WHY DO WE TEACH PHYSIOLOGY THE WAY WE DO?
AN ANALYSIS OF NATIONAL CHARACTERISTICS

The following invited reports express the personal views of physiologists on the historical influences on physiology education in their countries.

REPORT FROM ARGENTINA

In Latin America at the beginning of the twentieth century, the physiological sciences—biological chemistry and biological physics, as well as physiology itself—were taught in schools of medicine. The head of the department and other faculty were medical doctors who carried out their teaching responsibilities during time taken from hospital and private practice.

In 1919 Dr. Bernardo A. Houssay (later Nobel laureate) was appointed full-time Professor of Physiology in the School of Medicine at the University of Buenos Aires. Soon after his appointment he obtained full-time positions for some of his colleagues also. He argued that, in physiology, teaching and research should be associated. At this same time, laboratory work, with active participation by students, was added to a curriculum previously based entirely on formal, hour-long lectures given two or three times a week—a program that had allowed little active student participation. In the new curriculum selected students from each class were placed under the supervision of full-time faculty to carry out intensive laboratory procedures. Undergraduate and graduate students were encouraged to initiate research programs with the intention of providing, in due course, teachers and investigators for the future—in clinical as well as preclinical areas.

Cats and dogs were sometimes used in laboratory classes and in demonstrations, but rats were more commonly the experimental species. The procedures employed kept to the strict rules of hygiene, anesthesia, etc. that were used in clinical work.

This physiological model was the basis for similar arrangements in laboratories of histology, pathology, pharmacology, etc., not only in the University of Buenos Aires but in other parts of Argentina. The added impetus given to developing research within the health sciences was, moreover, influential in initiating research in the schools of science and technology. Other countries in Latin America realized the advantages of these innovations. Young graduate students were sent to Buenos Aires on fellowships so that they could return to their own institutions experienced in teaching and research.

In the older universities new schools were created in dentistry, pharmacy, biochemistry, etc. In the newer universities, physiology was usually included along with biophysics and biochemistry within one department.

Our present curriculum in physiology within medical schools may be seen to have derived from these beginnings. Theoretical lectures remain the basic elements of horizontally integrated teaching modules within the biological systems—the blood, the cardiovascular system, the respiratory system, metabolism, endocrines, and so on. Physiology is taught alongside biochemistry and biophysics and in association with anatomy, histology, and pathology. Teaching laboratories are organized in groups of eight students who spend two hours once a week under the direction of an associate professor. The students are themselves the experimental subjects for some of the classes; rats are used for others. When the students are dealing with respiration, circulation, and the neurosciences personal computers are provided—one for each group of eight. These activities—modules of lectures and laboratories based on horizontally integrated systems teaching—are correlated with vertically integrated, problem-based clinical cases. Faculty from clinical departments assist by presenting patients or analyzing
laboratory findings. Abnormalities of physiological regulation are then discussed.

The foundation of the Argentine National Research Council in 1958 was an important step because it allowed the development of new teaching and research programs and so provided full-time positions for workers in science, technology, and the arts.

In conclusion, departments of physiology in Argentina were models for improved teaching and laboratory research at the graduate, and later the postgraduate, level not only in schools of medicine but also in schools of science and technology. This same influence was later seen all over Latin America.

Professor Ricardo R. Rodriguez
Faculty of Medicine
University of Buenos Aires

REPORT FROM AUSTRALIA

The teaching of physiology in Australia began with the founding of the medical school at the University of Melbourne (1863), later followed by Sydney (1883) and Adelaide (1885). The first deans (all medically qualified) were educated in Britain just as physiology was emerging as an independent discipline and as medical training was moving from apprenticeship to academic study. The influential founding deans were, respectively, G. B. Halford (St. George's and Westminster), T. P. Anderson Stuart (Edinburgh), and E. C. Stirling (an Australian, educated at Cambridge). The first named taught both anatomy and physiology on arrival, with their academic responsibilities focusing on physiology as later appointments were made. Stirling, however, was appointed in 1882 to teach physiology even before the establishment of the medical school. All were involved more in teaching and other activities than in research, although all published some scientific observations. Interestingly, the colonial medical curricula were longer and more rigorous than those in England at the time, drawing heavily on Scottish and European models. Until well into the twentieth century, the three medical schools dominated the teaching of physiology in Australia, largely but not exclusively to medical students. Physiology once incorporated biochemistry and pharmacology, generally now accorded separate departmental status.

