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**THE TEACHING OF THE BASIC  
MEDICAL SCIENCES IN THE LIGHT  
OF MODERN MEDICINE**

**Eighth Report of the Expert Committee  
on Professional and Technical Education of  
Medical and Auxiliary Personnel**

	Page
1. General considerations . . . . .	3
2. Training of teachers and selection of students . . . . .	6
3. Textbooks . . . . .	8
4. The preliminary period . . . . .	9
5. The preclinical period . . . . .	12
6. Areas of contact . . . . .	30

WORLD HEALTH ORGANIZATION

PALAIS DES NATIONS

GENEVA

1961

**EXPERT COMMITTEE ON  
PROFESSIONAL AND TECHNICAL EDUCATION OF  
MEDICAL AND AUXILIARY PERSONNEL**

*Geneva, 22-27 August 1960*

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# THE TEACHING OF THE BASIC MEDICAL SCIENCES IN THE LIGHT OF MODERN MEDICINE

## **Eighth Report of the Expert Committee on Professional and Technical Education of Medical and Auxiliary Personnel**

The WHO Expert Committee on Professional and Technical Education of Medical and Auxiliary Personnel met in Geneva from 22 to 27 August 1960. Professor W. J. Hamilton was elected Chairman ; Professor P. Rijlant, Vice-Chairman ; and Professor M. Darrach, Rapporteur.

Dr M. G. Candau, Director-General, opened the meeting, and welcomed the members of the Committee. He drew attention to the recent trend in medical education towards the early introduction of the concept of prevention into the undergraduate curriculum. A study group on the teaching of physiology, and an expert committee on the teaching of pathology, had met in 1957 and 1958 respectively, and as a sequel to these meetings, the present Expert Committee was convened to explore and study the teaching of the basic medical sciences in the light of modern medicine and to formulate recommendations thereon. Furthermore, Dr Candau pointed out the desirability of emphasizing the close inter-relationship that exists between these subjects, and the necessity for co-ordination and co-operation among their respective teachers. He expressed the hope that teachers would be stimulated in this direction, and would increasingly stress preventive aspects in medicine.

### 1. GENERAL CONSIDERATIONS

The second report of the Expert Committee on Professional and Technical Education of Medical and Auxiliary Personnel<sup>1</sup> considered, *inter alia*, various features of medical education that had a bearing on the preventive and social aspects of medicine and the enlarging responsibilities of the medical profession in modern communities. Agreement was reached that, while the details of curricula must necessarily vary substantially in

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<sup>1</sup> *Wld Hlth Org. techn. Rep. Ser.*, 1953, 69.

different parts of the world, medical educators have certain responsibilities that are common to all countries : to train men and women for the care of the sick ; to make them conscious of the need to employ every known means for the prevention and elimination of disease ; and to encourage them to use their technical knowledge to raise the standards of living and health in their peoples generally.

The task of the present Committee was to amplify certain of the recommendations set out in the reports of the earlier expert committees,<sup>1</sup> more particularly by exploring the possible ways in which the preclinical scientific courses can make a contribution to the broad concept of prevention in medical education. The Committee believed that, if appropriate ideas were introduced early in the training of the medical student, he was more likely to appreciate the many opportunities now inherent in all branches of medicine for the elimination of preventable etiological factors for many common diseases and consequently to acquire a more sympathetic attitude to preventive concepts when later engaged in his clinical studies.

Until recently, the education of the medical student in every country has been almost wholly orientated towards the long-established curative aspects of medicine. It is only within the past decade that the potentialities latent in a number of the basic sciences for promoting the prevention of disease have begun to be appreciated ; still more recently has it been accepted that these sciences are in a position to contribute usefully to developing in the student an appreciation of the role of preventive medicine in his attitude to his future professional responsibilities. The inculcation of such an outlook will not be easy, for every student enters medicine with the preconceived belief that the care and treatment of sick people are his primary task.

For long, the conception of prevention in medicine was virtually limited to the communicable and parasitic diseases, but during the present century, mainly through advances in biochemistry, the idea has broadened substantially to include also the many and widespread diseases that are the outcome of under- or over-nutrition. There are good reasons for believing, however, that the time is opportune for further enlarging the scope of the preventive outlook by interesting other scientific disciplines in its possibilities and embracing a still wider range of physical and mental disorders. Figuring prominently among the latter are those diseases of the body and mind that have resulted from the rapidly increasing application of scientific knowledge to industrial processes and the accelerated *tempo* of production. Some of these occupational disorders are due to the direct effects of particular materials and technical methods employed and affect only those operatives who are engaged in some especially hazardous work ; others are less immediately associated with specific tasks,

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<sup>1</sup> *Wld Hlth Org. techn. Rep. Ser.*, 1953, 69 ; 1958, 155 ; 1959, 175.

and are dependent upon the urbanization of populations that inevitably accompanies the transformation of a predominantly agricultural population into an industrial society. These more general diseases of urbanization—especially tuberculosis—usually fall most heavily on the women and children in ill-housed and overcrowded communities.

In directing the minds of students towards the abundant possibilities for preventive measures inherent in modern basic medical science, everyone who takes part in the teaching of the basic sciences can make some useful contribution. In some subjects, notably in biochemistry and microbiology, the contribution is an obvious and accepted one; in others, however, such as physiology and psychology, the possibilities, though none the less real, may be less self-evident and still demand the enterprise of the explorer for their exploitation. The Committee attempted to review the opportunities offered by the principal medical sciences for fostering in the minds of students during their early years of study the concept of prevention as a major and growing contribution of modern medicine to the general welfare. But when teachers seek for illustrative examples from their own field of medicine, the applicability of Whitby's remark, when he opened the First World Conference on Medical Education in London in 1953, may well be taken to heart: "medical education in any one area must to some extent be related to the medical needs of the population of that area". The seeking of diversity of appropriate subject matter coupled with unity of the preventive aim presents a challenge to every teacher irrespective of whether he is instructing in the preclinical or clinical periods.

### **1.1 The purpose and scope of the preclinical sciences in modern medical education**

Before proceeding to outline the contributions that might be made by the individual sciences to the inculcation of the preventive outlook, some consideration may be given to the places that these sciences take individually and collectively in the transformation of immature university freshmen students into young men and women capable of undertaking responsible tasks in the care of the sick. The great majority of medical students are a selected group of intelligent boys and girls who come to their university medical school directly from college or school where for several years they have been concentrating upon scientific subjects. These early studies, however, are seldom designed specifically as an introduction to a career in medicine, but are of a general character intended to serve as a groundwork for subsequent higher education in physics, chemistry, engineering, agriculture or some other line of scientific professional activity. It is, therefore, almost always necessary to amplify the scientific subjects as taught in school or college in various directions during the early period

of the student's courses in a medical school. Radiation physics and biophysics, certain aspects of chemistry and biology, including cytology, ecology and genetics, are examples of early basic subjects that can be dealt with much more satisfactorily and convincingly in a medical school than in a general school or college. The atmosphere, too, for the teaching of the keen and eager student just embarking on his life's career can and should be much more stimulating.

The initial preclinical period of two or three years in a medical school should serve two purposes. First, to give the young student a better understanding of the methodology of the scientific approach—the collection, evaluation and final marshalling of facts followed by the drawing of valid inferences. Secondly, to train him in methods of thought while at the same time ensuring that the knowledge he is gaining is likely to be of use to him later in his preclinical and clinical studies by reason of its carefully selected factual content. It is largely in the choice of appropriate factual matter from the almost unlimited range of scientific knowledge that future teachers can display their judgement; much that is included at present tends to be traditional and of little intellectual or practical value. It is through the ripening of his reasoning powers and the acquisition of an appropriate store of information that the student is prepared mentally for making effective application of his training in the basic medical sciences when he enters upon his clinical responsibilities.

