One Hundred Years of Physiology Education in Singapore

SC Hooi,[1] *MBBS, PhD*, DR Koh[1] *MBBS, PhD, MRCP*

Abstract

Physiology is the study of normal function in the body and how genes, proteins, organ systems interact to maintain health. It provides a foundation for the health sciences profession and life science research. Physiology education in Singapore began soon after the establishment of the Federated States Government Medical School in 1905. The importance of Physiology to medical education was recognised by the appointment of a separate lecturer in Physiology in 1906, followed by the appointment of Professor James Argyll Campbell as the first King Edward VII professor and endowed Chair in Physiology in 1912. The teaching of Physiology in the early days was focused on the basics of normal function with little correlation to clinical problems and application. However, by the 1970s, first-year medical students were given the opportunity to visit hospitals where they were tutored by clinicians to help them apply Basic Physiology to clinical problems. Curriculum changes in the subsequent years emphasised a reduction in content, integration among preclinical subjects, independent learning and clinical relevance. Physiology is taught not only to medical but also dental, pharmacy and life science students. The teaching of Physiology to science students is a collaborative effort between the Department of Physiology, Faculty of Medicine and the Department of Biological Sciences, Faculty of Science. A lot of the teaching of Physiology to life science students occurs not in classrooms but in the laboratories, where students work closely with research supervisors and mentors on research projects. There has been a very significant increase in the number of students doing research projects in Physiology in recent years, especially in the areas of Cell Physiology, Immunology and Neurobiology. The completion of the human genome sequence poses new challenges to understand function, especially how genes, proteins and organ systems interact to sustain function. Physiology education will be increasingly important in the undergraduate and graduate life science and medical curriculum. Further, the country's vision of being the biomedical R&D and healthcare hub for the region means that Physiology education must remain at the forefront to prepare the next generation of doctors, clinician-scientists, researchers and entrepreneurs.

Ann Acad Med Singapore 2005;34:84C-86C

Key words: Curriculum, Future, History, Life science, Medical

Physiology is the study of normal function in the body and how genes, proteins, organ systems interact to maintain health. It provides a foundation for the health sciences profession and life science research. Physiology education in Singapore dates back to 3 July 1905, when the Federated Malay States Government Medical School began work in the old Female Lunatic Asylum in Sepoy Lines, which had been renovated to house a Lecture Room, a Dissecting Room, a Physiology Laboratory, a Students' Room and Offices.[1] The first medical class comprised 23 students. Recognising the importance of Physiology to the medical curriculum, the School appointed a separate Lecturer in Physiology in 1906. The importance of Physiology was underscored by the appointment of Professor James Argyll Campbell *MD, DSc (Edin)* as the first King Edward VII professor and endowed Chair in Physiology in 1912.

In the early days, the teaching of Physiology was carried out during the first 2 years of the medical curriculum and was focused on normal function, with little correlation to clinical problems. For example, students were expected to "*Describe the normal pulse tracing giving a diagram and show the relation of each part of the curve to the cardiac cycle*" and "*Describe the physiology of Cheyne-Stokes respiration.*"[2] The importance of applied Physiology was quickly recognised and by 1912, "*Special attention is paid to subjects, a knowledge of which is especially desirable in connection with clinical medicine.*"[3] Histology was an important component of the course. Students were expected

[1] Department of Physiology
National University of Singapore, Singapore
Address for Correspondence: A/Prof Hooi Shing Chuan, Department of Physiology, National University of Singapore, Blk MD9, 2 Medical Drive, Singapore 117597.
Email: phshead@nus.edu.sg

to study the structure of "teased" specimens of animal tissues and make proper drawings of their observations. By 1915, the Physiology course had become more structured, with 100 lectures and demonstrations in Physiology and twice weekly practical sessions over a period of 9 months. Practical sessions included histology, chemical physiology (focusing on the chemistry of proteins, carbohydrates, fat, blood and body fluids) and simple experiments to investigate organ function.[4] For the most part, preclinical and clinical teaching was neatly divided with little integration and reference between the two. This quotation taken from the 50th Anniversary Commemorative Publication aptly describes the attitude of medical students studying the preclinical subjects: "*The academic life of the medical undergraduates of the Singapore Medical School was in no way different from those of the older medical schools. They all went through the same boredom in their study of pre-medical sciences, the same trepidations as they faced their Anatomy tutors for the fortnightly 'demons', had the same discomfort in working with formalin-soaked tissues and the same disappointment at the uncooperative [sic] nature of the toad's heart preparation.*" There was a sense that preclinical subjects were merely something that was to be diligently studied to pass exams and a necessary evil so that one could get on with the "real thing" of clinical training. This was further reinforced by the lack of reference to basic science by the clinical teachers, who focused mainly on the practice of clinical medicine. Seniors in their clinical years would also reinforce this attitude among juniors doing preclinical subjects.

