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PROTOPLASM:

ITS ORIGIN, VARIETIES, AND FUNCTIONS.

BY

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P R E F A C E .

THE substance of this essay formed a paper on "The origin and nature of Matter and Force, and Life and Mind," read before the Literary and Scientific Society of Birkenhead, November, 1901.

It is now published, with emendations and additions, under the impression that it will be of interest to scientific physicians generally, as it contains some original views on the origin, varieties, and functions of protoplasm.

The author gratefully acknowledges his indebtedness to the works lately published

on the recent progress of science ; in particular, those of Prof. DOLBEAR, the Rev. Dr. DALLINGER, and Dr. SCHOFIELD : to the latter, not only for much valuable information, but also for permission to make use of the illustration in his excellent treatise on "The Unconscious Mind."

BIRKENHEAD,

April, 1902.

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PROTOPLASM.

PROTOPLASM being a living substance, the following questions may be asked concerning it, namely: As living substance, how did it first become living? Was it created already alive, or did it become so by the ordinary processes of evolution? When and how did it first appear on the not-living earth? How is it now being made?

The members of the medical profession do not need to be even reminded that protoplasm is a semi-fluid, tenacious, glairy substance, in appearance, consistence, and composition resembling white of egg; or that the late Professor Huxley named it "the physical basis of life," because it is the

substance in which life is manifested, or more properly the substance that manifests life ; or that for the same reason Dr. Lionel S. Beale named it "bioplasm," the living substance. Nor will they object to the statements that protoplasm is the *only* living substance ; that there is no life on the earth apart from protoplasm ;¹ that all the organs and tissues of living bodies, whether animal or vegetable, are in great part composed of protoplasm, in the form of so-called "cells" ; that many of these cells are without cell-wall, being then merely infinitesimal aggregations or clusters of molecules of protoplasm, by Beale called "bio-plasts" ; or that every living molecule in living bodies is protoplasm ; or that wherever there are molecules of protoplasm there is life, probably in proportion to the number of molecules : and they will admit that only part of any living organism is really protoplasm, is really alive ; that part

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¹ "Life," writes the Rev. Dr. Dallinger, "it is well known has its phenomena inherent in, and strictly confined to, a highly complex compound of fixed chemical constituents. This compound, in its living state, is known as protoplasm. It is clear, colourless, and, to our finest optical resources, devoid of discoverable structure. There is no living thing on earth but possesses its life in protoplasm, from the microscopic fungus to man." —DALLINGER, p. 29.

has been alive but, having served the purposes of life, it has passed from the living to the not-living state, from protoplasm to cellulose ; that part has not yet arrived at the living state, has not been elaborated up to the complex condition of living matter, has not been made into protoplasm.

The first protoplasm that ever existed must have been that of plants ; of the lowest plants, the protopyhtes, as the first living matter, made by Nature herself. And here it probably differs very little from the highest of the not-living organic compounds, the proteid chemical ferments, being only a little further developed in complexity of structure and activities.

Protoplasm is now made by animals as well as by plants : both make it out of their food ; when made by animals it is also called "sarcodé." The way in which it is made will perhaps be most easily understood by reference to the process as it takes place in the higher animals. It is there made by the cells of the already existing protoplasm : they make it out of their aliment, the blood. The blood is made out of the food, by the digestive organs.

The blood, after having been elaborated up to nearly but not quite the composition

of protoplasm, is carried by the blood-vessels to the innermost recesses of the body, and there brought into contact with the living cells of the organs and tissues: these appropriate it as pabulum, and raise it to the same degree of development as themselves, that is to protoplasm, make it into protoplasm, into living matter; not by communicating to it any living principle, any "principle of life," but by putting the finishing touches to its development; that is, to the number or arrangement of its molecules and to its peculiar activities—starting the balance-wheel of the chronometer, so to say.

The foregoing is the usual way in which protoplasm is now made, and by most biologists it is considered to be the only way; that is, that protoplasm, whether of animals or plants, is made only by existing protoplasm, as a continuation of itself, as its hereditary successor.

It is by the living cells of the organs and tissues that the blood is elaborated into protoplasm; the molecules of the blood plasma are drawn into the interior, towards the centre of the cell, and there and thence developed outwards through the granules and nucleus to the body-substance of the

cell. During this process they receive the last touch that completes their formation into protoplasm. Anterior to the nucleus they have not yet become perfect protoplasm, and at the cell-wall they have ceased to be protoplasm—have become cellulose.

The cell-nucleus is the centre of attraction and elaboration, the seat of innate vital activity, the vital point, the *punctum saliens*. Whether there is here one of the "primordial germs" of Darwin,² a "physiological unit" of Spencer; a single specialised molecule; a single endowed atom, or a speck of life or spirit, we will not even conjecture. It is undoubtedly the point of vital activity, and here certainly resides the *primum mobile*; by Hæckel, called the "cell soul."

Vital activity is not communicated, to the cell by or from its environment, the pabulum; it is innate in the cell itself, just as physical activity is innate in the molecule of not-living matter. The special kind of activity—vegetable, animal, muscular, nervous, etc., results from the

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² PRIMORDIAL GERMS—"The whole line of human experience, interpreted in the light of modern scientific knowledge, compels the conclusion that the primordial germs *in which life on earth began*, arose by the operation of natural creative laws."—DALLINGER, p. 40; [Italics, J. W. H.]

peculiar kind of the constituent molecules, or from their special groupings. The groupings result from and depend upon the innate specificity of the molecules. Vital activity is to a certain extent *modifiable* by environment, as Darwin has demonstrated. Environment does sometimes even seem to possess an originating power, but this is only in appearance: it has no such power, it really acts only as a modifying influence, and mainly as a stimulus to the innate cell activity.³ Throughout the whole of the universe the source of movement seems to be within—in the atoms and molecules of all in the earth, and in the solar and other systems.

