Three Approaches to Biology

Part I. The Mechanistic Theory of Life

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Introduction

THERE ARE three models or paradigms which provide different approaches to the science of biology, the mechanistic, vitalist and organismic. Within the confines of institutional science, the mechanistic theory has been almost completely dominant for over fifty years. Nevertheless, it has a number of important disadvantages, which will be discussed in the first of this series of articles. Then, in the second and third articles, the vitalist and organismic alternatives will be considered, and the possibility of their future development examined.

Modern Mechanistic Biology

In 1867, T. H. Huxley wrote as follows:

"Zoological physiology is the doctrine of the functions or actions of animals. It regards animal bodies as machines impelled by various forces and performing a certain amount of work which can be expressed in terms of the ordinary forces of nature. The final object of physiology is to deduce the facts of morphology on the one hand, and those of ecology on the other, from the laws of the molecular forces of matter".[1]

The subsequent developments of physiology, biochemistry, biophysics and molecular biology are all foreshadowed in these ideas.

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The programme outlined by Huxley is still the programme of mechanistic biology, and its basic philosophy has hardly changed. In many respects these sciences have been brilliantly successful, none more so than molecular biology. The elucidation of the structure of DNA, the 'cracking of the genetic code' and the discovery of the mechanism of protein synthesis seem to be impressive confirmations of the validity of the mechanistic approach. Not surprisingly, molecular biology has become one of the most influential branches of biological science, and molecular biologists have emerged as the most articulate modern advocates of the mechanistic theory of life.

Their accounts of the mechanistic theory usually begin with a brief dismissal of the vitalist and organismic theories. These are defined as survivals of 'primitive' beliefs which are bound to retreat further and further as mechanistic biology advances. The accounts then proceed along the following lines:

The chemical nature of the genetic material, DNA, is now known and so is the genetic code by which it codes for the sequence of amino-acids in proteins. The mechanism of protein synthesis is understood in considerable detail. The structure of many proteins has now been worked out. All enzymes are proteins, and enzymes catalyse the complex chains and cycles of biochemical reactions which constitute the metabolism of an organism. Metabolism is controlled by biochemical 'feedback' and several mechanisms are known by which the rates of activity can be regulated. Proteins and nucleic acids aggregate spontaneously to form structures such as viruses and ribosomes. Given the range of proteins, plus the properties of other physico-chemical systems such as lipid membranes, the properies of living cells can, in principle, be fully explained.

The key to the problems of differentiation and development, about which very little is known, is the understanding of the control of protein synthesis. The way in which the synthesis of certain metabolic enzymes and other proteins is controlled is understood in detail in the bacterium *Escherishia coli*. The control of protein synthesis takes place by more complicated mechanisms in higher organisms, but these should soon be elucidated. Thus differentiation and development should be explicable in terms of series of chemically operated switches, which 'switch on' or 'switch off' genes or groups of genes.

Very little is known about the functioning of the central nervous system, but eventually the advance of biochemistry, biophysics and electrophysiology should be able to explain what we speak of as the mind in terms of physico-chemical mechanisms in the brain. Thus living organisms are, in principle, fully explicable in terms of physics and chemistry; our present ignorance about the mechanisms of development and about the central nervous system is due to the enormous complexity of the problems; but now, armed with the powerful new concepts of molecular biology and with the aid of computer models, these subjects can be tackled on a scale and in a way not previously possible.

The way in which the parts of living organisms are adapted to the functions of the whole, and the apparent purposiveness of the structures and behaviour of living organisms, can be explained in terms of random genetic mutations followed by natural selection, such that those genes which increase the ability of the organism to survive and reproduce will be selected for; harmful mutations will be eliminated. Thus the neo-Darwinian theory of evolution can account for purposiveness; it is totally unneccessary to suppose that any mysterious 'vital factors' are involved.

