one move—and most of us are—this endorsement suffices; to the more restless spirits, and there are a good many of them in America, the roving commission of the National Board, which runs in thirty-seven States, makes a stronger appeal.

This seems an appropriate place at which to quote from the address of Dr. Platter, President of the Federation of State Boards, delivered in February of this year.

"Legislation is an American disease. Our greatest fault lies in strenuous efforts for new legislation, which is supposed to work automatically to relieve or cure a bad situation.

"I have an opinion that we are at the parting of the ways; either we must present a united front with a carefully considered and thought-out programme for general enforcement, or . . . we should quit deluding ourselves and fooling the public and profession, and embrace the British system of licensure. For the present, I prefer to be enrolled in the first group; we should have a Medical Practice Act Model capable of universal adoption . . . it will take perhaps five years to determine the results to be obtained by such procedure. If, at the end of that time, substantial progress has not been made, then I should unhesitatingly recommend that we busy ourselves with the improvement in medical education, and endeavour to have legal recognition given only to those holding proper educational qualifications, and permit the unprepared, the fakir, and the charlatan to practise to their heart's content, restricting them only in that they will have no legal recognition. These are the problems which I believe concern us. I offer you two solutions. The first is in line with the duties imposed upon us when laws creating Boards of Licensure were enacted, and may be characterized as the American 'ideal.' The second closely follows the British system, and may be characterized as 'practical.'"

Not the least difficult part of an address such as this is its conclusion. I have given you a rapid survey of the position in the United States, and from it you can appreciate the differences in methods. Last year, in Chicago, it was suggested to me that I might draw a comparison between the methods of our two countries. I declined then, and I do not propose to do it now. In February, 1928, I described our methods to an American audience and left it to draw its own conclusions; to-day I have endeavoured, to the best of my ability, to describe them to you, and I commend them to your very careful study. There is much that is good in the methods of both

countries, and we can each learn much from each other. There are some who think that our American friends are too fond of experiments, and suggest that they too often pull up the seedlings to see how they are getting on. Well, perhaps it is true that the Americans, as a nation, are more ready to make experiments than those of older civilizations, but, after all, this is the privilege of youth, and the less adventurous may derive much benefit from the ventures of the more daring. Co-ordination, co-operation, unification, simplification, rationalization, are the slogans of industry to-day, and they have undoubtedly influenced the reform of medical education in the States. There is a freedom in, and there are opportunities for, discussion which are less frequent here. Every year those interested meet in Chicago for three days to exchange views and discuss new proposals. One evening last February I had the pleasure and interest of dining with the deans of twenty-three medical schools, who had come from all over the States, and Canada. I commend the example to our deans.

When, a few minutes ago, I made a passing reference to the prophet Ezekiel, I was conscious that some of you might scent something of a fallacy. I refer the doubters to their Bibles. In the valley of Ezekiel's vision the bones were very many, like the American schools of medicine in 1900, and they were, metaphorically, very dry. Following Ezekiel's first prophecy, which may be compared with the various reports, there came a noise and a shaking, and the bones came together bone to bone, and then the sinews attached themselves to their proper origins and insertions; later, the flesh came upon them; and last, the skin covered them. "But there was no breath in them." An unfriendly critic might overdo that point, and say that the American schools are too uniform, show too much evidence of mass production, and are too mechanical. But Ezekiel had a second prophecy: he prophesied unto the wind, and the breath came into them. There is ample evidence to-day that the breath of freedom is stirring in American medical schools. They are striving for the freedom to try, each in its own way, other methods, some of them new, and some of them old. It will stimulate a healthy upward competition among their schools, all or almost all of them to-day excellent, towards yet higher levels.

THE PLACE OF HUMAN PHYSIOLOGY IN THE TRAINING OF MEDICAL STUDENTS.*

BY

FRANCIS R. FRASER, M.D., F.R.C.P.,

DIRECTOR, MEDICAL PROFESSORIAL UNIT, ST. BARTHOLOMEW'S HOSPITAL; PROFESSOR OF MEDICINE, UNIVERSITY OF LONDON.