The Committee considered that the student would be more impressed with the importance of the preventive aspects of the preclinical subjects, if he were required to answer examination questions on these aspects.

## **2. TRAINING OF TEACHERS AND SELECTION OF STUDENTS**

The progress of a medical school, and ultimately the value of its contribution to national life, are largely dependent upon the care with which it selects its teachers and students, for it is they who, as a community of scholars, will influence and largely determine the character and standard of medical practice in their country. Because effective medical faculties are products of slow growth and careful tending, no country can afford to neglect its system of medical education but should constantly strive to improve it.

### **2.1 Training of teachers**

The Committee gave serious consideration to the lack of adequately trained teachers in the basic medical sciences and particularly to the difficulties in this respect among medical schools in the less developed countries. It was agreed that while a medical qualification was not essential

for teachers in biochemistry, all teachers of anatomy and physiology should be medically trained scientists. The Committee felt, too, that teachers should be active research workers with most of their time available for the advancement of medical knowledge. Such teachers will create the research environment that is essential to good teaching. In any country, irrespective of its stage of development, there are numerous research problems that are essentially of local importance, and teachers of the basic sciences are often in a favourable position to stimulate the interest of their students in research by focusing their attention on such problems.

The Committee agreed that the lack of teachers of basic sciences is now a serious problem in almost every country, and that the time was ripe for directing efforts towards its solution. The authorities responsible for higher education could and should assist in improving the position by ensuring salaries for full-time university science teachers that are competitive with those prevailing in industrial research and other scientific institutions in the region.

In view of the urgent need in most countries for a large number of fully qualified senior teachers of anatomy, physiology and biochemistry, the Committee felt that very serious efforts should be made to encourage the recruitment and improve the training of professors for the preclinical departments of medical schools. While it recognized that the WHO fellowship programmes and teaching fellowship programmes were valuable measures whose extension in this field might in time have far-reaching effects, it felt moved to make the following proposals.

In view of the relatively small size and limited resources of most departments of basic sciences in medical schools, the Committee suggested that a scheme for the training of suitable teachers might be organized on an international basis by enlisting the help of various specialists in the different fields of knowledge and inviting them to arrange training programmes in their own particular field of interest. Such training courses should be limited to small groups of selected persons, preferably not more than twenty in number, and their duration in any particular institution might be only a few weeks. If such arrangements could be made with specialists in some of the more important branches of anatomy, physiology and biochemistry, as well as in other basic sciences of growing importance in medicine, a comprehensive curriculum could be established which would enable a young professor, after passing through a succession of laboratories, to acquire a broad survey of his field of knowledge in the space of, perhaps, two years. The strain upon any department undertaking such advanced teaching would be reduced by the grouping of the participants. Also, specialists might be prepared to give all their time for a short period to the teaching of a small group, whose enthusiasm and high intellectual level they might well find stimulating and rewarding.

The Committee felt the need to emphasize that any such training scheme would require organization at an international level, for only a few countries would be able to provide adequately for all the different aspects of the basic medical sciences. While the Committee believed that medical education would benefit greatly from the institution of such a training scheme, it regarded it as supplementary to any research training in that particular field in which the trainee is likely to specialise later on.

In addition to this broad scheme involving international co-operation, the Committee favoured the development of departments or groups of departments in selected medical schools within a region at which appropriate teachers from that region could receive advanced training in research and teaching. Through such experience and by association with his colleagues, the potential teacher would gain a better and more sympathetic understanding of the specific medical and social problems of his own country.

## 2.2 Selection of students

Faculties of medicine everywhere should endeavour to attract a large proportion of the best students that leave their national schools and colleges yearly, and should explore ways and means of encouraging the most able scholars to enter the service of medicine. They cannot continue to be oblivious of the fact that there is a shortage of scientists in all fields, and that the resulting competition for the best students by other professions and by industry is growing in severity. Much might be done through the co-operation of "careers masters" (or careers mistresses) in schools.

The Committee was agreed that both in the interest of the general public and to maintain the standards of the profession, it is essential for the students entering a medical school to have undergone a careful preliminary selection. It felt very strongly, too, that the final decision as to the admission of a student should be in the hands of the faculty itself. It considered that the criteria by which entrants are chosen should not be based solely on academic qualifications, but also on such qualities as emotional stability, reliability and capacity for co-operative work. These latter qualities can, it is believed, be judged best by personal interviews by selection boards supplemented by letters of reference from former teachers or other responsible persons who are familiar with the character of the student.

## 3. TEXTBOOKS

The Committee considered the character of the textbooks in current use and agreed that they often paid insufficient attention to the many possibilities for preventive medicine now latent in the basic sciences. Some of these books have passed through several editions and their design has

become so conventionalized that in many respects they no longer reflect modern developments and are not suited for a comprehensive preclinical education on present-day lines. The view was taken that there was need for a new book, written from the standpoint of "man, his life and environment" and placing more emphasis on the aspects of prevention to which various expert committees have drawn attention. A valuable volume that might supplement or replace current textbooks might well be prepared in one of the at present under-developed countries where the teacher and student are closely acquainted with the problems and living conditions of the great mass of their countrymen. As Cruickshank pointed out in his working paper written for a study group on physiology in 1957, for the student in such countries, "the idea of prevention could easily and advantageously be introduced at the preclinical stage, for its implications would be more readily apprehended". The task of writing such a newly-designed textbook might readily appeal to some experienced teacher of physiology who is sympathetic to the introduction of preventive ideas into his subject; a volume constructed on these lines, it was felt, might acquire a wide circulation and be a beneficial influence in many parts of the world.

Until such a textbook becomes available, the Committee considered the possibility of preparing bulletins to serve as special guides for each basic science discipline. These bulletins would suggest appropriate topics for the teaching and development of concepts in preventive medicine.

#### 4. THE PRELIMINARY PERIOD

The Committee drew attention to the fact that the leading members of the medical profession have very often been distinguished by their appreciation of, and contributions to, the culture of their times. The demands for technical knowledge that have followed the revolutionary advances in medicine often endanger the education as opposed to the training of the medical student, and the pressure that scientific studies exert tends to operate earlier and earlier in school and college life. The need for the maintenance of a balance between humanistic and scientific studies was discussed at length in the second report of the Expert Committee on Professional and Technical Education of Medical and Auxiliary Personnel in 1953.<sup>1</sup> There, too, the implications of the social and behavioural aspects of science received their proper emphasis.

For the student to take advantage of the courses in the preclinical sciences that he will receive once he enters the medical school, he should have had appropriate grounding in the basic sciences of biology, physics and chemistry. While it is inappropriate to attempt to set out here the possible scope and nature of such instruction, it might serve a useful purpose

<sup>1</sup> *Wld Hlth Org. techn. Rep. Ser.*, 1953, 69.

if some indication were given of the educational accomplishments in those sciences that might reasonably be expected of any intending medical student.

#### **4.1 Physics**

In general, it might be stated that the scope of a course in general physics should correspond roughly to that found in the many books on the subject employed in the senior classes of schools and earlier years in college. Of the various conventional divisions of physics, the study of electrical phenomena is of particular importance, for any deficiency in the preliminary training in this subject will later prove a serious handicap to the student when he encounters the phenomena to be covered in the courses on biophysics and physiology.

