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THE

MECHANICAL

CONCEPTION OF NATURE.

BY



✓
GEORGE MACLOSKIE, Esq., D.Sc., LL.D., &c.

Professor of Biology in Princeton College, U.S.A.

BEING A PAPER READ BEFORE THE VICTORIA INSTITUTE.

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THE MECHANICAL CONCEPTION OF NATURE.*

By GEORGE MACLOSKIE, D.Sc., LL.D., Professor of
Biology in Princeton College, U.S.A.

MATTER and energy, which are distinct from and constantly acting upon each other, constitute, along with their various transformations, the stock-in-trade of physical science. The scientific investigator may not feel bound to go back of them, so as to ask whence they come and who gave them their qualities; he has not to philosophize, but only to *speculate* about them, testing his speculations by observations of phenomena. He may speculate about matter having been at first in the shape of scattered atoms, subject to the pull of gravitation, this pull being "energy of position," and as the atoms came together into molecules, and ultimately into worlds, the energy of position was transformed into other forms of energy.

The leading generalization of science is that neither matter nor energy is alterable as to the total amount in existence. But this is qualified by the facts that whilst matter is constantly collecting into masses, all kinds of

* In this paper the word "Mechanical" is understood as having the meaning of "Physical and Chemical,"--ED.

energy are changing into light or heat, and light and heat are being dissipated into space, with a tendency in the end to equalize the temperature of the universe. While energy is changing from one form to another, as while heat is passing between objects of unequal temperature, it may be made to do work which is measurable in units. A machine is a contrivance for getting some kind of motion or work out of it in the course of its transformations; and the mechanical conception of nature signifies that all the physical movements and phenomena of the universe have been derived from the interaction of the matter and energy which are its constituent factors.

This theory may be held in a theistic or an atheistical sense. The atheist may hold that the physical world is the only world, and that nothing else exists. The theist may hold that even admitting all that the mechanical theory asserts, there are ethical and orderly phenomena in nature, not coming under the measurable categories of matter or energy, yet proving that there is close to us an extra-physical world, with extra-physical beings, and that there is a God before all and over all.

Though energy is indestructible, its constant dissipation is a continual loss for all practical purposes. Fifty years ago scientific men supposed that the world had been going on at the present rate from everlasting. Lyell admired the "sublime" view of the past history of our globe being an eternal round of similar cycles of geological formations, never beginning and never to end; and this was the scientific view of cosmogony taught in the text-books and encyclopædias. But it is now omitted as belonging to exploded science; since it was shown by Thomson that our universe probably had a beginning, and with equal probability is moving towards its conclusion. This depends on the puzzling fact that whilst many processes in nature can be reversed, by calling in new energy from the environment, the mechanism of nature as a whole is not reversible. If a plant has its starch converted into sugar which is dissipated through the sap, it is able to reconvert the sugar and collect it again as starch. But why the cosmos is not a reversible machine we cannot tell. Clerk Maxwell somewhere suggests that as heat is only the general or average result of molecular movements, an inability to controvert the individual molecules puts the recovery of the general result beyond our reach. But how does it come that the process is never reversed

in nature, which has control over all the molecules? Why do we never see the dust of the graveyard come together into skin and flesh, and the bones reassemble, "bone to his bone," and the life and warmth return, so as to present us the living man, and the old becoming young again, reversing the process down to the ovum, and back through several generations? and why does our sun not receive back all the heat that it has scattered over space? This inverse process, though never observed, is, scientifically speaking, as easily conceivable as is the ordinary course.

The considerations which apply to the entire universe are with proper limitations applicable to any part, as to our earth or to the microcosm of our body.

The earth and our body are, in whole or in part, machines at work, and a great deal more, and the task of science is to watch movements, transformations, and developments, and to formulate them into "laws of nature." These laws appear to be absolutely uniform in their action, to amount in fact merely to transformations of energy. The objection taken to physical law in general and to the *uniformity of nature*, as being only working hypotheses and incapable of demonstration, is, we think, misleading. The uniform action of natural molecules and forces is the basis of all science and of all animal movements, and has never been known to play us false; so that the unchangeable behaviour of the laws of nature is as well established as human experience can establish anything. But a *uniformitarian* theory, holding that the sum total of activities in a particular place, as on the surface of the earth, has been the same at all times, is no part of science; such an assumption was helpful to Sir Charles Lyell, and within limits had an element of truth in it, but it very often led him astray. Most of the attacks on Christianity that profess to be based on the doctrine of uniformity of nature, really involve uniformitarianism.

