of 1916–17 in New York. It was further recommended that the New York meeting be a special meeting in which all affiliated societies should be invited to take part and that such general convocation-week meetings should be held at intervals of four years, the second to be in Chicago in 1920–1921.

At its last meeting the council passed a resolution extending its warmest appreciation and thanks to the local committee, to the citizens of Atlanta and all those who contributed so ably and willingly to the comfort and entertainment of the members.

Atlanta has been called the metropolis of the "New South" and those visitors who found time to visit some of its many interesting places and institutions went away with new impressions that were not the least assets of a most enjoyable and successful meeting.

H. W. Springsteen,
General Secretary.

THE METHODS OF THE PHYSICAL SCIENCES. TO WHAT ARE THEY APPLICABLE?[1]

It is generally expected that a retiring vice-president shall deal in his retiring address with one of two things, either some aspects of his own work or some of the important questions which are agitating his own branch of science. My excuse for doing neither of these is that I do not feel that my own researches are of sufficient general interest for mention at this time, and that the masterly address of Professor Millikan last year on the theory of quanta had made it impossible for me to add anything to perhaps the most important of the recent new developments in physical theory. In deciding to content myself with some general observations I find that I have exposed myself to two risks, one that of repeating ideas that I have before expressed, the other that of seeming to have borrowed from the very interesting and fruitful address of Sir Oliver Lodge at the recent meeting of the British Association.

We physicists may certainly look with satisfaction at the present condition of our science, for although it finds itself in a period of violent flux involving the possibility of the discarding or modifying of some of our most cherished notions, it still remains as the model for the other sciences, many of which it logically includes in itself. When we speak of the methods of physical science, we of course mean the experimental method, as that is what distinguishes modern science from that of antiquity, but we include not only the methods and instruments of observation but also our methods of thought and reasoning. If we are to class sciences by the instruments used, we shall find most of them to belong under physics. Thus astronomy, so long confined to the study of the positions of the stars in two coordinates on the heavenly sphere, made use almost exclusively of the telescope and the clock, as important in the physical laboratory as in the observatory, while the modern part of astronomy annexes to the telescope the spectroscope and the photometer, the bolometer with its attendant galvanometer and the most recent developments of the physical laboratory in measuring radiation, including the recently discovered liberation of electrons from metals by light. For over a century chemistry has depended upon the physical balance as its chief instrument of measurement, while to-day the chemist uses the thermometer and calorimeter, the manometer for gas and osmotic pressures, and all the instruments for the measurement of electrical current and difference of potential that the physical labo-

[1] Address of the vice-president and chairman of Section B—Physics—American Association for the Advancement of Science, Atlanta, December, 1913.

ratory can afford him. As for meteorology or cosmical physics, it has no instruments except those of the physical laboratory.

But even outside of the purely physical sciences, we see the application of their methods of experimentation. In the physiological laboratory we find not only thermometers, but accurate manometers for the measurement of the blood pressure, and registering instruments for all the rhythms of the various organs and the study of fatigue, with electroscopes and galvanometers for the study of the electrical phenomena connected with the nerves and muscles. In fact the fertile brain of the physiologist Einthoven has given back to the physicist the most sensitive galvanometer that he possesses in the beautiful string-galvanometer which is used to study the action of the heart by means of the electric currents connected with its beating.

The science of botany is one that in many of its methods seems very remote from physics, and the work of the systematic botanist whose main interest seems to be to collect and label different plants and file them away in herbaria seems the antipodes of the methods of the physicist. And yet we have now the subject of plant physiology, in the laboratories of which we see again the familiar physical instruments in new applications. But recently in such a laboratory I saw an artificial tree, constructed of glass tubes and porous porcelain, which raised water from a reservoir and evaporated it into the air in close imitation of a real tree. Here again the thermometer and hygrometer are of prime importance, while we may expect the calorimeter, which has become so very important in physiology in connection with nutrition, to play its part in botany as well. It is of interest to find that the direction of the vertical, which seems to be so important in connection with the growth of plants, is not mysterious, but that if the plant is subjected to centripetal acceleration in a whirling machine, its root will yield exactly as to gravity. Finally we must credit to botany the study of osmotic pressure, the laws of which as discovered by Pfeffer have opened an enormous field to the physicist and chemist.