The Committee examined the related question of the standard that medical students should attain in mathematics. In its view, there is little doubt that the study of mathematics is a particularly effective means of training boys and girls in exact thought and that many of the more intelligent among them are attracted by mathematical ideas. Further, the increasing applications of quantitative methods in the medical sciences lead inevitably to mathematical and statistical concepts. With these ideas in mind, the Committee felt that the student entering medicine would benefit materially if he possessed some elementary acquaintance with exponentials, logarithms, and differential and integral calculus. While accepting the value of such training, the Committee was far from regarding it as essential for the admission of an otherwise suitable candidate to a medical school.

#### **4.2 Chemistry**

The Committee appreciated fully that the concepts of chemistry permeated the whole of the medical course, and that an inadequate preliminary training in this subject was a grave handicap to any student throughout his preclinical and clinical education. Two of the conventional divisions of chemistry—physical and organic chemistry—are of outstanding importance for the adequate comprehension of the ideas of biological and pathological chemistry. The Committee felt, therefore, that in considering the attainments of students seeking admission to the preclinical courses of medical schools, selection committees should attach great importance to the adequacy of their previous training in these branches of chemistry.

#### **4.3 Biology**

During the past century, none of the basic sciences of medicine has undergone so profound a change in relation to the medical curriculum as biology. It first acquired its place as a medical study because every physician

had to prepare his own medicaments from animal and vegetable sources and needed to be able to identify correctly the materials that he required. Indeed, none of the medical schools of repute in the later Middle Ages was without its botanical garden —some like that of Linnaeus having a remarkably wide range of species —and great emphasis for qualification as a physician was laid on a comprehensive knowledge of pharmacognosy. The nineteenth century, largely as a result of the powerful influence of Thomas Henry Huxley, saw a wholly new orientation of the subject in the medical course. Imbued with a missionary fervour to convince the great body of the medical profession of the truth of the then new Darwinian views on evolution, he devised a widely copied programme for the young student which took him stage by stage from the simplest biological forms to the most advanced. Although the intellectual need for this demonstration of the evolutionary sequence has long passed with the general acceptance of most of Darwin's interpretations, the structure of the pre-medical biology courses in some schools has undergone little essential modification.

In a modernized twentieth century form, the teaching of biology could provide numerous opportunities for illustrating the scientific background of many of our present-day practices in the field of prevention. Moreover, few aspects of the basic medical sciences, among which purely technical knowledge inevitably figures prominently, are so admirably adapted both through historical development and current beliefs to contribute an element of a liberal education.

The concept of natural selection as a guiding force in evolution has by now become part of man's intellectual heritage, but the fact that natural selection has not only operated in the past but is still operating in the present is not always fully appreciated. Yet few instances of the process at work and its effects on the species concerned have been as dramatic as the recent short and sharp encounter between the rabbit and the highly pathogenic virus of myxomatosis which has been so carefully studied by Fenner in Australia. The survival of resistant variants of the former and of attenuated strains of the latter has provided a remarkable instance of the struggle for existence and its sequel of natural selection.

The whole structure of the biology of the communicable diseases and their prevention has been erected on two foundations. The discovery by Leeuwenhoek of living multiplying forms of life of microscopic size and the later demonstration by Agostino Bassi that some of these minute agents possess pathogenic properties provided the seed from which the great science of medical microbiology subsequently grew so vigorously. But these studies, fundamental as they were, would never have attained their present significance if Pasteur, in one of the most masterly series of experiments and inductions in the history of science, had not conclusively disproved the age-old belief in spontaneous generation. The fundamental features of the work of these pioneers not only provide the basis of the

practice of many forms of community hygiene and prophylactic measures, but also give to the biologist an almost unrivalled opportunity for illustrating the methods of scientific inference.

Of an importance in the history of medical progress comparable with the exploration of the hitherto invisible living world of bacteria was the discovery that all higher creatures are elaborate aggregations of minute but highly variegated cellular units, and that in the diseased body the numbers, situations and sometimes the character of these units may undergo profound changes. The enunciation of the "cell theory", first by Schleiden and later by Schwann and Virchow, created a renaissance in pathology. The observations of morbid anatomical changes long familiar from necropsy studies gained an entirely new significance when they could be interpreted in the light of the new science of histology.

At the present time in many medical schools, the study of botany in relation to medicine is declining further and further in importance in the curriculum. There are, however, important reasons for retaining some measure of botanical instruction. Laboratory studies on plants provide in a very simple, cheap and humanitarian way a particularly good introduction to that distinctively biological scientific method, the "controlled experiment". Further, the results of such experiments can be expressed in quantitative terms, so that observations made by the students, both individually and collectively, are admirably suited to give practical instruction in some of the simpler and more dependable statistical techniques. The students have, too, the added incentive of using their own data for these purposes, and what may begin as a mere laboratory exercise may well end in a simple but instructive research. A wide range of variables, such as degrees of insolation, chemical additives to the nutrient medium in water culture, temperature, gravity, etc., can all be introduced into such experiments and the resulting data subjected to rigorous analysis. Such studies can provide a basis for the introduction of methods of evaluation of the results of clinical trials and epidemiological surveys.

Lastly, much of our knowledge of the cell has been acquired from the study of botanical material, and many of its physiological phenomena, such as mitosis, meiosis, polyploidy, can be particularly well displayed in plants. Since cytology, both in its morphological and functional aspects, is of such growing significance for pathology, especially in neoplastic conditions, this branch of biology has many features of value in the early years of preclinical study.

## 5. THE PRECLINICAL PERIOD

In modern medical courses, two, or at most three, academic years can be spared for preclinical education. It is therefore of great importance that the medical educator should seek to arrange this relatively short period

to the best advantage and to adjudicate equitably between the rival claims of the teachers in the different subjects in their understandable competition for the student's time. Opportunities must be found for instruction in the newer sciences, such as cytology and immunology, if the potentialities of modern medicine are to be exploited to the full, and this can only be done if the less valuable features of the more traditional subjects are reduced or even eliminated. But irrespective of considerations of detail, which must vary from school to school and country to country, the dual objectives of the preclinical period should never be lost sight of—education in thought and method, and exposition of the most important and relevant facts.

For such a graduated system to work to the best advantage, teachers are required who are sympathetic to the formulation of a coherent scheme of continuing education and who are prepared to accept periodical modifications in the curriculum if it is to undergo its proper evolutionary development. To ensure the closest collaboration among such teachers, they should all be members of the staff of the same institution and all concerned directly with medical education. The farming out of medical students to departments in faculties of science is often far from satisfactory. The heads of such departments almost invariably underrate the abilities of medical students and relegate their tuition to the less effective junior members of the staff. The undesirable sequels to such an introduction to medicine need not be stressed; it inculcates in the medical student a feeling of frustration and engenders an antipathy to science in general that handicaps the later teaching of the other preclinical sciences and often persists throughout professional life.

The candidate entering medical studies without prior university experience is generally accustomed to methods of instruction that are necessarily more didactic than those typical of university education. In the first year in the medical school, therefore, vigorous efforts should be made to render such students more self-reliant and more capable of employing the resources of libraries, laboratories and museums for actively acquiring knowledge for themselves. They should be made to realize that knowledge can only be gained by active effort—that “ God sells knowledge for sweat ”. The development of greater self-confidence during the first year or two meets with increasing rewards later, and may on occasion transform an indifferent and rather baffled student into one more interested and confident. The need for encouraging students to become less dependent upon textbooks and to learn to make productive use of monographs and periodicals is especially important, for once students have left medical school, where much of the instruction is inevitably oral, almost all their further education must come through selective reading.

