An Address ON BIOLOGY AND MEDICINE.*

BY
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THE aim of Medicine is the maintenance or restoration of what we call health. It is thus our conception of what health means that is at the root of our conception of Medicine. We recognize that health is a normal condition which tends to be maintained apart from any conscious effort to maintain it. Health is just the normal unconscious life of an individual, and knowledge of what, in detail, this normal life and departures from it consist in is thus essential when by conscious effort, as in practical Medicine, we seek to safeguard or restore health.

The Distinctive Features of Life.

The phenomena observed in connexion with life are so different from those observed in what we call inorganic Nature that we give the name Biology to the science or group of sciences dealing with unconscious life, and we distinguish Biology from the Physical Sciences, which deal with the inorganic aspect of Nature. Let us consider what this difference consists in.

In a living organism we find structure, arrangement of parts, and movements of them, just as in phenomena which we interpret as inorganic. But in the case of life the structure, including its mass and composition, is actively maintained or developed in the particular manner which is "normal," and the activity of the structure is of such a nature that the normal structure is maintained or developed. Normal structure and normal activity are thus inseparable: the structure is alive, and alive in a manner which is normal or specific. If, moreover, we consider the mutual reactions between an organism and its environment we find that these reactions are so co-ordinated or directed, as to maintain or develop the normal structure of the organism, and this co-ordination is what we call organic control. In inorganic phenomena, on the other hand, we seem to find no co-ordination of activity with structure. Inorganic structures hold together, it is true; but their activities are not regarded as being so directed that the structure is maintained. This is what we mean when we say that inorganic structures and activities have no functional significance, while organic activities have. The activity displayed for the moment in an inorganic substance or structure seems to us to be a mere matter of chance, and for this reason can be described as chaotic, and will be so referred to in the sequel.

In the phenomena of life, therefore, there is an element which we do not observe in connexion with inorganic phenomena. This is specific co-ordination in the relation between structure and activity. Details of both structure and activity are the manifestation of something which maintains and develops itself in a specific manner as a whole. This something is what we denominate and easily recognize as life; and the science of Biology is the science of the manifestations of life.

Within the body of an organism we can also recognize phenomena which do not, in much or most of their detail, seem to be different from inorganic phenomena. Thus we find within the living body what seem to be ordinary liquids, solids, or gases, behaving in every way like inorganic liquids, solids, or gases, except that a greater or less amount of organic co-ordination or control is evident in their mass, volume, and composition, and in the influence which they exercise on the organism. In virtue of the organic control we interpret their presence as "normal" or within "normal" limits. In the environment inorganic behaviour is present to what at first sight seems a predominant extent, and the physical sciences deliberately disregard the organic control shown in the mutual reactions between organism and environment. By biologists the action and reaction are referred to as

stimulus and response, and in the relation between stimulus and response—for instance, in responses to stimuli by light—characteristic biological co-ordination or control is evident, while definite physical or chemical connexion between stimulus and response cannot be traced. This control is, moreover, the distinguishing feature for Biology. Hence organic co-ordination, though no account is taken of it by the physical sciences, does not cease when we pass outside the bodies of living organisms, but extends indefinitely into their environment, since the characteristic mutual relations between organism and environment are those of stimulus and response. The relationship, for instance, between Sirius and a photographic plate which receives its spectrum is different from that between Sirius and an organism which responds to its presence. To take another instance, the relationship between stimulus and response in so-called "reflex action" is different from that between physical cause and effect, as modern investigations of reflex action are progressively showing. In other words, the conception of life applies over the environment no less than over the bodies of organisms. Between life and its environment there is no line of demarcation; and even when we attempt to draw a definite line of demarcation between living structure and its environment we never succeed. Living structure and the "plasma" which we endeavour to picture as surrounding it melt into one another.