The general outcome of scientific discovery has been not only to verify the uniform action of natural law, but to bring larger provinces of nature into the realm of mechanism; so that every new discovery becomes a contribution towards the mechanical theory. At the outset the search was random, often after what we now deem impossibilities. But though it never alighted on perpetual motion, or the elixir of life, or the philosopher's stone, it was not lost labour. One class of phenomena after another came to be understood relatively to their conditions and physical causes. The astrologers

sought for the horoscopes of their patrons, with exalted faith as to the superiority of the heavenly bodies above everything terrestrial. But to the surprise and disgust of some of them, their labours proved that the planets are not very different from the earth, and that celestial movements are mechanical; and they were compelled to settle down to observations and mathematics, as commonplace astronomers. When Newton investigated the forces that drive the machine, and Laplace finished off his *Mécanique Céleste* with his nebular theory, regarding the early development of the solar system as through a kind of physico-chemical embryology, and when their successors ascertained that gravitation-bonds and spectroscopic lines annex the movements and matter of distant stars to our system, the conquest of mechanism over the heavens was complete. At the same time the dreams of the alchemists by a singular metamorphosis grew into the science of chemistry. And chemistry has reduced all terrestrial things, living and dead, to the sway of its molecular and atomic sovereignty.

The stimulus given to inductive research by the writings of Francis Bacon, and by the establishment of the Philosophical Society in the time of the English Commonwealth, sent many inquirers to examine the minerals and rocks and the old puzzle of the fossils. There was a good deal of groping in the dark, and many theories arose to stir up controversy and at length to rock the cradle of infant geology. The sharp discussions attracted the public, who always enjoy seeing learned men set by the ears; the young science that excited so much controversy and feeling grew in favour, thriving on its difficulties; and when Lyell worked it out on the mechanical plan, discovering as Whewell has aptly said, "a new set of physical powers which we may call *geological dynamics*," men came to see that God's way of forming the stratified and other rocks of the earth's crust was by the employment of nature's machinery.

If for the moment we regard our world as devoid of living things, it is presented to us as mechanical throughout; its rocks, minerals, and chemical processes; its waters and meteorology; and the skies overhead with planets and suns. This starts the question whether such a world can bear testimony to God. Is the Psalmist justified when he declares that the heavens declare His glory? may we not suppose the order to be merely a result? What need is there of final causes where the efficient causes suffice? Recent writers on Theism

show a tendency to confine their arguments to the organic world, omitting the confessedly mechanical, which is by far the larger part of the universe; as if they supposed that a dead world is not sufficient to prove a living and intelligent God. But the order of the cosmos, the original characters and harmonies of the many millions and millions of atoms, and their relation to energy, their capacities for continuing in extraordinary yet definite and well regulated ways, all point to the necessity of going beyond them for their common origin. If the question of their origin does not properly belong to physical science, it certainly has an important place in philosophy and in the region of human faith, and thus has a claim on the attention of every man, and we cannot rest till we reach some unifying hypothesis, like that of the Divine Personality. Behind this hypothesis we cannot go, *since all genetic lines when traced backward lead to it as the ultimate cause.* The order of the universe may have been evolved according to Laplace's theory; but why were the molecules so constituted and so situated as to come naturally into this order? here the wisdom and will and power of the Author are all shown. So strong is this argument that all who reject it are compelled either to fall back on something which involves greater difficulties, or to evade the issue by pleading Agnosticism. The mechanical theory does not dispense with the argument for theism, any more than the successful working of a machine negatives its production by an inventor and its control by a superintendent. Even when it works imperfectly we may not in a dysteleological way argue from its defects that it had no inventor. Hence it does not exhaust the case to declare that a steam engine has a complete explanation of its going in its own mechanism, the fuel and water included, so that if these had all come together by accident it could still go, and if by similar accident rails were on the road, it could guide itself without having a horse in advance, not to pull it, but to direct its course, as (*vide* Lyell) the inventor of the locomotive at first proposed. Yet most surely the perfection of the mechanism would not debar us from endeavouring to find its inventor and director. It is objected that we should see the finger marks of the engineer in his work, and in rectifying its aberrations. But nobody has ever detected the finger marks by which our own mind governs our brain and our bodily organism; and it is improbable that God is more clumsy in His methods than is the spirit of man.

