circumstances, or perhaps coincidences, that seemed to just happen in 1888–89 and centered in the opening of Clark University and the Marine Biological Laboratory at Woods Hole. Through the personnel of these institutions directly, and through the Johns Hopkins University indirectly, Brown was in close touch with European biological ideas, especially German. Ideals of the German scholarship of that time were then grafted upon those of an old American college of English descent and this new thing was grown in an atmosphere of academic democracy engendered by the great emphasis upon life in the laboratory.

I have mentioned only those persons who have gone from us forever, or who, like myself, are academically extinct. I have talked only of the biological work at Brown in its formative stages; the post-larval development is another chapter. In its personnel and its increasingly effective work under the unwritten constitution of 1889–90, we old-timers all take parental satisfaction.

FUNCTIONS OF THE PRECLINICAL SCIENCES IN MEDICAL EDUCATION[1]

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WITH war raging in Europe, there is a tendency for all of us to feel an oppressive sense of futility in taking up our academic duties. College presidents and deans the country over have in their addresses before faculties and students been trying to counteract this tendency. But events that represented a potential threat to our existence can not easily be banished from our minds. Whether or not we become directly involved in the conflict, there is, as Park Commissioner Robert Moses[2] recently stated in an address before Union College students, "a mental and spiritual cost of war, as irremediable as other costs." Further, that "Unless we strongly will it otherwise, an oppressive cloud blacks out every non-military usefulness" of our minds. With such distractions, it is all the more important to do what we should always do, namely, pause now and again to clarify our aims and try to find out if our efforts are directed effectively in achieving the ends we desire. This morning it is my privilege to discuss some of the functions of the preclinical sciences in medical education.

The general purpose of a medical school is to train physicians and surgeons. Because this training is constantly undergoing changes resulting from advances made in experimental medicine and its allied sciences, the student must realize at the start that his task is to obtain a foundation which will not crumble under these advances. He must develop the capacity to alter his concepts according to new facts, and establish the habit of assimilating these facts in such a way that they will increase his confidence in his own resources even as he finds some of his earlier training misconceived. Much of what he will learn rests upon insecure experimental evidence—is indeed empirical. Other phases of his work will be well founded. He must learn to distinguish between the two. This he can do only by drawing his own conclusions from what he regards, after careful consideration, to be well-established facts. Such a scientific attitude, acquired early and practiced throughout his course, is the student's most valuable weapon for his medical training.

A large part of the medical course is devoted to scientific studies in which the student has no direct contact with the patient. These studies are designed to give a thorough understanding of the normal structure and function of the human body. For this purpose medical schools support large faculties and expensive laboratories, both for teaching and for research. It is apparent that such establishments would not be required if their services to the schools consisted only in imparting to students a measure of factual information. This could be accomplished by lectures, supplemented by text-books and demonstrations—a method generally employed not so many years ago.

The emphasis on research in preclinical departments is often a subject of speculation if not outright criticism by those who do not fully understand the relation of these sciences to experimental medicine and to the intent of medical faculties in training students. I must remind you that the ultimate goal of medicine is to gain mastery over living processes, in order that these processes may be directed to the welfare of the patient. If therapy is to emerge completely from the realm of the empirical to that of rational scientific procedure, it will do so only when all the factors that govern the normal structure and function of the body are understood. Such understanding is, of course, the ultimate goal of investigators in the preclinical sciences. It is hardly surprising, therefore, that they should be supported and encouraged with as much vigor as those who study abnormal structure and function.

[1] Delivered at the opening exercises, College of Physicians and Surgeons, Columbia University, September 27, 1939.

[2] Quoted from an editorial in *The New York Times*, Sunday, September 24, 1939.

