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THE

ADDRESS ON CHEMISTRY

IN ITS

RELATION TO MEDICINE AND ITS COLLATERAL SCIENCES.

BY

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MR. PRESIDENT AND GENTLEMEN,—When the members of your Council determined to select me for the performance of the highly honourable and responsible duty of addressing this important gathering of my medical brethren, representing as it does the intelligence and learning of our extensive and most honourable Profession, it is deeply to be regretted that they could not also ensure the necessary leisure to prepare an address worthy of the occasion. Numerous avocations have considerably interfered with the preparation of this arduous work, which has been one of considerable difficulty from various causes; the introduction of this subject itself being quite an innovation in the practice of the Association, and, in fact, it is one hitherto untouched by any one previously on any similar occasion; whilst the purely technical character of the science might, even in the generality of professional minds, fail to induce that interest and attention which all authors hope to produce in the persons of their audience. If, therefore, in the treatment of this subject, I may have failed to give satisfaction to any of my numerous auditory, or if this address suffer by comparison with the highly wrought productions of our worthy and accomplished President, or of any other of those who have similar duties to perform for the other and more practical branches of our noble profession, I trust that the members generally will give credit for my having attempted to make the subject as generally interesting as possible under all the varying circumstances of the case.

The science of Chemistry, although of modern growth, is one having extensive bearings on all other sciences and branches of human knowledge:—arts, manufactures, and mines, alike depend upon its teachings and discoveries for progress and support; whilst even geology, mineralogy, and astronomy must acknowledge that some of their sublimest discoveries have been due to the aid which chemistry has accorded to them at some period of their history. Metallurgy must necessarily depend upon the due performance of the chemical processes of reduction of the metals from the rough ores from nature's store-house; whilst the powers of the microscope and the far-seeing mechanism of the astronomical telescope alike owe their delicacy to the Chemist, who prepared the optical glass and the metallic supports of their various instruments.

But Medicine is even more dependent upon her sister science than any one of those previously named; for she must not only prepare her medicamenta by chemical processes, but the very constitution of the patients' bodies would not be known without an appeal to the aid of the analyst; and the due performance of all the phenomena of life depends upon those silent, hidden, and mysterious chemical processes which go on continually in the natural laboratories of our own bodies, and without an adequate knowledge of which no physician can hope to attain the power of alleviating those numerous ailments to which all alike are heirs, from the noble to the peasant, and from which even the physician himself is not exempt.

"The proper knowledge of mankind is man." How much more necessary is it for the physician to know himself! We will therefore devote the limited time at our disposal to the discussion of those topics of physiological and pathological chemistry which are more interesting at the present moment to the great bulk of our busy professional brethren, and which might be presumed to come daily under their cognisance in the exercise of those duties, which all appear to demand from us more as a right than as a concession from the benevolent feelings of our heart to the common exigencies of our nature.

Chemistry teaches us that the organised kingdom of nature contains four elements, of which both animal and vegetable structures are chiefly composed: these are carbon, hydrogen, oxygen and nitrogen. And as you are all doubtless aware, many of the proximate elementary substances into which our various bodies may be divided by the skill of the analytical chemist, consist of some three of these primary elements; such are, for instance, fats, oils, glucose and dextrine; together with an extensive class of the animal acids; whilst from the vegetable world we have also a large number of proximate elementary substances, having the same chemical elementary characters; and of these, woody fibre, cellulose, gum, dextrine, starch, and sugar, may be enumerated. All these bodies have been proved to be formed of varying proportions of carbon, hydrogen, and oxygen, the number of atoms of which are variously arranged and grouped amongst themselves; which molecular arrangement is sufficient to account to the scientific chemist for the different properties of the substances enumerated.

Some substances derived from both the organised and mineral kingdoms, consist of only two elementary bodies, such as carbonic and oxalic acids and carbonic oxide, in which carbon and oxygen alike enter into their composition, and water, in which oxygen and hydrogen can alone be discovered, when it is absolutely and perfectly pure; whilst ammonia is often illustrated as a compound of hydrogen and nitrogen only, but recent views have determined that oxygen also is one of its constituents—so that now we agree to write it as NH^4O, instead of NH^3, as formerly.

In addition to these binary and ternary classes of organic molecules, there is a large and important class in which all four elementary bodies are combined to form one quaternary group, and of such are almost all the vegetable alkaloids, as morphia, strychnia, quinine, cinchonine, etc.; whilst from the animal kingdom such compounds as urea, uric and hippuric acids may be enumerated. These are all characterised as nitrogenous bodies, as the atoms of the element nitrogen appear to govern the constitution and formation of the molecule. Another small group contains sulphur in addition to these four primary elementary bodies: such products are obtained from bile, and we may enumerate the tauro-cholalic acid and taurine, and cystine, occasionally procurable from urine. From the brain, we have the oleo-phosphoric and cerebric acids, bodies containing phosphorus as one of the primary elements of their compound molecule.

These illustrations are sufficient for my purpose to bring back to your minds the truths taught you long ago, and thence to start on a fresh excursion into the component elements of the organic world, which will inform us that many other bodies absolutely require phosphorus, sulphur, chlorine, iodine, fluorine, and silicon, as constituents of acids or acid-radicals; whilst they have either potassium, sodium, lithium, magnesium, or calcium, together with iron, manganese, and traces of copper, acting as bases. Most of these elementary bodies, though found in the various tissues of both vegetable and animal structures, are too often disregarded as being too purely mineral for them properly to belong to an organised being; but of what use would the teeth or bones of any animal be, without the phosphate of lime which gives them strength and hardness? and the external skeleton of a crab, lobster, or an echinus, equally requires the aid of carbonate of lime to give it permanence and durability. It follows from this brief *resumé* that there are nineteen or twenty elementary bodies of which organised beings consist; and further investigations devoted to the examination of the human organism alone, prove that the same elementary substances are sufficient to make up its tissue and build up "its glorious form divine".