Francis E. Abbot condemns the application of the term *machine* to the cosmos, suggesting in its place the term *organism*, which he makes to be a machine and something more, the addition being that internal ends are provided for. We think that when regarded in this light, the term *organism* equally misses the mark; the physical world includes all organic nature as well as inorganic, and is higher than the highest of organisms, as the whole exceeds its greatest part. But here we meet the fact that there is a great deal of mechanical structure in the human as in any other organism, and that the diathesis of the contemporary scientific mind is to make us entirely mechanical. Living things dwell on a mechanical earth, are subject to gravitation, heat and cold, contain lime and carbon and much water, and thus have much community with their environment. For a long time it was supposed that the souls of plants and animals lifted them in a semi-miraculous way above natural laws, that their parts and powers were somehow created by the "vital force" within. Mental phenomena were supposed to have no connection with the body, save that of locality.

Another class of thinkers were bold enough to turn all the forms and functions of the body into machinery; to regard our frame as a large hydraulic machine with its accompaniments. Geometrical figures and algebraic formulæ were invented and applied to all organisms; to explain the parts of flowers, the arrangements of leaves, the forms of shells, the vertebræ of animals, the action of the heart, the affinities or homologies between distinct species. These speculations, though many of them now seem ridiculous, sustained the interest of students, and fostered research. The discovery of the embryological method of investigation, and of the method of representing heat by its mechanical equivalent, introduced a new order of work both in morphology and physiology. We have found that the plant manufactures food and stores up energy which it has got from the sunshine, a process that is probably mechanical, or at least physical, though it is not yet fully understood. The activities of our body are as completely explained by the food which we consume as is the work of a steam-engine by the coal and water which are its food. It is in this way ascertained that the daily food of an able-bodied man will give as much energy as, if converted into its weight-equivalent, would raise his body about nine miles high; this energy is used partly to keep up his temperature, replacing loss by radiation and evaporation, part of

it for moving the organs of his body, part of it in external work. We can, therefore, compare him economically with the efficiency of a steam-engine; it is only particular kinds of fuel that you can give to him; but a loaf of bread and a pound of beef will give you more work if used as food by man, than if you had applied them to heat the boiler of a small steam-engine. It is found that the activity of muscles and nerves is dependent on a supply of blood containing nutritious matter; that electrical phenomena are observed; and that the muscular activity probably depends on a series of explosions with oxidations, which may be compared to the action of a set of minute gas-engines. The sense-organs and nerves resemble very closely a system of telegraph wires with their terminal key-boards. The semicircular canals and organ of corti in the ear, though not yet fully explained, have a correlation with the wave-lengths of sound; and the eye includes in itself a whole system of optics, its lens giving fine exercise in determining focal lengths, with chromatic and circular aberrations and corrections, and the retina, with its rods and changing visual colours, suggesting that it must be an instantaneous photographic camera. The victory of the mechanical theory over these organs is only partial; but all the same it is significant.

As might be expected, theory at this part has run ahead of discovery. Some people venture to assert the mechanical (or at least chemical) evolution of life from dead matter. In ancient times it was the sceptics, like Lucretius, who denied spontaneous generation. Christian teachers were rather disposed to favour the idea of worms growing spontaneously within human beings, of frogs being within trunks of trees and rocks, of reptiles coming from the slime of the Nile. They have latterly come to oppose this doctrine, and the most advanced scientific investigators agree with them in their opposition. Professor Tyndall, when before the British Association he threshed to death the theory of spontaneous generation, wound up with a parting prayer or scientific hope that after all, life may have arisen spontaneously in early geological times. This would help him against the theists who are continually tormenting him with their notions of the necessarily supernatural origin of life. Mechanism has not yet explained how life began, any more than how matter and energy began. So the theory is not entirely successful. But though life may have been of supernatural origin, its subsequent working and progress may be purely mechanical.

