphere, so difficult to meet with in such cases, is better than all the cold water in the world.

It would be very easy to multiply these facts to almost any extent, by quoting cases from medical works; but, as that is not the author's object, enough has been said, to show how necessary to health is a pure atmosphere, and how thankful we ought to be to the Great Creator of all things for adopting so simple a method of keeping our atmosphere free from deleterious and noxious exhalations.

Free ventilation is, next to a pure atmosphere, the most conducive to health. Where this is deficient, as in the houses of the poor in Liverpool, Glasgow, &c., low typhus fever is generated:—first among the low and dirty inhabitants, who next infect the rest of the community.

How necessary it is, then, for all classes of society to join in their efforts to prevent interments in towns, and ventilate and drain every populous district. The enormous quantity of disease generated in consequence of the neglect of these measures, is incalculable !

To make the reader understand what *real disease* is, it will be necessary shortly to explain the theory of common inflammation.

Whatever nervous influence may be, or however generated, we know that the energy of parts depends upon something which is communicated to them by the nerves, in conjunction with the brain and spinal marrow. While parts are supplied with this nervous influence, they retain their power of action; but not longer. Arteries become insusceptible of impressions from external agents when their nervous energy is low: and when the vital powers are sunk, the capillary arteries cease to secrete.

We know that the action of the heart is that of contraction, by which the blood is sent forward in the arteries: and the power of the heart's action is measured by the pulse, where there is no organic alteration, such as ossification of the valves at the beginning of the aorta, &c.

When a part is inflamed, the capillary arteries are weaker in their action; there is diminished arterial action; for the action of arteries is contraction. The arteries in inflamed parts are evidently larger than before—less contractile: that is, acting less. An inflamed eye-ball affords an apt illustration: the white part of the eye, which admits in health only the colourless serum of the blood, has its capillary vessels so enlarged, in consequence of the loss of nervous energy, that they admit red globules, which become visible.

The difference between congestion and inflammation is shortly this: in congestion, the capillary vessels become loaded; but they recover, and regain their original size and condition, without any further consequence. But in inflammation, the capillaries secrete and deposit coagulable lymph, which has the effect of altering the nature of the tissue: it glues parts together, and thickens them. This frequently remains for life, under the most scientific treatment: and it is this peculiar state, the product of either acute or chronic inflammation, which medical practitioners call organic disease.

The more the heart acts, the more, of course, it forces the blood in the arteries of the inflamed part; and the pulse, showing the power of action of the heart, is, erroneously, by some, considered as an evidence of arterial action; the throbbing of the carotid arteries for instance. As the heart, therefore, acts against the capillaries, if we cannot cause them to contract strongly enough to resist its force, we are obliged to diminish the force of the circulation; either by taking away blood, which both decreases the quantity of blood sent to the arteries, and the action of the heart itself—and in this way, we leave less for the arteries of the inflamed part to do—or we reduce the force of the heart sometimes, by medicine, &c.

In a burn from sealing-wax, for instance: the mischief is caused by the exhaustion of the nervous influence: the sudden removal of the excitant, leaves the capillaries destitute; and they yield immediately to the ordinary injecting force of the heart. But if the wax be allowed to cool gradually, before it is removed from the skin, the nervous influence is kept up in the capillaries; they do not cease to act, and do not give way: and although the pain is severe during the cooling of the wax, it ceases as soon as it has cooled, and no blister arises.

How do mercury, antimony, iodine, colchicum, and various other drugs, stop the progress of inflammation? This is a very necessary question; and one very little understood. They act by being absorbed into the venous blood, circulated through the lungs and arteries; and when they arrive at the capillaries, from their astringent properties, contract those vessels, and consequently push forward the blood, which has been, as it were, oozed out into them.

The inflammation of the mouth, well known as the specific effect of mercury, is caused by the extra contractility of the capillaries of the gums, producing so much irritation, as to be acted upon, irritated and ulcerated, by the contact of the teeth, and even in some cases by the contact of the air.

Antimony has not only this astringent power of contracting the capillaries, but produces sickness, and lowers the circulation. Colchicum has very much the same effect.

It is therefore very plainly seen that these substances are direct remedies for inflammation: and act quickly and with energy; in time to stop the deposition of coagulable lymph, and prevent organic disease.

Let us now turn our attention to a case of inflammation of the lung. The capillaries have lost their power: they admit blood in large quantities—venous blood, full of carbon: they pour out this adhesive matter, which we call coagulating lymph, and prevent the air rushing through the air vessels in its usual manner, causing that peculiar crepitating sound in respiration, already described. The effect of this is, that the oxygen of the atmosphere cannot readily combine with the carbon and hydrogen of the venous blood in the capillaries of the lungs; the blood is not arterialized, and therefore imperfect blood is circulated in the arteries. The lungs, by redoubling their efforts in respiration, try to overcome this difficulty; but in vain. As long as the capillaries are inflamed, respiration must be imperfect. The rusty-coloured expectoration evidently shows, in this stage, that blood is mixed with the mucus of the mucous membrane of the air-cells.

Suppose the case goes on: the next stage is a sort of solidification of the lung: the lymph has, as it were, glued it together, and it admits no air. Of course, there is no respiratory murmur; the voice sound is altered, and the resonance of the chest is flat and solid. The difficulty of breathing now, almost amounts to asphyxia: the poor sufferer is, indeed, to be pitied.

Should the disease still go on, pus is secreted from the inflamed capillaries: which is expectorated, and may be discovered by the microscope. This may either terminate in death very soon; or the miserable sufferer may linger days and weeks: and, at last, obtain a very imperfect recovery, with the loss of one lung. If both lungs should be attacked, death is soon the consequence of the uncontrolled course of the disease.