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I think that this is a fair summary of the modern orthodoxy, but the reader can form his own opinion by going through some of the admirably lucid accounts by molecular biologists themselves.[2]

Morphogenesis and Behaviour

There is no doubt that mechanistic biology has been very successful in explaining many of the physical and chemical aspects of living organisms. A nerve impulse is electrical, and can be understood in terms of electricity. Nucleic acids, proteins, lipids, polysaccharides and the compounds involved in the metabolism of cells and organisms are all chemicals and can be understood in terms of chemistry. But the form of an organism or the behaviour of an animal are not chemical molecules or physical quantities. The coming-into-being of the form of an organism — its *morphogenesis* certainly involves numerous chemical and physical changes, and the expenditure of measurable quantities of energy. So does its behaviour. But neither morphogenesis nor behaviour bears the same immediate relation to chemistry as do the molecules studied by biochemists and molecular biologists, or to physics as the physical processes studied by biophysicists and electrophysiologists. It is at this point the the mechanistic theory runs into serious difficulties.

The spontaneous aggregation of protein sub-units and of nucleic acids to form viruses or small sub-cellular structures such as ribosomes can be regarded as crystallizations. Although these are more complex than inorganic crystals, they probably involve no new chemical or physical principles. Given the right chemicals in the right concentrations under the right conditions, these morphogeneses take place spontaneously, presumably owing to the operation of normal laws of physics and chemistry. So far, so good. But while cyrstallization can account for the formation of crystals and quasi-crystalline aggregates within living cells, it is by no means so clear that it can account for the morphogenesis of the cells themselves. Cells are not in any normal sense of the word crystals or even quasi-crystalline. Still less are tissues, composed of many cells, or organs composed of tissues, or organisms as a whole. So how is their morphogenesis to be explained? At this stage, the mechanistic theory effectively abdicates. Biological morphogenesis is supposed to take place spontaneously by the operation of physical and chemical laws. Since these laws lie in the provinces of physics and chemistry, it is not considered necessary either to specify or discuss them. The task of mechanistic biology reduces itself to finding out how the synthesis is brought about of the right types of chemical, in the right quantities, in the right cells. This problem in turn reduces to that of the control of protein synthesis.

But even this task is dauntingly difficult. Consider the morphogenesis of the arm and the leg. Both contain the same types of cells, the same proteins, the same enzymes and the same genes. Yet they have different forms, and the cells and tissues are arranged in different patterns. It is necessary to suppose that, during embryology, the cells in the developing limbs are exposed to different physico-chemical environments. Experiments show that the fate of embryonic cells depends on their position. Hence what is often referred to as 'positional information' must depend on chemical or physical gradients, or some other physico-chemical stimuli.[3] This must in turn depend on the biochemical or physiological activity of particular groups of cells in particular places, and the activation of these cells can only be explained in terms of some preceding physico-chemical stimuli, and so on. But now there are the following problems:

i) Biological development is epigenetic, that is to say it involves an increase in complexity of form. Therefore the forms or patterns that appear during morphogenesis cannot be explained indefinitely in terms of preceding forms or patterns.

ii) Many developing embryos show remarkable powers of regulation, i.e. after mutilation or damage, the pathways of development are able to readjust themselves so that a more or less normal final structure is produced. This makes the problems of explaining the physical or chemical basis of 'positional information' exceedingly difficult even in the simplest systems.

iii) After decades of intensive investigation, all attempts to obtain unequivocal evidence for the hypothetical physical or chemical morphogenetic gradients in animal embryos have failed. It is only in higher plants that chemical morphogens, notably the hormone auxin, have been chemically identified. This hormone plays an important role in the control of the differentiation of vascular tissue. But any explanation of patterns of differentiation in terms of auxin must in turn depend on an explanation of the pattern of production and distribution of auxin. Recent research indicates that this hormone is produced in the differentiating vascular tissue itself: the system is circular. Auxin may help to account for the maintenance and repetition of patterns of vascular differentiation, but it cannot account for the establishment of these patterns in the first place.[4]