The spiritual principle of the whole animal kingdom has hitherto eluded the skill of the chemist, as it has equally baffled the research of the anatomist: but in the same way that chemical logic will enable the chemist to demonstrate satisfactorily the existence of a material elementary principle even before its isolation and production in the test-tube, so analogical reasoning proves the possibility and probability of such a spiritual principle as one of Nature's powers. For the same reason that chemistry has failed to detect and demonstrate the existence of this spiritual principle, whose proper domains are the realms of thought and the sphere of perception, so it has hitherto been unable to render any assistance to the elucidation of the diseases and derangements of the mental powers, dependent as they are upon the combined agency of spirit and matter. The true corporeal structure so intimately connected with the phenomena of mind, may be, and has been, subjected to numerous investigations by both the anatomist and the chemist, and even further submitted to microscopical analysis and investigation, without as yet giving any satisfactory evidences of change, during many of those diseased conditions, which, alas, too often afflict humanity. But wondrous are the discoveries which chemistry has unfolded to us during the past half century; and who amongst us can foretell what may not be done in the succeeding age? We are as yet only on the dawn of youth of true organic chemistry; for, as a science, it has only had its birth some twenty years since. Those questions which now appear to us mysterious and profound, will probably, ere long, become clearly explained in proportion as science advances in the path of philosophical investigation. Even now it is scarcely possible for the professional man, after he has left the schools, to keep pace with the progress of discovery; unless he specially devote himself to that branch of intellectual culture. The profound speculations of Berzelius, Laurent, Dumas, Liebig, Mulder, and Hoffman, together with those of such lesser names of note as Wurtz, Lehmann, Kolbe, Stenhouse, Buckland, and Frankland, have created such a mass of materials for mastery and thought, that few minds are capable of the task or equal to the labour.

I will not go further into these enticing fields of chemical investigations, than just to allude to the wondrous theory of compound ammonias, by which it has been demonstrated that various compound atoms, such as ethyle, methyle, amyle, and propyle, together with a host of other bodies of like character, are capable of taking the place of either one, two, three, or even four of the elementary atoms of hydrogen, from the molecule of ordinary ammonia, and producing such compounds as ethylamine, methylamine, propylamine, amylamine, or dimethylamine, trimethylamine, tetramethylamine, when more than one atom of hydrogen has been replaced by methyle, all of which are powerfully alkaline bases, similar in properties to the ammonia from whose type they have been derived, by the principle of substitution. The importance of this discovery is already bearing fruits in the arts of life by giving extensive fields of industry in the production of the new purple, mauve, and magenta dyes from aniline, obtained in the manufacture of coal-gas; and is abundantly illustrated in that beautiful substance magenta, which is the nitrate of rosaniline, already rendered available to the histologist in demonstrating the various structural elements of which his numerous complex tissues are composed.

The discovery of these volatile compound ammonias will, in a medical point of view, be eventually productive of new theories of miasmata, and will probably explain the obscure causes of the wonderful propagation of many epidemic and contagious diseases: as trimethylamine has been separated from the urine of man and found also in the herring, and propylamine has already been discovered to be the cause of that peculiarly disagreeable odour evolved during the decomposition of certain fish, and it has also been discovered in the ergot of rye; and in other organised products of decomposition and disease we might expect to find analogous compounds. In another direction we might anticipate these theoretical views to expand themselves, practically, in the building up of the complex molecules of the valuable medicinal alkaloids, quinine, cinchonine, and cinchonidine, now only obtainable by the aid of pharmaceutical chemistry from the products of the cinchona barks, and for the supply of which we are still almost wholly dependent upon the primeval forests and unsettled governments of South America. After almost unheard of difficulties and dangers innumerable, it is true we have succeeded in creating extensive nurseries of these glorious trees in our Indian colonies, which, in process of time, will render us in a measure independent of such precarious and failing sources of this veritable "tree of life" and monument of human knowledge; but what a glorious future would burst on that man, who, by dint of industry, theory, and scientific manipulations would be able to say, "I can produce quinine artificially, in any required quantity, from substances as comparatively valueless as ammonia, aniline, or methylated spirit."

The bearing of organic chemistry on medicine may be further illustrated by that glorious gift of science to humanity, so well known as chloroform, whose wondrous property of alleviating pain and banishing mortal agony, entitles it to the well-merited appellation of the elixir of life.

Wine, and its product alcohol, also owe their discovery to the chemical processes of fermentation and distillation, practised from the earliest times, and celebrated in glorious verse as the gift of gods to man.

"'Oτ' ἐγω πιω τον οἰνον."

"When wine I quaff, before my eyes
Dreams of poetic glory rise;
And freshen'd by the goblet's dews,
My soul invokes the heavenly Muse.
When wine I drink, all sorrow's o'er;
I think of doubts and fears no more;
But scatter to the railing wind
Each gloomy phantom of the mind."

But they bear no comparison in their usefulness to the product of the decomposition of alcohol or methyle by chloride of lime. Yet who can number the lives which have been saved by the agency of alcohol, timely administered by the hands of attendant medicine? whose tongue can celebrate the joys which ruby wine has conferred to the nuptial board and social hour, since Eve first plucked the golden fruit from Knowledge's tree and tempted man to drink thereof? But, on the other hand, who can paint the misery, degradation, and ruin which alcohol has introduced to the world since Adam's fall and Eve's temptation; who can picture the disease, madness, and woe which its indulgence will yet bring upon sensual humanity? Yet the chemist, by his wondrous enchanter's wand, converts it either into chloroform, ether, or aromatic vinegar, to cool the parching thirst, to allay the aching brow, to soothe the troubled spirit, or to rob our surgical operations of all their horrors, and assuage the piercing pangs of labour.

These transformations are chiefly brought about by the manifestations of those mysterious laws of chemical substitutions and organic molecular transpositions, which the changing affinities of various compound molecules exhibit amongst themselves, and the knowledge of which has enabled the chemist to multiply his products of decomposition almost indefinitely. And, as it has only of late years been discovered that the now well-known chloroform possessed such marvellous remedial powers, and "such a charmed agency for good," so may we expect that many of those products, which, as yet, possess scarcely more than a purely scientific interest, will, as time rolls on and they have passed from the cabinet of the chemist to the hands of the practical physician, add to our healing powers, so that we may attain greater and more enlarged powers over disease and death, the mortal enemies of the human race.

It has often served as an illustration of the same law of change, that, by the act of respiration alone, man contributes his quota of carbonic acid to the atmosphere, to be again subservient to the production of vegetation, and return to himself as organised tissue; yet the magnitude of this process of oxidation is scarcely appreciated even by the sanitarian, although its primary importance has been long recognised and admitted by the uninitiated multitude. An adult human being has been shewn experimentally to consume daily about fourteen ounces of carbon in the various articles of food obtained from different sources, which is subsequently expelled in equivalent quantities by the excretions of the lungs, kidneys, and skin, whilst some portion is thrown off as excrementitious in the products expelled from the intestinal canal. Of these fourteen ounces of carbonaceous food, he returns to the atmosphere, as carbonic acid, about twenty-five cubic feet in the same period, weighing about 46½ ounces, and representing about 12.7 ounces of the carbon consumed. In every year of his life he would therefore contribute 290 lbs. weight of solid carbon to the atmosphere: and, supposing him to live the full period of seventy years, he would have thrown off by his lungs alone somewhat more than nine tons weight of solid carbon, equal to twenty-one tons of sugar, starch, cellulose, or paper. It would therefore require about 4500 individuals to exhale by respiration a quantity of carbonic acid sufficient to reproduce all the paper manufactured in the United Kingdom during one year, which, in 1857, was calculated to amount to 65,478 tons. Or, if we suppose this amount of carbonic acid expended in the reproduction of the woody fibre of the oak, every individual member of this Association would evolve nearly sufficient carbon during his lifetime to regenerate two ordinary sized oak trees, weighing about five tons.