THE MEANING OF HUMAN PHYSIOLOGY.

In a lecture delivered before the Harvey Society in New York in 1916 Professor J. S. Haldane of Oxford said: "Medicine needs a new physiology which will teach what health really means, and how it maintains itself under the ordinarily varying conditions of the environment." It would be difficult to frame a better explanation than this of what is meant by human physiology; and the selection of this subject for discussion indicates that a serious attempt has been made to provide such a new physiology.

For half a century before that date physiology had been progressing actively, stimulated by the desire to account for activities of living organs in terms of physics and chemistry. Great strides were made in demonstrating the functions of organs, in determining the mechanism of their action, and in analysing the mechanism in terms of physics and chemistry. These advances in what may be termed "analytical physiology" were the result of experiments on isolated animal organs, by means of which the variables could be eliminated and causal factors studied under carefully controlled conditions. Their effect was to indicate the possible functions of an organ and the causes of its activities. The probable functions of human organs

and the probable causes of the activities of these organs in the living body were then deduced. To take a few simple examples: the capacity of such an organ as a salivary gland to secrete a juice of importance in digestion was demonstrated, the conditions of its blood supply necessary for successful secretion were defined, stimuli capable of causing this secretion were discovered, and it was shown that these acted through the nervous system. It was inferred from observations in the human being that the human salivary glands secreted their juices in response to similar stimuli and for a like purpose. The contractions of muscles were shown to be the result of certain stimuli conducted to the muscles by nerves, the physical and chemical phenomena coincident with the activities of the muscles and nerves were seen to be essential, the energy requirements of these experiments were quantitated, and their sources defined. The order of events in the beat of the heart was elucidated, and the dependence of each event on those preceding was demonstrated. The paths of excretion of the waste products were discovered. The characters of the blood, and the variations found in healthy individuals, were defined.

The new phase in thought and in investigation in physiology turns on the meaning and implications of "normal." The human body is exposed to the ever-varying conditions of the environment, and is constantly adjusting itself to them. So long as it maintains its

* Read in opening a discussion in the Section of Physiology and Biochemistry at the Annual Meeting of the British Medical Association, Manchester, 1929.

efficiency under these varying conditions and adjustments it is considered to be in health and to be normal. Health and normality are not therefore strictly definable, but indicate a wide range of bodily activity. Within this range no single organ maintains a fixed and rigid condition, but is constantly active to maintain its part in the functioning whole and constantly altering its activities in co-operation with the other organs of the body in response to the ever-changing conditions imposed from without by the environment. Certain features of the body seem to be relatively constant within the limits of health, while others show more variability. The body temperature, the hydrogen-ion concentration and salt concentration of the blood are relatively fixed. The frequency of the heart beat, the respiratory activity, and the composition of the urine vary to a much greater extent. The older physiology told us little of how in the ever-changing conditions of human life these relative constants are maintained, and of how the various organs of the body co-operate to effect this. It told us much of the possibilities of the organs to act in this way, and how these activities can be brought into play. It has given the clues for the newer physiology, for human physiology, for the study of the human body in health; and so for the recognition of the points at which these adjustments may fail. When they fail, inefficiency results and symptoms appear. As an example of this conception I should like to quote an experiment that brought home to me the range of adjustment compatible with health and the ultimate appearance of symptoms under excessive stress.

We had the opportunity of making careful observations on a healthy man of the effects of the administration of an acid in the form of ammonium chloride. By increased breathing, by increased urinary output, and at the expense of a lowering of the carbon dioxide carrying power of the blood, adjustment was at first successful in maintaining apparently healthy conditions. With an increase in the dose of ammonium chloride, however, the adjustments failed to maintain efficiency, and symptoms appeared. The increased breathing became such that dyspnoea resulted, the frequent micturition and the thirst became a burden, and nervous irritability and restlessness appeared. At the same time the carbon dioxide carrying power of the blood dropped below the limits of the accepted normal, the hydrogen-ion concentration became definitely altered, and the rise of haemoglobin indicated definite loss of water beyond the limits usual in health. No observations were made on the circulation and the digestive system, but I have no doubt that they also shared in the general adjustment and ultimate derangement, every organ and system of the body doing its best to co-operate in reducing to a minimum the effect of this simple, though artificially produced, alteration in the conditions of life.