However, the importance of clinical relevance and application was increasingly recognised and by the 1970s, the department was organising visits to the hospitals to help students correlate what they learnt in Physiology with clinical problems. Students were tutored by staff members with clinical training as well as by clinicians in the hospitals, with an emphasis on learning physiological principles rather than clinical medicine.[5] A major curriculum review that began in 1991 also recognised the importance of "increased subject integration and more collaboration between basic science and clinical disciplines and increased emphasis on primary health care training."[6] Physiology teaching was carried out as part of the Human Biology block taught in the first year. The block also included Anatomy and Biochemistry and provided the scientific foundation for the study of clinical topics and human disease in subsequent years.

Another major curriculum restructuring began in 1997, and was implemented in 1999, emphasising horizontal integration of the first-year subjects, namely Anatomy, Biochemistry and Physiology. The other major drivers for the restructuring of the curriculum were the need to reduce curricular content and a greater emphasis on clinical relevance in preclinical subjects. The department of Physiology anchored the Systems Biology track, where subject matter was organised and integrated into systems. The departments of Medicine, Anatomy and Biochemistry contributed to lectures in the Systems Biology track. Clinical relevance was emphasised by getting clinicians to provide the overview and summary lectures of each system. Only practicals that dealt directly with the human body function were carried out. Some of the practicals involved doing simulations on the Human Patient Simulator, guided by clinicians. The application of Basic Physiology was further enhanced through case-based tutorials, problem-based learning and hospital visits. These activities encouraged the students to learn independently and from one another in small groups.

Physiology has been taught not only to medical students but also, in the early days, to hospital assistants, dispensers and to those seeking a licence to practice dentistry. By the 1970s, the department was also involved in teaching human physiology to Science, Pharmacy and Dental undergraduates. The department of Physiology offered a major in Physiology for Science undergraduates until 1999/2000, when a major restructuring of the Science undergraduate curriculum occurred. In 1999/2000, the Faculties of Medicine, Science and Engineering collaborated to teach the Life Sciences undergraduate course, with oversight provided by the Office of Life Sciences. The department of Physiology is an integral part of the Life Science undergraduate curriculum and is responsible for the teaching and coordination of several Level 3 and 4 modules, including Human Physiology, Neurobiology, Immunology, Advanced Neurobiology, Advanced Cell Biology and Tumour Biology. The department is also involved in the teaching of graduate level modules in Cell Biology, Neurobiology and Immunology. Physiology is also taught by the Department of Biological Sciences, Faculty of Science.

A significant part of the teaching in Physiology occurs in the research laboratories. Since the 1950s, the department has offered research opportunities for students who wish to pursue Masters and PhD degrees by research. The earliest PhD thesis was submitted in 1953 by Lee Teow Seng, entitled "*A study of sweat formation with special reference to non-thermal sweating*".[7] The department continued to distinguish itself in the areas of research such as gastrointestinal physiology, physiological responses to physical stresses like heat and haematology during the 1950s to 1960s. Notable publications include those by Dr Toh Chin Chye and colleagues characterising stimulants present in the walls of the intestinal tract.[8,9] Research in the department broadened and moved away from classical physiology in the 1970s to include lipoprotein metabolism in heart disease, experimental neurotoxicity, nutrition and iron storage. In the late 1990s, the department focused on

4 major areas of research – Apoptosis and Tumour Biology, Neurobiology, Immunology and Tissue Engineering. These research programmes were chosen because there was existing strength in the department in these areas and because they were in line with Faculty- and University-wide initiatives. The department's research productivity increased significantly in the 1990s. More than half the Masters and PhD theses were submitted after 1990. By 2003, the total research impact factor of the publications in department was about 170. By 2004, this increased to about 240. The impact and relevance of the research carried out by the department were evident in recent press reports highlighting staff members research achievements. These include "*Stuff in wine isn't always a cancer fighter*",[10] "*Get tumor cells to send 'eat me' signals*",[11] "*Zooming in on genes*",[12] "*Eating disorder: girls, women here too at risk*".[13] Concomitant with the increase in research productivity, the department attracted many more graduate and honours students to join its laboratories. In 2004, 62 graduate students were registered with the department, pursuing either Masters or PhD degrees by research.