Protoplasm is well exhibited in the amœba, and in the living cells of the tissues of animals and plants, where it can be seen by the aid of the microscope. It is an extremely complex organic body, with immensely complex activities; perhaps, indeed, it is the most complex substance known, and possessed of the most complex activities. It is in fact alive. It can be

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³ "Protoplasm," writes Professor Dolbear, "organizes itself into cells and tissues in the same sense as atoms organize themselves into molecules, and molecules into crystals."—DOLBEAR, p. 281.

killed by excessive heat or cold, though not by long keeping or moderate drying. By these latter its vitality is only made dormant, and may be revived by moisture and warmth. It cannot be analysed ; any attempt to do so acts like a touch to a house of cards. The chemist is left to examine the constituent elements that have fallen back from the living state, and re-arranged themselves into the not-living, the non-protoplasmic condition. Only living matter can be protoplasm : there may be dormant, but there cannot be dead protoplasm.

In all probability the first protoplasm was made by means of successive combinations and re-combination of not-living matter, by the ordinary processes of nature.⁴

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⁴ "Manifestly, then, there was a time in the past history of the globe, when its matter was without life, and therefore there must have been a time, perhaps at a point of intense activity in the not-living matter of the globe, when it became endowed with the properties of life."—DALLINGER, p. 32. [Would not 'acquired' be more appropriate here? 'Endowed' implies an external influence, an endower, which does not seem to be Dr. Dallinger's meaning.—J. W. H.]

"Every process of nature that ever man has investigated throughout all space and all time, results from perfect and unalterable method which we call a 'law' of nature. Then why should the primal process, by which not-living matter became, once for all, living, be brought about by any other means than the pre-ordained action of competent natural laws?"—DALLINGER, p. 39.

As, however, there are two theories of the primal origin of protoplasm ; first, that it was specially created already alive ; second, that it was developed by the ordinary processes of evolution ; let us examine the subject for ourselves : for this purpose it will be well to inquire into the origin and nature of matter itself and its various forms.

THE ORIGIN AND NATURE OF MATTER AND ITS VARIOUS FORMS.

It has of course been long known that the earth is a ball of matter, in different forms—metals, earths, solids, fluids, gases ; that these are each made up of very small particles, called “ molecules ” ; extremely minute, much too minute indeed to be detected by our most powerful microscope ; and that even these molecules themselves are made up of still more minute particles called “ atoms.”

Molecules are the smallest particles of the special forms of matter, and they are made up of atoms of the primitive matter.

Many scientists hold that atoms are probably hard, solid particles, which do not cohere together ; do not even touch one another. They suppose that each atom is

surrounded by a still more subtle substance, which they have named "ether." Some, however, maintain that the ether is itself the all-pervading primitive material substance, and that the atoms were formed out of it, and are not solid particles, but centres of movement, infinitesimal whirlpools in the ether.⁵ And others are of opinion that the atoms are elastic spheres filled with ether. (Hovenden.)

In the fluid state of substances it is supposed that the hard atoms are able to move about freely in the ether; that in solids they are attracted or pressed closely together; whilst in gases they are separated to considerable distances from one another. As vortices in the ether it is supposed that in liquids they are separate from one another; in solids they are in a state of contraction and pressed into one another; and in gases they are expanded as well as separate. As elastic spheres it is supposed that in liquids they are in a state of separation from one another, simply filled with ether; in solids that they are infolded,

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⁵ "What knowledge we do have, and the inferences that may properly be drawn from it, all tend to convince that matter and ether are most intimately related to each other, and that some such theory as the vortex-ring theory of matter must be true."—DOLBEAR, p. 42. (See note to p. 21.)

invaginated into one another with the ether pressed out; whilst in gases they are expanded with ether, and that in proportion to the ether absorbed. (Hovenden.)

Scientists are then not at one as to what the primitive matter was, nor as to the nature of the atoms. What the original matter was is perhaps of less importance to science than what and whence the atoms, because it is by the atoms and their unions and combinations that all the materials and phenomena of nature are produced. One thing about the atoms is certain, namely, that they are always in motion, are centres of motion, the centres of all cosmic activities, that they are endowed with innate power of self-movement,⁶

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⁶ "The primal atoms with their inalienable motion."—DALLINGER, p. 48.

"Movement is an innate and original property of matter."
—HÆCKEL.

If a steel magnet of one inch length were cut into two half-inches, one end of each half would manifest attraction and the other repulsion; so if each half-inch were cut into two, the ends of each quarter-inch would similarly manifest attraction and repulsion; and so again, if each quarter-inch were bisected, the ends of each eighth would manifest similar attraction and repulsion: and so would the ends of each particle were the bisection carried as far as sight could follow. Nor would this attraction and repulsion cease were sub-division carried as far as the particles could be detected by the microscope; and if carried to the very atoms, each would necessarily possess similar attraction and repulsion.

instinctive motion, which shows itself especially as attraction and repulsion, as if they were minute magnets.⁷ It is this innate power that makes them move freely about amongst one another, and forces them to be in constant movement, never to be at rest even in the most compact substance, but always in motion, attracting and repelling each other with great force, with force so great that it has earned for itself such names as "The bombardment of atoms," "The rhythmic swing of the atoms," "The eternal dance of the atoms," "The polarity of the atoms," "The life of the atoms," and similar designations; and with

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⁷ "How atoms may be magnets and exhibit polarity, may be imagined by considering the phenomena of vortex rings."—DOLBEAR, p. 203.