The teaching of physiology soon extended to undergraduate students from other faculties. Indeed, for a time in Sydney, all science students were required to study the subject. Thus, from early days, academic physiologists in Australia have generally been medical or science graduates, with the latter group increasingly dominant. The later development of a fourth honors year in science or an intercalated year in the six-year medical programs provided opportunities for students to experience research, laying the foundations for further studies and subsequently many distinguished academic careers. Students in dentistry and veterinary science have also studied physiology since the inception of degree programs in the early 1900s in Sydney and Melbourne.

Courses in physiology for allied health students were largely organized by the relevant professional bodies until the 1970s, when training moved to colleges of advanced education. Until the 1980s, when they joined the college sector, nurses were trained in hospitals, where physiology was taught by physicians rather than professional physiologists. In the late 1980s, the division between universities and colleges was abolished; there are now 38 amalgamated universities. Physiology is taught in most of these; staff are from departments of either physiology or multidisciplinary medical sciences, although detailed organizational patterns vary.

The earliest courses in physiology were dominated by the strong personalities of the founding deans and consisted of didactic lectures and practical work. Nowadays, the great diversity of institutions and the varied goals of the many programs make it difficult to generalize. Nevertheless, that original pattern has persisted as the core of many physiology courses although the nature of the material studied reflects our increasing understanding of both the discipline and educational issues. Goals of specific courses are now clearer; lectures are now often supplemented with tutorials and other more interactive methods. Practical work is retained but with an increased emphasis on human experimentation, group projects, and simulations. This pattern reflects not only changing attitudes but also the increasing expense of animal experimentation and the difficulties of providing state-of-the-art facilities for large classes. Computer-aided learning is incorporated into most programs in the
form of tutorial assistance, provision of learning resources, self-assessment, and self-study modules. In addition, computers are used extensively in practical work to simulate modern experiments that could otherwise not be undertaken in a classroom setting and as devices for measuring, displaying, storing, and analyzing data, as well as for presentation of results.

The most recent challenge to the traditional courses in physiology has been the widespread introduction of integrated, problem-based learning to medical schools. Problem-based learning was successfully introduced into the Newcastle medical school over 20 years ago; by 2000, it will represent a core experience for the majority of medical students in Australia. One challenge for teachers is to ensure that a modern approach to important physiological principles is incorporated into the multidisciplinary problems in an appropriate way. In at least one department (Sydney), the principles of problem-based learning have been successfully applied in a core science course on cell physiology.

Educational innovation is alive in Australian departments of physiology as we strive to meet the needs of a wide range of students whose professional lives will be spent in the next millennium. It is supported from time to time by symposia and displays at meetings of the local Physiological and Pharmacological Society and the Australian Neuroscience Society, providing opportunities to share experiences, evaluate teaching developments, and plan new strategies.

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Professor Ann Jervie Sefton
Faculty of Medicine
University of Sydney

REPORT FROM GERMANY

When I had been asked the title question, I wrote a letter to some colleagues in order to base my answer on a broader viewpoint than my own. One reply came from Wolfgang Trautwein,1 who closed his long letter with a short personal answer: “Because I was curious and had always great fun with it and because I am convinced that physiology plays a central role in the education of medical doctors.” That’s exactly what I and others (2) think, too, but the editors also asked for a scholarly analysis. Let me try to meet their expectations.

It was in the middle of the last century when independent institutes (departments) of physiology were founded in Germany, e.g., 1844 in Würzburg and 1858 in Berlin (3). Since that time, they have been part of the medical schools (mostly medical faculties of universities), where they are responsible for the education of medical and dental students. The close ties of physiology to medicine are also reflected in the fact that virtually all German textbooks of physiology of the last 150 years concentrate on human physiology. In his textbook (1879), Leonard Landois emphasizes that he wants to educate his students “not to be physiologists but to be good physicians.” Even today, graduation from medical school and, in addition, promotion to Dr. med., are generally prerequisites for a career in physiology. More recently, however, quite a few graduates of biology and other natural sciences (Dr. rer. nat.) have entered medical physiology, too. This is excellent for basic research in physiology but sometimes creates problems when pathophysiological and

1 Thanks also to Klaus Hierholzer, Gundolf Kell, Rainer Klinke, Robert F. Schmidt, Paul Spieckermann, Gerhard Thews, and Klaus Thurau.
clinically applied aspects of physiology have to be taught.

Teaching physiology is an integral part of the curricula of the 36 German medical schools. In the traditional lecture, which was usually given by the Head of Department every morning to the whole class during the second year, teaching of theory was combined with demonstrations of experiments. The tremendous growth of knowledge in physiology was probably the main reason that most experiments disappeared from the lecture hall in the 1950s and separate laboratory courses (64 hours), where small groups of students could do their own experiments, were established. In 1990, seminars (32 hours), where students present selected topics that are discussed in groups of up to 20, were added to the curriculum.