Thus the distinctive science of Biology is not a science which applies merely to the living bodies of organisms. It represents the interpretation of one aspect of what we observe, not merely in the living bodies of organisms, but also in what surrounds them. Biological interpretation is, in fact, a method of interpreting part of our perceived experience, just as is physical interpretation. The difference between biological interpretation and physical interpretation is a logical difference. If we ask what necessity there is for extending biological interpretation over the whole of our perceived experience, the answer is that we can distinguish the same co-ordination between specific structure and activity in the relations between organism and environment as in the relations between the parts of an organism, so that organic wholeness is just as manifest in the relations between organism and environment as in the relations between the parts of an organism. From its very nature ordinary physical interpretation cannot express this wholeness, since structure and activity are regarded as independent of one another.

The Hippocratic Conception of Life as a Struggle in Nature against Chaos.

It is evident that we can see far more in both organism and environment than what we can describe in terms of life. We have to content ourselves with physical interpretation of these phenomena. Life, with its essential co-ordination, therefore appears to us as a constant, and under normal conditions successful, struggle with the essential chaos of what we interpret as a physical and chemical world, both within the body and in the environment. It is in this struggle that life manifests itself; and practical Medicine is simply the help we can give by conscious interference in the natural struggle for normal life or health. Were it not for the actual existence of this struggle therapeutic Medicine or Surgery would be helpless in face of the endless delicacy of living structure and its normal activities. We cannot repair the living body as we repair a machine: we can only assist the natural process of repair. Similarly, in preventive Medicine we can do no more than see that the struggle is not too hard for Nature to succeed in it.

The struggle of life is a natural phenomenon. We do not interpret it as conscious behaviour, but as a blind or unconscious manifestation of Nature. Another conception is needed for the interpretation of conscious behaviour. The fact that in studying life it is simply Nature that we are studying, and that it is the nature of life to maintain, restore, and reproduce itself, was first pointed out clearly by Hippocrates, who at the same time objected to the intrusion into medical theory of philosophical atomism, the early Greek form of the modern physico-chemical interpretation which reached its full development during

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last century. The word Physiology, derived from *φύσις*, nature, and taking us back to the Hippocratic conception, is a reminder that in studying life we are simply studying a natural phenomenon.

Physiology, Anatomy, and Biochemistry.

In modern times the word Biology has been substituted for the word Physiology, to indicate the whole science of life, while Physiology is regarded as dealing solely with the activities of life, and is distinguished from Anatomy or Morphology, which deals with the structure of organisms, and Biochemistry, which deals with their chemistry. In so far as we make sharp distinctions of this kind we are losing sight of the essential unity of biological phenomena. Normal structure and chemical composition are only the expression of normal activity; and apart from the structure and composition which are the expression of normal activity, this activity is without biological significance. Whatever methods of investigation we may mainly be employing, it is active life itself that we are studying, since we cannot separate living structure and composition from living activity. It is impossible for investigators to be experts in every method of investigation, or be familiar with all forms of life. Hence it is necessary to divide biological investigation into different branches. But if, in doing so, we forget that every branch of biology is concerned with the essential wholeness of the phenomena of life for each individual organism, the result can only be confusion, since we lose ourselves in endless unconnected matters of detail. Functional significance is what biology is always searching for, and its discovery is for a biologist the understanding or power of predicting phenomena. Explanation in biology is simply the demonstration that a detail of structure or activity expresses the organic wholeness of life.

The Vitalistic and Mechanistic Theories of Life.

The view just presented is essentially the Hippocratic view of biology and Medicine, but is not the view which is at present commonly regarded as orthodox in the teaching of physiology and anatomy, and which is to a considerable extent reflected in the teaching of Medicine. If we go back to the commonly accepted biological conceptions of the early part of last century we find that instead of regarding the distinctive feature of life as corresponding to a conception applying to the whole of the relations between organism and environment, biologists generally believed that the behaviour of the whole environment and much of what is observed within the living body can be interpreted as nothing but physico-chemical behaviour, and that only within the intimate structure of the living body does such interference occur as to impart to the behaviour of living organisms its distinctive character. The interfering influence was called the "vital principle" or "vital force," and the corresponding general biological conception was known as vitalism.