This is often accompanied by pleurisy: which is inflammation of a sort of serous membrane, which covers the lungs and lines the ribs. The effect of inflammation in this membrane is, to produce a large quantity of serous fluid, which is poured out into this bag, accumulates at the bottom, presses the lung close to the spine, and, of course, destroys its action. Pleurisy is accompanied by more acute pain than inflammation of the lung itself: and is one of those diseases which goes on so quickly as very soon to destroy life, if the most prompt measures are not used to check it.

Inflammation of the liver is another serious disease; which requires all the energy and skill of modern science to subdue. Observe the consequence of this. It is the largest organ in the body; and carries away from the blood a great amount of carbon; which, if left in it, would soon act as a poison. During inflammation of this organ, this carbon remains in the blood. The liver, in consequence of the capillaries throwing out coagulating lymph, becomes thickened and enlarged; and if not at once stopped, the enlargement goes on, producing either organic disease, or abscess. The abscess may, fortunately, discharge itself in such a manner as to allow nature to cure the disease: but, if real organic disease is the consequence, then the accumulation of carbon in the system, the effect of pressure on the veins and other organs, soon bring on dropsy, with all its accompanying catalogue of symptoms.

What mode of treatment then is to be adopted in such cases of disease as those just described? Are we to trust those remedies which have been sanctioned by the experience of a century, and received the approval of the wisest and oldest men, who have devoted their whole lives and energies to the philanthropic and noble science of relieving human suffering? Or, are we, because of the popular cry against bleeding and mercury, to trust these cases to the care of the hydropathist, homœopathist, and mesmerist?

We need not resort to a hatchet or a pen-knife to cut bread with, when we have a table-knife at hand, which we know has always been successfully used for such a purpose. Nor need we try whether cold water or mesmerism, may, by chance, cure inflammation of the lungs, or liver, or remove the secreted fluid in pleurisy, and run the risk, by its not doing so, of losing the only time, during which, our known remedies can act! and, by such means, consign our patients to an untimely grave! For we know, that for the last hundred years, bleeding and the proper use of mercury, will cure these diseases, in a great majority of instances. We can also fully explain the action of bleeding, mercury, and antimony: but are yet in doubt as to the action of the other falsely called remedies.

The laws of nature are fixed and defined. Is it likely they will, in one case, be altered to suit the hydropathist, and in the other the homœopathist or mesmerist? If so, every adventurer, who has a new theory to try, or a fortune to obtain out of the pockets of the credulous and unthinking, must expect those laws which have been acting ever since the creation of the world, will stop, alter their course, and assist him, in his knavishly, unblushing, and extraordinary undertakings.

It would be as absurd to set up a theory to make the lunar month go on to six weeks! and I would as soon believe that theory, as many of those, which, in late times, have received much attention from a large proportion of the community, who will not give themselves the trouble to examine and think for themselves.

It is well known to the oldest and wisest in the profession, that organic diseases are incurable: and that the best assistance we can give to the unfortunate subjects of those diseases, is, to prevent irritation, keep up the supply of nourishment by attending to the respiratory organs; by which means we smooth the rugged path to the grave. But I have, more than twice, seen letters from the professors of hydropathy, promising to cure, in six weeks, the most confirmed cases of schirrus of the pylorus: cases that could be felt—almost seen! This requires no comment.

When we can look back, through the agency of science, to the origin of our very existence; and satisfactorily account for it, even from the commencement of the formation of our atmosphere; and trace, through the discoveries which modern chemistry has disclosed, the progress, step by step, of one race of men after another; and when those discoveries tally with the experience of centuries;—when we can trace the very atoms which form our tissues, from the atmosphere, through vegetation, to the different organs which build up, not only the lower animals, but that lord of all animals—MAN;—when we can actually and clearly account for even the superior organisation of his brain, with regard to the animals beneath him, giving him thought, wisdom, and command!—is it to be supposed that, in this age, in our great schools of science, where, not only classics, mathematics, natural philosophy, chemistry, human, comparative and morbid anatomy, physiology, pathology, or the knowledge and treatment of disease, are studied and taught by those very men, through whose enlarged minds most of the late great discoveries in science have been made!—can it be supposed that such men are not able to find out the easiest, safest, and best modes of relieving the sufferings of our fellow-creatures! but must leave them to such designing persons as pretend they have discovered an universal remedy?

Reflect, friendly reader, on the value of human existence! Can we carelessly trifle with the life of a fellow citizen, who has an immortal soul, in the same way as we can experiment upon an animal to make some discovery? We can confidently appeal to those who have made the diseases of human beings their constant study, together with the contributary sciences, and ask them if they will not maintain that teetotalism should be confined to the confirmed drunkard; hydropathy to the gouty voluptuary; homœopathy to the fanciful; and mesmerism to the weak-minded? But that the pure science of the present age must be brought into action for the relief and cure of real disease, wherever it exists; water being one of the substances which science and experience have proved to be useful.

There can be no impropriety, while on the present subject, in adverting to the advantage of obtaining proper advice early, in what may appear, to a common observer, slight ailments. Those who have carefully watched the progress of disease, will readily acknowledge the difficulty they often experience in obtaining a proper examination of a delicate female, when her physician fearfully apprehends she may be labouring under the influence of latent tubercles in the lungs. He knows that the very earliest stage of such a disease is the only one to stop its progress; but he also feels, that by raising a fearful doubt in his interesting patient's mind of the nature of the malady, he would be doing her more injury than, perhaps, all his skill could cure: namely, by adding to the already existing depression of the vital organs. He is also aware that feverish action, if let alone a few days, will run its course, as to time, in spite of the most approved and energetic treatment; but, that if proper steps are taken in the earliest stage, nothing is easier in his profession, than to stop its current in many instances.