The curriculum must meet the federal regulations for the education of physicians [Ärztliche Approbationsordnung, with their roots in the Prussian regulations of 1861 (5)]. These regulations have influenced and continue to influence the teaching of physiology to a great extent. For instance, as a result of the 1968 student revolt, the laws held in the 1970s and 1980s in West Germany included the requirement that medical students had to undergo a nationwide standardized multiple-choice test in physiology, anatomy, etc. after their second year. The examinations previously given by their teachers were put on the shelf. As a result, many students concentrated on learning questions from previous exams and became less interested in local lectures. Thus the mutual feedback between students and their teachers was severely hindered, reducing the motivation of both groups substantially.

Moreover, as a consequence of Article 12 (right of free choice of education) of the Grundgesetz (Constitution) of 1949, the medical schools (today also those of the former GDR) have to accept many more students than these schools and the numbers of their faculty were designed for, and, by the way, also more than are needed as physicians in Germany. With the help of lawyers, the number of medical students more than doubled since the 1960s without a significant change in the number of teachers. These occurrences aggravated a bad situation, and faculty often simply became resigned to an inadequate situation.

When it became evident in the 1980s that these conditions would seriously endanger the quality of medical education in West Germany, the written tests were supplemented by local oral examinations, and the number of students entering medical school per year was reduced by about 20% to roughly 10,000 today. At the moment, new changes in the regulations are under way by which the student-teacher ratio is to be lowered again. However, this goal will not be an easy political task, because the number of applicants for medical schools is rising again (2.8 per vacancy in 1998) and, at the same time, the Länder (states), operating all medical schools except one, have to cut their budgets. (Tuition fees do not exist.)

Besides these sociopolitical influences, teaching physiology in Germany was (and is still today) closely connected with doing research. The great German physiologists of the past became famous and influential for their research first and thereafter for teaching their postdoctoral associates and students and/or for writing a textbook, to name a few of them (1, 4), Emil du Bois-Reymond (1808–1896), Carl Ludwig (1816–1895), Hermann von Helmholtz (1821–1894), Adolf Fick (1829–1901), Julius Bernstein (1839–1917), Otto Frank (1865–1944), Otto Loewi (1873–1961), Hermann Rein (1898–1953), and Kurt Kramer (1906–1985). Certainly, not every good scientist is a good teacher, and selection of faculty members should not be based on their research only. The planned obligatory evaluation of teacher performance as well as voluntary workshops on teaching are hoped to elevate the mean levels of skills and motivation. However, the fundamentals of good research, i.e., careful observation, critical thinking, and a high strategic creativity, are also essentials for a good physician. Thus a department of physiology housing teaching and research under the same roof remains an excellent place to educate medical students.

References

REPORT FROM HUNGARY

The main achievements of teaching physiology in this century in Hungary can be summarized as follows: valuable traditions, outstanding scientific institutions, eminent physiologists who created influential “schools,” recognized integrative function in medical education, high-standard theoretical and practical lab training, teaching based on the best domestic and foreign textbooks, freedom and creativity in formation of the curriculum, a close relationship between teaching and scientific research, involvement and participation of the best graduate students in teaching and research, dynamic adaptation to recent scientific achievements, a leading role in formation, development, and interrelations among other branches of physiological sciences (pathophysiology, comparative physiology, veterinary physiology, etc.), stimulating interdisciplinary cooperation (e.g., cooperation between tutors of technical and medical universities), priorities and support given by the Hungarian Physiological Society (HPS) in education, extensive international relationships and experience, and substantial independence of actual political situations.

We have always had and still have to overcome serious obstacles, e.g., the still substantial impact of the sequels of the Second World War (outdated, poor infrastructure, etc.), the low level of support from the state budget, the lack of a long-term concept for development and financing of medical education, increasing pressure by students' organizations aimed at reducing the curriculum, a relatively poor knowledge of foreign languages characteristic of the last 50 years, rapid expansion of molecular biology that might lead to disproportion in teaching and financing of integrative physiological sciences, nondifferentiated and discrediting actions organized by animal protectors, and sequels of the decreasing prestige of the medical profession.

Valuable traditions in teaching physiology have been continuously accumulating since 1769, the foundation of the first permanent Hungarian Medical Faculty, which was a predecessor of the present Budapest Semmelweis University of Medicine (SOTE). The Department of Physiology was one of the five institutions founded. At that time physiology had been taught together with pharmacology in Latin (Physiologia et Materia Medica). In 1789 the first textbook of physiology in the Hungarian language written by Professor Samuel Rácz reflected the highest European standards of that period (see Adv. Physiol. Sci. 21: 85–203, 1981). During the last century a variety of outstanding Hungarian textbooks of physiology have been published, but the tutors have also been using other modern books, mainly in the German and English languages.