Not even the most ardent mechanists claim that the problems of morphogenesis have been even partially solved.[5] They simply express the hope that they will be solved mechanistically at some time in the future. The problems are even greater when it comes to the behaviour of animals. Even though the aspects that seem most likely to be explicable mechanistically, the simple and conditioned reflexes, have been studied intensively for years, they are still far from being understood. Meanwhile, the efforts of the behaviourist school of experimental psychology to explain all animal behaviour, including language, in terms of chains of reflexes have, even in the eyes of many mechanists, failed dismally.[6]

In relation to the problem of memory, after years of research its basis is still entirely mysterious. One early theory, in terms of reverberating circuits in the nervous tissue, may possibly help to account for short-term or 'labile' memory; but all attempts to explain long-term memory physico-chemically — for example in terms of chemical or structural changes in the nerve cells or in the connections between them — have remained entirely speculative.[7]

The problem of instinct is more difficult still. To account for the fact that a spider, for example, can spin a perfect web without learning how to do it from other spiders, it is usually assumed that this task must be 'programmed' into its nervous system as a result of 'genetic information' or 'instructions' in the spider's DNA. How the synthesis of unspecified proteins within the nerve cells of the spider could possibly result in the right 'wiring diagram' of the nervous system is a problem of appalling complexity; but how protein synthesis could explain the characteristic web-spinning behaviour of the spider defies imagination.

But these are greater problems yet. Consider the instincts of birds, for example those of the European cuckoo. The young are hatched and reared by birds of another species and never know their parents. Towards the end of the summer the adult cuckoos depart, migrating to their winter habitat in Southern Africa. Several weeks later, the young cuckoos form groups and then they also migrate to the appropriate region of Africa. They instinctively 'know' that they should migrate and when to migrate; they instinctively recognize other young cuckoos and congregate together; and they instinctively

know in what direction they should fly and where their destination is. According to the mechanistic theory, all this is somehow 'programmed' in their DNA, and is ultimately explicable in terms of the controlled synthesis of specific proteins. Furthermore all these instincts originated in the first place as a result of random mutations in the DNA.

By this stage, rigorous experimentation of the type involved in cracking the genetic code has been left far behind. The fact that DNA is a mere chemical is soon lost sight of, as it becomes submerged beneath ill-defined phrases such as 'genetic instructions' or 'genetic programmes'. These conveniently teleological concepts are then used to provide vague interpretations of morphogenesis, instinct and behaviour. But these phenomena have not in fact been explained at all. Whether or not these mechanistic speculations seem plausible depends on whether or not one believes in the mechanistic theory in the first place. The experimental study of morphogenesis and behaviour has provided no independent evidence in favour of this theory; if anything, it has revealed the enormous difficulties of this approach.

The Arguments in Favour of the Mechanistic Theory

The arguments in favour of the mechanistic theory are of four general types:

i) The facts that living organisms are material, that physical and chemical processes take place within them, and that they are influenced by physical and chemical stimuli are frequently regarded as evidence in favour of the mechanistic theory. The force of this argument depends on a polemical device, or perhaps simply on an ignorance of the alternative theories of life, especially vitalism. The mechanistic theory asserts that *all* aspects of life are explicable in terms of physics and chemistry; mechanists speak as if, or even believe, that the opposing theories assert that *no* aspects of life are explicable in terms of physics and chemistry. Then all the physical and chemical facts about living organisms appear to be exceedingly powerful refutations of these imaginary theories, and hence proofs of the 'common sense' mechanistic view.

Two further arguments are used to make what is essentially the same point. First, it is asserted that sometime in the future it will be possible to create life from chemicals in a test tube. Second, it is assumed that life originally arose from chemical aggregates in a Primeaval Broth, containing amino acids and other compounds produced by flashes of lightning, etc. These assumptions are then regarded as proofs that living organisms are nothing but complex aggregates of chemicals.