Finally invading the domain of the mental sciences, we find in the laboratory of experimental psychology, which may be variously termed physiological psychology or psychophysics, the same physical instrument and new ways of applying them. However color is interpreted to the brain by means of the physical and physiological mechanism of the eye, its physical properties must be definitely determined before any progress can be made. Similarly the sense of hearing can not be examined with definiteness until physical standards of sound are forthcoming. The slight advance made in the study of the sense of smell is probably due to the lack of its specification in chemical or physical terms. And the favorite subject of study in this field, that of the time of transmission of nerve impulses or of the formation of judgments, depends on the most fundamental of physical instruments, the clock.

But it would be tedious, as well as unnecessary, to attempt to enumerate all the instruments that have been contributed to the other sciences by physics. Let us turn to the methods of investigation which have proved characteristic of physical science. The collection of examples of phenomena, and their arrangement in classes, is of course characteristic of all the sciences, of botany or of anthropology as of physics. But the essential idea in classification in physics is the quantitative method, which results in methods of measurement, and the invention of instruments for their performance. After this has become possible, the next step is to formulate a theory, which may be of two kinds, either an explanation of the phenomena by means of simpler and more familiar phenomena, or what is more likely to be possible, a theory which is the mere description of the phenomena mathematically in quantitative terms. For example, perhaps the first natural phenomena to be observed were those connected with the recurrence of day and night, the seasons, and the weather. But how long was it before the simple hypothesis was formed of the rotation of the earth, to say nothing of its orbital motion around the sun! And until clocks were invented no very profound conclusions as to the constancy of the length of the day or year were possible. That the properties of space and time might be discussed by philosophers was to be sure possible, but their results would not carry great weight with the new school of natural philosophers. When Galileo deduced by experiment, and described with mathematical precision, the acceleration of a falling body, he probably contributed more to the physical sciences than all the philosophers who had preceded him.

The investigation of physical phenomena has been a most fertile source of improvement of mathematical methods, but this to me most alluring subject I have no time to develop, having treated it at length elsewhere.[1] Of this the most notable example is Newton's invention of the differential and integral calculus, which has given us probably the most powerful instrument devised by man for making discoveries. Without it no progress could have been made in the examination of continuously varying phenomena. Is nature continuous or not, that is, in the neighborhood of every point of space within a distance no matter how small, are there as many other points as we please, and may a similar statement be made for time? Is matter continuous, and do all varying quantities vary continuously? This I do not intend to discuss, referring you to Sir Oliver Lodge, who took that for his subject. But whether nature is continuous or not, it is extremely convenient to postulate that it is so. We are thus enabled to describe phenomena by means of differential equations, explaining or describing what happens at any point of space and time in terms of what is happening at the infinitely near ones. This has been then the most important of our ways of thinking about physical phenomena. For upon this we have based the method of dynamics, so auspiciously begun by Galileo and perfected by Newton. Galileo gave us the notion of acceleration, very important for a single body, but Newton completed it by that of force, which enables us to describe the actions of one body on another. Let me point out to you that what Newton did in connection with gravitation was not to explain it in the sense of telling what its cause is, but, as I have stated above, to describe it in exact mathematical terms. But, much more than this, Newton, by his succinct statement of the laws of motion, gave us the possibility of the explanation of a vast number of recondite phenomena in terms of the more familiar ones of dynamics.

The dynamical method then became the most important of physical methods of explanation. Here mathematics, by some thinkers considered, as Huxley said, to be "that science which knows nothing of observation, nothing of experiment, nothing of induction, nothing of causation," has rendered invaluable services. It is true that mathematics can not turn out more than is put in, but it can transform the data in a wonderful manner. Thus proceeding from Newton's definition of force, it led to the notion of energy, and eventually to the conception of the conservation

[1] Presidential address, American Physical Society, *Physical Review*, 1904.

of energy. To be sure, the notion of energy could not become of universal application until justified by multifarious experiment, and yet this has now come to be a principle in which we have more confidence than any other, not only in physics, but in all the natural sciences. But the principle of energy is not the only generalization of mechanics, nor in fact is it sufficient for the establishment of the equations of mechanics. A more general one is found in the so-called principle of least action, established upon a secure basis by Hamilton. From this principle all that we know of dynamics can be deduced, and by dynamics thus defined all the phenomena of celestial mechanics can be explained, with an accuracy almost beyond belief, the single law of the inverse square sufficing for all heavenly phenomena with an accuracy probably beyond that of our description of anything else in nature.

As one of the triumphs of the dynamical method in the explanation of recondite phenomena must be mentioned Maxwell's theory of the electromagnetic field, leading him to the discovery of the electromagnetic nature of light, and the prediction of electromagnetic waves. But in spite of this and other triumphs, the dynamical method alone was not sufficient in many cases.