The middle of last century saw a general uprising against vitalism, and a determined attempt to substitute for vitalism the conception that biology is simply one part, though a difficult one, of ordinary physical science. There can be no doubt that this attempt has not brought us, in appearance, any nearer to a physico-chemical conception of life. The distinctive features, already referred to, which separate biological from physical and chemical phenomena stand out now far more clearly and in far greater detail than they did at the middle of last century. This is the result of detailed investigation by ever-improving physical and chemical methods. When the results obtained by these methods are put together, what they reveal is not mere physical and chemical mechanism, but the distinctive and specific co-ordination of structure and activity which is characteristic of life. With every experimental advance this co-ordination appears in greater and greater detail, and the assumed mechanism of life recedes further and further into the background.

To see this we have only to compare our present knowledge of nutrition, secretion, circulation, respiration, nervous activity, cell structure, or hereditary transmission with the knowledge of the middle of last century. There is, it is true, a popular and singularly confused idea that

because the increased knowledge has been obtained with the help of physical and chemical methods the interpretation of the results must also be physical and chemical interpretation. The actual interpretation is, however, obtained, not from isolated observations, but from putting together a mass of physical and chemical data, and noting the co-ordination of structure, chemical composition, and activity. As isolated physical and chemical facts these data are unconnected and unintelligible; but they become logically coherent, and therefore intelligible or predictable, when they are interpreted as phenomena of life; in other words, as functionally significant—as manifestations of the struggle for normal life.

Vitalism gave apparent recognition to the characteristic co-ordination in the phenomena of life; but though vitalism is not dead there is no general tendency among biologists to return to it. In present-day theoretical Medicine this position is to a large extent reflected. In the actual practice of Medicine, however, the characteristic co-ordination between structure and activity—the so-called *vis medicatrix naturae*—becomes such a prominent feature that in the absence of a more adequate conception many, if not most, medical men are, I think, still at heart vitalists.

Why is it that biologists cannot return to vitalism? Instead of regarding the conception of life as a conception which applies to the environment as well as to the intimate structure of living organisms, the vitalists applied it only to the intimate structure, and accepted the idea that outside the intimate structure there is nothing but the essential chaos which, as already pointed out, appears to exist in the environment as interpreted on Newtonian lines by the physical sciences. Only inside the living structure is, according to vitalism, this chaos guided into biological order by the influence of the vital principle. Now it is easy to prove by actual experiment that all which the vitalists attributed to the interference of the vital principle within the body is dependent on conditions in the environment, or consists in responses to conditions in the environment. To deny this would not merely be to deny evident facts, but would tend to fetter or discourage experimental research. Vitalism is not the Hippocratic conception of life which I tried to place before you, and which embraces the environment in the conception of life. Whether from the standpoint of this latter conception or from that of experimental biology, vitalism is totally unsatisfactory; and in so far as the mechanistic movement among biologists was a throwing off of the shackles of vitalism I think it was a great step forward.

I have sometimes been called a neo-vitalist. Let me assure you that I am neither a neo-vitalist nor a paleo-vitalist. On the other hand, I am quite unable to accept the conception that biology can be regarded as a branch of ordinary physics and chemistry. My reason is that, as already pointed out, we find, as a matter of fact, that in the phenomena of life there is inseparable co-ordination of structure and activity, in such a way that the specific structure of each centre of life is maintained through its activity, and the activity is of such a nature as to maintain the structure. This fundamental fact distinguishes biology from the physical sciences, or at any rate from the physical sciences as interpreted on ordinary Newtonian lines, since structure and activity in the physically interpreted world are not regarded as connected with one another to form a specific and persistent whole. To make biological phenomena intelligible or predictable the distinctive conception of life is essential. If a label were required for this teaching one might call it neo-Hippocratism.

The Logical Separation of Biology from the Physical Sciences.

