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ORDINARY GENERAL MEETING.*

DAVID HOWARD, ESQ., D.L., IN THE CHAIR.

The Minutes of the last Meeting were read and confirmed.

The following lecture, entitled "Water Essential to all Life," was delivered by Professor Lionel S. Beale, F.R.C.P., F.R.S. :—

WATER ESSENTIAL TO ALL LIFE.

By Professor LIONEL S. BEALE, F.R.C.P., F.R.S.

MR. CHAIRMAN, LADIES AND GENTLEMEN,—The first thing I must ask to be allowed to do is to return my best thanks for the honour which the Council have recently conferred on me by electing me one of the Vice-Presidents of the Victoria Institute. I have always felt much interested in the work of the Institute, and have been anxious to help in every way within my power the important objects for which the Victoria Institute, or Philosophical Society of Great Britain, was founded in 1867, and which now includes nearly one thousand members and associates who support its principles and are interested in its work.

The subject to which I venture to draw attention this afternoon is one of very great interest; and perhaps I may begin by affirming a proposition which I daresay everyone here will accept: "that water is absolutely necessary to all life."

As far as I can make out, there is no living thing from which water can be entirely removed. There are many organisms that live in dry lands and that are protected in various ways from being injured by wet; but I do not think

* Monday, February 3rd, 1902.

there is one which is destitute of moisture in all the active parts of its body. Only so long as moisture remains will a living particle continue to live; indeed before all moisture is completely removed, death must take place. So that it may be said, I think, that water is *absolutely* necessary to all life. Not an instance can be found of matter which is absolutely *dry*, free from water—and which is alive.

Everyone is probably aware that of late years "science" has been tending in the "physical" direction. During the last fifty years or more, the belief that every living thing depends upon physics and chemistry, rather than upon *life as distinct therefrom*, has been very popular. But the position that I have ventured to take, is very different. It seems to me, that Life is absolutely distinct from Physics—that there is no general gradation from the physical world to the life-world—that life is absolutely different from non-life—and that in no way can it be proved, that at any time or in any place or under any circumstances, non-life shades into the life state. Life is exceptional; matter and force the rule—in the infinite non-living cosmos.

A point of great interest is, that all the life we know of, comes from life only. As for spontaneous generation, it is useless to discuss the question at this time. It was long ago established that the idea was mythical—contrary to knowledge and the results of observation and experiment. Nevertheless, very different views with regard to the formation of living things, are now held to be possible. Certain elements it is suggested, or certain substances, might come together, under certain circumstances, and a living particle might result. But this, I think, must be denied as being against facts we know. Of course I am ready to be convinced if it can be shown that I am wrong; but I express my opinion distinctly, that there may be no doubt or ambiguity concerning the conclusion arrived at from my point of view. My contention is this—that as far as we have yet proceeded, we cannot in any way obtain a living particle, however small and simple its components may be, from any matter which is not living. Every particle that lives, as far as is known, has been derived from a particle which was living before it, and if we ask, "whence came the first life?" we plainly reply, that from the science side—"we do not know." Life has nothing to do with *Force*, it has nothing to do with *matter*, it has nothing to do with *Energy*, it has nothing to do even with *Ether*. So that in reason, we must make an

absolute distinction—at least I venture to take this view—between Matter that is *living* and Matter that *does not live.*

Now, one has to bear in mind that the part of a living organism that is *alive* is, in proportion to its whole weight, something very small indeed—almost, in many cases, infinitesimal in comparison. Another point of great consequence is that there is no separate living particle in most animals and not one in man, that is much more than one two-thousandth part of an inch in diameter, and the greater number of living particles are less than this. In the smallest insects and in the very lowest organisms, it is doubtful whether the one five-thousandth part of an inch will not represent the dimensions of the largest distinct separate individual particle of living matter that can be obtained and examined, while the lowest protozoa, fungi and bacteria being still more minute, the individual living particles will be too small to be visible by the aid of any magnifying power yet obtainable.