The HPS, founded in 1931, and the 40-year-older Section of Physiology of the Royal Hungarian Society of Natural Sciences, as a spiritual predecessor of the former, both played an outstanding role in maintaining traditions and valuable experience. Our HPS is proud that the Nobel prize laureate Professor Albert Szent-Györgyi was one of its founders and its first Secretary. At present the Society comprises about 500 members, who work in different fields of the physiological sciences. A teaching symposium has frequently been on the agenda of the annual meetings of the Society.

After the tragic historical events of the twentieth century—two world wars and two revolutions—the territory of our country has been reduced to about one-third, and the population has been halved. After the Second World War, because of the decisions of the winning powers, Hungary lost its independence. The losses in spiritual life cannot be overemphasized. The nation could survive only because of the enormous efforts of the Hungarian people. Most of our current problems, including those in teaching and research, are still the sequels of the war. Therefore, the existence of five departments of physiology and four departments of pathophysiology in the four medical faculties of our small country (population of 10 million) is itself a substantial achievement. In the
twentieth century medical physiology has always been a basis for development of new medical disciplines in Hungary. Besides pathophysiology, this branch of medicine made a valuable contribution in the formation and progress of veterinary physiology, comparative, clinical, and applied physiology, as well as sport, immun-, and psychophysiology. At present, some branches of physiology are included in the curriculum of about 15 accredited faculties of different universities and colleges.

Despite devastating historical storms, outstanding teaching and research groups led by eminent physiologists sprang into life in Hungary. A comprehensive presentation of all significant scientists is beyond the aims of the present paper. Let me just mention some names of the most prominent physiologists of the past: A. Beznák, F. Verzá, K. Lissák, I. Went, E. Grastyan, L. Hársing, and A. G. B. Kovách.

Physiology maintains and further develops its integrative role in the teaching of medical sciences. At the Semmelweis University of Medicine in the course of a two-semester curriculum (30 weeks) the second-year students have weekly three lectures (2 hours each), one seminar (3 hours of human measurements, or computer labs, or animal experiments using modern protocols), and one consultation or “demonstration” (2 hours). Optional training for the fourth- and fifth-year students comprises different credited fields of clinical physiology. The physiology curriculum embraces wide territories of cell-organ-organism functions, as well as neuro- and endocrine regulations including higher nervous functions. Teaching is based on knowledge of anatomy, histology, biochemistry, biophysics, and medical biology. A stimulating new trend in teaching physiology is introducing basic ideas for health protection and education in the curriculum.

The structure and organization of teaching still reflects some German traditions, whereas the choice of textbooks (e.g., Guyton-Hall, Ganong, Berne and Levy) rather shows American preference. The new Hungarian Textbook of Physiology (A. Fonyó), oriented mainly toward recent achievements in cell and molecular biology, was published in 1997. In addition, printed lecture notes (e.g., basics of psychophysiology, physiology of the venous system) and yearly updated laboratory manuals help students in learning physiology. Animal experiments, which make up a major part of the students' lab, yield valuable information on scientific research and modern methods of recording and evaluation of the experimental results. Other Hungarian universities of medicine— in Debrecen, Pécs, and Szeged— have similar curricula.

High standards of teaching physiology are one of the major factors that attract many foreign students to Hungarian medical universities. At the SOTE we teach students from Greece, Cyprus, Israel, the Scandinavian countries, Germany, and even from the US and Canada. Medical education, including physiology, is done in parallel classes in the Hungarian, English, and German languages for about 290, 150, and 120 students, respectively. Although prestigious, this foreign language program is also a substantial burden for the staff. Financial needs, however, force the universities to participate in this education program. Without this extra income the physiology departments of the universities can scarcely function, because the state normatives for financing university education are extremely low.

High standards of teaching physiology are also based on multiprofile international scientific collaborations built up and maintained by Hungarian professionals. Important international events held in Hungary reflect the efficacy of such collaborations: in 1980 the HPS organized the World Congress of Physiology, IUPS XXVIII, in Budapest. As decided by the International Society for Pathophysiology (ISP) recently, HPS has won the privilege to organize the 4th World Congress of Pathophysiology in 2002. Most Hungarian physiologists have spent some time working in the most relevant institutions of the US, Germany, Great Britain, the Netherlands, Sweden, Finland, France, Japan, Russia, etc., and they maintain these contacts with their colleagues from abroad. Many Hungarian physiologists frequently participate at international congresses. Their knowledge, experience, and international cooperation contribute to maintaining high standards of teaching physiology in Hungary. Collaboration based on professional relations and friendship cannot be overestimated and should be maintained also in the future.