If every adult human being discharge daily such an immense quantity of carbonic acid as 46½ ounces, or 25 cubic feet, how great must be the daily production of such large and densely populated cities as that we now inhabit, containing as it did 130,000 human beings at the last census. Were there not most effective means provided for its removal, the whole population would soon be destroyed by suffocation in its own poisonous emanations; and for this purpose the atmosphere is continually in a state of agitation and movement by the ascending currents, heated by the contact with the warmer soil, or thrown into more violent commotion by the winds of heaven, blowing from every point of the compass, and carrying with them all that which would oppress and destroy all animal life, as well as the whole human race. But these noxious matters are most beneficially distributed over large agricultural districts, and so efficiently mixed up with the whole bulk of the atmosphere, that the most experienced chemists have not been able to discover more than from 3·7 to 6·2 parts in 10,000 equal measures of air obtained from different localities. Our beautiful green pastures and fields of ripening corn, our delightful hedge-rows and princely avenues of aristocratic oaks and ancestral elms, purify the atmosphere of that carbonic acid, of which the plebeian artisan has equally contributed his share alike with the noble and the peer, and all the sacred majesties of the world. Not only is the atmosphere contaminated by the addition of these large quantities of carbonic acid, but human beings and most animals evolve, both from the lungs and skin, ammonia in considerable proportion, and various odoriferous principles which may be readily detected by our senses, and which, when suffered to accumulate in confined localities, as happens in densely populated districts, and in the crowded courts and alleys of large cities, prove highly injurious.

The noxious effects of these organic products may be everywhere witnessed around us; and were there not some provision made for the removal of these deleterious matters, the atmosphere would ere long become so foul and contaminated with impurities, that virulent epidemics would become generally diffused throughout the civilised world.

There is a peculiarly active principle, which chemists have recently isolated and identified as an altered or allotropic form of oxygen, but presenting many of the destructive powers of chlorine, and thus of infinite benefit in disinfecting the atmosphere of those contaminations. Oxygen, in its ordinary condition, requires some intermediate agency to bring its peculiar powers into play upon organic matter; there must be constant moisture and an elevated temperature, occasionally even that of a red heat, for the decomposition and perfect combustion of some animalised compounds. But ozone will act instantly, and at the ordinary temperatures, upon most bodies of this description, and all power for harm disappears as if by the enchanter's wand. In the laboratory, the chemist produces this body by the aid of phosphorus in a state of slow combustion, or by passing electric sparks through atmospheric air; or he obtains a small percentage of the same gaseous odoriferous agent, mixed with ordinary oxygen, during the electrolysis of water and separation into its component gases by means of a continuous galvanic current of electricity.

Among these various methods, nature avails herself of the thunder-storm as the grand producing agent of this remarkable body; and when a house has been struck by lightning, it is well known that the inmates have often become aware of the presence of some remarkable odoriferous principle, which may be compared to sulphurous odours, and which effect is due to the ozone evolved; as may be proved by the peculiar decomposition of iodide of potassium in the presence of starch, and the elimination of iodine, and production of the characteristic blue colour of iodide of amidin. Now, during the evaporation of water, which is continually going on over the extensive surfaces of the Atlantic and Pacific oceans, electricity is evolved to a great extent; and the atmosphere becomes charged with enormous quantities of aqueous vapour, which acquire a highly electrical condition, opposite in character to that of the surface from which the vapour has been raised.

The moisture and heated air, when it has been elevated by expansion to the higher strata of the atmosphere, and carried, by the revolution of the earth upon its axis and by other causes, towards the cooler and more temperate zones, deposits its moisture in dense cumuli, which become so many highly excited galvanic batteries, ready at a moment's notice to deluge the earth with moisture, and discharge their electricity in the torrent of the storm, hurling destruction on all sides at those trees, buildings, or other elevated points which do not possess sufficient conductive power to withstand their Herculean shocks. The violent electrical tumult of these magnificent storms produces a large quantity of ozone, and purifies the atmosphere of all deleterious agents, destroying the potency of infection by the rapidly oxidising agency of this wondrously active oxygen, and washing away all organic refuse too extensive for such a chemical agency to destroy in so short a period.

We also find that the quieter electrical agency of evaporation and condensation of moisture will evolve ozone extensively, without the tumult or violence of a storm; and these are the more constant sources of the ozone necessary to our existence. We find ozone predominating very decidedly on all the sea-coasts of our island home; and the annual ozone standards in these districts are always higher than in the interior of the kingdom, where the animal matter predominates, and destroys the ozone by the using up of its powers of oxidation and combination.

Hence we have the explanation of the beneficial agencies of the healthful sea-breezes of our coasts, and why our patients become invigorated by the change of occupation and climate which a sea-side residence occasions. Hence we have the reason why a long sea-voyage generally restores power and energy to the debilitated nabob or cachectic invalid from our Australian or Indian colonies, and why even our nautical brethren, as a class, enjoy more health than any other equal number of men under different climatal agencies.

The true elements of food are sugar, starch, and oleaginous materials, on the one hand, as carbonaceous materials; and on the other, nitrogenous products, the so-called protein compounds—albumen, gluten, fibrine, and other analogous bodies. The digestive process is carried on by the aid of the decomposition of common salt or chloride of sodium, the hydrochloric acid produced being the active agent of the gastric juice, assisting the pepsine, or peculiar albuminised ferment generated by the gastric follicular glands; the liberated soda going to the bile to produce the biliary soaps, consisting of the cholate and choloidate of soda, two conjugated compounds of animal hydrocarbons, and containing but a small proportion of nitrogen, whilst one of them contains a large percentage of sulphur. The biliary acids are sometimes called glycocholic acid and taurocholic acid.

These biliary soaps not only serve to neutralise the free hydrochloric acid of the chyme, but to help to form an emulsion with the other oleaginous elements of food, and occasion their absorption by the lacteals, assisted in this operation by the pancreatic juice, which serves as the medium for dissolving these soapy materials.