"The evidence that the atoms are such magnets does not rest upon the necessity of the conception for the hypothesis, but upon much confirmatory experiment that has led physicists to the conclusion that they are such . . . . for all that is implied in the above is that whatever their form and substance they are magnets."—DOLBEAR, p. 255.

"The vibrations of the atomic magnet are rapid because it is small; the waves it produces are changes in its magnetic field in the ether, so that one may trace back in this manner the phenomena of light, of heat, and electricity to the mechanical structure of atoms; and it is mechanically intelligible too, and, like the preceding accounts of properties, it appears, *that magnetic and electric qualities are due to the peculiar kinds of motion embodied in the atoms.*"—DOLBEAR, p. 345.

such velocity that "six million molecules in a thimbleful of gas manage to give 8,000,000,000 shocks on either side in the course of a second." (L. Büchner.)

I wish to call special attention to this primæval motion with which the Creator has originally endowed the atoms of matter, and to lay particular stress on it, because I believe here is the great "Secret of Nature," the source of all Motion and all Force, and of Life and Mind. Let me repeat: I believe that the motion innate in the atoms of primitive matter, is the source of all motion and all force, and of life and mind.

I believe the atomic matter of the universe was primarily one and single, and is now only named differently under various conditions—atomic, molecular, massive, etc.; and I believe so-called force or energy is one, differently named under different manifestations—atomic, molecular (chemical affinity), massive (gravitation), physical, electrical, vital, etc. But force or energy is not a real or separate existence, any more than is motion, or heat, or light, or electricity. All the so-called "forces" are "modes of motion," motion of matter; and motion is the result of the *innate* attractions and repulsions in matter, in

the molecules and atoms. Chemical affinity is a result of attractions amongst molecules and atoms; and gravitation a result of attractions amongst masses.⁸

The expression "matter and motion," or "matter and force," is misleading. It is true there is motion, and that there could not be motion without matter; but it is equally true that there could be matter without motion, that is, if motion were not innate *in* matter. Neither is the formula "matter affected by motion" any more satisfactory, because it implies the separate existence of motion—motion acting on matter. Now, motion as a separate existence is an absurdity: there is no such thing.⁹ The most satisfactory formula is "matter in motion": this is in conformity with the fact that the atoms have innate motion—that motion is innate in matter.

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⁸ "One thing seems certain, if the vortex-ring theory of matter be true, or anything like it, then 'gravity' must follow from the structure; for in the absence of any evidence of the existence of gravitation in the ether, no one is at liberty to postulate it there for the sake of the definition of matter. It must be looked for as due to the particular kind of motion that constitutes the atom."—DOLBEAR, p. 349.

⁹ "Pure motion, motion by itself, is impossible to thought."
—DALLINGER, p. 23.

[So also is separate 'force.'—J.W. H.]

Though all scientists acknowledge that the atoms have innate motion, the importance of this fact appears not to have been yet fully recognized, nor its main-spring, its *primum mobile* character, thoroughly realised.

The fact that the atoms have innate motion explains much hitherto considered to be inexplicable, and does away with the chief "difficulty of science." It clears up the "mystery" and solves the "riddle" of the Universe! I repeat: the fact that motion is innate in the atoms of primitive matter removes the chief difficulty of science; clears up the mystery, and solves the riddle of the Universe.¹⁰

These may appear very bold and sweeping statements; but to me such conclusions are logical, legitimate, and unavoidable.

The force by which the molecules and atoms hold themselves together, and that is displayed by their rushing into other

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¹⁰ "Given this 'first beginning' of the cosmogonic movement, it is easy, on mechanical principles, to deduce and mathematically establish the further phenomena of the formation of the cosmic bodies, the separation of the planets, and so forth. . . . In our opinion, this second 'world-enigma' is solved by the recognition that movement is an innate and original property of substance."—HÆCKEL, "Riddle of the Universe," p. 246.

combinations when an unstable compound is forcibly broken up, is sometimes prodigious, as in the case of gunpowder and dynamite.

Modern study of electricity and magnetism, and of the X- and cathode rays, has confirmed scientists in the belief that the ultimate or original matter of the universe was not the atomic condition of the material bodies with which we are acquainted; but a single, uniform, non-atomic, very subtle substance, filling all space; and in which it has been conjectured there occurred in the unfathomable past innumerable "centres of condensation" or motion in the shape of infinitesimal whirlpools or vortices: and that perhaps in this way were made the atoms of the matter out of which have been formed not only the stars and planets and the solar system, but also the various kinds of matter discoverable in the earth. To the present writer it seems very probable that primitive matter was dual—the non-atomic ether, and the atomic substance.¹¹

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¹¹ "Lastly, if the atom itself be a vortex-ring, as explained in the chapter on the ether, it follows that in the absence of such form of motion there would be no atom—no matter: the substance out of which the ring was con-

Some philosophers have even maintained that originally all was "spirit"; that there was and perhaps is no such stuff as "matter."