I appreciate the invitation by the Editors of this special issue of Advances in Physiology Education to present
the main characteristics of teaching physiology in Hungary. On behalf of the Hungarian physiologists, let me wish all our colleagues and the readers further successful work, health, and prosperity on the occasion of the centenary of the American Journal of Physiology.

Professor Emil Monos
2nd Institute of Physiology
Semmelweis University of Medicine

REPORT FROM INDIA

The teaching of physiology to our medical undergraduates is mainly oriented toward providing them with the necessary understanding of physiological principles that will enable them to be good practicing physicians. The graduating degree in Indian medical colleges is MB or MB BS—equivalent to the North American MD degree. However, we still do manage to entice some of these people to become researchers and teachers in the basic sciences in our medical colleges (5, 7, 12). To this end, we have a three-year postgraduate MD degree that includes a research thesis. This program enables the participants to obtain a proper scientific temperament and rigor necessary for conducting high-quality research and teaching.

Most medical colleges in India follow a traditional medical curriculum of 5½ years duration. The first 1½ years are devoted to basic sciences [except in All India Institute of Medical Sciences (AIIMS), which has reduced it to 1 year]. The curriculum has been rationalized and includes more relevant components incorporating recent trends (8, 9). More human experiments have replaced the amphibian experiments (3, 8). Lab experiments, however, continue to get due weight in the curriculum and assessment. An objective, structured practical examination developed at AIIMS (11) has been adopted by some medical colleges.

Anticipating the need for basic science teachers, AIIMS instituted a BSc honors course in human biology in 1982. These graduates then obtain MSc and PhD degrees in various disciplines including physiology. Science faculties and life sciences departments of a few universities also have physiology programs at undergraduate and postgraduate levels. They all contribute to the pool of physiologists. Presently, the Medical Council of India, which is the accreditation authority for medical education throughout India, requires that two-thirds of the physiology faculty should have a basic medical degree.¹ No wonder then that 20% of physiology positions in medical colleges in certain regions are still lying vacant (7). The Medical Council of India is considering whether 50% of the physiology faculty can be nonmedical (9).

Physiology in India Developed Mainly After Independence

Political influences. At the time of independence (1947), there were only 15 medical colleges. Following the Bhore Committee (1) recommendations, a large number of medical colleges have been opened by the government to meet the health care needs of the country. The increase was spurred on by allowing private medical colleges to be opened. The total number now exceeds 160. This rapid expansion has caused a great concern about maintenance of standards in medical education in general and in physiology or basic sciences in particular.

Funding policies. Most of the medical colleges are funded by the government. A large proportion of the budget is used for patient care services. Most basic departments are, therefore, starved of funds even to run minimal activities.

Research is mainly supported by government agencies like the Indian Council of Medical Research, the Council of Scientific and Industrial Research, departments of science and technology and biotechnology, and some benevolent international agencies. State-of-the-art basic research has, therefore, been confined to a few institutions.

Influential schools and persons. The establishment of the All India Institute of Medical Sciences at New Delhi in 1956 with the following objectives has

¹ Establishment of the All India Institute of Medical Sciences was the brainchild of A. V. Hill (Nobel laureate, 1922) in 1943–1944 when he visited India as an advisor to improve the quality of medical education and research. Ironically, his words written to Major General Bhatia in 1937 are proving true. He wrote, “A danger is that no man may be allowed to hold any place of importance in physiology unless he has a medical degree. Avoid this tradition like poison. It means that you will miss many of the ablest people of all—your Pasteurs, Langleys, Barcroftss, Cannons, Baylisses...” (4).
made a sea change in the way we teach and learn medical sciences: “to develop patterns of teaching in undergraduate and postgraduate medical education in all its branches so as to demonstrate a high standard of medical education to all medical colleges and other institutions in India and to attain self-sufficiency in all fields of medical education.”

The physiology department of AIIMS, of which the author was a postgraduate student and later its head, has assiduously pursued the fulfillment of the above objectives.

Two physiologists, Prof. B. K. Anand and Prof. A. S. Paintal, who were the founding Professors of this prestigious institution, have influenced three generations of physiologists. They have also been inspiring leaders for indigenous manufacture and development of scientific instruments for laboratory experiments, all of which were imported earlier. The traditions set by them have been preserved and nurtured by their successors.