In fact, of course, the alternative theories of life do not deny that living organisms are material entities, and that some aspects of living organisms can be accounted for in physico-chemical terms. What they do say is that not *all* aspects of life can be explained in the same terms as the inanimate systems studied by physicists and chemists; in addition, other laws or causal factors are at work in living organisms.

It has been known for millenia that men and animals have material bodies and require food; that the substances they eat are changed inside their bodies, some becoming the substance of their flesh and bones, while others are excreted; that animals and men can be killed by physical injuries or poisonous substances; that plants require water and light for their growth; that the yields of crops can be improved by manure and by irrigation; that consciousness can be influenced by alcohol and by other drugs, and so on. More is now known in detail about these processes than ever before, but a knowledge of these general facts is almost universal, and not a unique feature of mechanistic biology. What is unique is the assertion that because living organisms depend on physical and chemical factors, they are nothing but physico-chemical machines. This is no more logical than the related assertion that because *some* aspects of living organisms have been explained in terms of physics and chemistry, *all* aspects can be so explained. In actual fact, many aspects of living organisms have not been explained in terms of physics and chemistry, in spite of prolonged and intensive efforts to do so. This may be because of their sheer complexity, as the mechanists claim, or it may be because the mechanistic approach is fundamentally mistaken. There is no way of deciding on the basis of this type of argument. The same applies to the arguments based on

a hypothetical synthesis of a living organism, and on speculations about the origin of life. Since these arguments are often regarded as especially convincing it is perhaps worth illustrating their weakness by a simple analogy.

Imagine a village in a remote part of the world where nothing is known about modern science. One day someone arrives with a simple transistor radio set. The villagers are astonished to hear human voices and music coming out of it. Most attribute them to spirits; others conclude that they must be due to subtle influences or emanations from people in distant places. But an ingenious artisan examines the radio set carefully, takes it to pieces and finds that it is composed of copper wires, crystals and other recognizable substances. Because it consists entirely of materials, he concludes that it is in principle fully explicable in terms of the properties of these materials themselves. He finds its weight does not change when it is switched on or switched off and deduces that nothing enters into it from outside. Although he cannot explain in detail how it works, he confidently dismisses the ideas of spirits or aetherial influences from far away. He tries to build a replica of the radio set, and finally succeeds. Voices and music come out of it. He regards this as a conclusive proof of his opinions. But, of course, he still knows nothing about electricity, electromagnetism, electromagnetic radiation, or how a radio really works.

ii) Viruses, which lie on the borderline between the living and the non-living, are complex crystalline aggregates of proteins and nucleic acids. They can be described in purely physico-chemical terms. Mechanists often argue that living organisms differ from viruses only in degree and can therefore also be understood in purely physico-chemical terms. The trouble with this argument is that viruses are entirely parasitic; they cannot reproduce themselves. Under natural conditions they can only be replicated when they enter a living cell; their component parts are synthesized, on the basis of their DNA or RNA, by the biochemical mechanisms of the cell. In the laboratory, the replication of the nucleic acid and protein components of the virus can be brought about in the test tube by supplying the necessary enzymes, etc.; but the virus is still dependent on other living organisms, in this case the cells from which the enzymes etc. were extracted, and the molecular biologist who so carefully provides the right conditions for the reactions to occur. Viruses pre-suppose the existence of living organisms; they cannot be used to explain the nature of life.

iii) The mechanistic theory is founded on the analogy between living organisms and machines. Machines are purposeful and are at the same time purely physico-chemical systems. Hence, it is argued, purpose does not involve anything other than physics and chemistry and therefore living organisms can be regarded as nothing but complex machines.

But, obviously, machines are made by men to serve human purposes, as extensions of human powers of movement, human senses, memory and calculating ability. They are not independent, self-motivating, and self-constructing entities with purposes of their own. Their designs and purposes are imposed upon them from outside themselves.