Furthermore, the spirit of research has a vitalizing effect on the teaching staff. Instructors who are themselves engaged in widening the horizon of science can scarcely lose sight of the need for continually revising interpretations and theories in the light of new facts. Their presentation of last-minute discoveries and theories is not, however, as important as the experimental attitude of mind which they can impart to the student. The experimental method aims to correlate observed phenomena by establishing their true relation with respect to cause and effect. The order of the steps by which this is accomplished may vary, but there are three essential parts to the process: (1) the observation of facts; (2) the idea or concept of their relationship and (3) the experimental proof. The man engaged in research knows that his interpretations are likely to be correct only in so far as his observations are true. Therefore, his first concern in teaching is that the student learn to observe accurately and to evaluate facts carefully. Recognizing also that facts without ideas are sterile, he encourages the student to assemble the facts into concepts, that is, to interpret them. Whether or not such concepts are in the beginning correct is immaterial, provided they are subjected to analysis or defended in discussions. An erroneous hypothesis or explanation originated by the student is often most instructive to him in demonstrating the value of the experimental method and in revealing the weakness of unsupported ideas. By stressing this experimental attitude in teaching medical students, the preclinical sciences fulfill their most important function in medical education.

The part of the laboratory in this scheme is apparent. As we have already pointed out, the aim is to train the student to make his own observations, in order that these may form the groundwork upon which he builds his knowledge. In many instances the technics he employs are also to be his tools in clinical studies, and it is important that he examine them critically with respect to their validity and limitations. Above all, the purpose is to establish confidence in his power to observe and to reason correctly from his observations. This can only be accomplished by practicing the experimental method; it can not be taken over ready-made from the text-books. I regret that this concept of the function of laboratory work is not infrequently neglected by instructors as well as students. The tendency is to regard the laboratory simply as an aid to the memory by reviewing material which has already been delivered in lecture or text-book. Such a procedure may be successful in stuffing the mind with information until examinations have been passed, but the information rarely remains as useful knowledge for long because it was not assimilated with the inner conviction which comes only from subjecting it to critical analysis.

A phase of the teaching in the preclinical sciences about which there is a difference of opinion is the writing of theses based on the reading of original scientific articles. Scientific literature is vast; without some early training in dealing with it, this source of information may be neglected by the clinician. Practice in finding one's way in it, learning to get the gist of articles without great waste of time, is a necessary part of the medical training. At least the student should be acquainted with the abstract journals that cover the scientific literature in which he is likely later on to find information related to his principal interest in medicine. Furthermore, students who depend solely upon text-books miss the flavor of scientific inquiry. I have watched with satisfaction the change in attitude which a student often develops towards his text-books after writing a thesis. The assembling of facts and opinions from different sources and the arranging of the information into a well-organized review of his own gives the student a critical appreciation of the element of personal judgment and selection that enters into the writing of any text-book. The very fact that he soon reaches a point in his reading of original articles where some aspect of his subject is under controversy stimulates him to form his own opinions, perhaps to originate an idea. These ideas are frequently the germs that develop into important contributions to medical science.

If the views I have expressed apply to undergraduate work, they apply with even greater force to post-graduate medical teaching in which the preclinical departments are expected to take part. The graduates have behind them years of academic work filled with text-books and lectures. Simply to give them more lectures or other forms of didactic teaching is, in my estimation, to repeat the mistake which has already been made in their basic science training. The experience that will help them in their specialties is the experience which only the practice of the experimental method in the laboratory can give them. That this work should be in the nature of research is perhaps not necessary, but it certainly seems preferable because of the stimulating effect of trying to solve the problems of normal structure and function underlying the post-graduate student's special field in medicine.

Compared with the average college course, the medical curriculum makes heavy demands upon the student's capacity to learn. How to help him to make the fullest use of his mental endowments and to keep him from becoming confused and swamped is a problem that falls mainly to the lot of the preclinical departments which he meets in his first year. The order and arrangement of courses, starting with the study of structure (gross, microscopic and neuroanatomy) followed by the study of function (physiology and biochemistry) is designed to reduce the student's difficulty

as much as possible. Nevertheless, the task is not an easy one, and the student sometimes becomes discouraged because he finds so much to be learned that appears to be quite remote from the practice of medicine, which after all is his goal.

Now, a student might attack the bewildering amount of material before him by setting out to memorize facts —some people can achieve extraordinary memory feats. There is, however, a limit to which this process can go, for so far as I am aware, no one has ever been able to memorize everything in the medical course or even within a single subject of this course. Furthermore, as we have noted above, isolated facts, that is, facts unconnected by ideas, may be quite useless even in an examination where it is usually necessary to employ the facts to demonstrate a new relationship, that is to solve a problem. A "memorizer" soon fails in such a test.