Now, whether matter was originally spirit and eternal, or whether it was called into existence by a pre-existing spirit-power, and its innate motion is potential life or spirit, it is not necessary for us to try to determine or wise for us to dogmatise on. It is sufficient for all scientific purposes to admit that universal ether became differentiated into matter with innate motion as we now find it: by what steps or stages; whether by way of the "protyle" of Sir W. Crookes, or the "cosmic haze" or "nebulous matter" of other physicists, and by what power, we need not inquire.

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stituted would exist, but without any of the characteristics that we assign to matter in any of its forms. . . . Such an atom is a particular form of motion of the ether in the ether, in the same sense as what is called light is a form of motion of the ether in the ether. One is an undulation, the other a vortex. One we call an ether wave, the other a vortex. . . . Thus, one after another of the properties of matter are found to be resolvable into ether motions, ether being the primal, and matter only one of its manifestations."—DOLBEAR, p. 350.

"The phases of this evolution consist in a periodic change of consistency, of which the first outcome is the primary division into mass and ether."—HÆCKEL, p. 248, "Riddle of the Universe." (See p. 21.)

Therefore, in seeking the origin and nature of the various forms now existing of matter, we may begin at the atomic stage; we may take the atoms as the starting point. And we will take it for granted that these atoms have innate attraction and repulsion, affections so to say, the "loves and hates of the atoms" as they have been called, which I believe betoken the potency, incipency, and promise of life and mind. The atoms themselves may perhaps be destitute of sensation and without intelligence, but they may possess the potency and promise of both. Attraction and repulsion, it is granted they have; and these may possibly be susceptible of development into both sensation and intelligence, as they are into motion and force, heat, light, electricity, and magnetism.

To begin with, then, let us follow the chemists in supposing that two of the atoms of the original matter became attracted to one another, and that they united and formed a molecule of one of the simple substances which chemists call "elements," *viz.*, hydrogen. Hydrogen, then, is supposed to be made up of binary atoms of primitive matter; and these must, of

course, possess a motion made up of a combination and modification of the special motions of the two atoms—a *tertium quid* motion, so to say. Chemists also believe that four of the atoms combined to form a molecule of phosphorus, which of course must also possess quadruple activities; and that six atoms combined to form a molecule of sulphur, which in like manner must possess six-fold activities; and so on for the formation of the other elementary substances, each having its own special activities, its own attractions and repulsions, its own polarities.

Hence arose the mutual attractions, repulsions, and elective affinities, sometimes very strong, amongst the chemical elements, that caused one element to attract and unite with some elements and repel others, thus forming the various compound bodies known to chemists; for instance, molecules of hydrogen united with molecules of oxygen and formed water; molecules of oxygen united with molecules of potassium and made potassium oxide, and with molecules of ferrum made ferrous oxide; single molecules of oxygen united with single molecules of carbon and made carbon monoxide; single molecules of

carbon united with double molecules of oxygen and made carbon dioxide, that is carbonic acid; and so on with the other elementary bodies, forming other complex bodies: these combined with each other, and with each other again, and again and again, through a long series of combinations and re-combinations in an apparently interminable chain of developments and complexities, from the original primitive matter up through the various complex inorganic bodies and the not-living albuminoids; so that eventually there was formed that extremely complex substance called protoplasm, with its immensely complex activities, which in this case are called "vital"—vital "force," vital "energy."¹² The atoms in the molecules of the constituent elements of protoplasm necessarily

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¹² "It has not occurred to me that any one uses the term 'vital force' in any other way than as a convenient method of expressing the sum total of the physical and chemical activities of organisms."—Prof. E. L. Mark: DOLBEAR, p. 359.

"The hypothesis of a 'vital principle' is now as completely discarded as the hypothesis of phlogiston in chemistry. No biologist with a reputation to lose would for a moment think of defending it."—John Fiske. DOLBEAR, p. 358.

"A vital element, *i.e.*, an element peculiar to organisms, no more exists than does a vital force working independently of natural and material processes."—Claus and Sedgwick. DOLBEAR, p. 158.

retained their innate motions, and these were of course combined and modified by the immense number of combinations and re-combinations through which they had to pass in their long progress up to those of the immensely complex body called protoplasm.¹³

In such processes as these Nature works so slowly and with such infinitesimal quantities that we cannot see, cannot even imagine, the processes and quantities; she has no need for the chemist's laboratory or his retorts and balances; and she does not permit the microscopist to see these processes under his microscope. Chemists

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¹³ Writing on the actions of chemical proteids and ferments, Mr. Herbert E. Davies, analytical chemist and microscopist, states: "All evidence goes to show that these changes are what are called hydrolytic changes, that is to say the proteid molecule takes up a molecule of water, and splits up in so doing into two molecules of new substance, and these molecules each take another molecule of water, and in so doing split up into two further molecules, and so on. . . . This building-up operation may be supposed to occur indefinitely; more and more complex molecules being formed, with increasing complexity of function. . . . : At some stage in the increasing complexity we begin to get a range of functions, the ferment actions; akin to vital action, but simpler."—*Presidential Address: Liverpool Microscopical Society*, 1901, by Herbert E. Davies, M.A. (Cantab.), B.Sc., (Lond.), F.I.C.