In man and in the higher animals, life depends—not on the great part of the body which we can see, but upon those minute living particles which exist in all the tissues and organs, and which from their origin to their death live in darkness, and to the extent not only of hundreds or thousands, but millions. There are millions of these separate living particles in everyone of us. Most of them are well protected in the positions where they have grown. They are not in close contiguity, nor do they run into each other, but they are separate. They are arranged at an early period of development in collections or groups. In the germ stage, they grow and multiply enormously as development proceeds. If you study any particular tissue soon after death, you will be surprised at the enormous number of these little particles of living matter among the tissues, everyone of which has been formed from, and by, them. These particles used to be called "cells," but it has been impossible to give an exact definition of a "cell," and everyone who has attempted to do so, has failed. The original idea of "cells" was that they were like the bricks in a wall, but that is not so—for nothing in living organisms is arranged or built up, as it used to be said, like bricks in a wall. Every part *grows.*

Each little particle or so-called "cell" consists of matter in two distinct states—*living* and *not living.* In many cases there is an outer covering or envelope, which is permeable to air and moisture—and *within* this envelope is the *living*

matter. It is the living matter which has *formed* the envelope which is no longer living.

In many of the lower creatures and in plants that live in water, small particles of living matter derived from previously existing living matter may escape into the water; and the first thing that happens, is that a thin layer of the surface dies and becomes the so-called "cell wall." This protects the living matter within, which may go on growing for a considerable time. The envelope, as in many of the microscopic fungi, may gradually increase in thickness until a strong protective covering is formed like the capsule of a seed. In all, this covering, or envelope, is outside; but it is not deposited from a solution, or from substances *around it*, as in the case of the accumulation of a deposit or enlargement of a crystal, but the thickening *is always from within.* The *oldest*, the part of the envelope which was first produced, is *outside.*

If you consider the enlargement of a stone or a snowball, with which cells have been compared, the last part deposited, is that which is *outside.* You see then the absolute difference between what only can correctly be called *growth* in the *life world*, and *aggregation* or *deposition* or *precipitation* which occur in the non-living world. Herbert Spencer, years ago, advanced the doctrine that growth was a kind of deposition, but this is not so, and cannot be. In life there is always matter in an exceptional and peculiar state, *living* matter, or *Bioplasm*, from, and by which everything in living nature is formed. Years ago, when I brought forward the question of the nature of *life* and *growth*, and *formation*, I spoke of *germinal matter*; because the living substance universally present in every living organism like that in every "germ," is *alive. The material which was formed* from it but *is not living*, was termed, "*Formed material.*" So you see that even in a single "cell" we are not dealing with living matter only. In all cases, we have a certain proportion of living matter within, which is protected by a thin membrane or layer of tissue, which in some cases becomes very thick, but all of which was *formed* from the living matter. This is outside, and it is never living.

This protective substance especially when thin, performs the office of a filter. Everything that is taken up by a living thing for nutrition is dissolved, and when the solution passes through the membrane, the access of solid particles is prevented, so that they do not come in contact with the living

matter. Of course there are very important and deep scientific questions that have been, and may be suggested as regards the state of the living matter which receives the solution of non-living nutrient substances—and there is room for difference of opinion. The nutritive matter in solution certainly passes through the "cell wall," and actually "into the substance of the *living matter* of the cell."

The living power or *Vitality* is the factor which selects from the water certain appropriate substances and causes their elements (?) to change their position and to be differently arranged. The elements being brought into new relations with one another, are so arranged that new living matter *immediately* results. Life power seems to be imparted by the already existing living matter, but without change in, or loss of its power, and some of the non-living matter *which was* in solution *lives*. The arrangement, as it seems to me, really depends on what we call *living* or *vital power* only, the actual nature of which has not yet been ascertained, and I do not know how it is to be discovered. You cannot isolate *life*, or separate it, or examine it, or investigate it, or study it, or cause it to change its form or mode, as you can heat, light, electricity, magnetism, etc. You can only judge by what vital power has effected. You can analyse the material which passes into living matter, and you can make out its composition by chemical analysis, but as soon as it gets into the *living matter*, it is changed—it *lives*—and then, if you try to find out what *living* matter is composed of you fail. *In fact the first thing you do is to kill it.* Some physical philosophers have said, the "protoplasm" consists of so and so, but I answer:—"the material you examine is *lifeless*, and is produced at the death of the living matter, and certain *non-living* substances result." It is impossible to say what is the composition of living matter, because you cannot test it *without* first destroying its life, and therefore what you test is not living matter but only the substances which result from its death.