In the last ten years much progress has been made in extending the knowledge of the physiology of the living body. There have been valuable advances in the physiology of respiration, of the circulation, of renal secretion, of the nervous system, of general metabolism, and in the chemistry of the blood, and there has been important advance in the knowledge of how each system depends for its successful functioning on the others, and of the ways in which disturbances in one system react on the others.

THE NEED FOR INSTRUCTION IN HUMAN PHYSIOLOGY.

That there is now sufficient knowledge of human physiology to enable instruction to be given to medical students needs no further discussion, and many simple experiments suitable for practical class work in human physiology have been devised.* I believe that there can be no doubt in the minds of any that it is desirable that such instruction should be given and such practical work carried out as part of the training of medical men. In the practice of his profession the medical man must decide first of all in what manner and to what extent the functions and structures of the body and its organs are disturbed, in what particulars the adjustments for maintaining health have failed. He must then decide what external factor has caused this departure from the healthy state. If possible he must remove it, but more frequently he can only aid the body

in its attempts at adjustment, and by so aiding it enable it to return to the state of co-operative functioning and efficiency that is called health. Surely, then, it is of the utmost importance that he should understand the means of adjustment that have failed, in order that he may co-operate with them in the therapeutic measures he employs.

If textbooks are any indication, the practice of medicine has so far consisted to a large extent in the recognition that certain groupings of symptoms or syndromes are indicative of certain disease processes, which must then be treated according to certain methods that have been found effective. We know, of course, that the textbooks of medicine do not reflect fairly the best practice of medicine, but they do probably indicate the prevalent methods of practice. The conclusion must be that in the practice of medicine the individual patient is not studied as carefully as he might be, and that there is too great a tendency to try to fit his signs and symptoms into one or other of the labelled syndromes or clinical pictures, and to treat accordingly. The need for the study of each individual patient was demonstrated in the war. The shock or loss of blood that resulted from a wound was frequently so great that the normal mechanisms for maintaining life were not sufficient unless help was forthcoming. The medical men did not know these normal mechanisms, nor how to help them; the physiologists did not know either; and much new work had to be done before they were able to devise effective methods of treatment. The changes consequent on gassing found most medical men and physiologists in a similar position of having to investigate along the lines of human physiology before deciding on the treatment to be adopted.

In several medical schools, to my knowledge, instruction in human physiology is given, and I have no doubt that it is so in all schools, while many are endeavouring to give it to an increasing extent. That it should enter into the training of every medical student is probably conceded, but I find that it is the almost unanimous opinion of clinical teachers that the student is not properly equipped in knowledge of physiology when he commences his clinical studies. This complaint from clinicians was readily understandable when the instruction was based on experimental work on isolated animal organs, for it is human physiology that is required at the bedside, and clinicians have always acquired some, if rather scrappy, knowledge of this from their observations on the countless experiments performed by Nature on the patients in their wards, and have learned to seek for an understanding of physiology somewhat different from that provided for the student in the pre-clinical years. There should have been less ground for complaint recently, and I think there has been since human physiology has been included in the courses of instruction that the student receives before entering on his clinical years.

Place in the Curriculum.