Can there be any risk of deserving the censure either of our medical brethren, or of the public, if we recommend the invalid to select a well-educated, conscientious, attendant, of good common sense, either physician or general practitioner; one who is not mercenary, who practises his arduous profession with the taste and warmth of science, and who keeps up, by study, with the improvements of the day,—and give him implicit confidence?

The most anxious care of every head of a family should be to select some competent confidential medical person, with whom he may live on terms of intimacy and friendship. A trifling disease often leads to most disastrous consequences; and it requires more than a parent's skill to discover such danger, or to avert it. To this friend he can fly on every occasion, when his mind is alarmed by the first approach of sickness in his family; and he will find, at all times and hours, his advice and assistance promptly and cheerfully afforded. He is his companion and solace in the most anxious and trying moments of his life—he may have witnessed the loss of children and relations with him—alleviated many painful feelings by his kind and soothing attention—and dissipated the terrors of imaginary, as well as softened real dangers. Secure in his confidence and friendship, he recollects instances in which he has been instrumental in preserving to him the dearest blessings of his life; and has consoled him when almost overcome with despair! These feelings and circumstances ought to endear a man to his medical friend; and make him always mindful of the obligations he owes to him, who has sacrificed health, time, and comfort, and watched with the most anxious solicitude, by day and night, the critical changes of a dangerous disease: and whose joy at the unexpected recovery of an amiable and excellent wife and mother, or darling child, can only be surpassed by the more anxious husband and father.

Such men as these are to be found in the present day. The general practitioner is now a much better educated man than the late physician: and, in future, (thanks to Her Majesty's Secretary of State, Sir James Graham, for his acumen, attention, and perseverance,) the public will have yet a higher grade of medical attendants. Henceforward, every person who enters the medical profession in England, whether intended for physician, surgeon, or general practitioners, must, at the age of twenty-two, go through exactly the same examinations in both medicine and surgery; and practise for a certain number of years as a general practitioner: he may then, by undergoing another examination, qualify himself either for a consulting physician or surgeon. This is as it ought to be! The old plan of manufacturing consulting physicians at twenty-one was certainly too ridiculous to admit of any observation.

Whenever a medical practitioner practises his profession on really sound principles, there will be no quackery: those who practise without science, have nothing else wherewith to obtain the confidence of the public; and which, unfortunately for the public, too often succeeds.

The ailments of the animal frame may be divided into three classes: 1st, *disorder;* 2nd, *disease;* 3rd, *organic disease.* *Disorder* merely relates to alteration in the performance of the natural function of an organ; and is frequently relieved and cured by the efforts of nature alone. *Disease* consists of increase or deficiency of nervous energy supplied to an organ, with or without inflammatory action, and their consequences; and this requires the interference of art for its cure. *Organic disease* consists of the ultimate effect of inflammation; increased or deficient nutrition; and has the effect of changing the structure of the organ affected. This is incurable, but admits of being greatly relieved by well-directed treatment.

A very familiar disorder, Indigestion, will illustrate this part of our subject very efficiently.

The first symptoms are mere irritation: the patient feels that he has a stomach; then he has a pain or uneasiness after eating or drinking certain kinds of food: this increases very gradually to actual pain, either immediately, or an hour after, taking any kind of food: in a short time, varying according to peculiarity in the nervous system, and exciting causes of irritation, the food is rejected in from one to three hours after taking it into the stomach; the person begins to suffer, not only from acute pain in the stomach, but from general debility. His muscles refuse to do their work; animal heat is not kept up to its proper extent; he always feels chilled; and, at length, complete emaciation takes place.

What has been the process of disease going on in the stomach alone during this period? At first, it was mere irritation of the mucous membrane: i. e., functional disorder; which may easily be cured. In the next place, it becomes inflammation of the mucous membrane: i. e., real disease. This continuing, coagulable lymph is secreted by the arteries in the capillary vessels, instead of the proper fluid, gastric juice; the glands of the pyloric extremity of the stomach become thickened; and permanent thickening of the mucous membrane of the stomach, and scirrhus of the pylorus, is the consequence; this is real organic disease—incurable.

It is well-known to empirics that stimulants and opium will relieve all the unpleasant sensations of this common disease; and therefore these falsely called remedies, which mask the disease, and allow its insidious progress, are made use of. The consequence is, the inflammatory action is kept up; the greater the pain, the stronger will be the stimulant and sedative used; until the last stage, organic disease, sets in: when, finding quackery ceases to give relief, the unhappy and deluded sufferer applies for scientific aid—too late.

The well-educated physician will, from the very first symptoms of such a disorder, recommend the mildest and blandest diet, with the total exclusion of stimulants and opium; and, by carefully selected remedies, gradually recover the capillary vessels of the mucous membrane from their inflamed condition; and prevent the second and third stages of such a disease making their appearance.

When, from accidental mechanical injury, or other cause, the action of the capillary vessels is changed by direct impression on their nerves, the derangement of their action is the commencement of disease. The secretions become altered, checked, or profuse; nutrition is either diminished, so as to produce emaciation, or there is an excessive deposition, so as to produce dropsical effusion; vapoury exhalations are diminished to dryness, or increased to fluid; bony particles are deposited in wrong places, or albuminous, fatty, and other particles, so as to constitute tumors; the nerves of parts become morbidly sensible, so as to derange the functions of such parts; and portions, losing their vitality, undergo spontaneous decomposition, and are removed by the absorbents.

To explain more in detail,—every disease is some alteration of those actions, which, when perfect, constitute the welfare of the animal; and in some instances, by a provision of nature, the newly altered action, which is the consequence of the injury, leads to the reparation of the damage, without assistance from art. For instance, the tubes which conduct the air through the lungs, are, under ordinary circumstances, scarcely moist; but, if particles of dust or insects get in, the irritation causes morbid sensibility, followed by the extra production of mucus, which entangles the foreign substance, and so brings it away by coughing.