Now, I may venture to consider the question of water which is present in *every living particle in nature*? I hope some day, when there may be time, I may be permitted to offer some remarks on the broad question of air and its service to *life*. Water is a very broad question indeed, and I do not think it has been adequately considered during the past fifty years, in its relation to life. No living matter can exist—no living matter can be produced or originate—no

matter that is alive, can continue to live in the absence of water; and I think we may go so far, as to say, that throughout the whole world of life water is an absolute necessity. I will not go into the question of the origin of water or of life just now, for there is so very much to be said in regard to all living things *as they are—as we see them* —that it would be a pity to attempt the consideration of the much larger question of how they came to be, and I shall say nothing in reference to the question of the creation of life or of matter or water. Air and water must have existed at the moment when, or before, any living organisms appeared on this earth.

Now, think of the driest tissues of the body we can select; for example, the nails, the hair, the teeth, or the oldest part of the enamel or dentine of our teeth, or that of the ivory of an elephant's tusk, or piece of shell fully formed. All these textures are not only *not* living, although belonging, and of great importance, to the living organism—but they may have been lifeless for many years. They cannot increase or grow. They cannot produce more tissue of the same, or any other kind. Nail will not produce nail, hair develop hair, or the hard tissue of teeth give rise to tooth structure. All these things have *grown* and have been *formed* by, and from living matter. Not only so, but the whole of the material of the teeth, the material of the enamel, hard as it is, and the hard matter of the shell, was dissolved before their conversion into dentine or enamel, ivory or shell. Before the enormous tusk of the elephant began to assume the hard state, every particle of the hard matter must have been in solution. The phosphate and carbonate of lime and other inorganic, as well as organic matters, are selected by the living particles from their solution, and caused to assume definite form. Before the matter became part of the elephant's tusk—before it became part of the matter of the enamel of teeth, which is as hard as shell, and shell itself, it must have been taken up by structureless living matter which consists principally of water. Even the hard matter of the enamel of our teeth, must have been taken up by the particles of soft living matter, by which also, the solution was caused to flow towards each living particle, the inorganic matters being then deposited in the organic structure already formed by the living particles, and now ready for calcification. Dry and hard tissues composed of organic matter like horn, hair

and feathers, which, in their fully formed state, contain very little moisture, were all produced by moist living matter. Every part of the dry feather of every adult bird, just before each moulting period, was in the state of soft living matter, consisting principally of water, and so with horn, hair, nail and all other like structures in nature. But for the soft structureless living particles, the production of these tissues would have been impossible, so that, after all, the whole process seems to be comparatively simple. Certain materials are deposited in certain forms, and often in the most beautiful patterns, in some extremely minute organisms, and yet all these materials were at first dissolved in water and then taken up by the living matter of the particular living tissue, whatever it is destined to be, and arranged in its previously determined ultimate form. Thousands of diatoms can be identified and classed, according to the predetermined arrangement of the silicious particles, which is effected by the living matter of each class and species. These hard tissues, the hardness of which depends on organic or inorganic matter, exhibit widely different structures. The hair has a structure of its own; but not only so, but the hair of almost every hairy animal known, can be distinguished and identified by its microscopical characters. The external skin of insects, animal and vegetable hairs, and all such tissues were formed by living matter rich in water. Though our teeth *look like* the hard matter of shell, anyone seeing a thin section under the microscope would at once discover the difference from shell, ivory, and other structures. The difference of structure depends not on the properties of the material of which in its fully formed state it consists, but on the *Power* of the living matter by which alone its formation was rendered possible.

