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Introductory Lecture

to the

Course of Physiology

IN KING'S COLLEGE, LONDON, 1869.

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INTRODUCTORY LECTURE.

Gentlemen,

When a professor opens his first systematic course of lectures, it is customary for him, instead of plunging at once into the details of his subject, to occupy the attention of his audience with some remarks of a general character. In conformity with this custom, I have on this occasion to request your attention to some observations on the general scope of the science of physiology, its past history, its present aspects, the mode in which it is being advanced, and the manner in which I hope to teach it in this school.

The term physiology, derived from *φυσις*, nature, and *λογος*, a discourse, is strictly applicable to natural science in general. In this sense it was used by the Greeks, but it has for a long time been employed to designate only that part of natural science which treats of the origin, development, and death of living beings, together with the functions which they perform, and the conditions necessary for maintaining them in a state of health.

There is a physiology of plants, and a physiology of animals, but the considerations involved by these departments are so elaborate and complex, that it has been found convenient to divide physiology into three branches. The physiology of man, that of the lower animals, and that of vegetables; in other words, human, comparative, and botanical physiology.

These three divisions are each so comprehensive, that they are taught by three professors. Human physiology is the section which falls to our consideration, and is itself a subject of such vast extent that it will occupy our attention during the entire session.

Physiology is based upon a tripod, consisting of Anatomy, Chemistry, and Physics. Hence we have physiological anatomy, physiological chemistry, and physiological physics.

The term "physiological anatomy" is conventional, and somewhat apt to mislead. Anatomy treats of the structure of living beings: all anatomy must therefore be physiological, inasmuch as it is the province of physiology to determine the functions or actions which the various parts of living beings perform. It has, however, been found convenient to discuss, in a course of human physiology, that part of anatomy which relates to the minute structure of the tissues and organs of the body. This subject has therefore been termed physiological anatomy, and is often also designated general, minute, or microscopic anatomy, or more frequently histology. Physiological chemistry treats of the chemical composition of living beings, together with the chemical changes which take place within them; while in the province of physiological physics are discussed those non-chemical laws regarding matter and energy which are common to animate and inanimate objects.

Ancient Greece was the cradle of physiology and of medicine. In that strange old time when Pythagoras, Hippocrates, Plato, Aristotle, and Epicurus lived and wrote, and when the morning of science was but beginning to dawn, it was fancied that all matter consists of four elements—fire, water, earth, and air. Thales imagined that in water the secret of life may be found. According to Anaximenes, it is in the air. In the opinion of Xenophon, it is in the earth. While Pythagoras and many of his followers thought that it is to be found in *heat*.

Strange to say, this old Pythagorean notion, which originated twenty-four centuries ago, is now a popular tenet with some of the leading physiologists of the present day. Hippocrates, who lived four centuries before Christ, agreed with Pythagoras in ascribing an important place to the agency of heat, but he further supposed that there is a principle, termed by him Nature (*φυσις*), which presides over and directs all the actions of the body. He ascribed to this principle the power of selecting what is beneficial, and of rejecting what is detrimental to the body—a notion which still exists among the physiologists of our time.

Immediately after Hippocrates came Plato, the precursor of the spiritualists. He imagined the existence of the soul within man, and believed that it consists of three parts—the appetites, seated in the belly; the passions, residing in the breast; and the cognitive faculty, placed in the head. To the influence of these spirits he ascribed all the actions which take place in the body.

Aristotle held a somewhat similar doctrine. "Soul, generically considered, he defined to be the vivifying principle, or vital energy, common to all organic bodies, distinguishing this principle, as it exists in plants, in animals, and in man, into the vegetative, the sentient, and the rational soul. The organic functions of nutrition and generation, as they occur in plants and in animals, Aristotle attributed to the vegetative soul; the animal functions of sense, voluntary motion, appetite, and passion, he referred to the operation of the sentient soul; and the exercise of those powers of intellect by which man is distinguished from other animals he ascribed to the agency of the rational soul."*

* Thomson's Life of Cullen, vol. i., p. 167.

The vegetative soul Aristotle defined as the power by which all organized beings live. It is the same principle as that termed *Nature* by Hippocrates, as the *Archæus* of Paracelsus, the *vis essentialis* of Wolff, the *nisus formativus* of Blumenbach, and the *vital principle* of Barthez and other modern authors.

But the views of Aristotle, powerful though his great genius rendered them, did not go unchallenged. There arose a sect of materialists, headed by Epicurus, who refused to believe in spirits, and who maintained that the body is but an accidental assemblage of atoms, and that the various functions of its organs are simply due to different modes in which these atoms are grouped together.