Chemical experiments readily convert starch into sugar, passing through dextrine. The chief agency in this transformation is that of the dilute mineral acids. The recent experiments of Dr. Pavy have demonstrated the existence in the normal liver of large quantities of a substance called by him hepatine, and since shown by me to be closely analogous to dextrine, if not absolutely identical. Consequently, digestion converts starch primarily into dextrine or hepatine, which is absorbed and laid up in the liver as in a storehouse.

Other experiments clearly demonstrate that fatty matters are readily producible from starch or sugar; as witness the fatty fermentation of saccharine matters into butyric, rutylic, and margaric acids; and we have availed ourselves of this fact in agriculture by giving abundance of starchy materials to those animals which we intend to fatten, whilst we reduce the respiratory power and muscular energy by long and close confinement. It is, however, necessary at the same time to give them albuminous substances; otherwise we rapidly fill their systems with carbonaceous matters, which cannot be got rid of by the pulmonary oxygen. Under these new circumstances, the conversion of starch and albumen into fat evolves considerably more oxygen than can be obtained by respiration; and the liver, *in producing biliary fats, gives up oxygen* to compensate for the want of respiratory powers.

Hence we see the necessity of keeping our gouty patients on a farinaceous diet; for we thus oxidise their excessively nitrogenous blood, and assist in converting the carbonaceous elements of diet into cholic and choloidic acids, urea, and carbonic acid. Every 4 equivalents of albumen, with 20 equivalents of starch or sugar, will produce 6 equivalents of margarine, 12 of water, and 192 of oxygen; uniting with the elements of albumen to produce 4 equivalents of choleic acid, 8 equivalents of cholic acid, 12 of urea, and 26 atoms of carbonic acid; whilst the addition of 40 atoms of water is requisite, and we must also obtain 32 atoms of oxygen from the air by the function of respiration. Were *no starchy elements* employed, the 4 atoms of albumen would require 224 atoms of oxygen (seven times as much) from the air to produce the same products, with the exception of the 6 atoms of margarine.

The functions of the stomach and liver, therefore, are partly to prepare fat and bile from the amylaceous portions of the food; and, in doing so, to break up the effete and worn-out albuminous materials by adding oxygen through the simultaneous destruction of starch; assisted as these powers are by the oxidation of respiration and the addition of water. The ultimate products are on the one hand carbonic acid, water, and ammonia, passing off by the lungs and skin; and on the other hand urea, uric acid, and the other effete products thrown off by the kidneys.

In the carnivorous reptilia, the absence of starchy food and the influence of rest and full animal diet are well illustrated by the production of lithic or uric acid in immense quantities; whilst urea and fat are not products of their digestive process, or the results of the destruction of their effete tissues. They may be said to labour under the lithic acid diathesis, and to suffer from chronic gravel or stone, or to be the very analogue of our gouty aldermanic patients, who may with justice be said to live a purely reptile kind of life.

In diabetes, we get large quantities of glucose eliminated by the kidneys. Under these circumstances, the starchy elements of diet produce less bile, less fat; and the necessary stage of hepatine or dextrine has been passed through, and has gone beyond that stage at which the process should have been arrested. We will study this process somewhat more in detail, as its importance is very great, and it is a problem of vast interest to the medical practitioner.

Starch, therefore, excluding the gluten accompanying it, contains, according to chemical analysis, twenty-four atoms of carbon united to twenty atoms of water, and its formula is usually written $C^{24}H^{20}O^{20}$. During ordinary digestion, having been first rendered gelatinous and soluble by the action of the slightly acid gastric juice, aided by the increased temperature of the stomach and possibly by the pepsine itself, it becomes converted partially into hepatine or dextrine, a substance which may almost be considered an allotropic form of amidin or gelatinous starch, as it bears so close a relationship to this substance that most chemists give it the same identical formula. However, Dr. Pavy has stated that his hepatine has the atoms in the relation $C^{12}H^{12}O^{12}$, or doubled, $C^{24}H^{24}O^{24}$; but it is quite probable that the analysis was made of a hydrate of the pure material. Another portion of the starch is converted into glucose by the action of the salivary fluid and pancreatic juices; but the far greater proportion ultimately becomes converted into fat, as we have previously shown, by the joint agency of the liver, upon the alimentary starch and effete fibrinous materials. These fatty matters, having been thrown out by the liver as bile, in which we find the copulated biliary acids (cholic and choloidic acids), combined with soda, here meeting with the acid chyme from the stomach, becomes decomposed; the products being again chloride of sodium, water, and liberated fat; this is subsequently made into an emulsion by the pancreatic juice, and absorbed by the lacteals, entering the superior vena cava by the thoracic duct and left subclavian vein, whence it goes at once to the right side of the heart and thence through the pulmonary circulation.

Dr. Pavy has shown us that cane-sugar, when taken into the animal economy, is equally capable of producing dextrine or hepatine; and other observers have also found that animals and man fed on cane-sugar in large quantities equally produce fat with those supplied with amidin or starch. And to undergo this preliminary change into dextrine or hepatine, it would be requisite for anhydrous cane-sugar to assimilate two atoms of water to become dextrine.

During the process of lactation in the female of all the mammalia not purely carnivorous, starch has another duty to perform; and it becomes the source of some of the elements of the natural pabulum of all the junior mammalia; sugar of milk or lactin being one of the principal products of its conversion. Under these circumstances, we have $C^{24}H^{20}O^{20}$ converted into $C^{24}H^{24}O^{24}$ by the assimilation of four atoms of water.

Supposing that the change occasioned by the dilute acid of the gastric juice *fails to stop* at the allotropic stage of dextrine or hepatine, but passes on to that of glucose, we have the formula $C^{24}H^{28}O^{28}$; or the further assimilation of the elements of water to the extent of eight atoms. Normally, the alkaline bile and the soda of the liver become the agents of stopping the conversion of the amylaceous matters at the point of allotropism, in consequence of the soda of the bile neutralising the hydrochloric acid of the gastric juice, in the lower portion of the duodenum and in the hepatic cells.

Hence we see, that under some conditions of system *soda* must be employed as a remedy to hinder the change of starch from passing on into that of glucose. Thus we perceive the reason of the conversion of our starchy food into glucose, and why alkalies, opium, and creasote, arrest the change at the allotropic condition of hepatine or dextrine; just as, in our chemical experiments on starch, we arrest the conversion or hydration by means of chalk, as soon as tincture of iodine ceases to give any evidence of unchanged amidin.

The theoretical action of our principal remedies for diabetes now developes itself.