What is the best time for this instruction to be given? It would appear rational that the student should be as fully equipped as possible in the knowledge of the structure and functions of the healthy body before commencing the clinical years in which he studies patients, individuals who are inefficient because the processes of adaptation and adjustment have not been adequate. But the question is not solved so easily. It is difficult to present the methods by which health is maintained, and their limitations, without instancing the ways in which the methods may fail, and it is still more difficult for the student to grasp their importance without the appreciation of the results of their failure. A similar difficulty is seen in the teaching of anatomy, and the failure to solve this difficulty may be one of the reasons why physiology is so often laid aside by the student when he enters the wards. Human physiology must surely be taught while the student is working in the wards, and observing for himself the examples of how ill health is brought about. At present in many schools a combination of these two methods is in operation. The simpler conceptions are presented in the preclinical years, so that the student may appreciate what is meant by the physiology of the human being and have a few examples of the processes of adjustment in greater detail, and the applications of these conceptions are then observed by him

* See *Human Physiology*, by Douglas and Priestley, Oxford, 1924.

under the guidance of a clinician. Unfortunately in most instances the clinical teacher is unable to keep abreast with the advances in physiology, and is quite incapable of guiding the student along the lines that his preclinical training has opened up and prepared. This is, of course, not always the case; but it is so common that it is necessary to supplement the clinical teaching with courses of lectures in clinical applied physiology in the final years. Such lectures are useful, but are far from ideal, since they suggest that the subject cannot be dealt with at the bedside or is something other than an essential part of the practice of medicine.

By whom should the instruction be given?

There are large gaps in our knowledge of human physiology, and the subject is so incomplete by itself that it cannot be separated from animal physiology and the physiology of organs. It is not a good educational instrument if so separated. It is therefore not advisable to alter to any great extent the courses of physiology as at present constituted, for the purpose of the preclinical years is not only to give instruction in what is to be of practical value, but also to train the mind in the meaning of biological actions and reactions, in the appreciation of accuracy, in the value of quantitation, and in the meaning of controlled observations. The courses in physiology are given at a critical period in the training of a medical man, and their educational value is of more importance in his career than any detailed facts that may be presented to him, even if perchance these can be retained in his memory for subsequent use. It is advisable, therefore, that human physiology should be taught in the preclinical years only so far as it can be fitted into a subject that must be regarded primarily as an instrument for an education in science. It is advisable, however, that every opportunity should be taken by the teacher in physiology to indicate the human or clinical applications of his science.

The head of the department of physiology in every medical school should be so eminent in his subject that it is impossible for him to have devoted much time to the careful observation of diseased persons. To recognize with clarity in any patient the points at which the intricate web of adjustments has failed is a matter of great difficulty, even for skilled clinical observers of extensive experience, so that it is obviously impossible to expect the successful physiologist to do this except in the very limited number of symptoms that have been satisfactorily investigated in human subjects. The clinician, on the other hand, can have but a hazy knowledge of the adjustments that have broken down, but he can indicate the symptoms that result from the failure and the way in which their breakdown causes inefficiency, and he can also, with the help of the pathologist, indicate the factors of interference from without that have proved too great for the individual, and perhaps also how the restoration to a healthy state may be brought about. For example, the physiologist can instruct the student in the parts played by the heart, the vasomotor system, and the respiration in the maintenance of a circulation adequate to the needs of the body; he can guide him in observations on how the rate of beating of the heart alters with exertion; and he can demonstrate Starling's law of the heart on a heart-lung preparation. On entering the wards the student meets with cases of heart failure which he recognizes by the dyspnoea, cyanosis, and oedema, and he sees that they recover with rest and perhaps digitalis and diuretics. There is no apparent connexion between his physiological training and the clinical skill of the physician whose practice he studies, and he allows physiology to slip out of thought and memory.

If the physiologist could have given point to his instruction by examples of patients who have adapted and adjusted, in spite of a damaged heart, so that economic efficiency can be maintained—some with an altered distribution of blood that gives rise to recognizable signs on physical examination of the heart, lungs, or liver, others with clearly defined capacities limited by pain on exertion—and by examples of the more advanced forms of congestive failure that follow later, the student would see the importance of the physiological adjustments and not forget them. If the physician would trace in the history of his patient

the gradual breakdown of the physiological adjustments with the successive appearance of the signs and symptoms so that the student could appreciate where and how the adjustments had failed, the student would see in every patient a wonderful problem in treatment and appreciate just how far his patient can be restored to health and to what extent the symptoms and signs are indicative of permanent and progressing damage, and he would understand how the practice of medicine depends on human physiology. Instead of forgetting what he had learned, he would study it afresh that he might understand the practice of medicine. Similar examples could be cited in the practice of surgery.