Great fatigue from labour includes a certain exertion of the brain in the production of voluntary motion. But, if the body and mind together be greatly fatigued, as, where a person has to walk a very long distance, the mind being at the same time most anxiously occupied, the expenditure of nervous influence will be exceedingly rapid, and the exhaustion succeed in proportion.

The expenditure of nervous influence which takes place in intense study or professional business, combined with great anxiety, as often happens to lawyers and medical practitioners, over excites the brain so much, as to diminish considerably the nervous energy of the digestive organs; when a common meal, devoured in a very hasty manner, too often the case under such circumstances, is quite sufficient to bring on a severe attack of disease. In this way the cares of business become the fruitful source of indigestion and gout; particularly when, as in great cities, perpetual feasting adds to the labours of the stomach.

We are much indebted to the discoveries of modern organic chemistry for the means of detecting such states of the animal system, long before actual disease makes its appearance. In such a case as we have been describing, if we take the trouble to examine the urine of the person, we shall almost certainly find a large quantity of phosphatic salts; perhaps sufficient even to make the urine alcaline instead of acid. These are beautiful crystals, when viewed under a powerful achromatic microscope; and their evidence sufficiently repays the observer for the trouble of detecting them.

If a person is seized with excruciating and deep-seated pain in the abdomen, shooting down the thigh, which resists the usual mode of treatment; let us examine the urine, and we may there find blood, pus, oxalate of lime, uric acid, or phosphates. This, at once, explains the nature of the malady; and we can confidently inform our patient that he has a small calculus of a certain description in the tube which brings the urine from the kidney to the bladder; and our treatment becomes at once plain and straightforward. Whereas, before this mode of testing such a case was discovered, our treatment must have been, in some degree, empirical.

Or, a practitioner of medicine may be consulted by a person with various anomalous symptoms of a debilitating nature, to which he finds it impossible to give a name, or to relieve. Let him chemically examine the urine, and he may soon discover either albumen, sugar, oxalate of lime, or a large quantity of urea:—which will, at once, determine the point, explain the diseased process which is going on in the animal system, and suggest the remedy.

This being a favourite subject, it becomes difficult to know when we have said sufficient on it. We will therefore only venture to notice another change in the system, which the examination of the urine explains very characteristically.

It has been already stated, that urea is changed into carbonate of ammonia, by the combination of two atoms of water. Now, as long as the nervous supply is sent in natural quantity to the kidneys, they secrete urea from the blood; a substance perfectly unirritating, both to the kidneys and bladder: but when the nervous supply is checked or stopped, from an injury or disease in the spine, carbonate of ammonia will be secreted from the kidneys, instead of urea; the chemical change going on in the animal body, just as it would do in the laboratory of the chemist; the organic life of the kidney being partially destroyed. The secretion of carbonate of ammonia is one of the most irritating matters that can possibly have to go through the bladder, and of course brings on a host of horrible symptoms. Let us thank modern discoveries for enabling us not only to find out, but prevent, such an accumulation of evils.

It is an opinion too commonly current, that the same remedy will cure the same disease in different individuals. Nothing can be further from the truth. Every effect depends upon its cause. We know of no real specific. Even mercury, the peculiar action of which is considered almost specific in certain diseases, very frequently fails, in consequence of the animal organs being in an unfit state to receive it. It either is not absorbed at all, or, when it is absorbed, it adds to, instead of relieving the disease. To prescribe exactly the same remedy for the disease known by the same name, without taking into consideration various circumstances connected with the origin and progress of it, would be very injudicious; and, by the failure of the remedy, tend to bring it into disrepute. To attempt, therefore, in a work like this, to give a code of laws for the treatment of disease, must be a failure. The sincere wish and hope of the author is, that those who may read this essay will discover, by a careful perusal of it, that, in order to enable any person to treat the diseases of human beings successfully, he must in the first instance be educated in such a manner as to understand, almost at a glance, the common laws of inorganic, as well as organic nature; to allow for the working of human intellect on such of the laws of organic nature as are concerned in the theories of function, secretion, assimilation, and excretion; and to modify and adapt his views of treatment to particular circumstances and idiosyncracies or individual peculiarities.

Nothing tends so much to prevent the approach of disease, in the healthy, as freedom from anxiety of mind, regularity in habits, sufficient walking exercise in a pure atmosphere, and a nourishing unstimulating diet, composed of those animal and vegetable substances, most easily digested and assimilated, if not taken in too large a quantity. The varied delicacies of a fashionable dinner table, followed by copious libations of wine of any description, repeated daily, produce, eventually, some kind of derangement in the vital organs. But when this is habitually followed by the stimulating beverage of spirit and water at night, the approach of disease is generally quicker.

The effect of tea and coffee upon human beings has been differently estimated by various writers: some recommending, and others condemning their use, in no measured terms. On reflecting upon the enormous produce from both the tea and coffee plants; and, from the knowledge of their growing in the two opposite regions of the earth: and comparing their general effect upon human beings all over the world with the effect of other known nutritious vegetable substances; it must be admitted there is some reason why the family of man should so eagerly seek them. This was not known until Liebig discovered that *theine* and *caffeine*, the two nitrogenous principles of tea and coffee, are exactly the same; and, by combining with the elements of water, form taurine, the nitrogenous principle in human bile. Tea and coffee are used by the inhabitants of the countries where they grow, instead of animal food: and we now can account for their good effect. It has always been the author's opinion that both tea and coffee, when used moderately strong, and not abused, have been most useful articles of diet, both in health and disease: but he now can confidently recommend them, on scientific principles, to those individuals whose biliary secretions are languid. Good black tea should be preferred to green, generally. Asparagus, and some other vegetables of that family, are also very useful in such cases.