As I have remarked, a great many tissues are dry—we may almost say, perfectly dry in their fully formed state. Think of the wing or the very hard coriaceous outer covering of the body and legs of a butterfly or a beetle. The delicate muscles and far more delicate nerves within the dry outer sheath are all moist, and so indeed are they in not only in all classes of insects, but in all organisms. An acting dry nerve or muscle, is a thing unknown and impossible in nature.

It will be interesting, perhaps, if I may very briefly refer to the great and most wonderful changes which take place in the formation of an insect. From the moist matter of

the egg comes a larva, and this larva contains much water and is soft and moist, and possesses nerves and muscles, and many most elaborate organs and tissues, not yet half investigated. The larva eats voraciously and grows, but though it is an imperfectly formed immature thing for some time, its tissues are most perfect and its movements most delicate and wonderful. Sooner or later, it passes into a state of comparatively passive living existence as a chrysalis or pupa, which remains, sometimes for many months, as it is said in a "dormant" state, within its dry outer envelope. But the living growing substance of the chrysalis is very moist and in many instances quickly undergoes the most wonderful *vital changes*.

Almost the whole of the inside of the chrysalis consists of moist living matter. The tissues which are gradually being formed are totally different in every respect from those of the larva, grub or caterpillar. These tissues become very distinct as the time for the great and final change approaches; when at last what is in fact a new creature with organs, structures, and powers different in nature, and even in the principle of living action, is evolved, and sees the light. In short, after wonderful constructive changes have been going on for some time, the various structures of which the imago, or final stages of the butterfly or beetle, or other insect, appear in perfection. The air tubes by which the insect breathes, the muscles, nerves and the more complex organs and structures of the imago are all developed in the chrysalis stage. An insect has no lungs, the air is conveyed to the ultimate parts of the different tissues direct, by little tubes or tracheæ, which open on the external surface of the insect. The air is drawn in and passes through these tubes, which extend to every part of the tissues and organs, by the movements of the body, and thus the fluids and tissues in all parts of the organism are supplied with air. The air is in fact taken direct to the tissues. In the act of breathing in the vertebrate animal and man, on the other hand the air is taken up by the blood as it traverses the blood vessels of the lungs, and after passing to the heart, the ærated blood is distributed to all parts and tissues by means of the systemic vessels. The air is dissolved by the blood, and the oxygenated fluid filters through the thin walls of the capillaries, and thus reaches all the different organs and tissues of the body.

Every part of the active living matter is moist and

receives all its nourishment dissolved in water. Nothing that is perfectly dry, lives. The scales of the butterfly's wing, the wings of beetles, flies, etc., and the hard external covering of the legs and claws of insects are dry, but the muscles and nerves, concerned in every movement and in every part that is moved, are always moist. The particular muscular movements and the degree of movement, as is in other creatures, depend entirely on the nerves, and nerve centres which are invariably moist.

It is the nerve "current," which starts from the living matter of the nerve-centre, that determines and regulates the rapidity and degree of contraction of every muscular fibre. The anatomical arrangements are indeed very complex, but all nerve action is in its nature *vital*, and not to be accounted for by physics: but I must not attempt to discuss further this part of the question this afternoon.

With regard to plants, the proportion of water to the solid matter, especially in the growing state, is enormous. Many succulent vegetables, when fresh, probably consist of as much as nine-tenths of water, and the quantity of actual solid matter in leaves and flowers when dried, is very small. The power of growth in vegetables, as we all know, is wonderful. If you look at the growing extremities of a root as it makes its way through the moist soil, you always find the tissue very soft from containing much moisture. The active growing extremity of every rootlet consists, indeed, principally of water: but, nevertheless, this soft delicate growing part of the root may gradually make its way, as we all know, into furrows or fissures in rock, and even penetrate through some hard substances, and continuing to grow in a moist fissure, it may split very hard wood or even stone, or a very heavy mass may be lifted up. It has been thought that all this active pressure depends on simple imbibition, but no imbibition or absorption of water, as by a porous substance, will account for the facts. A piece of dry wood driven into a chink in a stone, and then caused to absorb water, will perhaps split the stone; but this is a process very different from that of the pressure exerted by a continually growing root or other part of a plant. By the force of vigorous living growth a stone weighing a hundredweight or more may be forced out of its place. Some of the huge gourds of America exhibit this enormous power of growth in a remarkable manner.

