Challenges and opportunities in integrative physiology education

R.G. Evans and K.M. Denton, Department of Physiology, Monash University, VIC 3800, Australia.

Integrative physiology, which of course also forms much of the knowledge base for human and animal pharmacotherapy, is by nature the antithesis of reductionist scientific disciplines. Students find our discipline challenging, as we expect them to develop the intellectual juggling skills required to integrate the multiple complex feedback loops that govern the functions of individual organs and the organism as a whole. Our experience of delivering education in integrative cardiovascular physiology at Monash University, over the last 15 years, has identified both challenges and opportunities to improve the quality of our graduates.

We hope and expect our graduates to get a lot more than just a basic grounding in physiology from the learning environment we create. We also expect them to understand the evidential basis of scientific knowledge, and to appreciate the fact that all scientific evidence must have flaws which limit the interpretations that can be drawn from it. We also expect our graduates to be scientifically literate and numerate, have the skills they need to learn rather than be taught, and have a basic understanding of what research scientists do. When we achieve this outcome, our students are prepared not only to embark on training in scientific research, but also specific training for virtually any other professional career.

A major challenge is to break the habit of teleological reasoning, which in many ways is an occupation hazard of any integrative discipline. The tendency of students to work their way through a problem by considering what would be a sensible response to a physiological challenge is ultimately corrupting. In the first place it encourages intellectual laziness. But more importantly it downplays the primacy of evolution and natural selection in driving adaptation, and encourages students to neglect the most crucial aspect of the scientific process; that all knowledge has an evidential basis. Additional related challenges include the generally poor English expression of students at third year level and their previous under-exposure to basic skills in data analysis, literature research and the practical aspects of scientific research.

To address these problems in our third year courses, we place significant emphasis in our didactic teaching on the experimental evidence underpinning our understanding of cardiovascular physiology. We also set our students research-based written tasks (essays, editorials) for which they have personalized support from a researcher, and research based oral tasks (journal clubs) which are moderated by senior academics. For the written tasks we encourage a collaborative approach between student and teacher, so students learn core skills in scientific reasoning and written expression. For the oral tasks, the students are the audience, but a senior academic moderates each session to ensure a focus on the evidential basis of knowledge. At the practical level, our third year course in Clinical and Experimental Cardiovascular Physiology includes a mini clinical trial which the students design, conduct, analyse and interpret under the supervision of a researcher.

A few years ago we ceased the use of animals in our third year teaching of cardiovascular physiology. This now means that students considering an honours year in cardiovascular physiology have virtually no experience of some of the core methodologies in integrative physiology. But the move away from the use of animals has provided an opportunity, through the use of the Finipress system which allows students to measure their own arterial pressure, heart rate and cardiac output in a non-invasive manner. We use this system to demonstrate the complex physiology underlying the cardiovascular responses to orthostatic stress, diving, mental stress, exercise and the cold pressor test. This technology can also be used for in-lecture demonstrations.

Two additional challenges deserve mention. Firstly, the proliferation of graduate medical schools in Australia has resulted in many students studying integrative physiology as a route to entry into a medical course. Our challenge is to ignite the fire of interest in research in these students, and so lay the foundation for the next generation of physician scientists. Finally, we must acknowledge that all this must be achieved by time-poor academics. We are lucky at Monash Physiology because we are able to mobilize a relatively large pool of research only staff and colleagues from affiliated research institutes.