Last of all these ancient physiologists came Galen. He lived seventeen centuries ago. Previous to his time physiology had made little progress, but his brilliant genius gave to it a new and powerful impetus. He eagerly studied anatomy, and was thereby led to inquire into the functions discharged by the various organs of the body. His knowledge of the minute structure of parts was so much more profound than that of his predecessors, and his notions regarding their functions so ingenious, that for centuries after his death his followers simply accepted and believed all that he had said, as though he had been an oracle.

But the morning of physiological science, which had dawned so auspiciously, became overcast. The struggling light grew dim by reason of the thickening darkness of barbarism which set in, and more than a thousand years came and went ere further progress was made in the investigation of living things.

The fifteenth century ushered in a new era. Learning revived, and with it physiology. For some time after this revival physics and chemistry were eagerly studied; and it not unnaturally followed, that while the mathematicians attempted to explain all the actions of the body by mechanical laws, the chemists were equally anxious to shew that their science could satisfactorily account for these.

But notwithstanding the eagerness of the mathematicians and the zeal of the chemists, physiology made no important advance until two centuries and a half ago, when our immortal countryman Harvey discovered the circulation of the blood, and so ushered in the dawn of modern physiology.

Although the Novum Organum was published soon after the circulation of the blood was discovered, it was long ere the inductive method was adopted in the investigation of vital phenomena; and it must be confessed that it was in Germany, and not in England, that the writings of Bacon first influenced the physiologist. It was the great German physiologist, Haller, who, a century ago, first showed that physiology must be founded upon observation and experiment—who systematized and greatly added to the then existing knowledge, and thereby gave to our science its present shape. On this account Haller has been termed the "father of modern physiology;" but I think that this title may be claimed for Harvey, without doing injustice to Haller. Harvey made the greatest of all physiological discoveries ere the Baconian method was promulgated; while Haller, more than a century later, merely gathered together and arranged facts and made discoveries with Bacon's tools.

The activity which physiologists began to display after the impetus given by Haller led to the rapid growth and development of our science. I need not at present name to you the master-minds of this and other countries who in this and the latter part of the past century have raised physiology to its present elevated stand-point. These will become household words to you as we discuss the various branches of our subject. Let me rather now indicate to you the present state of physiology, and how the science is being, and is still likely to be, advanced.

You are entering upon the study of physiology at a singularly active stage in its history. There never was a time when physiologists have been more thoroughly in earnest than they are now. The fashionable philosopher of a bygone age, who sat in his closet and dreamt, but who thought it beneath his dignity to condescend to experiment, and thereby allow fact to bridle his fancy, is happily now a *rara avis.* He now is reckoned the true philosopher who carefully observes the operations of nature, and questions her by means of experiment; who draws just inferences from his data; and who, though he may launch forth brilliant conceptions needing verification, nevertheless earnestly strives to find out things as they are, and not as, according to his feeble fancy, they ought to be.

The number of investigators in physiological science never was so great as it is at this moment; and yet, strange though it may appear, the progress made is not in such proportion to the number and talent of the workers as it has been during the last fifty years. The explanation of this is readily found in the fact that all the easy things have been done. Lines of research which some years ago readily led to the attainment of numerous and brilliant results have now landed us in regions where exploration is difficult, and therefore slow. For example, the great improvement which took place in the construction of microscopes some forty years ago was speedily followed by a multitude of discoveries regarding the minute structure of the tissues and organs of the body, and the functions which many of these discharge. But now nearly all the facts which can be easily ascertained by this instrument have been discovered; and although startling revelations still reward those who diligently explore the field of histology, it is nevertheless true that these are now few and far between. Among those who have used this instrument with great success, my predecessors in this chair, Mr. Bowman and Dr. Beale, stand pre-eminently forth. Mr. Bowman by his researches on the structure of muscle, the structure of the eye, that of the kidney, and other parts, gained for himself a wide-spread fame as a histologist; while my immediate predecessor and present colleague, Dr. Beale, by his beautiful researches on the structure of the nervous system, by the introduction of high magnifying lenses, by the remarkable skill with which he has used these, and by the brilliant conceptions to which his microscopic researches have led him, has won the deepest respect and admiration from the whole scientific world, and has conferred an undying reputation upon the chair of physiology in this school.

Although the future progress of microscopic research doubtless depends not a little upon improvements which will be effected in the construction of the instrument, it has for some years been evident to all that histology now waits on physiological chemistry. We want new modes of acting chemically upon the tissues ere we subject them to microscopic observation.

Still, however, there is yet a deal to be done in searching out the normal structure of the tissues and organs with the means at our command. Although the structure of the human brain has been explored to such an extent by that most skilled microscopist, Dr. Lockhart Clarke, and, as might be expected, nothing remains for any but accomplished histologists to undertake, still in the minute structure of the brains of the lower animals we have a most extensive subject, which many of you might now begin to investigate; and assuredly you could not work at anything more interesting and more important in the whole range of histology.