Under other circumstances, should there be an excess of the peptic element of the digestive process, we get the starchy elements of our diet changed still further into lactic or acetic acids; for we all know that by the aid of casein in a state of decomposition or decay, we can easily change starch, through sugar or glucose, into lactic and acetic acids.

This amyloid substance, glucogen or hepatine, so analogous in its composition and chemical properties to dextrine, has been discovered in the cells of the liver of most animals as well as man. It has also been found in the placenta of the mammalia and in the cells of the amnion in the order *Ruminantia*, but it has also been proved to exist in the tissues of the fœtuses of rabbits, cats, Guinea pigs, sheep, oxen, and pigs; whilst in the skin of the chick *in ovo*, and at the points where the aggregation of epithelial cells shows the incipient formation of feathers and hairs, it is most abundant. The horny structures contain it plentifully; in the bill, the hoof, and the claws, it exists in a large proportion. The muscular tissues of the fœtus are full of it; even from twenty to fifty per cent. can be extracted from the muscles of fœtal calves, during the first seven months of their intrauterine life. During embryonic life, a great part of the fœtal tissues are found to be so impregnated with amyloid substance, that it appears to be the formative material from which the tissues are evolved; and, in fact, it would seem to be as clearly related to their growth and development as starch and sugar are to the growth and development of the tissues of all vegetables.

It follows, therefore, from these premises, that this amyloid substance, hepatine or animal dextrine, is not normally converted into sugar in the animal economy. Although so nearly related to the saccharine principle on the one hand and to starch on the other, it is really a substance intermediate in properties and necessary to the constitution of the animal frame; being more especially serviceable in the building up of the gelatinous tissues of the skin and muscular structures, and in the earlier stages of the formation of hair, feathers, hoofs, and nails.

But by an abnormal progressive action going on in the degree of conversion of the starchy elements of food, we find that hepatine passes on to glucose, and then is eliminated from the animal body as so much refuse material, so much lost matter; fat disappearing from the system, that which has been already formed becomes lost, and there is no longer a production of the adipose substance, of which the chief ingredient is margarine in the human race.

We now have that condition which pathologists have called glucosuria or diabetes; and in this disease it is by no means unusual to find eight, ten, or even twelve ounces of sugar voided every day by the kidneys; and the urea is increased in a corresponding ratio, so that even 800 or 1000 grains of this substance have been frequently found as the quantity expelled from the unfortunate patient.

In that rarer form of disease which has been called diabetes insipidus, a substance has been detected in the urine, having many of the properties of sugar, but which is destitute of sweetness—yet capable of being converted into grape-sugar by the action of dilute acids, and susceptible of fermentation and conversion into alcohol. This will probably eventually be proved to be hepatine or dextrine, as its intermediate characters are so clearly indicative of such relationship to glucose and starch.

Under other diseased conditions of the body, in which the liver plays so conspicuous a part, we find the colouring matters of the bile, the fatty acids, and probably hepatine and taurine, escaping from the body through the kidneys; and now we have those phenomena due to one of the forms of jaundice.

Dr. Macdonnell, in a paper recently published in the proceedings of the Royal Society, says, in reference to this subject, that "the recent researches of Lehmann, Pavy, Bernard, Brown-Séquard, and others, tend to prove that the fibrine, and much of the albumen, of the portal blood vanish in the liver; and that at the same time that it destroys these azotised compounds, it forms its non-azotised amyloid substance, and excretes bile containing so little nitrogen, that it hardly need be taken into account. Are we not, from the consideration of these functions, led to infer that the nitrogen which leaves the liver by no other outlet, may go forth in the hepatic blood in union with the amyloid substance thus changed into a new azotised principle? That thus the liver is a great blood-forming organ, in which there is constantly going on a reconstruction of certain ingredients of the blood; that in it the fibrine, etc., which has done its work is disintegrated, the hydrocarbon of the bile abstracted, and the nitrogen combined with the amyloid substance, which, instead of being converted normally into sugar, emerges from the liver a constituent principle of the protoplasm, from the bosom of which (to use the words of Bernard with reference to the fœtal tissue) organic evolution is to be accomplished?"

Now, during the normal conversion of starch into fat, as previously shown by the action of the effete albuminous or fibrinous materials, a considerable proportion of oxygen must be eliminated from the elements employed; and one portion of the function of the liver may be said to be that of a grand accessory organ to the function of respiration; the products eliminated being highly charged with hydrocarbonous materials and deficient in nitrogenous matter.

The existence of the amyloid substance as a constituent of the muscular and gelatinous tissues, accounts satisfactorily for the presence of hepatine and production of glucose, even in those diabetic patients who have been deprived of amylaceous food during long intervals of time. In this case, they are producing the glucose from destruction of their own tissues, or from those portions of their dietary which also contain the amyloid substance in the normal condition.

During the next generation, our duty will be to examine the nature or constitution of the hepatic blood for its nitrogenous elements, and to make a comparison of its constitution with that of the portal system.

We must endeavour to compare the percentage of hepatine, urea, and other constituents in both the afferent and efferent currents of blood; whilst the fluid contents of the thoracic duct must undergo a complete examination anew.

The function of respiration, when efficiently performed, has been shewn to account for the major portion of the carbonaceous matter consumed in the human organism; but, although the supplied carbon has been eliminated to the extent of nearly thirteen parts out of fourteen as carbonic acid from the pulmonary circulation, it is well known that the true formation of the evolved carbonic acid takes place in great measure within the systemic capillaries, from the oxidation and destruction of those portions of the corporeal frame which have died in doing their destined work, and henceforth require removal from the body as effete tissue and disorganised material.

The new carbonaceous and nitrogenous materials of the food, by the functions of primary and secondary assimilations, undergo those molecular rearrangements of particles and chemically organic combinations necessary to produce by their modifications either fat, cellular tissue, muscular or nervous fibre, or bone—in fact, are employed in replacing those histological elementary tissues which have become exhausted and worn out.

It is not necessary to dilate further upon the manner in which the remaining fourteenth part of the carbon disappears. The kidneys throw out some portion, as creatine, creatinine, lactic acid, and urea; whilst the skin also contributes to its elimination as various fatty or sebaceous products, as well as carbonic and lactic acids. But next to carbonic acid, the principal excretion from the animal body is most undoubtedly urea, as it is one of those ultimate products of destruction of tissue which the processes of oxidation going on in the corporeal laboratory has no further power of destroying. It is scarcely necessary to say that, when thrown off from the body, its permanent character ceases to exist, as decomposition readily ensues, either by heat or fermentation; and its conversion into carbonate of ammonia rapidly occasions the well known phenomenon of alkaline urine. In this condition, it returns to nature's laboratory the principal part of the nitrogenous matters which have been taken into the organism, and formed a portion of the animal frame; the residue of the nitrogen being eliminated from the body as ammonia by both the skin and pulmonary cells, and through the tubular structure of the kidneys as creatine, creatinine, lithic acid, and some other bodies of less importance both in physiological and chemical points of view.