The motives that lead students to adopt medicine as a career naturally vary widely, but common to the great majority is the praiseworthy desire

to care for patients and to be successful in the treatment of the sick. The concept of prevention in relation to disease is a more sophisticated and less familiar one which can rarely have the same appeal to the young student as that presented, often much more dramatically, by some successful medical or surgical treatment. For this reason, the more thoughtful and discerning the student, the more likely it is that he or she will appreciate the remarkable successes that have followed many medical advances in the prevention as well as in the treatment of diseases. But it is not to be denied that those teachers who wish to gain the interest and sympathy of the students for preventive ideas in medicine have a more difficult task and have to work harder and more persuasively for their ends than their clinically orientated colleagues. At the same time, it cannot be wholly disregarded that a possibly important reason for the indifference of many students in the past towards preventive ideas in medicine has been the unaccountable dullness with which a subject that intrinsically is of deep interest has been presented to them.

Whatever the student's aptitudes and inclinations, however, there is serious danger of blunting his interests and enthusiasm if he is forced to remain immersed for too long in purely preclinical sciences, some of which appear to him to have no obvious applicability to medicine, before he enters upon his clinical work and its pressing responsibilities. Emotional appeal is an important ally for the teacher in any branch of learning, and those in medical faculties are fortunate in having so many resources of this kind from which to draw support. With enlightened exposition and enthusiasm on the part of the teacher, it should never be hard to convince any ordinary student that the modern practice of medicine, irrespective of whether it is essentially clinical or preventive in nature, stands firmly on a foundation of the basic sciences. But to prevent the development of a sense of frustration and to sustain an interest in these sciences that may sometimes be in danger of flagging, it is essential for the teacher to have recourse from time to time to appropriate practical illustrations that can both exemplify and vivify his contention that modern medicine is in many respects the application of certain basic sciences to the problems of disease, and that many features of his teaching in the preclinical courses will be found ultimately to have a clinical bearing. It is sometimes forgotten that these young students are primarily concerned with medicine and not with science and that other than purely academic interests have influenced their choice of a career. An understanding attitude towards such students is not always to be found among their teachers, especially some of the younger and less tolerant teachers in faculties of science, and any unsympathetic attitude that may be displayed is quickly noticed by the student and in due time reciprocated.

During their preclinical studies, a number of students will develop a particular interest in one of the basic sciences. Such students demand a

peculiarly personal response from their teachers, for it is from their ranks that the investigators of the future will in the main be drawn. For such young people, a period in a research laboratory, helping a keen and active investigator in his work, can provide an incomparable stimulus and source of encouragement. Each of the major sciences in any large school can obtain its devotees, and the balanced development of a medical school depends upon an equitable sharing of these able young people among its various departments. It is through the efforts of such students that invaluable formal and informal discussion groups and societies are likely to develop and flourish. It is unnecessary here to expand further upon the education of these specially gifted students; no school can afford to neglect the development of their natural aptitudes and interests. They form the group that will ultimately give the school its standing in the world of academic medicine.

### 5.1 Biophysics

Most students who wish for a career in medicine have concentrated increasingly upon scientific subjects in their later years at school or college. Such an education, essential as preliminary for entry into any of the scientific programmes, is, however, necessarily general in character and requires to be supplemented in various directions for those young men and women entering medicine. While additional instruction can often be given in a general physics department of a modern university, the nature of the material selected and its intimate association with biological and medical problems provide cogent reasons for inclusion of such teaching in the early part of the preclinical period proper.

Of the subjects treated in any medical school department concerned with instruction in biophysics, none carries greater implications for preventive concepts than the nature and biological effects of ionizing radiations. To attempt to cover the whole field of atomic physics in any preclinical scientific course, even at the level of ordinary undergraduate education, would clearly be impossible without encroaching undesirably on the time available for the student's other preclinical scientific studies. Health questions related to such radiations are encountered so frequently, however, and in so many different connexions in modern life that it is essential for the medical student to be acquainted with the properties of ionizing radiations and radioactive substances and their potential uses and dangers in human activities.

The known hazards of ionizing radiations, irrespective of whether they are emitted by electrical apparatus or by radioactive isotopes, are twofold: first, they may injure or even cause the death of the irradiated individual himself, and secondly, they may injure the germ cells causing a defect that may be handed down to future generations. Both in the

undergraduate courses on biophysics and in the later courses on genetics and pathology, the nature of these hazards must be set out with as much clarity as present knowledge allows, and the measures now available for protection or treatment covered in considerable detail. Radioactive elements are being increasingly employed in industries of the most diverse kinds—even for instance in the sterilization of food—so that the physician of the future may at any time be asked for advice on a variety of unfamiliar questions, especially in connexion with some real or imaginary exposure. Moreover, it is unavoidable that accidents involving large-scale atomic reactors and other equipment in which large amounts of radioactive material are employed will occur from time to time. In such cases, prompt action from medical practitioners near the seat of the disaster will be essential.

Many of the fundamental aspects of the teaching of atomic physics to medical students have been covered in the fifth report of the Expert Committee on Professional and Technical Education of Medical and Auxiliary Personnel<sup>1</sup> and need no detailed recapitulation in this report. It may be re-emphasized, however, that such biophysical teaching, running through a number of subjects, provides an excellent example of the need for intimate collaboration between the different preclinical and clinical departments of a modern medical school. The effects of ionizing radiation on the person exposed—whether acute (radiation sickness) or chronic (leukaemia, cancer)—are essentially the joint concern of the departments of biophysics and pathology, while the effects on the germ cells concern equally the departments of biophysics and genetics. In reviewing both these problems, the need for imparting some knowledge of current preventive precautions becomes particularly apparent.

While the sources of ionizing radiation most in mind at the present time are radioactive isotopes emitting gamma rays and certain types of electrical apparatus, short-wave radar is another form of electromagnetic radiation that may soon demand attention. At the present time, the power fluxes employed in producing such radiation are still low and its use is confined mainly to telecommunications, but the technical advances occurring in this field of physics may soon extend the use of short-wave radar to the transmission of power. The consequent stepping up of the energy levels involved may conceivably lead within the next decade to medical problems of a novel and at present obscure kind.

The teaching of radiation physics in its associations with genetics and pathology provides abundant examples of the importance of the preventive concept in medicine. Furthermore, many of the warnings as to the potential hazards of ionizing radiations can and should be reinforced later in the clinical course in the departments of diagnostic and therapeutic radio-

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<sup>1</sup> *Wld Hlth Org. techn. Rep. Ser.*, 1958, 155 (*Introduction of radiation medicine into the undergraduate medical curriculum*).

logy. These dangers are set out clearly and briefly in a number of inexpensive publications<sup>1</sup> which describe the comparative risks that may be attached to various forms of radiation, avoidable and unavoidable. The student should be made aware of the cumulative features of the genetic effects of ionizing radiation, and should be warned that unnecessary exposure, especially of children and young persons, should always be avoided. Furthermore, he should realize the special vulnerability of the human embryo during the early stages of its development and consequently the need to minimize as far as possible the irradiation of pregnant women during the first few months after conception.

## 5.2 Anatomy

The Committee agreed that in the interest of the education of the medical student the teaching of anatomical details be reduced to an amount necessary for an understanding of the inseparable principles of structure and function. During the anatomy course many opportunities for the teaching of preventive aspects of medicine arise, given a little imagination and enthusiasm on the part of the instructors. For example, attention may be drawn to the effects of radiation on the germ cells, the potential hazards to the embryo from malnutrition of the mother, and the effects of certain viruses and drugs that may pass the placental barrier and cause maldevelopment of the foetus.