Looking forward, what can one expect in the near future? Medicals students will in the future meet patients at the beginning of the course, allowing for a better grasp of "dysfunctional physiology". There will be increased integration in the teaching of Physiology to medical students, not only horizontally across the first-year subjects but also vertically, into the clinical years. This integration will occur not only in problem- and case-based teaching and discussions and also in the longitudinal follow-up of real patients with chronic ailments. This way, students can integrate basic knowledge and patient management across the 5 years of undergraduate training. There will no longer be an artificial divide of preclinical and clinical subjects. Teaching will be patient-focused and integrated. To do this effectively, we need clinician-scientists who have integrated basic and clinical material themselves, and are hence able to help students to do the same. This will ensure a more robust and deeper education and create a stronger foundation for the students to build upon for the rest of their careers. It is heartening that the faculty has recognised the importance of clinician scientists and that it began the MBBS-PhD programme in 1999. However, it must be recognised that the role of clinician scientists must extend beyond research to include education. Who best to teach our brightest minds than those who are at the forefront of clinical practice who also have great depth of understanding with regard to the fundamental problems in their specialties, consequent to active research in the area? It will be a joy to learn under someone like this.

As Singapore poises itself to be the biomedical R&D and healthcare hub in the region, Physiology education will play an increasing role in the undergraduate science and graduate curriculum. With the thousands of human genes identified and associated with many diseases, there is an increasing need to understand how these genes function together in a complex organism like humans. Physiology is well placed to provide the foundation of systems biological functions and applications in areas from drug discovery to treatment. Already, the bulk of the teaching carried out by the department is for non-medical students. Department staff members teach about 2000 students per year, of which only 460 are medical students. We also foresee the department taking in more graduate students. To excel in the training of the next generation of scientists and entrepreneurs, the department must remain at the forefront of research and increase its links with industry. Sufficient resources, especially manpower, must be invested in to ensure that the department excels in the training of the next generation of doctors, healthcare professionals, scientists and entrepreneurs.

Acknowledgements

We wish to thank Prof Peter Hwang, Prof Chia BL, Dr Francis Chen, Prof Ho Ting Fei for sharing their experiences and recollections as teachers and/or students in the department of Physiology and for their views on Physiology education in NUS. We also thank Shirley Aw, Ong Hong Kiat and Mercedes Cheong for helping to research the history of the Department of Physiology.

REFERENCES

1. The Straits and Federated Malay States Government Medical School Syllabus 1908. Singapore: Govt Printing Office, 1908:9.
2. The Straits and Federated Malay States Government Medical School Syllabus 1910. Singapore: Govt Printing Office, 1910:30.
3. The Straits and Federated Malay States Government Medical School Syllabus 1912-1913. Singapore: Govt Printing Office, 1912:29.
4. The King Edward VII Medical School Calender, 1914-15. Singapore: Govt Printing Office, 1914:21.
5. 75 Years of Medical Education. Singapore: Faculty of Medicine, National University of Singapore, 1980:44-5.
6. A Continuity of Ideals – Commemorating 90 Years of Medical Education (1905-1995). Medical Faculty, National University of Singapore. Singapore: Armour Publishing, 1995:27.
7. Lee Teow Seng. A study of sweat formation with special reference to non-thermal sweating [thesis]. Singapore: Department of Physiology, University of Malaya, 1953.
8. Feldberg W, Toh CC. Distribution of 5-hydroxytryptamine (serotonin, enteramine) in the wall of the digestive tract. J Physiol 1953;119:352-62.
9. Dalgliesh CE, Toh CC, Work TS. Fractionation of the smooth muscle stimulants present in extracts of gastro-intestinal tract; identification of 5-hydroxytryptamine and its distinction from substance P. J Physiol 1953;120:298-310.
10. Natalie Soh. Stuff in wine isn't always a cancer fighter. The Straits Times (Tech and Science Section), 20 February 2004:H12.
11. Natalie Soh. Get tumor cells to send 'eat me' signals. The Straits Times (Tech and Science Section), 9 March 2004:H8.
12. Natalie Soh. Zooming in on genes. The Straits Times, 27 August 2004.
13. Lee Hui Chieh. Eating disorder: Girls, women here too at risk. The Straits Times, 1 October 2004:H5.