There is much more to be expected from that kind of research which consists in stimulating, mutilating, or removing a part of the body, and watching the result. In the hands of Bell, Majendie, Reid, Brown-Séquard, Schiff, Bernard, Eckhard, Vulpian, and others, this method of procedure has led to the most important consequences; but, inasmuch as it is not a particularly difficult kind of research when applied to anything but the brain and delicate nerves, it has already been well-nigh exhausted. By this method we have attained most of our knowledge of the functions of the nervous system more especially. But although that knowledge is, on the whole, satisfactory in the case of most of the nerves and the spinal cord, it must be admitted that, with regard to the functions of the brain, the most important organ of all, the information hitherto acquired in this way is far from what it may yet be, if even no other method than this be resorted to. I shall describe to you at a future time the peculiar manner in which researches on this subject may yet be undertaken.

In speaking of the nervous system, I may mention that there is a fruitful mode of research open to you when you become physicians. It consists in the careful observation of the symptoms of nervous disease, combined with an accurate microscopic examination of the diseased parts after death. In this manner much will yet be learned of the function of the brain more especially.

Modern physiology has been enriched by a number of ingenious instruments for assisting us in the study of the motions which take place in the body. By means of the ophthalmometer, the movements of the crystalline lens have been accurately measured, and the changes it undergoes when we look at near or distant objects absolutely determined. Nerve force, which until lately was supposed to travel with such wonderful rapidity that "quick as thought" actually became a proverb, has, by means of Helmholtz's myograph, had the rate of its transmission along a nerve accurately estimated; and it turns out that, after all, this mode of energy moves with snail-like slowness when compared with the rate at which light and electricity travel. The movements which take place in the respiratory and circulatory systems are now being studied by means of numerous instruments of great ingenuity. We no longer trust our easily misled sense of touch when we want to accurately ascertain many obscure facts with regard to the pulse. In performing an experiment upon the circulatory system, we no longer estimate the force of the heart's action by merely feeling the pulse, or by observing the distance to which the blood is projected from a divided artery: we accurately measure the force and record the movements of the heart by means of suitable apparatus. These various instruments have been called "instruments of precision," inasmuch as they have rendered definite what could be only conjectural, or at best doubtfully ascertained, before their introduction. A great feature in many of them is the employment of a graphic method, by means of which the facts ascertained through their aid may be recorded. Thus we have the myograph, for recording the movements of muscles; the spirograph, for the respiratory movements; the cardiograph, kymograph, and sphygmograph, for registering movements which take place in the circulatory system. By means of these instruments, movements are recorded on revolving cylinders or on flat surfaces, so that a tracing, or writing, indicating the character and extent of the motion, may be preserved. A very important advance has taken place in physiology since this ingenious method was introduced. We owe it to our countryman, Thomas Young, who invented it while prosecuting some researches in physics; but to Vierordt and Helmholtz in Germany, and Marey in France, must be awarded the credit of having introduced it into physiological research.

The instruments to which I have alluded, together with many others employed in aiding physiological experiment, I hope to be able to show you in operation during the present session.

Undoubtedly the great achievements which are yet to be made in physiology will be accomplished by the chemist and physicist. Much, indeed, has already been done in physiological chemistry and physics; yet it is but a tithe of what undoubtedly remains. Physiological chemistry is yet in its infancy; at this moment it resembles the bottomless abyss at the foot of a cataract. A torrent of facts and speculations is continually pouring into a seething, surging gulf, in which there is scarcely anything but unrest. We have to deal with little else than a mass of facts as yet without arrangement. Do not, however, be discouraged by the unsatisfactory picture which I am obliged to place before you; rather let it stimulate you to enter the ranks of those who strive to find out the hidden things which have as yet baffled the investigator. In this great department there is assuredly work enough for centuries yet to come.

The physicists and the chemists are now more energetic than ever they have been in endeavouring to ascribe vital phenomena to physical and chemical force acting in certain peculiar arrangements of matter. Mayer's great conception, that energy, like matter, can neither be created nor destroyed by man, and that one form of energy is convertible into another, furnished a point of departure, which has led to a new epoch in natural science. This theory, curiously enough, brings us for the explanation of life back to the idea, put forth by Pythagoras, that heat is the parent of vitality. It was a happy guess on the part of the ancient philosopher; while with Mayer, the theory which leads to this conclusion resulted from the consideration of facts well ascertained in modern physics.