International Stimulation of Physiology

The greatest stimulus to teaching and research in physiology came from the XXVIth International Congress of Physiological Sciences, which was held at New Delhi in 1974. This meeting was a gateway to the world for many Indian physiologists, enabling them to explore opportunities for international collaboration. We learned that we had to modernize our teaching and research initiatives. It acted as a wake-up call for on-going conferences and teaching workshops on a regional and national level for advancement of continuing education in physiology. Many of these initiatives were taken by AIIMS (under the leadership of Prof. S. K. Manchanda) and some by other medical colleges with the financial support and assistance of WHO, IUPS, and many other agencies. The physiology curriculum was rationalized (8, 13), objectives of physiology teaching were evolved (1, 3), and trends in educational technology and objectivization of assessment strategies were adopted (2). Concepts of computer-aided learning and assessment were introduced (6). The Association of Physiologists and Pharmacologists of India (APPI), established in 1955, has played a key role in producing a multiplier effect in all these efforts.

Influential Textbooks

English is the primary vehicle for the teaching of physiology. The most popular textbook from 1947 to 1967 was Samson Wright’s *Applied Physiology*, but during the past three decades emphasis has shifted to Arthur Guyton’s *Textbook of Medical Physiology*. Numerous locally used textbooks did, however, appear. A recent publication, *Understanding Medical Physiology*, edited by Dr. R. L. Bijlani, Head, Department of Physiology, AIIMS, contributions to which have been made by other teachers, has received laudatory reviews worldwide and has gained acceptance all over India and in other neighboring countries.

The future of physiology education in India in the next millennium would depend upon the active steps taken by policy makers to make basic sciences more lucrative and intellectually stimulating.

REFERENCES

In the Netherlands there are many ways to become a professional physiologist, but none is specially developed for this goal. Of the present full professors in physiology at the medical faculties about one-half are from a medical origin; the others come from biology, biochemistry, or pharmacology. The chairs in the faculties for biology are mainly held by biologists or physicists. If we look to the composition of the group of PhD students or postdoctoral fellows the palette is even more colorful; in addition to the already-mentioned groups, we will meet students from technical universities as well as from our single agricultural university.

There are several causes for this diversity in roots of the Dutch physiologists:

- The number of jobs in physiology at the few universities and colleges in the Netherlands is decreasing continuously at present but has never been large enough to warrant a specific type of course.
- In this country students enter university directly from high school, and physiology is at that time terra incognita; if they feel interested in that direction they will choose medical study or study in biology.
- Medical faculties have a preference for physicians as physiologists on tenure, in the belief that both teaching and clinical science integration would be more fruitful with physicians than with nonmedical colleagues.
- The admission to medical faculties in the Netherlands is limited to about 1,700 students per year, the number of applicants being more than 5,000. Some of them will go into studies in biology, health sciences, medical informatics, etc., in the hope of being able to change during the study or to find a place in a medical faculty after finishing their undergraduate education.

This report will be limited to the two mainstreams for future physiologists, medical education and study in (medical) biology.

In the study of medicine, physiology is learned as part of the regular medical program with an increasing emphasis on clinical relevance and applicability of knowledge in physiology to clinical medicine. In this respect it is important to note that the number of hours for education in basic science, of which physiology has had a prominent part, has been reduced from nearly 70% in 1910 (1) to less than 40% at present. In a comparative study of all Dutch universities in 1994 we found a maximum of 53% for credit points for all basic sciences together (medical faculty in Rotterdam) and a minimum of 38% (medical faculty in Maastricht) (2). Neither the courses in physiology nor the medical study as a whole is giving specific training in scientific reasoning, research methods, information sciences, and all the other tools that a young physiologist would need to become a successful researcher. This all has to be learned after the student has decided to go into physiology. The common way to do this is by application for a four-year project financed by the university, by the national organization for the advancement of research (NWO), by one of the many health-promoting foundations, or by a pharmaceutical company. Because, however, modern physiology requires scientific training in many of the above-mentioned skills, a medical student is commonly not exactly the student for whom the project leader is looking. If a medical student is accepted, one of the reasons may be that after graduation, a physician will find a job much easier than a scientist without a medical background. However, there are in the Netherlands quite a number of prominent physiologists, especially in the field of clinically oriented physiology.

The second mainstream leading to professional physiology is at present the study of biology, with an emphasis on medical biology, and disciplines with a similar program. Students with this background are much better equipped for fundamental research than their medically educated colleagues. Hopefully, in the future these two groups will share forces.

The Dutch Society of Physiology, which is responsible for the recognition of medical physiologists, considers both disciplines (and many others on request) suitable
as primary training. This must be followed by a period of four years of research and teaching in a department of physiology and the production of a thesis or comparable publications.