Seeds, you may say, are surely *dry*. But this is only true

to a limited extent. Examine carefully the capsule or husk of a seed, and you will find its structure well calculated to resist for a considerable time external changes in temperature and moisture. Study the *growing* seed, and it will be found to contain much water in its living growing part. The shell or capsule, which exhibits great differences of structure in various kinds of seeds, is very striking. After being fully formed, the seed and its protective capsule gradually become dry, and if you carefully moisten it, you may discover several layers of different structure, one within the other. Each layer consists of a number of little so-called "cells," each cell in the dry state of each layer contains air. One cannot easily imagine anything better as a non-conductor than this arrangement of the "cells" of the capsule, by which the seed is protected for a time from heat and cold, and its living germ preserved from action, it may be, for a long time. But the seed, when kept moist or placed in water, will gradually imbibe it, but the capsule in its dry state would keep out the water for months. In some cases a long time passes before it is moistened. The living embryo may, in fact, for a long time be kept from becoming too dry or too moist in very dry, hot, or cold, or wet weather, by the remarkable structure of the layers of its capsule. The common cocoa-nut is a seed on a gigantic scale. Remove the very thick outside shell, with its thick fibrous layer beneath, and you come to a shell as hard as ivory, dead and most *impermeable*. Within this is a thick layer of moist firm tissue, which, as we know, may be eaten, and within this is the so-called "milk" containing much water. The life of the germ may be preserved without much change for weeks, months, or years, and in some cases probably for many years. I do not know that we can exactly fix the limit of life in many instances, but there is something connected with the small vital germ of the seed by which this is determined, for different germs may live in a quiescent state for very different periods of time. Some seeds should be planted very soon after their formation is complete, or they will not germinate. Others will not grow until, as we say, they are *ripe*. This power depends upon something in the economy of the particular seed which is inherited. Some seeds will not bear drought after they have once imbibed moisture. Others will become dry and may get moist again and again, without the death of the germ being caused, and more than one kind of seed will bear frost and wet, and alternate drought and cold during many months without its germ-

life being destroyed. It may be placed in water, or it may be scorched by the sun again and again, and it will not be killed. The common acorn is an example. It is a seed, the germ of which is most difficult to kill, and the growing embryo, at least in its early stages, is not easily destroyed. The constitution of the germ of the acorn, in fact, exhibits in its constitution that of the oak into which it is to grow. Of all the little plants loved by children, the oak, as it grows from the acorn, is one which will afford much interest. Many a tiny oak tree, when five or six inches high, may be treated carelessly and almost deprived of water for some time and yet survive, so vigorous is it in vital constitution.

In the education of young children, it is wise to allow them to grow a few plants in this simple way, and they should be encouraged to watch the growth of plants from year to year as they grow in water, or damp sand, or earth. Common mustard seed is very suitable for the instruction of children. It only requires to be placed in a saucer with a little water, or on a piece of damp flannel, or sponge, or blotting paper, so as to be prevented from getting absolutely dry—and the process of germination and growth may be studied and thought over day by day. The child will, in a few days, observe the little roots growing down, and the little stem growing upwards. Those who have watched such living growth in childhood never forget the wonders of life and growth. Chestnuts, peas, beans, and other seeds may be tried, but mustard seed, which is so easily procured, and may be grown even in mid-winter if placed near the window in a light warm room, is among the most interesting seed for schools. Poor, as well as rich, have the means of showing their children how living growth takes place; and may see how root, and stem, and leaves are formed.