Mr. Darwin's theory of the origin of species was an attempt assuming some simple vegetable and animal forms as a starting point, to derive from them in a mechanical way all the forms and functions of existing vegetable and animal life. Without going into details on this subject, whilst acknowledging both the strength and weakness of Darwin's theory, and that it assumes many factors which are not known to be mechanical, we have to face the fact that it has convinced the biologists, securing the general, though not the universal, assent of the only men who are able to deal with its arguments, many of whom would be glad enough to subvert it, if they only knew how. Though not entirely mechanical, it has unquestionably been a great gain for the mechanical conception of nature, just because the existence of many thousands of distinct species was formerly the chief argument on the other side.

Assuming evolution of species to be true, the irreducible cases are, besides the origin of matter and energy, and the general order of the universe, the origin of vegetable and animal life, of sensation and intelligence in animals, and, furthermore, of self-consciousness and the moral faculty in man. We must also provisionally regard the origin of the human body as among the unreduced cases; for although the evolution of man can be deductively obtained from the general theory, and finds partial confirmation in anatomy,* and although such a doctrine is readily reconcilable with the scripture narrative of man's creation, all attempts to find geological verifications have failed; so that, if man was evolved, the process must have been very rapid, or must have occurred in some region not yet explored; and, indeed, it is hardly conceivable that such a being as Haeckel's *Pithecanthropus* would be viable in the struggle for existence. The attempt to reduce *mind* to a mere synonym for the functions of the brain is based mainly on the relation between insanity and cerebral disease; and is supported in some degree by the localization of functions. But Professor John Fiske's argument appears to us conclusive, that our inability to turn thought into exact quantitative equivalents of mechanical force negatives its homology with merely physiological func-

* At the same time Topinard shows that it is impossible to derive man from the *Quadrumana*, and that it will be necessary on the hypothesis of his evolution to start from the lower level of the Lemurs. (*L'Homme dans La Nature*, ch. xxii.)

tions.* Bain's rejoinder that we cannot reduce to such equivalents a man's constitutional vigour fails, because this vigour is the complex result of the working of all the organs and tissues, and its component factors may be measurable. Whilst the weight of evidence appears to negative the purely physiological explanation of mind, we should not only be tolerant of, but encourage investigations that look in a different direction, as we are indebted to them for large accessions to our knowledge of physiology.

The so-called "organic compounds" were at one time supposed to be obtainable only from living objects, but now many of them can be artificially prepared, some to economic profit. The study of "physiological psychology," that is, of the functions of the brain from the physiological side, has already proved valuable. Ryder has shown that the calcification of bone is comparable with the calcifications around encysted trichinæ, and is more of a physical process (depending on the behaviour of calcareous salts in colloids), than exclusively vital. Bütschli has found the movements of living amoebæ to be imitable by olive oil kept in moderately warm water, from which it is inferred that the movements of protoplasm are partly or exclusively physical. It is also now known that the non-coagulation of the blood sucked in by a leech is a physical phenomenon, which can be imitated by keeping blood in vessels lined with oil. These attempts to approach the problem of life and of mind from the chemico-physical side mark the limits of the mechanical conception of nature as actually established. There has long time existed deep apprehension among Christians regarding the tendency of this kind of science. What we have now to face is not a remote risk, but a state of facts. If the mechanical theory means ruin to faith, then the deluge is upon us, only a few fragments (very important ones indeed) remaining to carry us to land. Now it must be conceded that mechanism has often been associated with atheistic materialism, and that atheists have welcomed such mechanical explanations as promised to explain the world without a God. The same consideration has led Christians to fight shy of Astronomy, Geology, Physiology, and recent advances in Biology, and to discountenance investigations and theories which promised to explain the world too well, lest science should explain away our God, and leave us ignorant where to find Him.

* *Popular Science Monthly* (New York), Sept., 1891.