Largely as a result of the opportunities provided by radiology, there has been a growing tendency in recent years to study structure as it is seen in the living subject as well as in the dissecting room. This has not only given a valuable incentive to the study of anatomy, but has also brought anatomists into closer contact with their colleagues in the preclinical and clinical departments.

Many diseases and disabilities exhibit their early signs in structural disturbances of so minor a nature that they are more easily recognized

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<sup>1</sup> For example :

World Health Organization (1957) *Effect of radiation on human heredity*, Geneva.

Expert Committee on Professional and Technical Education of Medical and Auxiliary Personnel (1958) *Post-graduate training in the public health aspects of nuclear energy, fourth report...*, Geneva (*Wld Hlth Org. techn. Rep. Ser.*, No. 154).

Expert Committee on Professional and Technical Education of Medical and Auxiliary Personnel (1958) *Introduction of radiation medicine into the undergraduate curriculum, fifth report...*, Geneva (*Wld Hlth Org. techn. Rep. Ser.*, No. 155).

United Nations, Scientific Committee on the Effects of Atomic Radiation (1958) *Report...*, New York (UN document A/3838).

Great Britain, Medical Research Council (1956) *The hazards to man of nuclear and allied radiations*, London, H.M. Stationery Office.

National Academy of Sciences—National Research Council (1960) *The biological effects of atomic radiation. Summary report*, Washington.

by the anatomist in his living studies than by the pathologist, by whom they may be seen only at necropsy in their more advanced and often irreversible stages. These minor changes are particularly likely to affect the skeleton, especially in childhood when growth is active and the body less capable of withstanding unusual stresses. Many of these disabilities are known to arise from some deficiency in the diet, and the radiological resources of the anatomist, together with his detailed knowledge of the normal, place him in a particularly favourable position to evaluate, in collaboration with his paediatrician colleagues, the success or failure of preventive measures in which nutrient supplements have been administered experimentally or therapeutically. During the period of growth, nutritional deficiencies, especially those of the D group of vitamins, may seriously impair normal bone development in many parts of the body. Children suffering from such deficiencies are frequently left with serious deformities. In later life, these may prove a handicap to the male in the performance of ordinary manual labour, while in the female the effects are doubly to be deplored for deformities of the pelvis may render normal parturition difficult or impossible. Chronic endemic diseases, many of them of parasitic origin may also stunt general growth and retard the normal development of the child.

Through the examination of adults, the anatomist is particularly well placed to detect the appearance of many types of incipient deviation from normal structure. Many of these abnormalities are again skeletal in nature and can be observed by skiagraphy; furthermore, many of the remedial measures that could be applied in early cases require a detailed knowledge of the muscular system and the part that may be taken by any particular muscle or group of muscles in increasing or reducing the stresses imposed on the bones. In devising measures likely to correct or obviate such deforming stresses, the anatomist and the orthopaedic surgeon should co-operate in the closest manner.

Structural defects in the locomotor system are most likely to be seen under conditions of life in which strenuous physical labour is the rule and where loss of capacity for such work entails distressing consequences. In industrialized countries, two changes have taken place that have lessened the incidence of preventable chronic deformities directly attributable to unsatisfactory conditions of labour. The first is the greatly extended application of powered machinery, so that the more arduous tasks are now merely controlled by the artisan or labourer and no longer performed by him with his own limbs. The second is the introduction and elaboration of detailed movement studies in repetitive mechanical tasks, as a result of which the artisan not only carries out his work more economically and expeditiously but also, often unconsciously, eliminates those movements of his trunk and limbs that may throw an undue stress on vulnerable structures. Anatomists are now being called upon to play an important

part in designing modern labour-saving machinery from the point of view of the convenience and health of the operative.

An aspect of anatomy that might well yield valuable results in preventive medicine is the study of the structural changes found in elderly people. Such studies might throw light on forms of physical activity that, pursued over the greater part of a working life-time, may be followed by the joint deformities and arthritis that can cause great distress in old age. Were more known of the delayed ill effects of certain forms of employment—apparently undertaken with impunity in early adult life—it might be possible to modify conditions of work by the introduction of better tools or appliances to lessen or eliminate these hazards.

### 5.3 Physiology

The teaching of physiology in its various aspects to students of medicine should aim at giving them a more dynamic concept of living matter than the rather static one that they have often acquired during their earlier education at school. This will place the student in a better position to comprehend his relationship to his environment and his obligations to his fellows. Moreover, after qualification, the outlook of the young physician will be directed towards ways and means of maintaining the functional balance of the body in health or re-creating it in disease. He will, in fact, be inspired by the idea of prevention rather than by that of corrective therapy.

Prevention implies a clear realization of the wide variations possible in man's environmental conditions and the corresponding range of responses that the human organism can make to exposure to such diversified conditions. It is the fundamental aim of general physiology to provide a broad knowledge of these relationships, while special physiology is concerned with the reactions of particular organ systems. In their courses in experimental physiology teachers should begin by describing the constitution of the human body and then the reactions that its chemical or physical balance can undergo as a result of changes in various environmental factors. Such a treatment of the subject will also pave the way for the introduction of the student to the requirements of quantitative data and their statistical analysis. The reactions of the body must be studied above all in the light of its homeostatic powers—its capacity for immediate or delayed readjustment to change. Observations from general pathology will here be of great value, for they illustrate the exact and particular significance of these permissible limits.

Instruction in special physiology will not only provide information on the functions of organs in health but also on their adaptation to deviations in the environment and on the mechanisms of adaptation that may enable a modified organ to function effectively. Such knowledge enables the

multiplicity of physiological and pathological homoeostatic mechanisms to be more fully appreciated, and again places emphasis on the limits of tolerance beyond which compensatory adaptation is no longer possible. It is on this knowledge that specific preventive measures must ultimately be based.

Psychophysiology, or the psychological aspects of physiology, is inseparable from physiology proper. The teacher of physiology in the faculty of medicine should never lose sight of the fact that he is responsible for the comprehensive presentation of both function and behaviour.

The progressive pruning of the science of physiology by the lopping off of such branches as experimental medicine, pharmacology, biochemistry and experimental pathology has nevertheless left behind a still imposing tree. It is from its somewhat mutilated trunk that new ideas and methods of teaching in the preclinical course must stem, and attempts to introduce the preventive concept into the subject might well encourage the growth of a new and in time fruitful branch.

A physiological life implies the maintenance of a bodily equilibrium in the face of constantly changing, and even highly diversified, external surroundings. Throughout the course of his evolution, man has been exposed to natural environments which have often imposed very substantial stresses on his powers of adaptation. It is with a remarkable endowment of physiological adaptability that he confronts the modern world with its manifold stresses of an entirely new kind. These will raise novel medical questions, to many of which the physiologist will be very favourably placed to supply an answer, for no-one is more able to assess the permissible limits of healthy adaptation. The study of ergonomics—the investigation of the conditions of manual labour—is rapidly growing into a science in its own right, but for years to come it must continue to shelter under the aegis of physiology. The early stages of industrial revolutions in most European countries showed how appallingly all types of employee, but more especially women and children, could be overworked, frequently under grossly unhygienic conditions, and years were later needed for factory legislation to impose a more humanitarian system. The applications of the general principles of ergonomics in developing countries, suitably adapted to climatic and cultural conditions, may prevent the repetition of such a dreadful apprenticeship to industrialization.