Chemistry remained intractable by its means, and all the phenomena involving heat seemed outside its range. But it was at this very point that a powerful addition to the dynamical method came to its aid. As remarked above, the principle of conservation of energy would not have become so intrenched had it not been for its experimental confirmation, especially in the domain of the relations between heat and work, as carried out by Joule. The principle of equivalence, which has since been considered as the first law of thermodynamics, then, extended the dynamical generalization to a far larger field, and explained the disappearance of dynamical energy by its reappearance in the form of heat. But even then certain phenomena remained intractable by dynamical means, such as the well-known phenomena of heat conduction. To turn aside for a moment, the treatment of heat conduction by Fourier furnishes an admirable example of a merely descriptive theory, in which everything is exactly described, but it is of no moment for the theory whether heat is a fluid substance, a form of energy or an agitation of molecules. The laws of flow of heat, although merely descriptive, by analogy led to other great generalizations, notably in connection with the flow of electricity and with magnetism and electrostatics.

The method of analogy, always an attractive but dangerous one, led in connection with heat to a generalization which led to possibilities that dynamics could not furnish. The analogy of the working of water in a mill by falling from a higher to a lower level led Carnot to a conclusion, which though based on an imperfect analogy, led to most important results regarding the possibility of thermal changes. From his statement regarding the efficiency of heat engines, as based upon the fall in temperature of the heat employed, has resulted the second law of thermodynamics, or the principle of entropy, which together with the principle of energy has given us a method of enormous power, which may be indeed extended to those sciences toward which the dynamical method has shown itself as yet powerless. It was to the methods of thermodynamics that chemistry was destined to yield, largely through the efforts of our countryman, Willard Gibbs, and of Helmholtz. The reason for the failure of dynamics alone in chemistry may be stated as follows. The method of dynamics requires the complete specification of a system in terms of a certain number of variable parameters, in terms of which two energy functions may be formed, one involving both the parameters and their velocities of change, and called kinetic energy, the other the parameters themselves only, and called potential energy. Now since we can not see the atoms or molecules, and do not know how they move, we can not form these energy functions, and hence can not form the differential equations. But by means of the principle of equivalence, we may determine the *sum* of the energies, by allowing them to be transformed into heat, and measuring this in a calorimeter. For this purpose we have the valuable thermochemical material of Julius Thomsen and others. But later other methods were devised of holding chemical reactions in equilibrium, and making them go in either direction reversibly. For instance, a salt, which would dissolve in water or an acid with the emission of heat, could in an electrolytic cell, to which a balancing electromotive force is applied, be dissolved or removed from the solution. By distillation the salt could also be removed from the solution, while the use of the semipermeable diaphragm and the methods of osmotic pressure introduced by van't Hoff furnished a variety of methods for the calculation of the energy involved, and the separation of it into two factors, one analogous to a force and the other to a displacement, leading to the definition of chemical affinities. This necessary step being taken, and Rayleigh and Gibbs having shown how the entropy could be computed, the methods of thermodynamics became applicable, and chemistry came under the domain of mathematical treatment.

During all this time the question had been many times asked whether the second law of thermodynamics and the properties of entropy could not be deduced from purely dynamical principles, so that thermodynamics should be brought under the classification of dynamics. To this question a negative answer had always been returned, although Helmholtz had described a certain sort of system for which the law of entropy applied. It was not until the development of a new method in physics, which though using the principles of pure dynamics, went much farther, that this end seemed to be attained. This was the so-called statistical method, which becomes every day more important, and may sooner or later supersede some of our classical methods involving differential equations. The first example of this was afforded by the kinetic theory of gases, in which the properties of a gas were explained by considering it to be instead of a continuous body, an aggregation of a huge number of small similar molecules, moving about with great velocities in all directions, and by their impacts on each other and the sides of the containing vessel causing the pressure. It was at first the custom to treat them as if moving all with a common velocity, the directions being distributed at random, but to Maxwell occurred the happy idea of applying the principles of probability or statistics, the method namely of averaging up the actions of a great number of individuals of which we know little or nothing singly. For instance, we know nothing of the direction or magnitude of the velocity of any particular molecule, nor of the direction joining the line of centers of two colliding molecules, but we may assume, since we know nothing to the contrary, that all velocities and directions are represented, and that there are fewer individuals possessing very large or very small velocities than those having some mean velocity. The only laws of mechanics made use of were that between impacts the velocity of a particle was constant, and that in each impact the momentum and energy were conserved. The important thing then was the application of the laws of probability, and by this means Maxwell was led to show that in a steady state, that is, one independent of the time, the velocities were distributed according to the so-called law of errors. As this law is so important, permit me to give the familiar example which illustrates the main points of the discussion. Suppose we have a vertical board into which are driven a large number of horizontal pins regularly arranged in symmetrical diagonal lines. If now we allow shot to fall from a funnel above the middle of the board, a shot striking any pin will fall either to the right or the left. Of course the circumstances will, according to the laws of dynamics, determine in each particular case which way it will fall, but if we know nothing more about them we can only assume that it is equally likely to fall either way. The next time it strikes the same thing is the case, and the question arises what will be the effect of a great number of similar causes each equally likely to act one way or the other. The answer is simple. Evidently there will be more shot that will fall directly below than toward either side, and the distribution will be symmetrical on both sides, falling off to nothing at great distances. If we should find that the distribution was unsymmetrical we should immediately infer that there was something unfair about the apparatus, for instance, the pegs were different on one side from the other.