Numerous experiments have shewn that an adult healthy man, who lives well, discharges on an average from 30 to 40 *grammes* of urea in twenty-four hours. It is therefore within just experimental data to say that every man gets rid of 540 grains of urea daily from his circulating medium, by means of his kidneys, or about twenty-eight pounds and one-seventh every year, and, during the seventy years of his natural life, upwards of seventeen hundredweight of urea.

The importance of this elimination has been hitherto much underrated in both pathological and physiological calculations; and it is only of late years, since we have been furnished with Liebig's most excellent method for the quantitative estimation of this ultimate element, that its true import has been fully understood. It is, in fact, *the measure of the imperfection of the respiratory function;* the vital power and combining agency of the nitrogen atom having obtained the mastery over the destructive power of pure oxidation, and effected a compromise between the two functions by the discharge of a substance intermediate in character, properties, and composition, yet differing slightly only in arrangement from carbonic acid, water, and ammonia, the absolute products of true combustion and perfect oxidation.

A city such as Bristol, with 130,000 inhabitants, would produce 1625 tons of urea every year, which enormous quantity, under the present defective method of managing the sewage, is now thrown into the sea, and lost to agriculture; such a product, if it could be possibly saved and utilised, would represent more than 2112·5 tons of carbonate of ammonia and 1841 tons of pure ammonia; which, in money value, would be equivalent to £110,460 sterling. It is almost impossible to calculate the immense money value of the enormous waste which must occur in the United Kingdom from the loss of this material, which an improved and perfect mode of sewage would enable us to collect and employ most extensively in agriculture.

When the quantity of nitrogenous materials consumed is in great excess over that required by the organism, as occurs in the generality of our aldermanic brethren, we find disturbance of the respiratory process, an imperfect oxidation in the eliminated products, and a failure in the phenomena of life, which expresses itself in the elimination of a large quantity of carbon and nitrogen as lithic acid gravel, or produces the more severely agonising diseases of renal or vesical calculus, or the horrors and pangs of gout, if the lithic acid be produced faster than the powers of its elimination can expel it from the system in some one of its soluble forms.

Increase the powers of oxidation, and the molecules of lithic acid will disappear from the blood-vessels of our afflicted patients, broken up into urea, or even further decomposed into carbonic acid, water, and ammonia; and now the lungs and skin will assist the kidneys in getting rid of this poison from the system.

Assuming that our patient's powers of oxidation are sufficient to produce the due quantities and proportions of urea and carbonic acid, yet from the occurrence of some interference existing in the eliminating powers of the numerous epithelial cells of the kidneys, these organs refuse to throw off the urea from the body. This substance necessarily accumulates in the system, producing the disease known as uræmic poisoning, and the nervous system soon shows grave and violent phenomena, as witnessed in the convulsions of epilepsy, of scarlatina, and of the pregnant or parturient female; whilst, in other cases, the serous membranes come to the relief of humanity, and the pavement epithelium cell does the duty of the spheroidal or glandular, and serous accumulations or dropsies occur, containing large quantities of that urea which ought to have been discharged for manure; and, should some speedy outlet not be found for this virulent poison, the overcharged system fairly succumbs to the noxious influence, and rapidly increasing drowsiness, thence passing into coma, and closing the scene with an early death, proves the virulence of that poison, which has been produced in our own bodies by the natural action of physiological laws, but whose elimination has been interfered with and interrupted by simple arrest of the normal excretory function.

Assuming the average weight of each individual in this assemblage to be 150 pounds, and that the relative weight of the bones to the whole body would be 10·5 per cent., it follows that the whole skeleton would weigh about 15¾ pounds. Now, dry bones contain on an average 57 per cent. of phosphate of lime, together with some phosphate of magnesia; which proportions would furnish us with about 9 pounds of actual bone-earth, or ashes, upon incineration and removal of all organic matter, and exclusive of the carbonate of lime. Supposing that we extract the phosphorus from these 9 pounds of bone-earth by the most perfect possible method, we should obtain about 21·3 per cent. of that pure body; consequently, our total 9 pounds of bone-earth would give us 1·917 pounds of phosphorus, or nearly 2 pounds of that material to each individual skeleton. I need scarcely say, that such a quantity of so highly a combustible matter would be nearly or quite sufficient "to set the Thames on fire," if properly used; whilst, if it were converted into lucifer matches, it would be the means of radiating more light in the world, and thus driving away a deeper Cimmerian darkness than ever any one of the individuals would be capable of doing in a life time devoted to illuminating their species by their philosophical speculations.

The whole of this immense quantity of inorganic skeleton has been introduced into our bodies slowly and imperceptibly with our food, principally obtained from the *cerealia* directly containing it, or gradually eliminated from the albuminous and fibrinous materials of flesh which contain it as phosphorus in combination with the so-called protein substance or its analogues; and which, having already formed part of the organised structure of some herbivorous animal, has also been in like manner obtained from the herbaceous and seminiferous portion of the *gramineæ*, or other plants used as fodder.

If we consider, then, for one moment, how large a quantity of bread-stuff this inorganic skeleton represents, we are lost in amazement at the results, and clearly perceive that, should we desire to rapidly introduce phosphates into the system, it would be desirable to employ some material more richly impregnated with phosphorus than either muscular fibre or vegetable gluten. For this purpose, eggs would be the best dietetic or indirect source; inasmuch, as the dried substance of white of egg contains 13 per cent. of ash, chiefly consisting of phosphate of lime.

In addition to the large quantity of phosphorus contained in the bony portion of our skeleton, every individual discharges on an average about 45·5 grains of phosphoric acid daily in the urine alone; whilst the fæces also contain a very considerable proportion. It is evident, therefore, that during each year of our lives we eliminate by the kidneys alone, about 2½ pounds of phosphoric acid, equivalent to about 11·2 pounds of bone-earth. Thus, we perceive, each adult throws away more phosphoric acid every year by his kidneys than would suffice to build up his skeleton anew; and he may be said to have discharged his whole skeleton through his kidneys every year that his life has been prolonged. Such a calculation strikes one very forcibly that our organisms demand an immense quantity of bone-earth supplied to us during our natural lives; for one moment will convince us that a man of seventy years of age, would have eliminated a proportion of phosphoric acid by his kidneys equal to about 784 pounds of phosphate of lime, which is exactly seven hundredweight of that material. This would be sufficient, if converted into artificial manure, to produce two tons of this material, enough to spread over ten acres of ground, and render it fertile for reproducing grain crops to a large amount.