At present, then, this subject, which is so important in the training of a medical man, cannot be taught satisfactorily by the physiologist alone, and probably never will be taught satisfactorily by clinicians alone, but should be presented by both, so that its full value, for both educational and utilitarian purposes, may be obtained—not by the two separately, but by the close co-operation of each.

THE NEED FOR INVESTIGATIONS.

Investigations in human physiology at the medical schools are desirable, not only for their obvious value in increasing knowledge, but also because any subject of instruction becomes dry and lifeless unless the teachers are also investigators.

The arguments for co-operation by physiologist and clinician apply even more clearly when the need for investigations in human physiology is considered. It is the clinician who sees the experiments that Nature performs; he alone can have the necessary experience to relate cause and effect and eliminate the accidental and coincident, and he alone has the skill to recognize many of the signs and symptoms of altered structure or function. But he knows little of the methods of investigation, and he has not sufficient knowledge to utilize the clues provided by the enormous amount of animal experimentation that has been performed already. The history of the development of knowledge in such subjects—to take a few obvious examples—as carbohydrate metabolism, internal secretions, cerebral localization, the control of the peripheral circulation, calcium metabolism and its relation to bone formation and to tetany, points in the same direction, since in none of these subjects could the present state of knowledge have been reached unless the physiologist had helped the clinician and the clinician the physiologist. Not only, then, for the teaching of human physiology, but also for the encouragement of investigations in human physiology, it is important to have co-operation between the physiologist and the clinician. The introduction to the report of the Medical Research Committee for 1918 contains the following:

"It has often been pointed out that in England the work of the physiologist has been too divorced from practical medicine, and that the British school of physiology, which by the admission of other nations stands second to none elsewhere, has not been brought in this country into due contribution to the work of the physician and surgeon. No doubt this is true, and mainly perhaps because of the defects in our systems of medical education, which have allowed the physiologist to remain too much in academic retreat and the clinician too far from the laboratory and its methods."

In the ten years since that was written far too little has been done to correct the fault, but the time has not been wasted if it has resulted in the general acceptance of the truth of the contention.

CO-OPERATION BY PHYSIOLOGIST AND CLINICIAN.

How this co-operation can best be brought about must depend largely on the local conditions at each medical school. It is rare in this country to find a department of physiology that is not in a different building from the wards, and not separated from the wards by such a distance that some degree of determination is required before a member of the staff of one department will visit the other. In the newer medical schools in the United States an attempt to overcome this drawback is being made by designing school and hospital together, the department of physiology being above or below the wards, or else on the same level as the medical wards and in direct connexion

with them. Contiguity may help, but cannot solve the difficulty. The appointment of young clinicians as demonstrators in the department of physiology during the period of their graduate training must surely result in time in the clinicians of the teaching school being appreciative of the importance of human physiology in the teaching of the practice of medicine, but it cannot ensure that they will have the time to keep in touch with the advances in physiology, nor that they will be able to investigate problems in human physiology. Even if the staffs of the clinical departments include men who are free from the necessity of devoting their time primarily to practice outside the hospital, and who have facilities for investigations in laboratories in association with the wards and under the guidance of experienced clinicians, the work is not as fruitful as it might be unless the help and guidance of an experienced physiologist are available. Undoubtedly much may be done by the appointment of young clinicians to posts in the department of physiology and by the appointment to clinical posts of men trained in physiology, or by the appointment of the same men to half-time posts in each department. The successful teaching of human physiology and the successful investigation of problems in

human physiology must in the long run, however, depend on co-operation by the heads of the clinical departments with the head of the department of physiology, and if this is obtained the desired attitude on the part of the junior members of their staffs is certain to follow. Such co-operation can be obtained only if the clinician is free from the necessity of earning the major part of his income outside the medical school and hospital, and if for the physiologist the burden of teaching and administration that in most schools exhausts his time and energies is made lighter.