Ergonomics, however, penetrates much further into physiological conditions of work than merely defining permissible limits of maximal labour. In a world that is constantly demanding increased efficiency and production from its factories, optimal conditions of temperature, ventilation, humidity, and appropriate clothing in the workshops are all assuming greater significance. The strain that can be thrown on the eyes by improper illumination of work benches, especially those at which delicate manipulations are undertaken, and the psychic, nervous, and otological stresses produced

by excessively noisy machinery, can be greater than ever before, and the physiologist concerned with special senses is alone in a position to recommend palliative or preventive measures. Although the detailed regulations now required for factory legislation must inevitably be drawn up by specially trained and experienced medical officers, the ordinary student of medicine might with profit be given some elementary introduction into the principles of ergonomics.

Courses in physiology, like those in all the basic sciences, usually contain a large element of traditional teaching material which teachers are reluctant to discard ; but some elimination of matter from the customary teaching schedule is inescapable if the science is to contribute as usefully as it could and should to modern medical education.

Lastly, mainly through the studies of paediatricians, there is growing realization that infants cannot be regarded as miniature adults or "homunculi", since they differ profoundly from adults in many of their physiological responses to the environment. In most organ systems functional immaturity is clearly apparent during the first year or two of life, but in few is the delay in physiological development fraught with greater danger to life than in the kidney whose capacity for stabilization of the "milieu intérieur" of the body is dependent upon a progressive and relatively slow post-natal development of the renal units. From the preventive standpoint, the recognition that the excretory powers of the kidney evolve comparatively slowly is particularly important, for in some of the more serious communicable diseases of infancy, especially in the gastro-enteritis so common in tropical countries, loss of water and electrolytes can take place so rapidly from the intestines that renal excretion may be profoundly and even fatally deranged. The physiological adaptations distinctive of infancy provide an important field of interest for physiologists ; the further study of this field, and clinical application of the findings, would yield a harvest of much value in preventive medicine.

5.3.1 *Sociophysiology.* The functions of the different organs are determined by, and continually related to, the actual conditions of the environment. This means not only the physical, but also the social conditions, such as family and communal life, schooling, organized relaxation such as athletics, and the different professions ; in fact, social relations in general, whether professional or extra-professional. It is known that the functioning of the central nervous system, the endocrine system and, to a large extent, the digestive tract, as well as the regulation of the heart and the circulation, can be modified by the stresses of everyday life.

The sociologist can give a comprehensive description of the social environment and its influence upon the behaviour of the individual. He knows under what conditions, and to what extent, the social medium can be adapted to either human individuals or groups, and he is aware

also of the limits of that adaptation and when its characteristics seem to be unalterable. On the other hand, within these sociological limits, the physiologist can try to explore the characteristics of individual adaptation, and also of group adaptation, the actual adaptation modifying the environmental conditions for the other members of the group. Integration of physiology and sociology, which was already being considered at the start of this century by Solvay, Waxweiler, and others, could be attempted today, in order to form an adequate defence against the hazards of social life. The physiologist and sociologist should discuss together their related problems and agree on ways and means of preventing irreversible consequences of the stress to which members of a social group are subject. The medical student should be made aware of these problems, and perhaps some hours of teaching should be devoted, possibly with the aid of the psychologist, to help the medical student understand what is the actual position of the individual in relation to the group and in what measure organic functioning is dependent on the particular group of which the individual is a part.

#### **5.4 Pharmacology**

In the field of pharmacology there appears to be no need for a reorientation of teaching in the direction of preventive medicine, as already the pharmacologist attempts to teach the hazards associated with the utilization of drugs and to warn against their use in large amounts or under adverse circumstances. On the other hand, a large part of the activity of the pharmacologist is taken up by the preparation of drugs that have a specific preventive action against bacterial or parasitic infections, such as the prevention of malaria.

#### **5.5 Biochemistry**

The science of biochemistry deals with the chemical organization of all living things. Its goal is to acquire evidence regarding the molecular constitution of enzymes, cell particles, cells, organs, and individuals. A thorough knowledge of these biological systems requires chemical information about the component parts; thus the advances in biochemistry that have contributed so much to modern medical knowledge, have stemmed largely from careful attention to the intimate details of the mechanisms involved.

Biochemistry is essentially an experimental science and investigators in this field employ a variety of laboratory techniques. Chronologically, biochemical investigation falls into four phases: first, the isolation and, if possible, crystallization of a pure chemical substance from natural sources;

secondly, the chemical characterization of the substance in terms of molecular configuration ; thirdly, the metabolism of the substance, including its biosynthesis from precursors under the influence of enzyme systems as well as its alteration to other products ; and finally the mechanism of action of the substance and its relation to and influence upon other biochemical events in the environment.

Owing to the applications of biochemical methods in other fields of medical science and to the fundamental character of the science itself, biochemistry enters into teaching and research at practically all stages of the modern medical curriculum. Biochemists no longer confine their attention to their own departments ; they may often be found working on biochemical problems arising from the other established disciplines of medicine. Similarly, anatomists, physiologists, microbiologists, clinical investigators, etc., frequently direct attention to biochemical projects. This trend will continue as increased knowledge permits more accurate definitions of current medical problems and reveals that many of them may be vulnerable to attack by biochemical methods. Therefore, a good basic training in the discipline of biochemistry is essential for all students planning future careers in any branch of medicine.

Usually the biochemistry course is given during the preclinical period and follows a general educational phase in which certain subjects are indispensable. Biochemical training serves several useful purposes in the medical school curriculum. It provides a direct link between earlier work in chemistry and the application of chemistry to medicine ; it inculcates basic concepts of the human body as an organized chemical machine ; and it also brings to the attention of the student the importance of the environment in maintaining normal chemical functions. If taught during the same year as physiology, anatomy, and histology, the four disciplines supplement each other, especially when the departments co-operate to experiment with various techniques of appropriate and integrated teaching. Thus the student begins to develop and co-ordinate his own ideas of structure, function and metabolism.

A sound training in biochemistry also serves to prepare the student for other courses in the preclinical and clinical periods by facilitating the teaching of bacteriology, virology, pharmacology, pathology, pathological chemistry and many topics within the clinical courses. Biochemistry is ideally situated in the curriculum for emphasizing the inter-relations of the medical sciences ; by its basic nature it provides a meeting place for common problems that can be reduced to the molecular level. With this background, students are able to supplement their own laboratory work by frequent visits to the research laboratories for special exercises and demonstrations. There can be a variety of satisfactory teaching programmes for presenting the subject of biochemistry to medical students. Other factors being equal, the programme will vary with the size of the

department, the experience of the individual teachers, the time allotted to the course, and the student laboratory and staff research facilities. Usually the lecture series are similar in most medical schools whereas great variation exists in the laboratory programmes.

It is generally recognized that an important purpose of the biochemistry course is to permit the medical student to acquire an education in the discipline, philosophy, techniques, and accomplishments of a science that will aid his future approach to problems in medicine. Furthermore, an active research department provides the student with a desire to read and the ability to understand both the current biochemical literature as it relates to clinical and public health problems and the medical literature in general in so far as it deals with biochemical problems. This requires a comprehensive course of studies in the fundamentals of the subject, and a well-organized laboratory programme. During the latter the student should have the advantage of personal contact with all members of the biochemistry staff while he is learning at his own bench. He should work with the best research equipment whenever practical and see demonstrations of the procedures used to yield the type of evidence he must eventually learn to evaluate. The laboratory should also provide an opportunity for encouraging the student to develop his investigative talents. Hence adequate time and supervision should be made available within the course for conducting minor projects, for writing up the results, and for presenting them to his colleagues.