Even those who are liberal enough to concede the consistency of mechanism and theism, fear the effect of the new science on our faith in the Bible, and especially in the great miracle of the resurrection of Jesus Christ; a fear which has been intensified by attempts to account for all the miracles as natural occurrences or unfounded traditions. But whatever view may be held of the origin of mind, whether we regard it as a derivative under Divine direction from the material organism, or as a substance primitively created apart from matter, we are compelled by its actual phenomena to assign to it a certain measure of independent activity as to the moral quality though not as to the physiological quantivalence of cerebral action. We presume that the cerebration of the evil is as great quantitatively as that of the well disposed, and that the cerebration of an idiot involves as much expenditure of blood and brain-tissue as that of Newton; but there are moral and intellectual scales by which brain-work must be weighed, independently of its chemico-physical value. In man as well as beast there is much of the mere machine or automaton; and some have gone so far as to accord to the lower animals some measure of intelligence and will and often of "social virtues" which are found more liberally in ourselves. There is no special evidence of a soul in the lower animals any more than in plants; but in consideration of man's moral endowments and aspirations, the science which has invented ether as a vehicle of light, regarding it as a specially active form of matter, ought not, even on a mechanical theory of mind, to reject the hypothesis of something that shall carry our personal identity, with our faith and our joys, into Heaven. This is a subject beyond the scope of inductive science; but there seems no ground for fear that our hopes of immortality are at stake, if we accept the mechanical concept in its entirety.

The problem of miracles is frequently brought into the case, though not strictly pertinent. We do not think that any conceivable amount of evidence would convince us that a man rose from the dead at Jerusalem within the past year, or that we could be led to accept any of the mediæval or modern so-called miracles in support of corrupt cults; and pure cults make no claims to miracle-working. Thus in the ordinary course of nature we have no dispute with Agnostics as to the incredibility of miracles. The Bible-testimony for miracles is made to depend on the character of the Bible-

revelation, with which they stand or fall. The believer in the mechanical theory of the physical world may be justified in acknowledging on appropriate evidence the existence of an extra-physical world, with hosts of spiritual inhabitants, as well as in God, the Author and Governor of all: and that there may be, not physical, but equally effective means of communication between that world and our minds. Now if we have sufficient evidence in the pure and holy teaching of scripture, that it is a revelation from God, and that His Son came down to redeem us from our sin, then the absence of miracles might prove a difficulty, evidence of their occurrence is admissible, and they may be consistent with and confirmatory of the religion with which they are associated. They are the suitable accompaniments of a unique manifestation of the Divine love; and we do not know whether they were accomplished by reversing, specially diverting, or expediting natural processes, or by supplementing them with other laws, or by pre-appointed combinations at the outset of the world. The Bible that records them warns us against strange miracles, and honours the laws of nature by designating them as "the ordinances of heaven." These laws and forces are all God's appointed instruments, which He uses according to, and not in violation of their proper character, for the execution of His purposes.

It still remains true that the more perfectly we establish the mechanical mode of viewing things the less prominence is given to their Maker. The old arguments of natural theology are said for this reason to have lost their vigour, and hence the excellency of the cosmic system becomes a hindrance to faith. This, however, is only apparently the case, for the mechanism requires the explanation which was once spent upon its products. Once we tried our hands on explaining how a watch was made; now we are asked to account for the machine that makes watches, and that is always improving on the quality of its products, which it does according to natural selection by producing them in large numbers and of different qualities, and then securing the destruction of all but the best. In the childhood of science we investigated particular objects; now we consider not the teleology of organs, but of the underlying dynamical principles which produce them and regulate their development.

Many attempts have been made to banish from science the consideration of *teleology*, or purpose in nature. Investigators