The aim is not only to know but to understand, and understanding introduces the element of relationships. I have often remarked to students that they should be resistant to information, a comment which usually meets with disapproving looks from my colleagues. But a resistant attitude has this virtue, that the holder of it will take the trouble to examine information, no matter what its source, first with respect to whether or not it is true, and second with respect to its relation to other facts. When he has done this, he has also fixed the idea in his mind without just memorizing blindly. This habit is excessively helpful to my memory (which, I regret to say, had its edge worn off long ago in taxonomic botany), and you will find that it saves you the trouble of having your mind cluttered up with uncorrelated information that fails to come out in the order in which you may happen to need it.

I can not emphasize too strongly the necessity of correlating facts from the very start of your course. Don't be too ambitious and expect to see or be shown at once the relation of each detail to the practice of medicine. You can not start at both ends at once. Begin with the small circle of facts under immediate observation and let the extent of your attempts to correlate grow with your acquisition of knowledge. Gradually will come general principles which will serve to simplify the learning process for you, and which if based on sound evidence will stand you in good stead later for purposes of deductive reasoning.

The problem of how to correlate and integrate medical training is a matter of deep concern to your instructors. The faculty is constantly trying to improve the coordination of subjects taught by rearranging schedules, adjusting hours allotted to each course, changing the sequence of courses and even reorganizing the courses themselves to parallel the sequence within others. Unfortunately, no matter how perfect the organization, it can not run itself nor be a substitute for education. Learning is an *active* process in the student's mind; knowledge can not be fed painlessly by the establishment of an ideal sequence. If learning is to be an intellectual process (the process of understanding), the student must take the initiative. He must contribute something himself besides the effort made to retain the information in his memory. What is this contribution? When an idea passes from my mind to yours, it is set up in a new environment which colors the idea, gives it a slightly different meaning, because you may see it in special relations to other ideas determined by your past training and experience. By letting your own mind act on the idea, you have engaged in an intellectual process; that is the contribution which only you can make to your education. No instructor can do it for you. The instructor can expose you to facts and he can give them meaning by indicating some of their relations to each other and their future importance to your work. By so doing, he enlarges your understanding, but he hopes especially to increase your incentive to acquire knowledge.

The stimulation of the student's will-to-learn is the chief purpose in the instructor's mind when he points out here and there the practical application of certain facts in your scientific training to medical and surgical problems. In my opinion, one must beware of devoting too much time to this approach in the preclinical courses, for it is likely to result in focusing the student's attention upon specific facts that happen to be of immediate practical value rather than upon the significance of a knowledge of the science as a whole. What has been done in this school in the correlation clinics for first-year students represents a subtle but important difference in attitude from that customarily assumed. The clinic is given by a specialist in some branch of medicine or surgery, who takes up a clinical problem, analyzes it from the anatomical, physiological or biochemical point of view, and demonstrates how this analysis aids him in solving the problem. You will note that the emphasis in these clinics is not upon application of a specific fact or facts, but upon the methods and the power of reasoning acquired by a broad knowledge of the preclinical sciences.

In concluding, I wish to call your attention to a guiding principle stressed by Claude Bernard,[3] a French scientist renowned for his great contributions to physiology and experimental medicine. He states "that it is essential to distinguish between two things in experimental criticism: experimental fact and its interpretation. Science requires us first of all to agree on fact, because that is the basis on which we must reason. As to interpretations and ideas, they may

[3] Claude Bernard, "An Introduction to the Study of Experimental Medicine," p. 189. The Macmillan Company, 1927. Translation by Henry Copley Greene.

vary, and discussing them is an actual advantage, because such discussion leads us to make other investigations and to undertake new experiments." Failure to observe this difference between fact and interpretation has been the cause of many needless and bitter personal controversies, and indeed it may affect seriously the relation between the students and their instructors. You will find that there are contradictions in the opinions and interpretations of instructors in different departments or even in the same department. These need not be a source of confusion, provided, as Claude Bernard says, we agree on the facts. There are professors who unintentionally perhaps impress their own opinions upon students with such authority that these opinions are regarded as unalterable facts. All of us must guard against this tendency, for nothing is more destructive to the freedom of thought, ingenuity and creative thinking of the student, the very qualities we are eager to encourage. The student must never feel that he will be penalized for expressing an honest well-founded contrary opinion in our midst. Let it also be said that the student must examine his own motives to be sure that they are not simply a desire to contradict, but an earnest seeking after the truth. In that spirit only can academic freedom and freedom of speech be kept alive in our universities.