Before starting his biochemistry course the medical student has usually acquired some knowledge of general biology, general physics, general chemistry and organic chemistry. Depending upon the scope of these prerequisite courses some review work, especially in physical chemistry, is usually necessary. An early introduction to isotope chemistry, enzymes and enzyme kinetics is wise, since frequent references to these topics are made throughout the course. Similarly, in the laboratory early experience with isotope counting equipment, enzymes, paper chromatography and colorimetry has been found desirable. Many experiments are available that employ these techniques while teaching principles in biochemistry.

A period of several weeks is necessary to acquaint the student with the chemistry of the natural substances. During this time topics in intermediary metabolism may be introduced in preparation for the main body of the course, which concerns metabolism of the proteins, lipids, carbohydrates, nucleic acids, minerals, and the effects of vitamins and hormones. In the latter part of the year the student is helped if encouraged to study and think in terms of "themes". Energy provides an example of such a "theme": if traced from solar energy through photosynthesis to the chemical energy of starch, glucose and ATP and finally to the mechanical energy liberated by muscle contractions it provides a pattern for learning the many related biochemical details. Again, a nitrogen

atom may be followed from an amino group of ingested protein until its final elimination as urea or ammonia, thus providing a systematic pathway for studying and co-ordinating pertinent biochemical facts about nitrogen metabolism. The tracing of iron, iodine, acetate and many other substances through digestion, absorption, intermediary metabolism and excretion are other themes that help the student bring together what otherwise might seem to him unrelated facts. The biochemistry course affords excellent opportunities for emphasizing the importance of nutrition; the dramatic history of the elimination of certain nutritional diseases through vitamin research provides a stimulating environment in which to focus the student's attention on the function of vitamins as co-enzymes, thus strengthening his knowledge of general metabolism. Throughout the course, frequent review lectures are necessary to co-ordinate the details learned from lectures, textbooks, the laboratory, and other courses. Experience has shown that student interest is maintained at a high level during metabolic experiments, which rely heavily on isotope work and paper chromatography. Students also take keen interest in experiments on nutrition and endocrinology where they have an opportunity of working with their own experimental animals. Demonstrations on the Warburg respirometer and the ultracentrifuge, for example, not only teach biochemical facts but also afford opportunities for introducing concepts of cellular respiration and structure.

In general, it seems wise to subject the laboratory programmes to constant revision. The staff should not hesitate to challenge the students with new and difficult techniques when these serve to illustrate important biochemical principles. Medical students often respond surprisingly well to such stimulation.

Whenever changes in the lecture and laboratory schedules are made they should effect a more efficient use of time by condensing knowledge in some areas while permitting expansion of the scope of the course in others towards new horizons of the science.

During the biochemistry course every effort should be made to emphasize preventive medicine and illustrate the tremendous potentials of applied biochemistry. For example, the application of biochemical knowledge that resulted in the elimination, in some parts of the world, of goitre, beri-beri, pellagra and other deficiency diseases, are historical records that rank among the great achievements of medical science.

The application of chemical knowledge in the fields of antibiotics and anti-metabolites offers hope for the eradication of all remaining infectious disease and for the control of neoplasms. Hence, in biochemistry every opportunity should be taken to stimulate the student's imagination and make him aware of the unlimited possibilities for the prevention and elimination of disease through the application of basic medical knowledge.

### 5.6 Genetics

From the standpoint of preventive as well as of curative medicine, the student must be brought to realize that man is the product of both heredity and environment—the latter being varied, complex and subject to profound changes. Both these factors operate throughout the normal growth and development of every person, and equally affect his reactions during age and sickness. Much of our success in the prevention of epidemic diseases that formerly had a widespread distribution has come from the knowledge gained during the past century of their etiology and the nature of the environmental pathogenic factors responsible for their causation. Far less is yet known of the part played by heredity and genetic factors in the origin and evolution of most diseases—even the more common ones—and there can be little doubt that future studies in genetics, both on animals and man, will throw valuable light on the causation of these diseases and may even provide clues for their prevention. In such hopes lies the justification for enlarging the study of the science of human genetics in the medical curriculum.

The procedures employed for the teaching of genetics to the students will necessarily vary from school to school, and depend for many years upon the availability of competent geneticists to undertake its instruction. In general, and without any attempt to impose any standardization on the curriculum employed, the Committee agreed that it is best if the fundamental aspects of genetics are covered during the preliminary period before the student enters upon his preclinical studies. If such an arrangement is not feasible, instruction in genetics should be started early in the preclinical years. An acquaintance with cytogenetics—the study of the mechanics and chemistry of cell division—comes appropriately during the latter part of the preclinical period together with instruction in histology, embryology and biochemistry. Finally, human genetics, which forms the culmination of the subject in the medical course, and which requires considerable knowledge of pathological phenomena, must inevitably be postponed to the later part of the clinical period. Such an evolutionary development of the teaching of genetics throughout the entire medical curriculum should enable the student to grasp the impact that this subject is now making upon medicine and to discuss the concepts that it employs intelligently and with confidence.

The seventh report of the Expert Committee on Professional and Technical Education of Medical and Auxiliary Personnel<sup>1</sup> dealt with certain features of human genetics in relation to pathology, while the fifth report<sup>2</sup>

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<sup>1</sup> *Wld Hlth Org. techn. Rep. Ser.*, 1959, 175.

<sup>2</sup> *Wld Hlth Org. techn. Rep. Ser.*, 1958, 155.

referred at some length to the possible hereditary effects of irradiation. Both these reports have pointed out that it is only recently that the wide possibilities for research in this field have been appreciated. Abundant topics of great interest for the student can be presented to him, sometimes exemplified with illustrative cases; they include malformations, blood dyscrasias, abnormalities of the eyes, mental defects, metabolic diseases and diseases of the nervous system.

General genetic concepts, including polymorphism, as well as the applications of genetics to preventive medicine should be emphasized to the student. If he is made aware of the genetic factors in disease he will be better prepared not only for the clinical handling of patients but also for raising the general health of the community he serves. Modern medical teaching and research problems require the participation of qualified geneticists within the medical faculty.

### 5.7 Medical psychology

The Committee was of the opinion that medical students must be given adequate instruction in psychology. This instruction should be conceived of as quite different in character from that imparted to students in the faculty of arts. Medical psychology may be defined as psychology that is the product of medical experience and that is intended to serve purposes of general medical practice in its curative and especially in its preventive aspects.

Medical psychology is not merely an introduction to psychiatry nor, indeed, is it a part of psychiatry, although it is closely related to it, since both require an understanding of the patient-physician relationship and of group problems. In the future, it is essential that the general practitioner should be able to distinguish between "psychopathic personalities" and normal personalities suffering from stress liable to produce a psychopathological condition; he should know how to approach both types of patient in a rational manner and how they are likely to react to his interventions. This essentially "practical" and "concrete" aspect of medical psychology demonstrates its role in the detection and prophylaxis of psychic disorders and, in turn, determines ways in which people can be helped in their reactions to their surroundings. In teaching medical psychology the essential aim, therefore, should be to impart knowledge of the patient-physician relationship, since the physician cannot refer many of his patients to the psychologist or psychiatrist. Medical psychology must be kept apart from psycho-physiology; the latter should be taught in close collaboration with the physiologist and should not be restricted to experimental psycho-physiology but should also include human psycho-physiosociology.

Instruction in the specialized techniques and psychological tests should be included in psychiatry and perhaps also in paediatrics. The aim of

the teacher of medical psychology must be to provide the physician with the bases of the technique he uses—often without knowing it—so that he may understand the dynamics of patient-physician interviews and concern himself with the psychosociological consequences of disease.