POINTS FOR DISCUSSION.

There is little need for discussion on the meaning of human physiology, and on its importance in the training of medical students. There is much need for the exchange of views on the time in the curriculum at which it should be taught, and on the most suitable person or persons to teach it. It is most important, I believe, at this time that there should be discussion as to the practical steps to be taken so that human physiology may be efficiently taught and so that investigations in human physiology may be encouraged under conditions conducive to their successful outcome and to the increase of knowledge.

The Profession of Medicine.

INTRODUCTORY.

THE main purpose of this Educational Number of the *British Medical Journal* is to give prospective students and their parents full information about the steps that must be taken and the studies that must be pursued in order to become a registered medical practitioner. It is intended also to serve as a kind of guidebook for those wishing to know what a medical career has to offer, and for others who, having already chosen medicine as their life-work, or having entered upon it, are uncertain about the line of work for which they are best suited. As in past years, this introductory article gives an opportunity to review some aspects and tendencies of medical study and practice, in order to put the situation as we see it before those who think of devoting themselves to medicine, and thus help them to gauge their fitness for the calling and the prospects it holds out.

Intending students will find in the pages that follow an account of the course of training required of them, the places where it can be obtained, and the universities and other licensing bodies which test the knowledge gained and confer degrees or diplomas entitling successful candidates to become legally qualified medical practitioners. Sections are included also on post-graduate medical study, on the higher qualifications, both general and special, and on the many and varied spheres of professional work open to registered medical men and women at home and abroad. The details given are founded for the most part on official information, and are arranged along the customary lines.

GROUNDWORK OF MEDICAL STUDY.

The aim of a medical school should be to teach, not only the essentials of medicine, but also the right principles and methods of adding to knowledge after qualification. Such teaching, to be effective, presupposes a good general education. Next in importance is a good scientific education—a thorough grounding in the basic principles of science. Upon these the student of ordinary intelligence and industry can build up an adequate technical equipment for the practice of his profession. Medicine is an art founded on science, from which it follows that a real training is needed in science and the scientific spirit. An unfortunate tendency of the present system of teaching the preliminary subjects is to produce a temporary "cram"

knowledge which is quickly forgotten after the particular examination is passed. This is not how the basic sciences should be studied. These sciences interlock with each other and with the later subjects, and, properly approached, they give a drilling in exact methods, in precise manipulations, and in vigorous reasoning which will bear immediate fruit in the clinical part of the curriculum and prove of benefit throughout professional life. A sound training in medicine seeks to raise on scientific principles a firm edifice of practical knowledge and skill. Students who hold fast to this idea will regard "cram work" as a weakness in the foundations, and therefore as a hidden danger to the superstructure. Chemistry, physics, and elementary biology prepare the way for anatomy and physiology, and so for medicine and surgery and obstetrics. Changes in the details of the curriculum are needed from time to time, but all authorities are agreed that these preliminary and intermediate sciences form the only appropriate introduction to the study of clinical medicine. The great John Hunter "studied anatomy and physiology to get help in diagnosing and treating his patients. He studied dead things to understand the living, and observed living things to understand the dead. A knowledge of how this body is made and how it works must provide the basis for all the more practical subjects of medicine."

PORTALS OF THE PROFESSION.

The obvious goal of every student is the entry of his name in the *Medical Register*, which is the official statutory list of qualified medical practitioners kept by the General Medical Council. Those who are not acquainted with the system of medical teaching and examination in these islands, and with the history of our professional institutions, may well feel bewildered at the number and variety of ways in which admission can be obtained to the *Register*. They will see in the table of contents to this Educational Number that there are no fewer than twenty-seven bodies—eighteen universities and nine corporations—which either separately or jointly issue registrable qualifications; and the number of teaching institutions is even larger. Nevertheless, although we have no single State examination in medicine—no "one portal system," as it has been termed—the medical courses of the various universities and schools in Great Britain and Ireland run on parallel lines, and the obligatory curriculum is much the same for all students. As, however, the individual teaching and examining bodies