At a future time it shall be my duty to fully explain to you this principle of the conservation of energy put forth by Mayer, and elaborated by Helmholtz, Joule, Grove, Carpenter, and others; but I may at present briefly say, that on this theory we are led to look at the organic world in this way: we are invited to believe that just as the matter of which living beings consist is simply a peculiar arrangement and combination of that matter of which the inorganic world is composed, so the forces which organic matter exhibits are simply modifications of those forms of energy which we find in the inorganic world: they are but transformations of physical energy effected by peculiar arrangements and combinations of matter.

Should this theory be established, the notion of a vegetative soul or vital principle governing all the nutritive changes in organic bodies will be upset. Indeed, many leading physiologists have already abandoned their belief in the vital principle, and have adopted the explanations of the physico-chemical school. These have been accused of being materialists, and no doubt the epithet in its most severe sense is applicable to some of them; but, undoubtedly, not a little misconception exists among some of their critics. In the seventeenth century it was Stahl's great error that, while professing to counteract the physico-chemical tendencies of his time, he, in advocating the existence of what we now call a vital principle, identified that spirit with man's reasoning faculty. He failed to see what Aristotle had clearly perceived centuries before him—that a distinction must be made between man's rational soul and his vegetative soul or principle of vitality. Unhappily, there have been many writers since Stahl's time who have fallen into the same error. But it seems to me a great mistake to suppose that if we refuse to believe that a vegetative soul exisits in a cabbage or a snail we must necessarily no longer believe in the existence within man of that rational soul which gives him his true nobility. It appears to me that we may refer the vital phenomena of a cabbage to the agency of physico-chemical force, and yet none the less firmly believe in man's spiritual being. *But in all this we must beware lest our fancy carry us beyond the legitimate interpretation of our facts.* It of course becomes us as physiologists to view steadily and inquiringly the aspect presented by living nature, when viewed by the light which physics and chemistry already afford. By working with the aid of that light, we have some chance of rending the thick veil which yet shrouds the nature of life in mystery. For, to the cardinal question of physiology, What is life? we must as yet return the answer—We do not know. If we fold our hands and refuse to believe in anything but a hypothetical vital principle, we shall never know; but when we have learned how to rightly comprehend the various forms of energy and the transformations which matter may undergo, we may be able to say that we have found out the secret of vitality.

In thus rapidly and imperfectly sketching to you the past history and present aspect of physiology, I think I must have given you some idea, however faint, of the rich harvest which yet awaits the physiological labourer. Certainly, a well-arranged and most comprehensive science has already been reared; but it is destined to attain proportions much more gigantic than it now presents. When we look around and ask where physiology is advancing with greatest rapidity, we are compelled to turn away from the country of Harvey, and look towards the land of Haller. Long ago the Germans perceived the vast importance of every physiological school being provided with a laboratory, furnished with all the physical and chemical appliances necessary for the prosecution of our science. They have approached physiology from the side of chemistry and physics. Public money has been freely given to assist them in scientific inquiry, and the result is that at every German school of medicine there is a practical school of physiology, where an amount of work is done which, in the aggregate, is so vast that it surpasses the physiological work of all other countries put together. In this much wealthier country we are not so fortunate. Public money but seldom finds its way to the assistance of inquiries, even though these have the well-being of the human race, and the aggrandisement of no one, for their ultimate object. The Council of this College is sufficiently alive to the importance of attaching a physiological laboratory to this Chair, thereby introducing the study of practical physiology into this school. Unfortunately it has hitherto been found impossible to procure sufficient accommodation for the purpose; but happily there is every reason to believe that, in connection with a contemplated extension of the College, a laboratory, fitted to meet the requirements of modern physiology, will ere long be obtained. Meanwhile, however, it shall be my constant endeavour to render this course as practical as possible; for physiology is an experimental science, and just in proportion as the student is trained in the performance of physiological experiment, so will physiology, and with it medicine, advance. By-and-by I hope to establish a class for the study of practical physiology, such as that which has been attended with results so beneficial in the University of Edinburgh.

After the eloquent manner in which my colleague, Professor Johnson, pointed out to you, on Friday last, the fundamental position which physiology occupies among the medical sciences, and the absolute necessity there is for anyone who proposes to practise medicine to make a diligent study of physiological science, it is unnecessary for me to add anything. I have only now to invite you to enter earnestly into the study of what you will certainly find is very fascinating. It may be difficult, but assuredly it will not be dull. I doubt not that you will be interested, and that your enthusiasm will be kindled by the strange things which physiology has already revealed, and by the suggestive pictures which she has to present to your fancy. I cannot believe that you will be able to resist the promptings she will give you to inquire into her mysteries. Although she will show you inexorable laws which you cannot disobey and escape the necessary consequence, yet she points out how the snares and pitfalls into which the ignorant and perverse slip may be avoided, while she widens our infinitely too narrow conceptions of that great First Cause who created matter and energy and fixed their laws.