This has been very conclusively displayed by Mr. Herbert Spencer, in his *Principles of Biology*, see p. 482., Vol. I.

have never yet made protoplasm; nor have they ever made any of the so-called chemical elements out of primitive matter, but Nature has; otherwise whence came they originally? Chemists have never made protoplasm out of not-living matter; but Nature has; or whence came it originally? Whether she is now making the elements in the interior of the earth we do not know; but we do know she is still making protoplasm on the earth's surface. Originally she made it out of not-living matter, which process we in our ignorance call "spontaneous generation"¹⁴: now she makes it by means of germs, that is, she leaves it to the means she has provided for its continuous production; and which we find is the orderly plan of evolution from protophytes through a gradually ascending orderly series of plant life up to the highest plant, and from the amoeba through a gradually ascending orderly series of animal life up to man—"evolution," as demonstrated by Darwin, Wallace, and others. The universe is an orderly evolution—atomic matter, worlds, minerals and metals, plants and animals, and then man.

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¹⁴ See Appendix.

In the same way as the worlds came into existence, so did protoplasm and man ; all in pre-ordained time and succession, and by pre-ordained means, nothing needing special interposition. And as there may still be worlds being formed out of nebulous matter in the depths of space, so may metals still be in the process of formation in the interior of the earth, as protoplasm is on the earth's surface.¹⁵

In all probability protoplasm started in infinitesimal specks, single molecules, in the first instance—the “ primordial germs ” of Darwin, the “ physiological units ” of Spencer.¹⁶ And it may have started not in one region only of the earth, but perhaps in many localities ; in the depths of Nature's laboratories, where there were suitable conditions as to moisture, warmth, sunshine, or absence of sunshine ; and may even now be starting in the same way, under similar conditions.¹⁷

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¹⁵ “ The mind and will of the inscrutable Creator prevised and pre-ordered the whole series of conditions which, by their immutable action, inter-action, and rhythmic occurrence as ‘ laws ’ evolved the universe.”—DALLINGER, p. 41.

¹⁶ See note to p. 11.

¹⁷ “ Is it not conceivable that infinite resource, infinite wisdom, infinite prevision and power, could in a manner, which this illustration only suggests, have caused the non-vital universe to become in some parts vital ? ”—DALLINGER, p. 42.

Now, if the foregoing is anything like what really did occur during the long series of Nature's evolutionary operations in the vast ages through which the earth has passed, it does seem quite probable that protoplasm was truly one of the products of evolution: that it was *evolved* like all the other parts of the world out of the primitive matter of the universe, in the ordinary way of evolution, and was not *created* specially, as so many biologists maintain; that there was here no break in Nature's chain; not a break-down and start afresh in the scheme of evolving the earth and its inhabitants out of chaos; but that protoplasm first appeared on the earth when some of the matter of the earth had been made sufficiently complex for the purpose.¹⁸ Indeed, this is what was to be expected: what ought always to have been expected: to expect anything less; to suppose that protoplasm had to be

¹⁸ Some opponents of this opinion, though they maintain the special creation of protoplasm and of man, object to this being looked upon as a break in the course of evolution.

"Because life—living matter—does not *now* arise directly from that which is not life, does it follow that the creative method was discontinuous? that the primordial creative laws willed into operation 'in the beginning' were only competent to evolve the inorganic and not-living?"—DALLINGER, p. 40. (See p. 27).

specially created, would be to accuse Nature of bungling. Nature makes no such mistakes, her chain extends without a break from eternity to everlasting, by continuous infinitesimal links up through the whole of the universe; through not-living matter, living matter, life and mind, onwards, perhaps as an inconceivable circle, without either beginning or end.

There is, indeed, no sharp and distinct line marking off living from not-living matter, as is still the orthodox belief of biologists, any more than there is marking off inorganic from organic, or animal from vegetable matter, or vertebrate from invertebrate animals; or there is between the infant, the boy and the man, or between the sexually immature and mature; all are (indistinct) grades in development or evolution.

Man finds himself a being marvellously constructed of matter, in a material universe apparently evolved from atoms endowed with an innate motion that forced them to construct the universe. As a reasoning creature he is driven to be not satisfied with the knowledge that the atoms have innate motion, but must inquire after the origin of this mysterious power in the

atoms. In this inquiry he meets with evidences, everywhere present, of an eternal, omniscient, omnipotent source, and is compelled to believe that in the beginning—if there ever was a beginning—this eternal mind willed or gave the command: "Let there be matter; let there be atoms; and let the atoms have the property that will make them attract and repel each other, different atoms having different attractions, so that by their different attachments and combinations they may produce an infinity of varied motions, and an infinity of varied bodies and varied qualities of bodies, so that matter may gradually evolve by slow and imperceptible steps up from simple to complex, and from complex to living; through plants to animals, up to man."¹⁹

As already stated, protoplasm is the most complex substance known; and it is necessary that it should be so, for it has to serve the most complex of purposes, *viz.*, the purposes of life, of all kinds of

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¹⁹"Can there be any splendour of the Infinite Mind more ineffable and effulgent than the evidence in His works that in the beginning He determined the potency and prevision of all the life, and the adaptations, that ever emerged or can emerge."—DALLINGER, p. 57: (See p. 27.)

life from the lowest plant to the highest animal life. On its first coming into existence it probably differed but little from the highest of the not-living organic bodies, the proteid ferments, because it had to exhibit only the very lowest kind, the first dawnings of life. Perhaps it was by one of the molecules of one of these ferments attracting one or more molecules of some other highly complex body, or by other favourable circumstances, determined by the original designer, causing a slight re-arrangement in the constituent elements, that the first molecule of protoplasm was made. It is, indeed, very probable that something like this really did occur.