Biology is distinct from the physical sciences. It is an independent science with a fundamental conception of its own. The distinction is not one which, as the vitalists thought, we can localize in space within the organism. Nor can we, by tracing the course of evolution backwards, localize it in time. The theory of organic evolution requires the assumption of specific hereditary transmission, and hereditary transmission itself assumes the distinctive character of life. The idea that by a process of natural

selection life could be evolved out of, or "emerge" out of, physico-chemical mechanism is not a coherent idea. The distinction between biological and physical phenomena is a logical distinction, or a distinction in the general conception which we must employ in order to represent the distinctive character of the phenomena observed and be able to predict them. When we are considering what we call inorganic phenomena we deliberately neglect the biological aspect of our actual observations, setting this aspect aside as belonging only to what Locke quite inadequately designated as the "secondary qualities" of objects. But when we are considering living organisms themselves, or their environment in so far as it influences them, the biological aspect becomes of overwhelming importance, so that a biologist cannot neglect it without rendering his observations unintelligible as well as disconnected. The existence of biology is an assertion of the fundamental fact that Nature is no mere physical chaos.

The physico-chemical or mechanistic conception of life was doomed from its outset to failure. It attributed the characteristic behaviour of living organisms in regulating the influence on them of environment to peculiarities of their physico-chemical structure; but in so doing it overlooked the fact that the specific structure of a living organism can itself be shown by experiment to be dependent on the influence of its environment. The mechanistic theory was thus in reality constantly reasoning in a vicious circle. It separated anatomy or morphology, as dealing with structure, from physiology as dealing with activity, whereas any such fundamental separation is impossible, since living structure is merely the expression of living activity. Structure and activity are inseparable aspects of a co-ordinated whole which is specific or normal for each species of organism, and indeed for each individual organism.

The mechanistic theory, as represented in the *De Homine* of Descartes, or in writings of the mechanistic biologists of the latter half of the last century or of to-day, does not hang together, any more than the vitalistic theory. We have all been brought up on the mechanistic theory, as represented in the writings of such men as Huxley, and embodied in present-day popular literature. It is thus an intellectual wrench to abandon this theory; but, though it may survive as a widespread form of belief for many years, abandon it we must. When we abandon it, without returning to vitalism, we can form a satisfactory conception of biology, as being a branch of science which is progressively revealing to us, not the mechanism of life, but a more and more detailed knowledge of the structures and activities which express life as such—as a whole which in the case of each organism exists as specifically or normally co-ordinated structure and activity.

Biology and the New Physics.

This conception of life is, of course, in itself a direct challenge to the ordinary Newtonian interpretation of the visible and tangible world, as represented in traditional physics and chemistry, and amounting to the treatment of Nature as essentially chaotic in the sense already defined. A few years ago that challenge would, apart from the challenge of the eighteenth-century philosophers and their successors, and of ancient Greek writers, have stood alone. But physicists and mathematicians have now themselves joined in the challenge, and have come to regard the traditional Newtonian physical conceptions as no better than preliminary or provisional modes of interpretation. So far as I am able to judge, the new physical conceptions of the last few years are so closely allied in certain fundamental respects to the biological conception which I have tried to explain that the latter conception is no longer a direct challenge to them, but furnishes hints for their further development, while conversely the new physical conceptions furnish hints to biologists. In other words, physics and biology are coming together, not on the lines of reducing biology to the status of a branch of the old physics and chemistry, but on the lines of so fundamentally modifying the conceptions of physics and chemistry that a meeting-point between biology and the physical sciences can be anticipated. Even if that meeting-point were

reached, however, individual life would still appear as a struggle against chaos, since the warring units of life in a universe of life would still be chaotic.

Importance of Human Biology.

It is in the lives of the most highly organized organisms, when they are physiologically intact, that we can discern most sharply and easily the wholeness of life. It is therefore with their study that biology naturally begins. In so far as human life is accessible to observation, human biology tells us more, and tells it more clearly, than does the biology of lower organisms. The human subject of observation can himself tell us what animals cannot tell. It is also easy, with a human subject, to control exactly the conditions of an experiment. To observations made in the course of medical and surgical work, and under varying conditions of human activity and environment, we owe a very great part of biological advance. With every year, moreover, the human subject becomes more and more accessible to experimental investigation. It is not merely, therefore, because human physiology and anatomy are indispensable in practical medicine that they are of special importance, but because they afford so much accurate scientific insight into the phenomena of life. With the mechanistic physiology, which aimed at referring the characteristic features of physiological activity to innate peculiarities in the structures of different organs and tissues, both human experimental physiology and the physiology of intact organisms of every kind tended to be thrust into the background.