In those countries where the inhabitants are obliged to live on animal food, the smoking of tobacco, which supplies the air in the lungs with a certain quantity of carbon, and has a tendency, from its sedative effect, to produce congestion in the venous system, no doubt may be found a useful practice. But, in any country where its inhabitants can obtain plenty of digestible vegetables to supply the lungs with carbon, smoking must be considered, scientifically at least, a useless practice.

Liebig says, "It is not unworthy of notice, that the American Indian, living entirely on flesh, discovered for himself, in tobacco smoke, a means of retarding the change of matter in the tissues of his body; and thereby of making hunger more endurable; and, that he cannot withstand the action of brandy, which, acting as an element of respiration, puts a stop to the change of matter by performing the function which properly belongs to the product of the metamorphosed tissues. Tea and coffee were originally met with among nations whose diet is chiefly vegetable: some cause there must be which would explain how this practice has become a necessary of life to whole nations."

We have, in the course of this essay, seen, that as far as can be successfully fathomed, the original atmosphere consisted of a very large proportion of carbonic acid gas and nitrogen gas. That, as soon as the light and heat of the sun began to act, the first vegetation took place in such parts of the world as were not covered with the sea. This vegetation, by decomposing the carbonic acid gas of the atmosphere, fixed the carbon of it in the lignin of the trees. The sea, by washing over these forests, buried them, and layer after layer of other strata of the earth gradually covered them. These forests forming our present beds of coal.

At length, vegetation still going on, giving out oxygen and absorbing carbon, the atmosphere was so far improved, as to be able to allow very large cold-blooded vertebrate animals to respire in it. These large animals, breeding and dying, produced sufficient nitrogen, by their decomposition, to allow the vegetation at that period, by absorbing it, to produce not only carbonaceous vegetable products, but nitrogenized: in fact, every variety of vegetable substance which now exists on the surface of the earth. The earth, of course, having contained, originally, all the mineral substances which now exist.

At this time, the atmosphere, having been sufficiently purified; man was created; with all the present race of animals; and our present atmosphere is kept in such a state as to preserve the existence of both animals and vegetables, by the combined influence of both!

As it must now plainly appear to the reader, that all animals are naturally and constantly throwing off carbon and hydrogen from the lungs and liver; nitrogen and hydrogen from the kidneys and skin; and carbon and salts from the bowels; can it be a matter of surprise, that, whenever the organs which secrete and excrete these substances become deranged, disease must be the consequence?

And, in conclusion, I would ask, is not the correct and scientific knowledge of the anatomy and physiology of the various organs, which, by their healthy functions, keep up animal life, the only mode to enable one human being to assist another, in relieving the causes and effects of disease? Should the perusal of this Essay have the effect of convincing those friends who do me the honour to read it, of this position, I shall think myself amply repaid for the time and trouble I have devoted to the subject; and shall have gained the object of its publication.

APPENDIX.

APPENDIX.

INASMUCH as all the phenomena of life are carried on upon substances having for their bases carbon, hydrogen, nitrogen, and oxygen: inasmuch as these substances pass from the animal to the vegetable kingdom, through intermediate forms—carbonic acid, water, and nitric acid; since, in fine, the air is the source whence the vegetable world is nourished, is the reservoir within whose bosom the animal world is annihilitated; we are naturally led to study those different bodies from the particular point of view of general physiology.

Water is incessantly formed and decomposed in the bodies of animals and vegetables. With a view to the due appreciation of what is to follow, let us inquire into its composition. Direct experiment—the combustion of hydrogen in oxygen gas, in which I have produced more than a quart of artificial water, render it extremely probable that water is composed by weight of

1 part hydrogen, and
8 parts oxygen,

and that these simple and round numbers express the prime relations in which these two elements combine to constitute water.

As substances are always represented in the eyes of the chemist by atoms or molecules; as he always seeks to connect in thought, with every substance, the weight of its atom; the simplicity of the relation just stated is not without importance. Each atom of water, in fact, being a compound of one atom of hyrogen, and one atom of oxygen, we arrive at those simple numbers, which are not readily forgotten. An atom of hydrogen weighs 1; an atom of oxygen weighs 8; and an atom or a molecule of water weighs 9.

Carbonic acid is produced incessantly by animals, and decomposed incessantly by plants; its composition, therefore, merits especial attention.

Now carbonic acid, like water, is represented by the most simple numbers.

Experiments in which the diamond was burnt directly, and converted into carbonic acid, have satisfied me that this acid is formed by the combination of 6 parts, by weight, of carbon, with 16 by weight, of oxygen.

We are, therefore, led to represent carbonic acid as formed of 1 atom of carbon weighing 6, and two atoms of oxygen weighing 16; which, together, constitute 1 atom of carbonic acid, weighing 22.

Ammonia would appear, in its turn, to be formed, in round numbers, of 3 parts of hydrogen and 14 parts of nitrogen; which may be represented by 3 atoms of hydrogen, weighing 3, and 1 atom of nitrogen, weighing 14.

Thus, as if to show her infinite resources, nature does not bring into play, in connexion with organization, more than a very small number of elements, combined in the simplest relations.

The whole atomic system of the physiologist, in fact, resolves upon these four numbers, 1, 6, 7, 8.

1 is the atom of hydrogen,

6 is that of carbon,

7, or twice 7=14, is that of nitrogen or azote, and

8 is that of oxygen.

Let him always attach these numbers to these names; because to the chemist no such things as abstract hydrogen, carbon, nitrogen, or oxygen, exist. They are always true entities which he has in view; it is of their atoms that he invariably speaks, and for him the word hydrogen signifies an atom which weighs 1, the word carbon an atom which weighs 6, and the word oxygen an atom which weighs 8.—DUMAS.