were afraid to employ teleological language, and whenever they drifted into it, they soon backed out, apologising for its momentary use. Their shyness has often prejudiced their work, for as Gassendi said long ago (with the case of Harvey's teleological work on the circulation of the blood fresh in his mind), "the final cause often leads to the discovery of the efficient cause." Now, however, the advance of the mechanical view is forcing teleology upon our attention; for if the universe is a machine, it is by the same reasoning known to be a complexity of sub-machines, every one of which has its own purpose to serve. Hence we find Sachs, who has done more than any other man to apply the mechanical theory in botany, and who is not hide-bound by theology, pleading for the right to use the word *purpose*, calling it "a word which many fanatics of the theory of descent would, if possible, banish from our language," and adding that the whole of physiology is taken up with such questions. (Sachs' *Lectures on the Physiology of Plants*, Lect. I.) Huxley has made the discovery that physiological phenomena can be expressed in the language of teleology. (Huxley on *The Crayfish*, p. 137.) And though, like Sachs, he falls short of the theistic significance of this, he has more recently stated (in the chapter he contributes to the *Life of Charles Darwin*), that whilst Darwinism abolishes the commoner and coarser forms of teleology, it really reconciles teleology and morphology. In this sentence he adopts (perhaps unwittingly) the beautiful expression by which Asa Gray showed at once his Darwinism and his faith, viz., "Let us recognise Darwin's great service to natural science in bringing back to it Teleology, so that instead of Morphology *versus* Teleology, we shall have Morphology wedded to Teleology." (Asa Gray, Letter in *Nature*, June 4, 1874.) Weismann argues in his *Studies of Descent*, that the mechanical conception of nature favours teleology, thus, "The harmony of the universe, and of that part of it which we call organic nature cannot be explained by chance. Mechanism and Teleology do not exclude each other, but are rather in mutual agreement. Without Teleology there could be no mechanism, but only a confusion of crude forces; without mechanism there could be no Teleology, for how could the latter otherwise effect its purpose?" And quoting Von Hartman he says that, "the most complete mechanism conceivable is likewise the most completely conceivable Teleology"; and adds Von Baer's definition of the laws of Nature, as "the permanent expression of the will of

a creative principle." Charles Darwin's letter to Asa Gray, written in 1860, agrees with these views and with the stricter theology, though he knew it not. He wrote: "I am inclined to look at everything as resulting from designed laws—with the details left to the working out of what we call chance." The theologians say that under Divine Providence things "fall out according to the nature of second causes, either necessarily, freely, or contingently." (*West. Conf. Faith.* v. 2; discussed in Cunningham's *Reformers and Th. of Reformation*, p. 493.) Darwin would save his use of the term *chance*, as only so relatively to our knowledge, and the theologians would explain that neither free will nor contingency is independent of the Divine bounding. The arithmetic of expectations and probabilities, as applied by actuaries to matters depending alike on free will and fortuity, seems to show that these things are somehow under law, though not in a fatalistic way, and that Darwin and the divines are at one with each other and with the truth: nor ought this argument to lose its value, if it appear that in later years Darwin's difficulties rather increased, for he was often bewildered, so that he could not see his way. As to his chief difficulty, of there being too much misery in the world, Bishop Temple has remarked that Darwinism itself has rather helped us to meet it, by showing that we are looking on a work not yet finished; and besides this there is no evidence that misery was the end in view for any part of nature's machinery. W. Thistleton Dyer briefly gives the verdict in which all these witnesses are agreed, when he writes to the Duke of Argyll thus: "No scientific man is so foolish as to suppose that, however completely mechanical may be our conception of nature, he is in any way competent to account for its existence. The real problem of all is only pushed farther back." (Dyer, Letter in *Nature*, Jan. 16, 1890.)

The bearing of the mechanical conception of the universe may thus be summarised: 1. It is actually or provisionally established, save as to the origin of matter, of energy, of life, animal intelligence, and the body and soul of man. 2. It will not weaken, but rather fortify the evidence for design in nature, for theism, and for universal providence. Thus it is not materialistic, though it is accepted by some in a materialistic sense. 3. It will not invalidate the Divine claims of scripture; though it may favour naturalistic interpretations of the cosmogony, the deluge, and some other parts, in accordance with geological discoveries, and as suggested in the

Bible itself. 4. It will fortify the proper miracles of scripture, by showing that whilst incredible as part of the ordinary course of nature, they may be a unique case, bound to stand or fall along with the Divine character of redemptive revelation. 5. It will not weaken faith in personal immortality, or in the operations within us of Divine grace, or in the existence of an unseen spiritual world; but it may favour the opinion that the human soul is derived from and dependent on some physical substratum. 6. Whilst recognising God's continued control over all parts of nature, we do not understand that His control involves any disturbance of natural order or movements, nor that He is the only worker; nor do we expect ever to understand how He is able to operate upon nature. We can operate upon our own bodily organism, and thence upon the external world; but we cannot tell how, except that we act in harmony with natural laws. The fact of the Divine intervention is equally credible, and its mode must for ever remain equally inscrutable.



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