References


Professor Lennart N. Bouman
Formerly of the Academic Medical Centre
University of Amsterdam

REPORT FROM SWITZERLAND

Physiology is currently taught in Switzerland in five medical faculties and one science faculty. After one year of natural sciences, students learn physiology in the second year of the medical curriculum, together with morphology and biochemistry. Since 1900 they have had to pass a theoretical and a practical examination before being admitted to the clinical years.

At the beginning of this century Switzerland had excellent teachers in physiology. Two professors, H. Kronecker in Bern and J. Gaule in Zurich, were pupils of C. Ludwig in Leipzig. A. Herzen in Lausanne was a pupil of M. Schiff, and J.-L. Prevost in Geneva had worked with A. Vulpian, J. M. Charcot, J. Marey, and Claude Bernard in Paris. Ludwig had rejected the vitalism of the nineteenth century and, using physical and chemical techniques for his experiments, helped physiology to become a science equal in rank with the natural sciences of his time. The professors in Switzerland taught their students this “new physiology,” which, they believed, was essential to become a good physician.

When I read the complete lecture notes taken by a medical student who had studied physiology in Geneva between 1898 and 1900, I realized how well physiology must have been taught and how careful the professor was to describe and explain important experiments in detail. Students had six hours of lectures a week for three semesters. In addition, a practical course gave them the opportunity to carry out physiological experiments themselves.

Underlining the importance of experiments was the way physiology was taught in Switzerland for more than half a century. I remember personally how in the fifties R. Stämpfli, on his return from Cambridge, where he had been working with A. Huxley, explained with full details the experiments that demonstrated that conduction in myelinated nerve fibers is saltatory, and how S. Weidmann, also back from Cambridge where he had been working with A. Hodgkin, described all the experiments he had undertaken to discover the ionic basis of the cardiac action potential. We also spent much time in the practical course, where, in small groups, we had the opportunity to do experiments covering all aspects of physiology.

Teaching was a very heavy load that one professor had to assume almost alone. Assisted at most by one or two inexperienced young doctors who, before specializing in clinical medicine, helped him to take care of the students in the practical course and prepared their theses, he had little time to do his own research. One wonders how W. R. Hess, professor of physiology in Zurich between 1917 and 1951, managed to do the beautiful research for which he won the Nobel Prize in 1949.

Working conditions in Switzerland started to change only after 1952 when, at the instigation of A. von Muralt, professor of physiology in Bern, the Swiss National Fund for Scientific Research was created, and then, starting in 1968, federal aid became available to the cantonal universities. The size of physiology departments increased rapidly and substantially, and research activity developed. At the same time, the teaching of physiology changed, too. With the increase of scientific knowledge, which students had to memorize to pass their examinations, and the introduction of new disciplines, the curriculum became overloaded. Physiology lectures were used more and more to relate facts. Time became too short to describe experiments, and the numerous demonstrations that had been used, for many decades, to illustrate the lectures were abandoned. This led, very often, to a superficial acquisition of incoherent facts rather than to an honest understanding of physiology and an active intellectual involvement of the student. Teachers felt uncomfortable, and students started to complain.
As everywhere else in the world, attempts were made in Switzerland to improve the quality of teaching and learning physiology: learning objectives were formulated, teaching was integrated horizontally and vertically, and courses were coordinated, with little success. However, an interesting experiment, very different from other universities, was made in Bern: the formal lectures were reduced drastically and time devoted to the practical course was increased, so that the time devoted to each became approximately equal. The idea was that to teach better one should teach less and that a practical course with structured laboratory experiments would provide students with a useful exercise in problem formulation and problem solving, so essential, together with the acquisition of practical skills, in the education of a physician.

Convinced that the traditional method of teaching was failing to encourage self-directed learning and self-evaluation and to develop students’ skills in the analysis and the solution of complex clinical problems, Geneva (in 1995) and Bern (in 1996) undertook (following North American medical schools) a radical educational reform, replacing the traditional discipline-oriented teaching by problem-based learning. After a short trial with a parallel track, problem-based learning was extended rapidly to the whole class. A similar curricular reform, less radical, was introduced in Lausanne in 1995.

A series of carefully selected problems relating to the various functions of the human organism (circulation, respiration, reproduction, etc.) forms the backbone of the pedagogic strategy of the preclinical years. Students work in small groups and are guided by a tutor. The problems are conceived to encourage the student to learn and integrate important basic sciences into a clinical context. Practical courses and a few lectures complete the curriculum.

This way of teaching is going to change profoundly the image and the personality of the physiology teacher: he will certainly lose his monopoly on teaching physiology to medical students. What he may gain is a better integration into the medical faculty and the satisfaction of seeing how important the medical students consider physiology to be for their future profession.