Since the equivalents merely express the relative quantities of different substances which combine together, it is, in itself, immaterial what figures are employed to express them. The only essential point is, that the relation should be strictly observed. Thus, the equivalent of hydrogen may be taken as 10, but then oxygen must be 80. And as it is the principal object to use the most simple method of perceiving the relative weight one substance bears to another, we take hydrogen (the lightest body) as 1. Then oxygen will be 8; carbon, 6; nitrogen, 14. And when these elements unite with bases in more than one proportion, it will be found to be a simple multiple of their elementary number; that is, one-and-a-half, two, three, or four times their weight, &c. Thus, if the equivalent weight of carbonic oxide (one equivalent of carbon, 6; and one equivalent of oxygen, 8) be 14; the equivalent of carbonic acid (one equivalent of carbon and two of oxygen) will be 22.

ATMOSPHERIC AIR.

The ordinary constituents of the atmosphere, appear to be in the following proportions.

	By Measure.	By Weight.
Nitrogen	77·5 ..	75·55
Oxygen	21· ..	23·32
Aqueous Vapour ..	1·42 ..	1·03
Carbonic Acid ..	0·08 ..	0·10
	100·	100·

BRANDE.

WATER

Is composed of two volumes of hydrogen and one volume of oxygen gas. The specific gravity of hydrogen compared with oxygen, is as 1 to 16; these numbers represent the comparative weight of equal volumes of those gases; but as water consists of one volume of hydrogen and *half* a volume of oxygen, it is obvious, the relative weight of these elements will be as 1 to 8, or as follows :—

	Atom.	Equivalent.	In 100 parts.	Volume.
Hydrogen ..	1 ..	1 ..	11·1 ..	1·0
Oxygen ..	1 ..	8 ..	88·9 ..	0·5
		9	100·	

BRANDE.

CARBONIC ACID.

Carbon ..	1 ..	6 ..	27·27
Oxygen ..	2 ..	16 ..	72·73
		22	100·

BRANDE.

NITRIC ACID.

Nitrogen ..	1 ..	14 ..	25·9
Oxygen ..	5 ..	40 ..	74·1
			100·

BRANDE.

NITRATE OF POTASSA OR NITRE

Is composed of nitric acid and potassa, which is an oxide of potassium.

	Atom.	Equiv.	In 100 parts.
Potassa	1	48	47·1
Nitric Acid	1	54	52·9
			100·

BRANDE.

AMMONIA.

Nitrogen	1	14	81·13
Hydrogen	3	3	18·87
		17	100·

BRANDE.

NITRATE OF AMMONIA.

Ammonia	1	17	23·9
Nitric Acid	1	54	76·1
			100·

BRANDE.

NITRATE OF SODA.

Soda	1	32	37·2
Nitric Acid	1	54	62·8
			100·

BRANDE.

HYDRATED PROTOXIDE OF IRON.

	Atom.		Equiv.		In 100 parts.
Oxygen ..	1	..	8	..	21·6
Iron ..	1	..	28	..	75·6
Hydrogen ..	1	..	1	..	2·7
					99·9

HYDRATED PER-OXIDE OF IRON.

Oxygen ..	$1\frac{1}{2}$	..	12	..	29·30
Iron	1	..	28	..	68·47
Hydrogen ..	1	..	1	..	2·23
					100

BRANDE.

CARBURETTED HYDROGEN GAS.

Carbon ..	1	..	6		75·
Hydrogen ..	2	..	2	..	25·
					100·

BRANDE.

PHOSPHURETTED HYDROGEN GAS.

Phosphorus	2	..	31·4	..	91·06
Hydrogen ..	3	..	3	..	8·7
					99·76

TURNER.

SULPHURETTED HYDROGEN GAS.

	Atoms.		Equivalent.		In 100 parts.
Sulphur ..	1	..	16·1	..	94·024
Hydrogen ..	1	..	1·	..	5·84
			17·1		99·864

TURNER.

CLAY.

The best pottery clay is composed of three proportions of silica and one of alumina.

	Equiv.			
Silicium	8	Silica equiv.	16×3=48	
Oxygen	8			
Aluminum	10	Alumina	18	18
Oxygen	8			
				66 eq. of clay.

BRANDE.

HAY.

Carbon ..	45·8
Hydrogen	5·0
Oxygen ..	38·7
Nitrogen ..	1·5
Ashes ..	9·0
	100· parts of Hay dried at 212° is
	16·2

Equal to 116·2 parts of Hay dried in the air

LIEBIG.

OIL.

As oil will not combine with any base, without undergoing a change, it is impossible to determine its equivalent number. The following results of analyses, are the proportions which the elements bear to one another:—

	OLIVE OIL. Gay Lussac & Thenard.		LINSEED OIL. Saussure.		CASTOR OIL. Ure.
Carbon	77·213	..	76·014	..	74·00
Hydrogen	13·360	..	11·351	..	10·29
Oxygen	9·427	..	12·635	..	15·71
	100·		100·		100·

BEES WAX.

		Atoms.			In 100 parts.
Carbon	..	20	..	..	81·784
Hydrogen	..	20	..	..	12·672
Oxygen	..	1	..	..	5·544
					100·

GAY LUSSAC & THENARD.

COMMON ROSIN.

				In 100 parts.
Carbon ..	..	..	..	75·944
Hydrogen	..	..	..	10·719
Oxygen	..	..	..	13·337
				100·

GAY LUSSAC & THENARD.

SUGAR.

	Atoms.	Equivalent.	In 100 parts.
Carbon	12	72	44·4
Hydrogen	10	10	6·2
Oxygen	10	80	49·4
			100·

BRANDE.