I can speak from personal experience on this point. My own experimental work as a physiologist has been mainly in human physiology; but I had for long to accustom myself to its being regarded as of little real scientific importance, since it was done on an intact and very complex organism. As a matter of fact the work I was engaged on was of great scientific significance, and, as in the case of much other physiological work, it was only on normal and intact human subjects that it could be carried out.

The scientific, as well as practical, significance of human experimental physiology is now far more widely recognized than it was a few years ago; but I think that a good deal remains to be done in the way of getting rid of both practical and theoretical teaching based on the mechanistic idea of life. It is not merely because of its irrelevancy to practical medicine, but because of its scientific defects, that this teaching seems to me very unsatisfactory. From the study of an isolated organ or tissue we can certainly learn much; but we learn only a little about how the organ or tissue behaves under normally occurring conditions. This is because we have violently altered beyond normal limits the conditions of environment which Nature maintains in the intact organism, and have thus made the responses of the organ or tissue abnormal, so that we do not discover how it behaves in the intact organism. Even an anaesthetized, though otherwise intact, animal is not in a normal state. We are thus apt to miss knowledge which we should gain at once from experiments on an intact or nearly intact organism. The search for imaginary "mechanisms" diverts us from the search for what can be found.

From the behaviour of an isolated perfused kidney or lung we gain little or no knowledge of the amazing delicacy with which the kidneys and lungs in an intact man or animal regulate the composition of the internal body fluids. Attention is, in fact, directed away from this regulation, whereas when the living body is intact experiments which are easily carried out on man reveal the regulation in the most striking manner. Regulation or co-ordination means nothing fundamental for the mechanistic physiology, and thus receives very little attention, or is twisted round so as to be made to appear as if it were nothing but a sort of mechanical balance, dependent on innate peculiarities of structure or composition. It is common, for instance, to speak of the regulation of reaction in the living body as if this were an equilibrium of acid and base, maintained approximately steady by the presence in the body of buffering substances, instead of by

physiological activity. Language of this sort is imagined to be scientific: it seems to me only evidence of lack of scientific insight. A similar remark applies to such expressions as the "mechanism" of heredity, or of secretion or respiration. In actual fact the structure is bound up with the regulation, so that co-ordinated or regulated activity is a primary feature in life. In other words, the functional significance of biological structure and activity is of its very essence. The application of the word "mechanism" to life amounts to the assertion that this is not true.

Not only practical Medicine, but also Biology itself as a science, is dealing with the essentially and specifically co-ordinated structure and activity which we call life. In laying no primary stress on the co-ordination or regulation the mechanistic physiology has not only tended to divorce itself from practical Medicine in the manner we are all painfully aware of, but is radically unsound in a scientific sense. It is life as an essentially co-ordinated whole that physiology, no less than practical Medicine, has to keep in view. Practical teaching which consists mainly in experiments on isolated fragments of frogs or other animals, and in isolated chemical experiments on substances occurring in the body, is no satisfactory instruction in Physiology as a science.

The Hippocratic Foundation of Medicine.

I have already remarked that life appears to us as a constant struggle for organic order in an otherwise chaotic world, and that the function of Medicine is to give assistance in that struggle where assistance is called for. In order to give this assistance effectively we must know in detail how the struggle is normally conducted successfully during health. We must thus know normal anatomy and physiology, and this implies also a knowledge of physics and chemistry, without which we should be ignorant of what life is struggling against, or of the very existence of a struggle. Normal anatomy and physiology would include all the knowledge that can be obtained of the local conditions on which normal local structure depends, and of how attacks by foreign organisms are normally repelled. From such knowledge we can already see to some extent where failure in the struggle for normal life is liable to occur, and how such failure can be guarded against.

For the purposes of practical Medicine we must, however, push our investigations far outside the limits of normal physiology and anatomy, and study the consequences of quite unusual or not yet understood disturbances in environment, including, for instance, more or less successful attacks by foreign organisms. For Medicine the symptoms, such as pain, depression, wasting, failure of function, or abnormal behaviour, are all signs of a disturbance in normal environment. In such cases the struggle for life has been at least partially or temporarily unsuccessful; but the Hippocratic conception implies that there always is a struggle. Usually the struggle is more or less successful in the end, so that health is re-established. Sometimes, however, the struggle is more or less unsuccessful, and results in permanently impaired health or death unless conscious intervention in the struggle is effective.