Let me here diverge for a moment to point out that here is a method which is as applicable to biological phenomena as to dynamics, and that by its means the resultant of a large number of causes acting at random may be investigated. The essential of the method is that one of two effects is held to be as likely as the other. If we consider a large number of similar objects, say beans or shells, measure their length or some characteristic feature, the different values will in general be distributed according to the law of errors. If not, our assumptions as to what is equally likely are not true. This statistical method is of the greatest use in anthropology and in the study of inheritance, now such an important part of biological study. It is true that the biologist may object that this method is a purely mathematical one, and is not borrowed from physics. This I shall not stop to discuss, merely pointing out where the same method is applicable to both physical and biological phenomena.

To return then to the application of statistical methods to dynamics. Besides the law of distribution of velocities, Maxwell was able to show that if molecules of two or more kinds were admitted to the same space then when statistical equilibrium was attained the mean kinetic energy of the different types of molecules would be the same, thus leading to a dynamical explanation of the law of Avogadro, one of the most important of chemical laws. Boltzmann, taking up the subject at this point, pushed the generalization of Maxwell farther, and applied it to individuals each more complicated than the simple molecule, and was able to show how a system not in statistical equilibrium tends to approach that condition. Furthermore, he defines a certain function of the state of distribution which continually tends to increase, thus having the same property as the entropy of a system. Thus for the first time we get an explanation of entropy, which dynamics alone failed to give, by means of statistical dynamics or probability.

Perhaps the most striking triumph of the statistical method has been its application to the theory of radiation from a hot body, which has been successfully worked out in the last decade, through the endeavors of Lord Rayleigh, Wien, and particularly Max Planck. In order to explain the dependence of the distribution of energy in the spectrum upon the temperature of the radiating body Planck was led to consider the emission of energy from a large number of electrical oscillators, which from their power of absorption of energy may be also described as resonators. In order to find the entropy to be associated with these resonators by an application of Boltzmann's definition as a probability, and to define what is equally likely as to the amount of energy possessed by the individual resonators Planck found it necessary to assume that this amount of energy could not vary continuously, but must be an integral multiple of a certain very small amount which has been termed the elementary *quantum* of energy. The results of this quantum hypothesis of the atomic nature of energy has been to send a sort of earthquake shock through some of the foundations of physical theory, and we can not yet judge of the ultimate outcome. These matters were handled so thoroughly by my predecessor that I do not need to do more than mention their importance.