SCIENTIFIC EVENTS

NEW FELLOWS OF THE ROYAL SOCIETY OF EDINBURGH

ACCORDING to a report in *Nature*, the following have been elected fellows of the Royal Society of Edinburgh: E. B. Ball, president of the Institution of Mechanical Engineers; J. Bowman, city water engineer, Edinburgh; B. S. Bramwell, advocate, London; J. Brough, lecturer in vertebrate zoology, University of Edinburgh; Dr. A. F. Buchan, teacher of mathematics, James Gillespie's School, Edinburgh; J. M. Caie, deputy secretary, Department of Agriculture for Scotland; J. Cameron, formerly head of the Pharmaceutical Department, Peiping Union Medical College; Professor J. W. Cook, department of chemistry, University of Glasgow; Dr. J. Coutts, lecturer in pharmaceutics and demonstrator in practical pharmacy, St. Bartholomew's Hospital Medical College, London; Satchidinanda Datta, veterinary research officer, Imperial Veterinary Research Institute, Calcutta; Dr. T. Elder Dickson, art master, George Watson's Ladies College, Edinburgh; Dr. A. T. J. Dollar, assistant in the department of geology, University of Glasgow; Dr. H. I. Drever, assistant in the department of geology, University of St. Andrews; W. McC. Harrowes, medical director, New Saughton Hall Private Mental Hospital, Polton, Midlothian; T. Hart, collector of the Trades House of Glasgow; Professor C. F. W. Illingworth, department of surgery, University of Glasgow; J. G. Kyd, registrar-general for Scotland; P. R. Laird, secretary to Department of Agriculture for Scotland; Dr. Robert McAdam, lecturer in mining and surveying, Heriot-Watt College, Edinburgh; Dr. J. A. Macdonald, lecturer in botany, University of St. Andrews; Dr. A. E. W. McLachlan, clinical medical officer, Newcastle General Hospital, Newcastle-upon-Tyne; Dr. A. MacNiven, physician superintendent, Royal Mental Hospital, Glasgow; Professor G. F. Marrian, department of chemistry in relation to medicine, University of Edinburgh; Dr. E. R. A. Merewether, H.M. medical inspector of factories, Birmingham; R. M. Neill, senior lecturer in zoology, University of Aberdeen; Dr. H. B. Nisbet, lecturer in chemistry, Heriot-Watt College, Edinburgh; J. S. C. Reid, solicitor-general for Scotland; H. Riley, founder and head master of Strathallan School, Forgandenny, Perthshire; J. Thomson, distiller, London; Dr. H. M. Traquair, president of the Royal College of Surgeons of Edinburgh, lecturer on diseases of the eye, University of Edinburgh.

THE DETROIT CENTER OF THE UNIVERSITY OF MICHIGAN

FINAL arrangements for the construction of a building to cost $1,500,000 in the art center group in Detroit that will serve as permanent headquarters for the Engineering Society of Detroit and the University of Michigan Extension Service have been made. A memorial to the public spirit and philanthropy of the late Horace H. Rackham and of Mary A. Rackham, it will be known as the Horace H. Rackham Educational Memorial, will combine professional, scientific and educational activities.

The building will be located on the south side of Farnsworth Avenue, facing the Detroit Institute of Arts and diagonally across from the Detroit Public Library. Construction will begin early in 1940.

The exterior of white limestone, with marble spandrels and simple ornamental carvings, will house three distinct units of the building. The central section will be an auditorium, seating 1,000 persons, which will be at the disposal of both the society and the university. It will be flanked on the east by a wing housing the Engineering Society and on the west by a wing devoted to the University's Extension Service. The entire memorial will be 404 feet in length and will vary in depth from 150 feet at the center to 65 feet at the ends.

Three floors are provided in the wing of the Engi-