Besides, inasmuch as protoplasm has to serve the purposes of all grades of life, from the lowest to the highest, it must of course vary in its powers, and therefore in its composition and quality: it must vary with the life phenomena it has to exhibit; it cannot be of fixed chemical composition. The quality of the protoplasm of animals must differ from that of plants, must be of a higher type, because it has to exhibit higher life phenomena. The protoplasm of the nerves of animals

must be of a higher type than that of the muscles, because it has to serve the higher function of sensation ; that of the organs of the senses must be of a higher type than that of the nerves, because it has to serve the higher functions of smell, hearing, sight, etc. ; and that of the organ of the mind—the grey matter of the cerebral hemispheres—must be of a still higher, indeed of the highest, type, because it has to serve the very highest of life phenomena, *viz.*, those of conscious mind. These differences depend, in all probability, on differences in the number or arrangement of the component molecules : they are, however, much too subtle for our detection. Nature works here with such infinitesimal quantities and inconceivable arrangements that we cannot even imagine them.

The brain and the nerves are composed of two kinds of substance, the white and the grey : the white is made up of fibres, the grey of cells. The surface of the brain hemispheres is almost wholly grey matter—almost wholly cells and their connections.

So much for the origin and nature of the various forms of matter. This brings us to the question of

THE ORIGIN AND NATURE OF LIFE.

What is life? Is it an entity separable from the body? Is it a "force," or "mode of motion"? Or is it an evidence of the presence of protoplasm? Is there any difference between vegetable and animal life? What is death?

From what has been advanced on the functions of protoplasm, the reader will be prepared to learn that I agree with those biologists who view "life" as the *phenomena* resulting from chemical changes going on in protoplasm; as the phenomena evidencing that these changes are going on.²⁰ Let me repeat: Life is the sum of the phenomena resulting from chemical changes going on in the protoplasm of the body. Life is not a force or energy; all the natural so-called forces are convertible into one another, and are re-convertible: life cannot be converted into any force; it can only continue or cease: it ceases as the light of a match ceases, when the substance of the match is burned away. Nor is life a mode of motion: it is not

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²⁰ "In physiology the word life is understood to mean the chemical and physical activities of the parts of which the organism consists."—DOLBEAR, p. 358. (See note to p. 8).

motion at all ; it is only one of the results of the motion that is going on amongst the ultimate molecules of protoplasm, just as fire and warmth are results of the chemical changes going on in coal that is burning, and light is a result of the chemical changes going on in a lighted match or candle. Nor is it a separate entity, any more than is the light of the candle or the warmth of the fire : it begins with the beginning of the specific chemical changes, and ceases with their ceasing.

Animal life, as it now exists on the earth, is started in the individual by the union of the molecules and motions in the ovum of the female with those in the sperm cell of the male ; and in the higher animals in no other way. After the matter and motions of the two bodies are brought together they coalesce, and so re-arrange themselves that the resulting combination is able to maintain an independent existence, which neither body could previously do.

Life is maintained by the appropriation of pabulum, in response to the calls and needs of the organism in which it exists, which calls and needs result from wear and tear by the activity or work performed by the organism. The strength and vigour

of the individual life depend partly upon the vigour originally imparted by the parents ; partly on the activity and vigour of the chemical changes going on in the protoplasm of the body and the appropriated pabulum ; and partly on the general care and management bestowed during the life. Life may well be likened to the spin of a top, in which the spin is started by the spinner ; its vigour being imparted by the force given to the spin, and the continuance of the spinning by the care and assiduity of the whipping : its ceasing to spin is analogous to death.

As to difference between the life of plants and animals : life being the product of protoplasm, and protoplasm being present alike in plants and animals, both have life ; and the only difference there can be between plant and animal life is that of degree or quality ; and for the same reason there can be no other difference between animal and human life than that of degree and quality. The greater the quantity or proportion of protoplasm the more of life ; and the higher the quality the greater the vigour of life.

Death is the result of the ceasing of the chemical changes that go on in the proto-

plasm of the body ; whatever puts a stop to these changes causes death. And once stopped, these changes can never be re-started ; protoplasm once dead is dead for ever.

When life on the earth first began no one can tell. Nor does anyone know for certain how it began : whether it was one of the results of the pre-ordained or pre-determined evolutions of the universe, when evolution had produced the highest not-living proteid or ferment, *and progressed one step further*, as some scientists think ; or whether it was the result of a special creative act on the part of the eternal all-pervading Spirit, when the fulness of time had arrived for life to appear on the earth, as many scientists, most philosophers, and nearly all theologians maintain, we ought not to attempt to decide. These are questions that will best be left for each one to settle for himself.

So much as to the origin and nature of life. Now as to

THE ORIGIN AND NATURE OF MIND.

What is mind ? Is it an entity distinct from the body ? Is it what is understood

by the words spirit or soul ; the immortal soul ? Or is it one of the functions of the brain ?

What are Consciousness, Memory, Recollection, Will, Judgment ? Is there any difference between the mind of man and that of the lower animals ?