There has been great controversy during the past twenty years, in relation to the existence of fluoride of calcium, as a constituent of the bones and teeth of animals and man; but it has at length been conclusively shown that about 1 per cent. of this material occurs in the substance of dried human bone. Consequently, as the skeleton of man is about one-tenth part of his living weight, it follows that there would be about two ounces of fluoride of calcium in the skeleton of a man of that average weight; and I have no hesitation in saying that in the bones of the various individuals in this room, there would be sufficient fluoride of calcium to produce enough hydrofluoric acid to dissolve one pound of glass, or to etch the plates necessary to engrave the whole of the *Pictorial History of England*, or to illustrate the most copiously adorned volume ever published to the world.

A collection of three hundred individuals would give 600 ounces or 36·5 pounds—a quantity sufficient to evolve hydrofluoric acid enough to darken all the windows of the Crystal Palace, and render them wholly opaque.

The osseous frame-work of our bodies is one of equal interest and importance to the chemist, anatomist, and pure surgeon; and whether taken in a merely practical point of view, or only examined scientifically, it well repays us for the time devoted to its consideration; but at this period, it is scarcely necessary for me to allude, except incidentally, to the large percentage of animal matter which bones also contain, on account of which circumstance enormous quantities are annually employed in agriculture, both in a crushed condition and also even more extensively after having been converted into soluble superphosphate of lime. But when these hard materials of our corporeal framework are submitted to the processes of natural decay, it is astonishing how long they last without crumbling into that dust of which they, as we are told, have been originally made.

The idea of which this dogma is the well-known expression, probably was practically engendered in the mind of man originally from the ancient method of disposing of the dead by the process of cremation, and from the visible products of those burnt offerings which were the earliest modes of attempting to propitiate offended Deity. Ashes alone remained behind as a record of the past. Although, even in the present day, we follow the less scientific and certainly far less healthful mode of sepulture by entombing the remains of fallen humanity, the expression still continues to be commonly made use of, "Ashes to ashes, dust to dust," as a remnant of the former mode of consuming our bodily tenement and disposing of mortality. But when these bony portions of our structure are exposed to the whitening agency of the tropical sun, or left upon the plains of the Lybian Desert, the toiling caravan may be tracked by its long line of bleaching carcases long after all remembrance of the fact has been buried in oblivion and forgetfulness. The soft flesh, blood, fat, muscles, sinews, nerves, and brain, have all disappeared by rotting and decay; and their various organised elements have assumed new forms of combination, and taken on those of the multitudinous volatile bodies and gaseous products of decomposition, in consequence of that slower process of combustion arising from gradual eremacausis and the effects of atmospheric oxidation; while the naked skeleton alone remains, alike the image and typical resemblance of the destroying angel Death, and the personification of Time. Still much organic matter remains united to the earthy materials of the tissues, from which, by chemical processes, considerable quantities of ammonia may be obtained by manufacturing agency, or by that gradual destruction induced by the conjoined effects of oxidation and moisture. These disorganising processes slowly progress through the original structure of the bone, under the ordinary circumstances of burial, or during the usual exposure in a moistened soil, at a certain rate in a century; so that the percentage of animal matter gradually decreases in amount, and the phosphate of lime at length remains pure, and deprived of that power of coherence which the gelatinous tissues had formerly conferred upon the structure of the bone. Under these circumstances, some bones will incur a change of form, and readily give way to the agency of external pressure; and thus we are enabled to account for the misshapen human skulls found on the ancient site of Uriconium or Wroxeter; and when they have been longer exposed to these destructive agencies, we find them even crumbled to decay and reduced to their primeval dust. But, as may be expected on ordinary theoretical grounds, the thicker and larger bones of the extremities resist decomposition for much longer periods, and some of these have latterly excited considerable scientific interest from having been discovered entombed in certain geological formations as long anterior to the present creation as the date of that form of terrestrial surface which was coeval with the existence of the *elephas primigenius*, the mammoth and megatherium, and with the cave-bear, all of which are animals whose types have disappeared and been wiped out of existence by the destroying hand of Time, aided by the grand geological mutations of the relative levels of land and sea which have ensued during the past hundred thousand years of this world's history. Our ordinary chronological notions suffer rudely from the shock of such a sweeping scientific deduction drawn from those durable and immutable pages of the rock; and we are compelled to look on with wonder and amazement at this lasting monument of human duration in Time.

It has been conclusively shown by the researches of Professor Tyndall and other physical philosophers, that the whole of the mechanical powers employed by the united machinery of the world are ultimately derived from the light of the sun; whilst the supremacy of England amongst the nations of the earth depends upon those extensive mines of coal which have been stored up for us in certain beds of the carboniferous series, ever since the geological changes which ensued upon the destruction of those ancient magnificent forests which remain to us as evidence of a former fiat of creative energy.

Most extensively employed, as they are, thousands of years may elapse ere England feels the want, or exhausts her store of mineral wealth; yet all these she owes to that mysterious agency which light exerts upon vegetative power, by which the budding plant and growing tree transform carbonic acid, water, and ammonia, into the substance of their own cells, juices, and tissues; and by that law of mutual dependence which Omnipotent wisdom has ordained, rendering the animal subservient to the vegetable kingdom, by producing, through the exercise of their functions of respiration and excretion, those material compounds which vegetation demands; whilst, by that beautiful power of compensation between the respiration and assimilation of the vegetable kingdom, vital energy is restored to the atmosphere by the constant reproduction of "the breath of life", and deposition within the fabric of the exogenous and monocotyledonous trees or their succulent stems; and wrapped up in the swaddling clothes of its cellular envelopes, the bounteous gift of Ceres lays up those stores of starch, sugar, and gum, together with those nitrogenous proteine compounds, without which animal life would perish, and this whole creation pass away, like those successive faunas and floras of former geological eras ere man began.

In Nature's laboratory, nothing is wasted, nothing lost. As matter was when time began, atom for atom still remains; not one has disappeared, disintegrated, or been destroyed; chemical agency and organic transformation, alteration, and substitution, account for every atom as originally turned out of the Creator's mould. As one generation succeeds another, so one creation follows the former; the present is formed but from the atoms of the past.