I have thus mentioned as the chief methods of physical investigation the method of pure dynamics, that of thermodynamics and that of the statistical method. I may add the method of which I have given an example, that of simple analogy, without the backing of any definite hypothesis. I have spoken of Carnot's successful use of this plan, also of Ohm's law as the analogy of Fourier's. A further example is found in the case of chemical reaction-velocities. Without making exact dynamical assumptions, in many cases it is sufficient to assume that the velocity of a reaction is proportional, like that of a pendulum moving in a highly resisting medium, to the distance yet to go to reach equilibrium, that is, to the amount of substance that has not yet reacted. We thus get an approach to completion proportional to an exponential function of the time. This exponential is of so frequent occurrence in all parts of nature that the reason for it is often overlooked and we see amusing instances of its rediscovery. It seems likely that this method of analogy, perhaps in this very example, may be of considerable application in biology. Suppose for instance, a portion of jelly inoculated by a needle with a certain bacillus. If the jelly is physically and chemically homogeneous the colony will grow at such a regular rate and with such a symmetrical form that it seems as if a differential equation could be formed, and the analogy with diffusion is very strong. If we could express biological forces or tendencies as we now can chemical ones there is no doubt that we could make long strides in this direction. What is now the outlook for our other methods applied to biology? Where we have to do with a distinctly physical phenomenon such, for instance, as in the propagation of the pulse-wave through the arteries, we may use the methods of pure dynamics. Or where we have to do with the conduction of the electrical current through the tissues we may use the known laws of electricity. But in connection with most of the phenomena of life we are far from having a sufficiently exact notion of the phenomena to apply dynamical principles. On the other hand, the method of thermodynamics may be of great use. No one, I suppose, doubts that the first law of thermodynamics is applicable to all physiological phenomena, both animal and vegetable. Whether it may be extended to mental phenomena is not so certain, and can not be settled until we are able to measure the amount of energy in mental processes. Certain experiments seem to show that we are near to this, and yet I fancy that no psychologist will yet undertake to measure the relative amounts of energy involved in the composition of poetry, the translation from Greek or German, or the integration of a differential equation. Whether we believe with Mr. Arthur Balfour that "life and beauty and happiness are not measurable" or not, we are still far from having even proposed any units for their measurement.

The question whether the second law of thermodynamics is applicable to biological processes is an interesting one, and we may hope that it will some time be answered, but at present there seems to be great difficulty in defining entropy in connection with such processes. Until this at least can be done, we seem to be a long way from what seems to be the hope of many biologists to reduce the explanation of life to physics and chemistry. While I suppose that most of us believe, with Professor E. A. Schäfer, as stated in his British Association address of last year, that "the problems of life are essentially problems of matter; we can not conceive of life in the scientific sense as existing apart from matter. The phenomena of life are investigated, and can only be investigated, by the same methods as all other phenomena of matter, and the general results of such investigations tend to show that living beings are governed by laws identical with those which govern inanimate matter," while I say, most of us are willing to go so far, I presume that there are few physicists or chemists who will deny that there is probably some additional element involved in life, or who are willing to follow Professor Schäfer in his statement that "The combination of . . . these elements into a colloidal compound represents the chemical basis of life; and when the chemist succeeds in building up this compound it will without doubt be found to exhibit the phenomena which we are in the habit of associating with the term 'life.'" For if we can not answer the very direct questions that I have stated above how near are we to the position of certainty indicated by Professor Schäfer's words?

If the methods of dynamics and thermodynamics are not of present application in physiological processes, it is fair to suppose that they are even less so in connection with mental processes. That the statistical method is of value here however may be shown by consulting almost any psychological journal. A recent example is to the point. Many persons have the belief that they can tell when they are being stared at by a person whom they can not see. In order to test this subjects were placed under identical circumstances and an experimenter stared, or did not stare, as determined by the fall of a die, for a certain length of time, after which the subject reported on the result, without being informed of the true state of affairs. The guesses were then averaged, and the correct result having been arrived at in 50.2 per cent. of the trials, it was concluded that nothing more than pure chance had been in operation, and that the belief in the assumed ability is an error. What could be more like the examination of a physical phenomenon, and what more convincing? In the same manner we might examine the question of thought transference in general. The interest which the general public has in such investigations, and the desire that they be connected with physical phenomena, is illustrated by the incident of the publication, a few years ago, by a distinguished naturalist, of an obviously jocular account of "The Astral Camera Club of Alcalde," in which the formation of an actual image on the retina of a cat by thought transference was described with such particularity as to deceive so many readers that an apology and explanation had to be published. What then shall we say of the attempt to push investigations into phenomena supposed not to originate in the world of matter, but in another world of whose existence we have as yet little knowledge, to put it mildly. Only that not only the general public is profoundly interested in the matter, but that eminent scientists, including astronomers, physicists and chemists of renown, have thought such investigations worth their attention, and have even declared themselves to have obtained results worthy of credence.