These are very interesting and somewhat important questions, and are frequently asked. Let us attempt replies :—

From the preceding pronouncements on the origin and nature of matter and life, the reader will not be unprepared to hear that as I believe life to be the phenomena resulting from chemical changes going on in the protoplasm of the body generally, so I believe “mind” is the *phenomena* resulting from the action of the protoplasm of the grey matter of the nervous system, elicited or made evident by the stimulus of impressions conveyed to it through the senses. Let me repeat : “Mind is the phenomena resulting from the action of the protoplasm of the grey matter of the nervous system.” The following facts, among others, support this belief, *viz.* : (1) That where there is no grey matter there is no intelligent mind ; (2) That wherever there is grey matters there mind

phenomena show themselves under proper conditions ; (3) That mind phenomena correspond with the quantity and quality of the grey matter, and with the kind and intensity of the stimulus ; (4) That when the grey matter of corresponding parts of both hemispheres of the brain is damaged or diseased, mind in some of its faculties is impaired or diseased, and when the damage or disease is repaired the mind is restored ; (5) That on tracing the rise in the scale of intelligence, it is found that with every increase in intelligence there is a corresponding increase in the quantity of grey matter. The greater the quantity the larger the mind, and the finer the quality the higher the quality of the mind—from an amœba to a Newton.

Now, grey matter is present in many parts of the body, but is especially abundant in the brain and spinal cord. It is distributed throughout the whole body, perhaps in single molecules, in the lowest animals, the protozoa ; and must there be of the lowest quality, perhaps differing but little from the highest quality of non-nervous protoplasm ; but with the rise in the scale of intelligence it is collected into masses, and finally into the form of

CORTEX

DIAGRAM OF SENSORI-MOTOR ARCS

(Schon)

a brain, and improved in quality. Wherever present, when excited by appropriate stimuli, it manifests the phenomena called mental; and these phenomena vary with the position and quality of the grey matter manifesting them.

The illustration* shows the spinal cord; its upper end (medulla oblongata); the lower brain (optic thalami and striated bodies); and the upper brain, the cortex.

As pointed out by Dr. Schofield, the grey matter in the lower part of the spinal cord serves the very low mental functions, *viz.*, those of common reflex action; is of very low quality, and responds to very low kinds of stimuli, *viz.*, those conveyed from the skin, the muscles, and viscera. The grey matter in the upper part of the spinal cord—the medulla oblongata—serves functions that are higher and more important, the sub-“instinct”-ive, *viz.*, those of respiration, circulation, and digestion; is of a higher quality, and responds to higher and more complex stimuli, *viz.*, the calls in the system for oxygen and blood. The grey matter in the lower

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* A copy of the diagram in Dr. A. T. Schofield's excellent treatise on "The Unconscious Mind." He has kindly allowed me to make use of it.

brain—the thalami optici and corpora striata—serves the still higher functions, the “instinct”-ive, *viz.*, those of sub-consciousness, such as dreams, visions, sleep-talking, sleep-walking, habits and acquired reflexes ; is of a still higher quality, and responds to still higher and more complex stimuli, such as the higher bodily and lower mental calls and promptings. And the grey matter of the higher brain—the cortex or surface of the hemispheres—serves the most important of all functions, *viz.*, those of full-consciousness and the highest mental functions ; is of the highest quality, and responds to the highest kind of stimuli, such as social and mental promptings and impulses.

As well as rising in position and increasing in quantity, the grey matter also improves in quality, as every other organ in the body does, with the importance of the function it has to perform. The higher the function the *higher the position and quality* of the grey matter ; in other words, the higher the position of the grey matter the higher the function it performs. This law rules even in the grey matter of the hemispheres of the brain. Also the greater the quantity of grey matter, that is, the

thicker the cortex and more numerous and deep the folds, the larger is the mind.²¹

The frontal lobes are really the highest part of the brain ; the brain being doubled over forwards. The grey matter of the frontal lobes is therefore the most highly-developed protoplasm there is. It must be of an exceptionally fine quality in such brains as those of Messrs. Chamberlain and Asquith ; perhaps a little less fine but more in quantity in such as those of Lord Rosebery and the late W. E. Gladstone. Mind is not a single power ; it is made up of groups of faculties. The grey matter of the lower and back parts of the hemispheres serves the lower or animal faculties ; and that of the upper and front parts serves the moral and intellectual faculties. The cerebellum has nothing to do with the higher mental functions.

The logical conclusion to be drawn from these facts is that the protoplasm of the grey matter of the nervous system, especially that of the brain, is the source of the phenomena called mind, just as the protoplasm of the general system is the source of the

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²¹ "Mind is intimately linked with cerebral action. We do not know mind apart from brain."—DALLINGER, P. 45.

phenomena called life. As life is the phenomena resulting from the chemical changes that go on in the protoplasm of the body generally, and ceases with the ceasing of these changes, so mind is the phenomena that result from the vital changes that go on in the protoplasm of the grey matter of the nervous system, especially of the brain, and it ceases with the ceasing of these changes—goes out as the light of a lamp does.

Mind, then, is not a separate intelligent or spiritual entity that uses the brain as the medium through which to work and display its powers. Nor is it a universally existing something, an emanation from the Deity, that is apportioned off in separate quantities to individual human and other beings. There is no separate Ego or I. "I am," is only a result of consciousness; and consciousness is only one of the powers of the mind. Nor is mind the immortal soul, or spirit: it is the sum of the phenomena resulting from the activity of the grey matter of the nervous system.

Now, as nervous system and grey matter are common to all animals, so is mind; and the only difference there can be between the mind of man, the highest animal, and

that of other animals is quantity and quality.