In the preclinical period, the teaching of medical psychology should include a study of the development of personality which may well serve as a basis for the identification of psychological types (characterology). This should be followed by study of: intersubjective patient-physician relationships (preventive action with respect to the concept of the physician as the cause of disease); the psychology and prevention of non-pathological conflicts; group psychosociology; the sick social group.

Finally, in suitable seminars during the clinical period, the student of medical psychology can be given detailed instruction in the psychotherapeutic procedures available to the medical practitioner and their limitations; in this way certain problems of psychosomatic pathology may be approached in the light of the epidemiological factors.

In this teaching, great care must be taken to avoid any excessive intellectualization of the psychological aspects of medicine; it should aim at presenting the whole human-being and not at making distinctions between the "psychic" and the "physical". One of its most useful aspects will be that the training itself may help the medical student to meet some of his own psychological difficulties; making available to him the psychological help of which he might personally be in need can itself be a form of preventive medicine. A further application of medical psychology in the field of preventive medicine is to remove the possibility that the future physician may inflict psychic trauma on his patients; any traits apparent in students suggesting such a possibility should be analysed and neutralized as soon as possible.

### 5.8 Pathology

The preventive aspects in the teaching of pathology were discussed in the seventh report of the Expert Committee on Professional and Technical Education of Medical and Auxiliary Personnel,<sup>1</sup> and its findings need only be very briefly outlined here.

This committee interpreted the word "pathology" broadly, and set out, *inter alia*, a series of topics whose discussion with students would clearly exemplify the preventive idea. These topics, which were all eminently practical in character, included: diseases of industrialization; the pathology of trauma; iatrogenic diseases in modern medicine; radiation injuries; diseases of faulty nutrition; infections, infestations and venomous animals; pathology and human genetics; pathogenesis of congenital

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<sup>1</sup> *Wld Hlth Org. techn. Rep. Ser.*, 1959, 175.

abnormalities ; the pre-cancerous state ; and the growing importance of immunology in pathology. The committee recommended that, in view of the intrinsic importance of pathology as a science and because of its potentialities for inculcating a preventive outlook, the teaching of this subject should continue without interruption throughout the two or three years of clinical study. It felt that it should not be taught, as sometimes happened formerly, as an isolated discipline for a limited portion of the curriculum, but that it should maintain close relations with the other preclinical and clinical subjects—its contact with epidemiology being especially close. It seemed, too, that in some countries at least, the student might sometimes gain a better perspective of the success of preventive measures against some industrial and endemic diseases if these measures could be depicted against an historical background illustrating the often intimate connexion between medical advances, scientific discoveries, and social progress.

### 5.9 Microbiology

Although much was known of the ravages of the major infectious diseases in the Middle Ages and quarantine regulations were early adopted by some of the most important maritime powers, it was only through the development of microbiology as an adjunct to pathology about the middle of the last century that light was thrown on the methods of transmission of the causative agents and that the rational foundations for the control of epidemics were laid. The rapid improvements in microscope design early in the nineteenth century, together with the introduction of transmission experiments on animals, made possible the creation of a new science, whose significance was quickly grasped by epidemiologists and whose applications enabled them to approach with success the elimination of a number of important diseases that had formerly been scourges, especially in urban populations.

Methods have been devised for the eradication of many infectious diseases, either through eliminating the exposure of susceptible persons to the infective agent by the provision of clean air, water and food, or through the specific prophylactic immunization of exposed persons. But although much is now known about the principles underlying these measures, the extent to which it has been possible to introduce them effectively in different countries still varies very widely. In some countries, favoured with an abundant supply of clean water and a temperate climate, the introduction of such measures is seldom difficult, but in others where water is scarce, sanitation poor, and the tropical climate more congenial for insect vectors, the problems confronting the hygienist are many. For these reasons, the science of microbiology and study of the modes of transmission of living pathogenic agents acquire special importance among the medical sciences

in those countries in which epidemic and endemic infectious diseases are still rife.

The opportunities for the introduction of the concept of prevention are greater in microbiology than in any other medical science. In Europe and North America the eradication of cholera through the control of water supplies, the disappearance of the typhus group of diseases as a result of a revolution in personal hygiene, the dramatic reduction in the loss of child life through active immunization against diphtheria, and the retreat of tuberculosis through the introduction of anti-tuberculosis drugs are among the many examples that the teacher can place before his audience. Each country is afflicted with its own epidemic infectious diseases, and, while the teacher of microbiology has the important general principles of his science to impart to his students he has the additional responsibility of reviewing in a very practical and detailed way those that distinctively afflict his own countrymen. Many of these diseases are now almost confined to tropical countries, and their control often offers difficulties of a daunting kind. But in spite of frequent discouragement the microbiologist must not relax his efforts to reduce the prevalence of these diseases. Indeed, their very occurrence, often with high morbidity and mortality, should spur both him and his pupils to undertake research into their eradication.

In many countries the incidence of the infectious diseases is intimately associated with general economic conditions and especially with such social conditions as housing and nutrition. The mitigation of the effects of these communicable diseases can seldom be brought about by any single hygienic measure, and it is only when the standard of living is concurrently raised that the more specific measures of the microbiologist and immunologist can become effective. Every student of medicine should be impressed with the vicious circle of poverty and disease and the interaction of these factors upon one another.

## 6. AREAS OF CONTACT

Implicit in the foregoing portions of this report are many opportunities for collaborative teaching between the various departments of a medical school. The entire curriculum should be so organized that the medical student obtains the greatest benefit not only for medical practice, but also for his education in the scientific and humanistic aspects of medicine. The procedures for effecting such continuing and co-ordinated teaching will vary with the organization of the medical school and particularly with the personalities of the teachers. There are many fields of interest common to the basic medical subjects and these should be exploited to emphasize the interdependence that exists among modern medical sciences; the clinical pathological conference in which teachers of the basic sciences

also participate has been found a particularly fertile field for such co-operation. Frequent liaison between teachers of the overlapping subjects, for example, anatomy, physiology and pathology, should develop new ideas and lead to experiments in medical education. Time for such experiments can usually be obtained by eliminating superfluous material from existing courses.

No modern medical science progresses by itself; advances in one subject lead to advances in all. While the student must be trained in the constituent subjects of human biology and learn his fundamentals from experts in the various disciplines he should also be made aware of the fact that his final goal is a concept of the whole man and the influence his environment exerts upon him. The functions of medical schools are to provide such educational opportunities and to imbue doctors with a sense of their duty to society. The importance of teaching preventive medicine in the basic sciences as a means of developing an awareness of such social responsibilities has been emphasized throughout this report.

Although the Committee had been asked to consider the development of means for introducing the preventive concept specifically in the pre-clinical portion of the curriculum, it wished to emphasize its conviction that much of any benefit gained during the earlier years will be lost unless similar emphasis is laid upon such ideas during the years later spent by the student in the wards. To some extent this attitude of mind can be sustained during the latter period by teachers in the departments of pathology and microbiology, but it could be reinforced in a particularly convincing manner by clinicians if, during their ward rounds and clinics, they were to discuss relevant aspects of prevention as well as of diagnosis and treatment. It must be accepted that the majority of students, as is to be expected from the motives that led them to enter on a medical career, are more impressionable in the wards and clinics than in the laboratories. It follows that their attitude to their future work in medicine is likely to be more influenced by physicians and surgeons than by scientists and laboratory workers. Some clinicians, especially those with experience in industrial diseases, go very fully into the etiology of the conditions they are called upon to diagnose and treat; it would be much to the advantage of medical education and the practice of medicine generally if more were to do the same. Their collaboration in this direction could greatly fortify efforts made by teachers in the preclinical basic sciences to inculcate a preventive outlook, along the lines suggested in this report.

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