Growth does not depend alone on the organic matter and various substances dissolved in common water, for you can grow the mustard plant from the seed placed in distilled water. If, however, the seed be completely immersed in water it may die, but if placed in a thin layer of water only, so that air also may reach it, the dry shell of the seed will imbibe the moisture, and by keeping it in a small shallow saucer under a shade or tumbler for some days it will grow. I do not say that you can grow *any* plant for a long time in distilled water alone, for as growth proceeds, more nutrient material than is contained already prepared for the seed, will be required.

The tissues of all plants and animals, in early life, contain much more water than when they are full grown. In all growing embryos the proportion of water is very considerable. There is a higher percentage of water in the tissues of the young child than in growth and in adult life. Everyone knows how easily young children are injured, in consequence of the softness of their tissues, consequent on the large proportion of water present. The same remark applies to many of those unfortunate cases which we see from time to time where local or general growth is too rapid.

In tissues and organs which increase with abnormal rapidity, a large number of bioplasts in a given area will be found, and these contain much water and may divide and subdivide and grow, very fast. On the other hand, when tissues undergo condensation and in some forms of "degeneration," they are found to contain a much higher percentage of solid matter than those which are healthy, and this point is of interest to physicians with reference to the highest and most complex organs of man.

The organ which does the most wonderful *work* in all living nature, and the highest work we ourselves are capable of, is that part of the brain which is near the upper outer surface of the cerebral convolutions. As I suppose everyone knows, there is a great difference in the brain structure in different parts. Broadly, the cortical or outer parts of the surface hemispheres of the brain, are grey and are called grey matter of the cerebral convolutions. This is very largely supplied with blood, the vessels being everywhere very numerous. Beneath this outermost layer of the brain structure, is a considerable amount of brain tissue which is of much firmer consistence than the grey matter, and supplied with far less blood. It is whiter in appearance, and here and there it exhibits lines, and has a distinctly fibrous appearance. In the direction in which the lines run, the tissue, which contains less water than the grey matter, may be in some cases easily torn. The blood vessels in this white matter, are not numerous, and the amount of blood distributed to the grey matter of the convolutions is very small in proportion.

In all the nerve "centres," sometimes on the surface, and sometimes in the substance, is soft and very moist matter which corresponds to the grey matter of the brain, and contains many living growing bioplasts—and matter which is much firmer and more fibrous—not actually dry but

containing a larger percentage of solid matter than does the moist more active growing tissue to which I have alluded. This thin layer, extending over the whole of the outer surface of the folded layer of the convolutions of the brain, which in most vertebrata is just beneath the skull, is covered by a delicate, highly vascular membrane, so that the soft part, the grey matter, is supplied with a very free distribution of blood of course associated with the free distribution and interchange of nutritive and oxydizing fluid. The action of this part of the nervous system never ceases, from early life to death in old age, in healthy organisms. In other words, the grey matter of the brain, which contains a vast number of "cells" or living bioplasts, is active all through life, except in alternating periods of healthy sleep, when it "rests" from action altogether and waste matter is removed. I suppose the reason why we require so much sleep, about one-third part of the twenty-four hours, is to make up for the waste which has taken place during the active period of the day, in consequence of the active vital changes which occur in the living matter of the innumerable "cells" of the grey matter. Now these "cells," to this day have not been sufficiently studied, but I think there is no doubt whatever that they do all the intellectual work of the body, while multitudes are actively concerned in every voluntary movement. These "cells" are also the seat of thought and will. Indeed in structure and arrangement these "cells" are as elaborate, and are as numerous as we should expect to find them considering the wonderful and highly important work they do. If the brain matter concerned in thought, every kind of intellectual action and voluntary movement, is not kept constantly supplied with a large amount of water, its action will be seriously deranged.

By the general arrangement in "convolutions" of the upper part of the human brain, the greatest amount of brain tissue and active brain matter is caused to occupy the smallest space; and every portion of it is well protected from injury. Take a very thin section, say an inch square and not more than the one five-hundredth of an inch in thickness, there will be perhaps fifty thousand or more of these remarkable "cells." Each "cell" is of very striking and complicated structure. From each one of them a large number of very fine nerve fibres proceed. Each "cell" in man is not more than one two-thousandth part of an inch in diameter, and you may, therefore, conceive what millions

and millions there must be in a very thin layer of a very small area of the grey matter of the cerebral convolutions of the human brain. Hundreds and thousands of these very minute cells act together—act consentaneously, not only in thought but in voluntary movements.