Mechanists find the machine analogy so persuasive that they sometimes suggest 'thought experiments' of the following type to emphasize it even more strongly: human beings arrive on a strange planet where they find entities moving around and behaving purposefully. They do numerous tests and are unable to decide whether they are animals or machines. Therefore there is no difference between animals and machines because they cannot be empirically distinguished from each other.

In fact, the imaginary astronauts would be less likely to conclude that living organisms *were* machines, than that the entities were

either living organisms *or* machines which had been made by intelligent animals; they would then look for their creators.

The greatest weakness of the machine analogy as an argument in favour of the mechanistic theory is that exactly the same analogy is sometimes used by theologians to support a diametrically opposite conclusion. They argue that just as machines are designed by men to serve human purposes, so living organisms have been purposefully designed by God. An analogy as ambiguous as this can provide no more convincing support for the mechanistic theory than it does for the existence of a Divine Creator.

iv) The final type of argument seeks to account for the purposiveness of living organisms in terms of the neo-Darwinian theory of evolution. The origin of new structures and of new types of instinctive behaviour is assumed to depend on random mutations; then natural selection eliminates all those which are harmful and favours those which increase the ability of the organism to survive and reproduce. Thus evolutionary creativity and apparent purpurposiveness are accounted for entirely by the interplay of chance and necessity.

The randomness of mutations is an assumption which depends on the theories of physics, especially on the idea of the indeterminacy of quantum processes. It therefore presupposes that living organisms obey only the normal laws of physics, and that physical processes are not modified in some unknown way within living organisms. Since this is the very issue at stake, the argument is circular.

But leaving this objection aside, the neo-Darwinian theory can only help to account for *particular* purposive features of living organisms, but not for the underlying purposiveness associated with their survival and reproduction. This point can be illustrated by a technological analogy. Assume that the ideas responsible for new designs of bows and arrows, cannons, guns, bombs, etc. are a result of random changes in the brains of their inventors, or that accidents in the manufacture give rise to altered versions of these weapons. In battles, the side with the better weapons would tend to win; therefore ineffective weapons would be eliminated by a sort of natural selection. The interplay of chance events (assumed to account for technical innovations) and natural selection (in battles) would, over time, lead to the evolution of more and more effective weapons of ever-improved design. But these processes do not explain the basic purpose of the weapons, which is to kill. This purpose underlay their whole evolution; it was there to start with. Moreover, killing is not an end in itself; it is an aspect of more general purposes, such as the defence of the social group, or expansion into new territory.

Natural selection can only work on organisms which are capable of survival and reproduction in the first place. There could have been no natural selection and no evolution if there were no living organisms to start with. And the earliest living organisms, however primitive, must already have behaved purposively, their purposes being survival and reproduction. Thus the purposiveness of living organisms is not explained by the neo-Darwinian theory: it is presupposed. The problem can be pushed back to the origin of life, but this is a subject about which nothing can ever be known for certain. It is not even clear where life originated. The most popular theory is that life began on earth, in some sort of Primaeval Broth. On the other hand, two well-known molecular biologists have recently proposed that the first organisms on the earth were deliberately sent in a spaceship by the inhabitants of a planet in Outer Space.[8]

Mechanists usually suppose that the first living organisms happened to come into existence by chance in the hypothetical Primaeval Broth, or somewhere else. In this way the fundamental purposiveness of living organisms can be regarded as the product of a chance event. This is one possible speculation about the origin of life; other quite different speculations could equally well be proposed. But obviously a controversy about the essential nature of life cannot be resolved by an appeal to untestable theories about events that took place on the earth, or somewhere else, thousands of millions of years ago. In any case the circumstances of the origin of life would not in themselves explain its nature.