The lower groups of faculties—those of the lower and back parts of the brain—are the affections: these force action, and make man a social being. The higher group—those of the upper part—are the sentiments: these lift man above the lower animals, and make him a moral being. The frontal group are the intellectual faculties. The general action of all the faculties together is displayed principally in consciousness, memory, recollection, will, and judgment.

CONSCIOUSNESS, I take it, is mental perception, the power of being acquainted with or comprehending; that is, of mentally comprehending or appreciating the impressions brought to the mind through the organs of the senses. Its alertness and power correspond with the fineness and susceptibility of the grey matter of the hemispheres. It is no more a separate something apportioned off to individuals than is mind itself.

Memory and Recollection: there is, I think, some difference between these two mental powers.

MEMORY, I take it, is the power of retain-

ing or having always present in consciousness past mental impressions; finding them always absolutely ready for use; and is in proportion to the quantity and quality, especially the quantity, of the grey matter that serves the special faculties or special kind of knowledge to be remembered. It is the space or capacity for the storage of facts or mental impressions.

RECOLLECTION I take to be the power of re-collecting past mental impressions or facts of memory by mental effort; of finding them by mentally searching for them in consciousness, and is much under the control of the will.

The WILL, I take it, is the mental resolve resulting from the combined action of certain groups of cerebral cells or mental faculties, excited or prompted by certain stimuli; and in strength corresponds with the strength of the prompting causes or the prospective consequences.

JUDGMENT I take to be the result of the combined action of all the faculties together.

The SPIRIT, the immortal soul, is understood to be an entity separable from the body, being simply a dweller in the body during the body's life; and at death takes its flight or departure to some unknown region.

no explanation

APPENDIX.

(See page 27.)

SPONTANEOUS GENERATION, ABIOGENESIS.

IN past times many special creations were contended for, in particular those of plants and animals, and the human race. The special creation of the separate classes of plants and animals was early abandoned, but a belief in the separate and special creation of the animal and vegetable kingdoms was long retained ; even at the present day the special creation of the vegetable kingdom and of the human race, that is, of protoplasm and of man, is strenuously contended for ; the former especially by scientists, and the latter by theologians.

By "special creation" is meant the

immediate bringing into life by the Creator, as typified in the account given in Genesis.

By "spontaneous generation" is meant the beginning to manifest the phenomena of life by matter not previously manifesting these phenomena, and without the intervention of anything already manifesting them—matter beginning to manifest the phenomena of life spontaneously, from the innate initiative tendency within matter. Spontaneous generation really means generation by nature herself, or by the Creator *via* nature, which is the same thing.

Here the name "Creator" is used to signify the maker of the universe, the originator of all things that have been created; indeed, the apparent source of all, whether *created* or not.

From the earliest times to the end of the middle ages no one called in question the doctrine that, under favourable conditions, living matter might come into existence spontaneously, as well subsequently as at its primitive genesis. In the latter part of the seventeenth century, however, this opinion became disputed, and about the middle of the nineteenth century, by careful experimentation, Pasteur, Virchow, Tyndall, and other scientists satisfied themselves

that spontaneous generation never now occurs, but living things arise always from pre-existing living things, that is, from germs. They thereupon formulated the law: "*Omne vivum e vivo*": and this is now the orthodox belief amongst biologists. To doubt it is heresy, and to dispute it is to incur excommunication, both scientific and theological. On the kind of germs, how long these had previously existed, and whence they had originally come, these experimenters did not venture to dogmatise. It is, however, admitted that they belong to the vegetable kingdom, are separate simple cells of vegetable protoplasm, are minute plants, protophytes.

Though the experiments of Pasteur militate against the idea of the spontaneous generation of protoplasm taking place now, they are of no force against the doctrine of its primitive or original spontaneous generation. The beginning of life in organic fluids being prevented by filtering the germs out of the air, does not prove that these germs had not themselves arisen spontaneously; if they had not, then they must have been specially created; and no true scientist will contend for their special creation. Nor does it prove that they do

not now arise spontaneously, under favourable circumstances; their spontaneous generation may still be going on in much the same way, under similar conditions. Why not? The law *omne vivum e vivo*, applies only as far as we can see; it is not reasonable to suppose that nature's forces, that originally produced protoplasm, have ceased to operate. Similar soil, moisture, warmth, sunshine, and darkness still exist, and are likely to produce similar effects [See p. 27].

It is not contended that the Creator could not have communicated life directly to not-living matter, could not have made not-living matter into living matter at once; it is only maintained that such would be contrary to the whole plan of creation, and would have involved a break in the chain of evolution, and a special interposition on the part of the Creator.

Now the laws of orderly development rule throughout the universe. The highest plant life is gradually developed from the lowest—the graceful palm from the protophyte: so also is the highest animal life similarly developed by slow degrees, from the amœba to the most highly developed member of the animal kingdom—man

There are no breaks or lines of demarcation between the various sections of either plants or animals, not even marking off man from the rest of the animal world.²²

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²² "By what other means than by the operation of natural 'laws' can we think of the Infinite Power, extending through all extent as the fountain of all being, as acting?" DALLINGER, p. 39.

"He who is not content to look, like a savage, at the phenomena of nature as disconnected, cannot any longer believe that man is the work of a separate act of creation."—DARWIN, p. 927:

"The time will before long come when it will be thought wonderful that naturalists, who were well acquainted with the comparative structure and development of man and other animals, should have believed that each was the work of a separate act of creation."—DARWIN, p. 371

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