Cerebral action seems to depend *on the living matter of these "cells."* When the living matter is much injured, or poisoned by the presence of certain poisonous matters in the blood, their action is seriously deranged, or the result may be fatal. I daresay while I am now speaking the living particles of millions of my "brain cells" are actively engaged at the same time, for the same purpose and in the same direction. Of course I do not feel it, or understand it, but from the arrangement of the living matter structure one can see and study and think over, I cannot but feel pretty sure it must be so. There is, I believe, no other explanation; and the conclusion I have ventured to draw is certainly justified by the facts ascertained by microscopical investigation of the cortex of the cerebral convolutions of the human brain in excessively thin and well prepared specimens. If you were to see the actual appearances under the microscope you would I think come to the same conclusion. The statements involve much more than I am able to describe, for it would indeed take a long time to give but a short account of what I have seen in the course of my investigations. But the broad fact to consider is that the living matter of the "cells" we think with, must be freely ærated, as they receive a direct and very large supply of blood just oxygenated by having just passed through the vessels of the lungs, I think a larger supply than is received by most organs, except the lungs themselves. The delicate "cells" and fibres are separated from one another by fluid, thus being carefully protected from pressure or shock, and the living matter in the centre of each cell is constantly kept moist. As is well known, there is fluid not only around the brain and spinal cord, but in all the interstices of the brain tissues, by which the minute bioplasts and fibres are kept from pressing on one another, while probably many adjacent fibres may be carrying a nerve current in different directions.

A considerable quantity of water is required in all the changes connected with the living matter of all "cells." If you want to understand the action and movements of living matter you have only to look at some of the "cells" in

certain living plants. You may then see the *vital* movements of the living material, which used to be called protoplasm, whether living or dead, and is so still by some authorities. But the protoplasm of authority which is dead must be absolutely distinguished from actual *living matter* or *bioplasm*. Huxley used the term *protoplasm* very freely; but he did not distinguish the dead from living protoplasm. He went so far as to say that if he took the "protoplasm" into his body in the shape of roast or boiled mutton it would add to, increase, or replace the protoplasm of his body, which was being used up. But what he took was not *living*, but merely the products resulting from the death of the bioplasm, which had been roasted or boiled and then swallowed. This was dissolved and at length caused to live by living matter, and then became the "protoplasm" of his body. To this day Huxley's arbitrary fancy is received by many, and passes as if it were scientifically correct and true. (Applause.)

When water is exposed to the air for a certain time the ova or portion of the bioplast of many of the lowest, simplest, living forms, microscopic "protozoa," "bacteria," "fungi," etc., pass into the water, even if it is distilled water, and in a few hours or days, according to the time of year, you find minute living organisms in millions in a drop of the water. These minute creatures used to be termed animalcules, and are now called protozoa, but it matters little by what name they are known. Each consists of soft material with which is associated a very large proportion of water. If you took the water in which hundreds of these living organisms were in active movement and evaporated the water, you would probably find that perhaps ninety-nine per cent. had disappeared, leaving only this mere trace of dry solid matter. So that the bodies of these creatures must be composed almost entirely of water, incorporated with an infinitesimal amount of organic solid matter—or was the water itself incorporated with and an inseparable part of the living matter, and also *living*? The matter of all organisms and tissues in the early growing condition, as I have already remarked, consists largely of water. But the movements of the most minute living protozoa are of the most complicated and perfect kind. Not only are they wonderfully active, but you see them steering their way around and between obstacles; seldom coming into contact with them or with one another. Their unceasing activity is most remarkable. Many of the larger protozoa are easily

studied, and their movements are worth carefully watching for hours.