All these arguments in favour of the mechanistic theory suffer from a further fundamental weakness. They take it for granted that is biological phenomena are explained in terms of physics and chemistry, that is the end of the matter; they simply assume that physics provides a firm foundation on which the entire edifice of mechanistic explanation can be built. But while the mechanistic theory has hardly changed for over a century, physics has. Atoms are no longer solid and indivisible: they split up into other particles, which themselves seem to fragment indefinitely; matter is regarded as a sort of vibrational energy; the determinisms of classical physics have been replaced by probabilities. The quantum theory is grounded in a rigorous consideration of the nature and meaning of experimental observations; built into the theory is the recognition that measurements of quantum processes inevitably perturb the systems being measured, and that the observer has to be regarded as a part of the process of observation. In classical physics, it was assumed that observers could be entirely objective, somehow standing outside reality and measuring what was 'really' there. This naive assumption is no longer tenable.

Unlike most biologists, a number of physicists, including some of the most eminent, have actually thought about the problem of the reduction of biology to physics. They have come to the conclusion that this reduction is impossible not only in practice, but in principle. Wigner, for example, has argued persuasively that the existence of life and of human minds cannot be described in terms of existing physical theory, in particular in terms of the present formulation of the quantum theory. He points out that this conclusion suggests the need for a new theory of life.[9]

Is the Mechanistic Theory Testable?

The mechanistic theory has so far failed to explain most of the major problems of biology; its attempts to account for consciousness lead into insoluble paradoxes; the arguments in its support are weak and unconvincing. These are not unreasonable grounds for thinking that there might be something seriously wrong with the theory itself. If it were purely metaphysical, there might be no way of resolving these doubts. But it is, or claims to be, a scientific theory. According to the generally accepted philosophy of science, a scientific theory should be testable: it should make definite predictions which differ from those of alternative theories; it should be distinguishable from these other theories by experiment or observation. In the words of Sir Karl Popper, "the criterion of the scientific status of a theory is its falsifiability, or refutability, or testability".[10]

Believers in the mechanistic theory generally regard the increasingly detailed findings of sciences such as genetics, physiology, biochemistry and molecular biology as evidence in its favour, if not actual proof of the theory. But all that this evidence establishes is that physico-chemical aspects of living organisms can be explained in terms of physics and chemistry. This is freely admitted by the alternative theories of life. Mechanistic biology has so far failed to demonstrate that specifically biological phenomena such as the morphogenesis of living organisms, instinct and memory involve nothing more than the laws of physics and chemistry. If it had done so, this might indeed have increased its credibility, since it is precisely these phenomena that the alternative theories claim are not reducible to physics and chemistry. The most that mechanists can do is to express the belief that these problems will be solved mechanistically at some time in the future. But acts of faith in future consummations have no value as scientific arguments. Mechanists would certainly not admit contrary beliefs as evidence against their theory; therefore their own beliefs cannot be used as evidence in its favour.

There is in any case a fundamental difficulty in this line of argument: it is a general principle that evidence in favour of a theory can only make it increasingly plausible, but can never *prove* it. On the other hand, a theory can be refuted, in principle definitively. In practice, the theory can usually be saved by the elaboration of *ad hoc* modifications and subsidiary theories to account for apparently unfavourable facts.

The mechanistic theory clearly states that all the phenomena of life are explicable in terms of physics and chemistry. It would

therefore be refuted if there were any phenomena of life which were not explicable in this way. The most immediate and obvious examples are purposiveness and consciousness. Mechanists try to avoid these difficulties by the types of argument considered above. These arguments can never be won: at best, they can be reiterated until opponents are worn down by attrition. But there are other examples were the issues are less easily obfuscated.

The application of the mechanistic theory of life to medicine means that patients can only be regarded as complex physico-chemical machines. Therefore mechanistic medicine can only treat them physically or chemically. This type of medicine has been at its most successful in dealing with diseases of external origin — those caused by germs, faulty nutrition, or physical injury — and with disease of internal origin which are primarily chemical (e.g. hormone deficiencies) or physical (e.g. holes in the heart). But there are many diseases which do not come into these categories, especially those which are regarded as at least partially 'psycho-somatic'. Then there are the various types of mental disorder. The rigorous mechanist can only regard all these diseases and disorders, even those which are explicitly mental, as essentially physico-chemical. Accordingly, they can be treated only physically (e.g. by electric shock therapy) or chemically (e.g. by tranquillizers). Nevertheless, psycho-analysis and other types of psycho-therapy are admitted within the confines of orthodox medicine, even though they are non-mechanistic. These systems are regarded with grave suspicion by many committed mechanists[11], but they are tolerated because they seem to work, to some extent. In practice, it is not possible to carry mechanistic medicine to its logical conclusion.