GUM.

Carbon	12	72	41·4
Hydrogen	11	11	6·5
Oxygen	11	88	52·1
			100·

LIEBIG.

STARCH.

	Wheat Starch.	Arrow-root Starch.	Potato Starch.
Carbon	42·82	44·40	44·25
Water	57·20	55·60	55·75
	100·	100·	100·

BEANS AND PEAS.

	Peas.	Beans.
Carbon	35·743	38·24
Hydrogen	5·401	5·84
Nitrogen, Oxygen	39·366	38·10
Ashes	3·490	3·71
Water	16·000	14·11
	100·	100·

PLAYFAIR.

LIGNINE.

	Atoms.	Equiv.	In 100 parts.
Carbon	3	18	50·00
Hydrogen	2	2	5·56
Oxygen	2	16	44·44
			100·

PROUT.

VEGETABLE FIBRINE AND GLUTEN.

FIBRINE.		GLUTEN.	
Carbon	53·83	Carbon	55·22
Hydrogen	7·02	Hydrogen	7·42
Nitrogen	15·58	Nitrogen	15·98
Oxygen, Sulphur, Phosphorus	23·56	Oxygen, Sulphur, Phosphorus	21·38
	99·99		100·
	JONES.		JONES.

VEGETABLE ALBUMEN.

	From Wheat.	From Rye.	From Almonds.
Carbon	55·01	54·74	57·03
Hydrogen	7·23	7·77	7·53
Nitrogen	15·92	15·85	13·48
Oxygen, Sulphur, Phospho.	21·84	21·64	21·96
	100·	100·	100·

JONES.

VEGETABLE CASEINE.

	In 100 parts.
Carbon	55·05
Hydrogen	7.59
Nitrogen	15·89
Oxygen, &c.	21·47
	100·

JONES.

PROTEINE.

	Atoms.	In 100 parts.
Carbon	48	55·742
Nitrogen	6	16·143
Hydrogen	36	6·827
Oxygen	14	21·288
		100·

LIEBIG.

FAT.

	Hogs' Lard.	Mutton Fat.	Human Fat.
Carbon	79·098	78·996	79·000
Hydrogen	11·146	11·700	11·416
Oxygen	9·756	9·304	9·584
	100·	100·	100·

CHEVREAUL.

BILE.

The composition of the bile, when purified from fatty and colouring matter, is—

	In 100 parts.
Carbon	58·46
Hydrogen	8·30
Nitrogen	3·70
Oxygen	22·64
Soda	6·53
Common Salt	0·54
	100·17

KEMP.

TAURINE.

Which is the nitrogenized principle of the bile, is composed of—

	Atoms.	In 100 parts.
Carbon	4	18·2
Nitrogen	1	4·6
Hydrogen	7	31·8
Oxygen	10	45·4
		100·

LIEBIG.

If to the elements of caffeine or theine, (the active principle of coffee and tea,) we add the elements of 9 atoms of oxygen and 9 atoms of water; or if to the elements of asparagine, (the active principle of asparagus,) we add the elements of 6 atoms of water and 8 atoms of oxygen, we shall find we have the elements of 2 atoms of taurine.

	Carb.	Nit.	Hyd.	Oxy.
1 atom of Caffeine or Theine. .	8	2	5	2
9 atoms of Water			9	9
9 atoms of Oxygen				9
	8	2	14	20=2 atoms
Of Taurine	4	1	7	10×2

	Carb.	Nit.	Hyd.	Oxy.
1 atom of Asparagine	8	2	8	6
6 atoms of Water			6	6
8 atoms of Oxygen.				8
	8	2	14	20=2 atoms
Of Taurine	4	1	7	10×2

LIEBIG.

URIC ACID.

	Atoms.		In 100 parts.
Carbon	10	. . . .	39·083
Hydrogen. . . .	4	. . . .	2·441
Nitrogen	4	. . . .	33·361
Oxygen.	6	. . . .	28·126
			100·011

LIEBIG.

CRYSTALLIZED HIPPURIC ACID.

	Atoms.		In 100 parts.
Carbon......	18	....	60·742
Hydrogen....	8	....	4·959
Nitrogen	1	....	7·816
Oxygen......	5	....	26·483
			100·

LIEBIG.

UREA.

	Atoms.		In 100 parts.
Carbon......	2	......	20·02
Hydrogen....	4	......	6·71
Nitrogen	2	......	46·73
Oxygen......	2	......	26·54
			100·

WÖHLER AND LIEBIG.

CARBONATE OF AMMONIA.

When urine is left to itself, the urea which it contains is converted into carbonate of ammonia; the elements of urea are in such proportions that by the addition of the elements of water, all the carbon is converted into carbonic acid, and all the nitrogen into ammonia.

ONE ATOM OF UREA.				TWO ATOMS OF CARB. ACID.			
Car.	Nit.	Hyd.	Oxy.	Car.	Nit.	Hyd.	Oxy.
2	2	4	..	2	..	..	4
TWO ATOMS OF WATER.				TWO ATOMS OF AMMONIA.			
..	..	2	2	..	2	6	..
2	2	6	4	2	2	6	4

LIEBIG.

ON RESPIRATION.

Sir Humphry Davy having ascertained that a portion of air which measured 161 cubic inches, was composed of 117 cubic inches of nitrogen, 42·4 cubic inches of oxygen, and 1·6 cubic inches of carbonic acid, respired it for the space of one minute; during which time he respired nineteen times. At the termination of which the air consisted of 111·6 cubic inches of nitrogen, 23·0 cubic inches of oxygen, and 17·4 cubic inches of carbonic acid. Consequently, 15·8 cubic inches of carbonic acid had been generated in his lungs in one minute.