As I have said, everything that is taken up by living matter must be dissolved in water. Of that there is no doubt. But what is the state of the solid matter in these lowly but most minute, most elaborate and wonderful of living forms? Is it chemically "combined" with the water, or is the solid matter in such a minute quantity that the water as well as the organic matter must be regarded as actually alive? On this last supposition what becomes of the "atom," and where is the atomic theory? Is the matter as well as the water infinitely divisible, and, at least during life, the material atom non-existent? A *living atom* certainly exists not. An elementary material atom cannot even be thought of as alive in the present state of knowledge. A living atom is impossible in nature. The physicists, perhaps, would like to meet and discuss a broad, general question like this; but few physicists seem to care to enter into the consideration of any question of details connected with a purely *vital* possibility, and many seem opposed to discussion, and that every physical suggestion is a fact.

Let me, in conclusion, venture to offer one or two remarks with reference to water in relation to us and our ordinary and extraordinary food. There has long been what may be called a dead set in this country against "too much" water-drinking generally, and in particular too much water-drinking at the time of eating. Considering that every particle of food, which is to be of service to us, must, as I have already said, somehow be dissolved, water antipathy, and the idea of the desirability of combining or diluting water with something alcoholic, is foolish. We may of course take more water a day than is good, but probably most of us err in the opposite direction. If preferred, the water may be taken in the form of lemonade or weak tea; and as regards digestion, slightly warm fluids are preferable to iced or very cold drinks.

I am sure that many poor children are made miserable, because parents and guardians think they do themselves harm by imbibing the proportion of water they desire. Children as well as young animals require a good deal of water, or food mixed with milk or water, before it is taken. Plenty of fluid ought to be always passing to and from all growing tissues, if the young organism is to be kept in health. It seems to me almost cruel to allow children to suffer from thirst.

There is, I venture to think, yet another fashion almost as unfair to long-suffering adults. As I have reached a considerable age, I may perhaps be permitted, even at the risk of offending some of my friends who are but too kind on occasions of hospitality, in wishing me to partake of a diet which, considered from a vital or physiological point of view, must be termed "too liberal." Many who give dinner parties and invite their friends to enjoy a profusion of rich food, seem to have thought of everything but the necessary water required to dissolve and dilute it, before it can be assimilated, or become of any use physiologically to the organism, and for the want of dilution, some luxuries may act detrimentally. Every guest should have a small bottle of water in his immediate vicinity, so that he may help himself as often as he desires, during the feast, or even before the repast begins. The privilege of belonging to a City Company, or a dining-club, would I think be enhanced, and more highly appreciated, if plenty of water, lemonade and such beverages were not considered vulgar, or commonplace and inappropriate. On the few occasions, years ago, when I was able to indulge in dinners, I could seldom get water enough to dissolve even the small amount of food a person of my weight ought to take. Wine and beer and other alcoholic beverages that ought not to be asked for, or taken by a rational person desirous of easily digesting his food, were in excess, but water pure and simple, was not to be had. To ask for water under such circumstances was sometimes considered an offence. The waiters seem to detest water and even a little bottle of seltzer or other ærated water, is not often at hand.

Pardon me for thus attacking the anti-water custom—but when I think of the required solution of most of the constituents of our food soon after meals, before their assimilation is possible, and before they can be of service in the nutrition of our tissues, or of use in the physiological action of tissues and organs, I naturally look for a little modification of views widely entertained concerning eating and drinking in the case of man—the so-called *animal*. It will give me pleasure to hear any remarks on the questions I have brought forward, and I shall endeavour in answer to any questions arising to explain more clearly the views to which I have committed myself, as far as I am able to do so. (Applause.)

Discussion.

A discussion followed in which the Chairman, the Rev. Canon Girdlestone, Mr. Martin L. Rouse, the Rev. J. Tuckwell, Professor Orchard and Professor Candy took part, and bearing chiefly on the origin of life; a subject not within the scope of the author's communication, and consequently, with the Chairman's concurrence, not here reproduced.

A cordial vote of thanks having been passed to the learned lecturer, the Meeting adjourned.