Meanwhile, outside the bounds of orthodoxy, all sorts of other medical systems flourish: homeopathy, naturopathy, radionics, acupuncture, colour therapy, and so on.[12] Then there are the 'miraculous' healings at Lourdes and other shrines, and 'faith' healings by Christians and followers of other religions. The efficacy of all these methods is well attested. Not all of them work all the time, but then neither does orthodox medicine. Mechanists usually ascribe cures brought about by any of these non-mechanistic means either to coincidence — 'the patient would have got better anyway'

— or to 'suggestion'. Both are reasonable possibilities, but both apply with equal force to orthodox medical cures.

The power of suggestion is most dramatically demonstrated by hypnosis, but also operates more subtly, as in the well-known 'placebo' effect. For example, patients treated with tablets of inert material, believing them to be powerful pain-killers, often experience considerable relief from pain. Belief in, and expectation of, positive results probably play an important part in all medical systems, irrespective of their theoretical basis. But this does not explain the power of suggestion. There is nothing obviously mechanistic about it. So even if suggestion could account for much of the efficacy of non-mechanistic medical systems, this would simply present the mechanistic theory with another intractable problem. The power of suggestion could even be regarded as a refutation of the mechanistic theory, since it shows that there is a definite effect of something which is neither physical nor chemical. However, the armchair mechanist would always be able to argue that suggestion worked through unspecified physico-chemical effects in the brain, brought about by the nerve impulses carrying the suggestion from the sense-organs. This type of argument is irrefutable; there would be no empirical evidence from the whole field of medicine, however non-mechanistic it seemed to be, which could not be explained away in some way such as this.

The difficulties faced by the mechanistic theory are even greater in the field of parapsychology. All attempts to account for phenomena such as telepathy in terms of known physical forces or radiations have failed; they seem to depend on forces or interactions unknown to physics.[13] Their existence therefore appears to provide a definitive refutation of the mechanistic theory.

Again, the armchair mechanist is ready with an answer: all the evidence for parapsychological phenomena, even that collected by experienced scientists under well-controlled conditions, is invalid. Either it is due to coincidence, incompetent experimentation, fallacious statistics, or fraud, conscious or unconscious. Researchers in parapsychology are all too familiar with these arguments and generally use careful methods and statistical procedures which take good account of them. Scientific investigations of these phenomena

has now been going on for nearly a century, since the founding of the Society for Psychical Research in 1882. A large body of evidence has been built up; many responsible people who have examined this evidence thoroughly have come to the conclusion that at least some of the phenomena can be considered to be established facts.[14] But very few mechanists have taken the trouble to look at this evidence. Most think that they know in advance that these phenomena cannot possibly exist, simply because they cannot be explained in terms of physics and chemistry. The empirical evidence is therefore irrelevant; it can be dismissed *a priori*.

This obscurantist attitude clearly indicates that the issue at stake is not just a theory, but a dogmatic system of belief. As such, it is practically immune to any facts which go against it. If a diehard mechanist saw a demonstration of, say , psychokinesis, at close range, and even if he himself had full control of the experimental conditions, he would still not be convinced: he would probably think that he had been hypnotized. But if he did happen to believe his own eyes, when he told his colleagues, most of them would not take him seriously. The more charitable would think he had been duped, the less charitable that he was lying.