But how far are we justified in going in this direction? The objects of investigation in the physical sciences are manifold. In many cases we can control the phenomena to be observed, isolating them from disturbances, controlling the temperature, pressure, and other elements, and making the changes repeat at will. In other cases we can exercise no control, and yet the phenomena repeat themselves with periodic regularity, and can be observed at pleasure, as in the case of astronomical phenomena or the tides. In other cases the phenomena come at unknown times, irregularly, and we can observe them only by being prepared, as in the case of meteorological phenomena and earthquakes. But in all these cases there are definite phenomena, which we agree do exist, and which affect matter so as to be perceptible by instruments. But when we do not know whether phenomena exist or not how shall we investigate them? How easy it is for the layman to say, "We know that electromagnetic waves are transmitted through the ether, which we can not perceive by the senses, why should not waves be emitted by the brain, and be similarly transmitted through the ether?" Why indeed! We may answer him that even if we know nothing more of the ether than the speed of waves through it we know that extremely well, and that whether or not we know the mechanism of these waves (as I conceive we do) we at least know their differential equations, that is, the mode of their transmission. Moreover we have many instruments which are affected by these waves, whereas no one has ever managed, by means of thought waves, to affect the most sensitive instrument, whether torsion balance, quartz fiber, electrometer or galvanometer. When by taking thought, a mind in this world or the next, shall produce the smallest deflection in an instrument at a distance, then we shall be within the means of physical investigation. But, says the enthusiast, perhaps these waves, being not of physical but of mental origin, may be receivable not by physical, but only by mental apparatus, and may work only directly on the resonators of the brain. Very well, let us begin with the phenomena that we can control. It is easy to emit brain waves, if such there be. The method described above is then applicable. But if we are in the region of seismic mental waves, there is nothing to do but have our mental resonators always in adjustment and attuned. Then will come the difficulty of discriminating between "strays" and real receptions. How great this difficulty is is shown by the almost vanishingly small results of the societies for psychical research, so-called, and by the delusions from which reputable scientists have suffered. We may here mention the investigations on the celebrated Eusapia Paladino, who certainly secured good endorsements in Europe, but when brought here and examined by a committee including psychologists, physicists, and other detectives, was found to be explicable by purely physical hypotheses.

It is beyond my purpose to speak of the relations of science to religion and theology, if indeed it has any such relations. But I can not resist recalling the scorn with which, in my boyhood, I remember hearing the minister describe Tyndall's famous proposed "prayer-test." I am free to say that I can not at present see why such a proposal should have created such a storm. If people actually believe in the existence of God, and that in addition he does grant requests addressed to him by persons of suitable character, what could be more suitable for decision by the statistical method than such a simple question? Fortunately times have changed, and the nature of prayer is now supposed to be quite otherwise, and to have its beneficent effect by reaction on the emitter, quite irrespective of its treatment at the receiving station. Nothing is more striking than the varying attitudes of scientists toward the subject of theology and religion, from the simple faith of a Faraday, Maxwell or Kelvin to the quite different attitude of a Tyndal, Huxley, or Haeckel. I take this to be due to the difficulty of defining the meaning of the theological terms, and to hazard the opinion that if we could define them even as well as we can entropy we should be found not to disagree profoundly. If it be true that "the undevout astronomer is mad," it is true because we admit that the chief effect of the pursuit of science is to give us a profound admiration for the workings of nature, together with the conviction that its methods are beautiful, definite and simple, and are capable of being understood by the human mind. If this is to say that they thus show evidence of having been designed by a great intelligence, like the human, but enormously more powerful, very well, but it is at this point that we begin to differ as to the meaning of our terms. The chief thing that the scientist should have learned is the possibility of his being mistaken, and the danger of denying in cases where he has no evidence. We must therefore conclude that while the methods of physical science have a continually widening field of application, we must advise him who asks the profoundly interesting question, "If a man die, shall he live again," to seek to answer it by other methods, *if he can.*

ARTHUR GORDON WEBSTER

THE TEACHING OF PHYSIOLOGY TO MEDICAL STUDENTS[1]

IN no way is the relative importance of physiology in the medical curriculum better attested than it is by the designation of "the Institutes of Medicine," under which it still appears in the catalogues of some of the older universities. Originating as a division of anatomy, physiology gradually assumed such importance in the medical curriculum as to necessitate the creation of an independent department, although for long the close relationship of the two subjects was maintained on account of the fact that conclusions regarding function had in large part to be inferred from an accurate knowledge of structure. It is for this reason that the study of the microscopic structure of the tissues was, and in some schools still is, assigned to the physiologist, and it is indeed only within comparatively recent years that there has been anything like a general change in the nature of the practical work which the student must do in his course in physiology.

As it now stands, physiology is generally defined as being the study of the phenomena of living things. "It deals with the process of life." It has nothing to do with the structure or morphology of dead things, although obviously a sound knowledge of this must be acquired before any attempt

[1] Address of the vice-president and chairman of Section K, Physiology and Experimental Medicine, Atlanta, Ga., December, 1913.