In the above experiment it will be seen, the respired air was contaminated in the latter inspirations with what had been expired; and that there was a diminution of the proportion of nitrogen at the termination.

In some admirable experiments by Allen and Pepys, in which air was inspired from one gasometer, and expired into another, the mean of their result show that 27·2 cubic inches of carbonic acid is expired in one minute; and that there is neither increase nor diminution in the proportion of nitrogen, when atmospheric air is respired.

The quantity of carbonic acid formed by the process of respiration in twenty-four hours, according to the estimate of Allen and Pepys, is 39,600 cubic inches, or 18,612 grains. The quantity of carbon thus removed from the blood would consequently be 5,148 grains. After the frequent repetition of their experiments, Allen and Pepys found that air, after being once respired, contains 8 or 8½ per cent. of carbonic acid; and that however often the same is respired, even until it can no longer sustain life, it does not become charged with more than 10 per cent. of this gas.

MULLER'S PHYSIOLOGY.

PERSPIRATION.

That the cutaneous exhalation and sweat are true secretions, and not the result of the mere evaporation of those ingredients of the blood which are capable of taking the form of vapour, is proved by the fact, that the perspiration is quite arrested, in some febrile diseases in which the temperature of the skin is elevated, but where the nervous influence of the skin is in a state of depression. The mean loss by exhalation from the skin is 11 grains per minute, and which consists principally of chloride of sodium, acetic acid, phosphate of soda, phosphate of lime, oxide of iron; together with nitrogen and carbonic acid; the former in the greatest proportion when a diet of animal substances is made use of; and the latter when the food consists of vegetables.

EXHALATION FROM THE LUNGS.

The mean exhalation from the lungs has been estimated at 7 grains per minute.

Doctor Dalton estimated the quantity of water expired in twenty-four hours at 20½ ounces.

MULLER'S PHYSIOLOGY.

FERMENTATION.

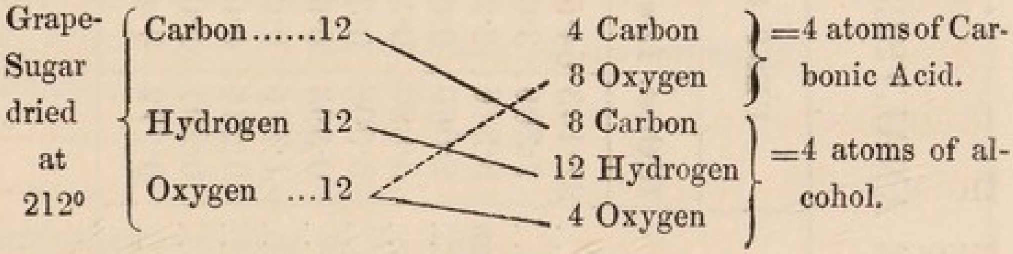
Fermentation is nothing else but the putrefaction of a substance containing no nitrogen; that is to say, a metamorphosis by which the elements of a complex molecule group themselves, so as to form more intimate and stable compounds, according to the special attraction of these elements.

Ferment or yeast is a substance in a state of putrefaction, the atoms of which are in continual motion. This motion or conflict of the elements communicating itself to the sugar, destroy the equilibrium of its atoms. These no longer retain the same arrangements, but group themselves according to their special attractions. The carbon of the sugar is divided between the hydrogen and the oxygen; there is formed on the one hand, a carbonized compound, containing almost all the oxygen (*carbonic acid*); and on the other, a second carbonized compound, containing all the hydrogen, (*alcohol*).

It is highly probable that the cane-sugar, before it undergoes the vinous fermentation, is converted into grape-sugar, by contact with the ferment; and consequently it is grape-sugar alone which yields alcohol and carbonic acid.

It is certain that in the fermentation of cane-sugar, (which consists of carbon 12 equivalents, hydrogen 11 equivalents, oxygen 11 equivalents,) the elements of one atom of water have a share in the transformation.

In the fermentation of one atom of crystallized grape-sugar, (carbon 12 equivalents, hydrogen 14 equivalents, oxygen 14 equivalents), it must lose two atoms of water; but grape-sugar, dried at 212°, contains the elements of four atoms of carbonic acid, and four atoms of alcohol, as in the annexed diagram.



RESULT OF THE ANALYSES OF SOILS OF DIFFERENT QUALITY.

	BEST SOILS.			MEDIUM SOILS.			BARREN SOILS.		
	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.	Highest.	Lowest.	Mean.
Silica and Siliceous Sand	87·143	64·517	77·676	95·660	88·456	92·143	96·274	51·337	84·650
Allumina	7·306	3·016	4·454	2.240	0·650	1·490	0·780	0·320	0·502
Protoxide and Peroxide of Iron	8·316	2·220	5·146	5·608	1·616	3·078	1·800	0·398	0·818
Peroxide of Manganese	2·080	0·090	0·830	0·960	a trace	0·312	0·220	a trace	0·032
Lime	5·880	0·319	2·120	1·531	0·083	0·592	0·286	0·005	0·127
Magnesia	5·008	0·312	1·534	0·730	0·080	0·362	0·240	0·006	0·066
Potassa and Soda	0·393	0·012	0·239	0·250	0·052	0·138	0·058	0·005	0·023
Phosphoric Acid	1·776	0·060	0·680	0·367	a trace	0·063	0·615	0·066	0·125
Sulphuric Acid	0·210	0·008	0·055	0·039	a trace	0·006	0·018	0·002	0·006
Chlorine	0·201	0·005	0·042	0·100	a trace	0·020	0·058	0·006	0·024
Organic Matter	9·772	0·450	2·474	2·989	0·440	1·061	45·310	0·502	12·000

Trimmers' Chemistry for Farmers.

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THE END.

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