A more subtle way of defending the mechanistic faith would be to argue that if any of the phenomena of parapsychology do in fact exist, then they must be explicable in terms of physics, but the appropriate laws of physics have not yet been discovered. However, if physics is taken to include all the known and unknown laws of nature, then the mechanistic theory would simply state that living organisms obey known and unknown laws. But then how would it differ from vitalism, or the organismic philosophy? It would only be a general principle, devoid of specific content, which included all possible theories of life.

Thus, for the committed believer, the mechanistic theory is irrefutable. Everything can be explained, or explained away. There is therefore no way in which it could be tested empirically.

Mechanistic Vitalism

One of the most common criticisms levelled against vitalism by the mechanists was that it sought to explain all the unsolved problems of biology in terms of 'vital factors', which were merely empty words. However, this criticism applies with far more force to the mechanistic theory itself than it ever did to genuine vitalism. By a curious paradox, the paradigm of modern biology has in effect become a degenerate form of vitalism in a mechanistic guise. Its 'vital factor' is the so-called genetic programme. Whatever the problem — be it the human mind, the social behaviour of bees, the development of embryos, the migration of birds — it is considered to be explicable in terms of 'genetic programmes' or 'instructions' in the DNA. These explain everything, and therefore nothing. Anything living organisms can do, the genetically-programmed physico-chemical machines of mechanistic biology can do. But these physico-chemical machines are no ordinary machines; they are vital machines. Words have lost their meaning.

The concept of 'genetic programmes'[15] is based on an analogy with the programmes which direct the activity of computers. Its apparent explanatory power depends on two thoroughly dubious ideas implicit within it. The first is that the fertilized egg contains a pre-formed 'programme' for the development and instinctive behaviour of the organism. But the whole idea of the 'programme' loses its force if it is simply identified with DNA, since identical copies of DNA are passed on to all cells: if all cells were 'programmed' identically, they could not develop differently. So the 'programme' must be something other than a mere chemical structure: it must be a dynamic, seemingly purposive entity that somehow directs development itself. But then what exactly is it in mechanistic terms? At this stage the idea can only disintegrate into vague suggestions about physico-chemical interactions somehow 'structured' in time and space; the problem is simply re-stated.

Second, a computer programme is put into the computer by an intelligent conscious being, the computer programmer. The analogy appears to imply that the 'genetic programme' is designed by some intelligent 'vital principle'. Now if it is argued that 'genetic programmes' are not analogous to ordinary computer programmes, but to those of self-reproducing, self-programming computers, the analogy is most misleading, since such machines do not exist. And if they did, they would have to have been programmed in the most elaborate way by their inventor to start with. The only way out of this dilemma is to say that 'genetic programmes' have been built up in the course of evolution by chance mutations and natural selection. But then the similarity to any actual or conceivable computer programme simply disappears, and the analogy becomes meaningless.

Thus the 'genetic programme' is simply an empty phrase. But it differs in one important respect from even the vaguest 'vital factors' of the genuine vitalists: its pseudo-mechanistic appearance serves to conceal the fundamental ignorance that lies behind it. The 'vital factors' of explicit vitalism did not pretend to be more than words which indicated the existence in living organisms of causal agencies not yet known or understood.

Notes

1. T. H. Huxley: *Science Gossip*, p. 74. London (1867).
2. See F. H. C. Crick: *Of Molecules and Men*. University of Washington Press, Seattle (1967) and J. Monod: *Chance and Necessity*. Collins, London (1972). Both these authors claim, probably rightly, that their views are representative of those of the majority of their colleagues.
3. For a recent account, see L. Wolpert: Pattern formation in biological development. *Scientific American* 239, 154-164 (1978).
4. A. R. Sheldrake: The production of hormones in higher plants. *Biological Reviews*, 48, 509-559 (1973).
5. E.g. F. H. C. Crick: Developmental biology. In *The Encyclopedia of Ignorance* (eds R. Duncan and M. Weston-Smith) pp. 299-303. Pergamon Press, Oxford (1977).
6. A. Koestler: *The Ghost in the Machine*. Hutchinson, London (1967).
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