In support of this allegation, we may adduce the following well known geological facts; viz., that man is now using for his extensive manufacturing purposes coal obtained from four different stages of the palæozoic period. That mineral is worked in Portugal in the rocks of the Silurian stage; in Spain, its richest mines are derived from those of the Devonian period; whilst in Saxony, it is worked in the Permian formations; and the magnificent coal-fields of England are, as we have already adduced, obtained from the Carboniferous era, the most extensive as well as the most recent of all the four important divisions of the great Palæozoic period of this world's history.

The scientific agriculturist of the present day extensively uses, as a fertilising material, phosphate of lime as an artificial manure, in the manufacture of which he has employed coprolites, massive sharks' teeth, and gigantic bones, with other organic remains obtained from the red crag of Norwich—a fossiliferous deposit arising from a comparatively more modern creation during the Pleiocene era.

These five successive geological eras are the remains of as many different worlds existing in all their grandeur; sporting in beauty and revelling in loveliness ages before the final appearance of man upon the earth; yet he has long since learnt to employ them all for his especial use and power; and in so doing, he fills the atmosphere with carbonic acid, he covers his fields with bone-earth, and his crops return to him with ten-fold multiplication, his herds fatten and increase in number, and, by consuming them, he may be said to rebuild his own body with the atoms derived from the destruction of no less than five former worlds. It is true that neither chemistry nor geology, will enable him to isolate or identify the various atoms obtained from each era; but these sciences conclusively prove the laws of transmutation and cyclical change.

It may be thought advisable to say a few words upon the various causes assigned to the production of these incessant changes in corpuscular matter, and the modifying powers which induce these energetic actions in the world around us.

Certain physical forces existing above, around, and within the area of our limited faculties, exerting powers of various intensities, and manifesting themselves to our senses in different manners, having been studied under the names of heat, light, electricity, magnetism, together with chemical affinities and motion, are, in fact, the main objects of experimental physics, and various affections of that matter which everywhere surrounds us as objective phenomena. They have been hitherto considered, until very recently, as so many distinct causations of all that of which we become cognisant by our senses. But Grove has conclusively shewn "that they may all be considered as correlative forces, and to have a reciprocal dependence on each other. That neither, taken abstractedly, can be said to be the essential or the proximate cause of the others, but that any may, as a force, produce the others; thus heat may mediately or immediately produce electricity, electricity may produce heat; and so of the rest, each merging itself as the force it produces becomes developed: and that the same must hold good of other forces, it being an irresistible inference that a force cannot originate otherwise than by generation from some antecedent force or forces."

As an illustration of this law, we may adduce a most conclusive experiment, performed by Grove, and related by him in his work on the *Correlation of Physical Forces*, p. 58.

"By a certain arrangement of a daguerreotype plate, in a darkened box, connected on the one hand by means of wires, with a gridiron of silver wire, and on the other, with one extremity of a galvanometer coil, and a highly sensitive thermometer, called Breguet's helix, interposed in the circuit, as soon as light is allowed to fall on the iodised silver plate by the removal of the interposed shutter, the needles of the galvanometer are deflected from zero. Thus light being the initiating force, we get *chemical affinity* on the plate, *electricity* circulating through the wires, *magnetism* in the coils, *heat* in the helix, and *motion* in the needles."

Of these various forces our earth receives as extraneous motive powers those of light, heat, and actinism—emanations radiating from our central sun, and which are so many modes of motion of that imponderable ether which exists not only within the interstices of all corpuscular atoms of our immediate and material presence, but also penetrates to the utmost limit of creation, and appears to be coeval with the existence of space itself, and the universe which it contains. This imponderable ether has the omnipresence and immaterial properties assigned as the characters of omnipotence itself; and, assuming that one eternal mind can bring this universal power into action, and develope either the undulations of light, the motions of heat, and the correlative currents of electricity and magnetism, we get chemical affinity necessarily resulting, and motion everywhere follows as a consequent phenomenon; so that these physical forces may be said to be the fingers by which divinity has acted through the immensity of time, and from all eternity. Natural philosophy here merges on the domains of religion; and both agree in the existence of One Universal Spirit, extraneous to and different from materiality, immense in power, the originator of all power and creator of all change.

The luminiferous undulations of this universal ether, when submitted to the refractive powers of Newton's prism, elicited the philosophical explanation of the gorgeous rainbow, "the harbinger of joy, and pledge of Divine forgiveness to man"; and now the more intimate study of the mysterious lines, within this wondrous arch of seven primitively refracted rays, has enabled the physical philosopher of the present day, not only to analyse the constituents of the solar mass and develope the constitution of his planetary worlds, but lately, by the examination of the stellar spectra, we have pushed our analytical inquiries into the immensity of space, and elicited the wondrous intelligence that the universe itself is filled with self-luminous matter, equal in beauty, rivalling in magnificence, excelling in power, our own glorious orb, the centre of all happiness on this terrestrial globe; and demonstrating by analogical inductive reasoning the astounding fact, that, throughout the whole universe of creation, one agency exists, one matter extends, and suns around suns, worlds on worlds, revolve, whose constitution and destiny are the same as our own planetary sphere.* By this it is evident that the Creator's powers have revelled in the immensity of space; and that our globe is but as a drop in the ocean of eternity, only an unit in the grand and inexhaustible scheme of creation's universe; and that man and his spiritual guide are present everywhere throughout the confines of space, even to the remotest nebula which has been visible in the gigantic telescopes of a Herschell or a Rosse. And, however much we might be disposed to tremble at such a development of the theory of the universe which such sublime discoveries unfold to us, we must ever remember that the Godlike author of our pure and spiritualised religion has already declared that "in our Father's house are many mansions, and that he has gone to prepare a place for us; and where, as our accomplished President has so beautifully said, "the new heavens and the new earth, which the highest and purest minds have been inspired to look for, and to prefigure in solemn vision, will infinitely surpass in beauty and in glory all those which have gone before them."

* The discovery of thallium has proved a monochromatic green to exist; whilst the metal osmium gives a pure violet band; thus adding *two* pure colours to the idea of the triple spectrum. That *seven* primitive colours exist is the more probable idea.

Diseases of the Maori. Dr. Rawson describes in the *New Zealander* a disease somewhat common among the Maori children after they are weaned, worse in its nature and results than fever. It cannot be mistaken or unobserved in its attack, for it is accompanied by swelling of the stomach, with constant coughing, and tumours in the neck. He ascribes it to feeding them on potatoes or putrid maize. The neglect of the feeding of children with wholesome food, such as will nourish and strengthen, is the great cause of the death of many before arriving at years of maturity, and is the source of much of the sickness that prevails among the Maori race.