It is on this struggle against abnormal disturbances, and the means of helping in it, that medical science must centre its attention, as Hippocrates first pointed out. For mechanistic biology there is no real struggle, and if the mechanistic biology represented truth we might despair of anything further than preventive Medicine of a very restricted kind. But on this point I am heart and soul with Hippocrates, and with the traditional faith which he inspired in the ranks of our profession. I have already explained why, as it seems to me, the mechanistic conception of life is inadequate in physiology and morphology. For the same fundamental reasons it is inadequate in Medicine, and in pathology, pharmacology, and therapeutics.

To assist Nature in her struggle we must understand the struggle as fully as we can. To realize the disturbances which are confronting her we need all the physics and chemistry which are essential in normal biology, as well as what can be applied to the abnormal conditions causing disease or injury. We also need to know the biology of invading organisms if the disturbance is due to them.

On the other hand, we must understand how, in detail, the struggle against the disturbance is being carried on, and we must not mistake, as we are very apt to do, the evidences of this struggle for the primary disturbance itself. It is only by patient observation, thought, and experiment, recorded, or communicated by example and orally, in the spirit of the Hippocratic oath, and continued from generation to generation, that we make progress in Medicine; but assuredly the evidences of that progress were never so striking as in our own times, or the prospects of further advance more encouraging.

Medicine has progressed along the Hippocratic pathway regardless of the mechanistic theory of life; but I think that with a more adequate biology, including proper regard for human physiology, and the definite establishment of anatomy or morphology as an experimental science just as much as physiology is, the progress will be still more rapid. I have tried in this address to give reasons for the conclusion that the mechanistic theory of life is an insufficient foundation for Medicine, and that the Hippocratic foundation is the only secure one. I well know how many, particularly outside our own profession, will be inclined to disagree with me, and I wish this address had been a less controversial one. But I am convinced that specifically biological knowledge is the scientific basis of Medicine, and that it is of very great importance to Medicine, as well as to biology itself, to be clear as to the fundamental conceptions on which biology is based. In the process of clearing our minds controversy is unavoidable, and this must be my excuse for being controversial.

EXCESSIVE AND IRREGULAR UTERINE BLEEDING IN MIDDLE-AGED WOMEN.*

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THE causes of uterine haemorrhage fall into two main groups—those which are and those which are not connected with recent pregnancy. This paper is concerned with middle-aged women between the ages of 40 and 50, who have passed the child-bearing age and are therefore free from the causes of bleeding connected with pregnancy. They are subject some time during this period to the changes of the menopause, which usually consist in a diminution of the amount of the menstrual bleeding and its duration. Sometimes a period or two are missed, and a small period occurs every two or three months or at increasing intervals; occasionally, after an interval of two or three months, the next period is rather severe, amounting to a flooding; but anything in the nature of irregular or excessive bleeding is abnormal, and must be regarded with suspicion.

For clinical purposes cases of uterine haemorrhage fall into the following three groups:

1. The menstrual periods are regular, but prolonged or excessive in amount—commonly called menorrhagia. This is found most commonly in the case of fibroids, hypertrophy of the endometrium, chronic metritis, and chronic sub-involution.

2. The bleeding is excessive and irregular, or there is bleeding at times other than the menstrual periods—commonly called metrorrhagia. This suggests malignant disease—for instance, carcinoma of the cervix, or, less commonly, the body of the uterus; sometimes it is due to one of the conditions mentioned in the previous heading which has gone on for some time.

3. Bleeding occurs at some interval after the menopause and may be only slight in amount, even just a show. This always suggests malignant disease, but is occasionally due to some non-malignant cause.

1. REGULAR BUT EXCESSIVE BLEEDING.

If the bleeding is excessive and regular (menorrhagia) the most likely cause is some innocent condition—namely, (a) uterine fibroids, or (b) a group including hypertrophy

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