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Professor Fritz Baumann
Faculty of Medicine
University of Geneva

REPORT FROM UNITED ARAB EMIRATES

The Emirates is a very young country, because the Federation of the United Arab Emirates (UAE) was established only in 1971. During the past quarter of a century, educational institutions both in the government and private sectors have mushroomed throughout the country. A number of these institutions train health care professionals such as doctors, nurses, dentists, and laboratory technicians. The importance of physiology education and research has been acknowledged by the Ministry of Health and Education by establishing physiology departments in the medical, dental, nursing, and science colleges in the country.

Although the curriculum in each of these institutions varies according to the aims of the institution, there are common factors that impact the methods of teaching and learning in physiology. Medical education in the UAE is still young, and curricula are undergoing modifications and development to make them suitable and relevant to the country’s special needs and to keep pace with international standards. For the purpose of this report we will take the Faculty of Medicine and Health Sciences (FMHS) as an example.

Special characteristics of physiology education in the UAE and the influences that have resulted in the current situation as exemplified by FMHS.

All medical students in the UAE University are citizens of the country. Most of them join the FMHS at the age of 18 or 19 after completing 12 years of school and one freshman year of University education with English, mathematics, and computers as main subjects. Human physiology is not included in the school curriculum, and this fact has to be taken into account in medical curriculum planning in the FMHS, in which the curriculum is both horizontally and vertically integrated.

Physiology is taught in all six years of the medical curriculum. The first two years of the curriculum are designed to lay the foundation and provide a continuum for the study of the organ-system courses
taken during the third and fourth years of the program. The teaching of physiology is integrated in each of the seven organ-system modules in the third and fourth years of the curriculum and in the multidisciplinary seminars during the final two years of clinical clerkship.

The medium of instruction in government schools of the UAE is Arabic. English is taught in all schools as a foreign language, and most of the students entering the UAE University have had eight years of English language instruction. The TOEFL score of students entering the medical school varies in the 400–600 range. The medium of instruction in most professional courses in the UAE is English, and the majority of the teachers are expatriates from countries all over the world. The fact that physiology is mainly a descriptive subject requires a strong base of English vocabulary so that the students can follow English lectures and study English textbooks. Thus, during the first two years of the curriculum, medical students at the FMHS also receive continuous support from the English Language Unit.

Each year, approximately 60 students are admitted to the FMHS, of which two-thirds are female. Male and female students are taught separately, and therefore the number of students in each class is usually 20–30. This small number of students provides opportunities to encourage discussions during lectures and seminars. Because of the difficulty in language, handouts are often prepared to support the lecture discussions.

Physiology practicals include human experiments emphasizing clinical physiology. Recording and interpreting ECG, tests for lung function, vision, hearing, pregnancy, and examination of the normal human are some of the practicals that the students perform in the multidisciplinary laboratory and the skills laboratory. Students examine peers and simulated patients to learn normality. For examination of private parts, like the breasts and pelvic areas, mannequins are used. Animal experiments, such as frog nerve-muscle preparations, Langendorff-perfused rabbit heart preparations, and isolated gut strips are also used to illustrate basic physiological principles.

The FMHS provides research opportunities to students that allow them to learn practical research skills in physiology and to consolidate their theoretical knowledge. Involvement in research may also encourage students to consider physiology as a career. Students do short research projects as part of a task in some modules, during elective periods and during the summer either in the Emirates or abroad. The students have been enthusiastic, and this has encouraged faculty to provide facilities for such activities. There exists a well-developed track in the UAE University to develop national academics. However, to date, no national graduate has yet selected physiology as a career in the FMHS, and most students aspire to be clinicians because the country is short of national doctors.

**Conclusion.** In a short space of time, physiology teaching in the UAE has established itself as a core discipline in the FMHS as well as in other health-related schools. As a discipline, physiology is by its nature integrative and capable of absorbing new concepts and new information. As such, it is ideally suited to the organ-systems model used in the FMHS. In addition, recruitment of well-qualified physiology faculty has played a major role in enhancing education with its focus on high-quality teaching and learning. New topics in medical education such as problem-based learning, case-based approaches, evidence-based medicine, and other innovations are currently being evaluated and assimilated in upgrades of the curricula. The well-recruited faculty, supported by the Dean’s Office for commitment of resources and leadership, has done much to instill in the students a growing sense of appreciation of the preciousness and beauty of life.

Professors Mandira Das and Wim J. E. P. Lammers
Faculty of Medicine and Health Sciences
United Arab Emirates University

Professor J. H. Lanphear
Faculty of Medicine
University of Texas-Galveston