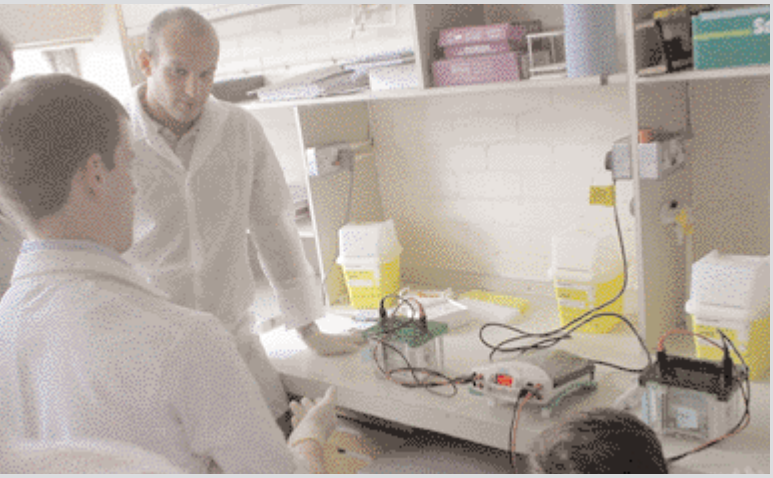
Why BASES should promote teaching and research in molecular exercise physiology

Dr Henning Wackerhage and Philip Atherton champion its cause in sport and exercise science

MOLECULAR exercise physiology is now one of the most important strands of exercise physiology and that is why we believe BASES should actively promote teaching and research in this field. The aim of this short article is to explain what molecular exercise physiology is, to illustrate its importance and to make a case for teaching and researching it within sport and exercise science.



What is molecular exercise physiology?

Molecular exercise physiology (MEP) is a shortened version of the term 'cellular and molecular exercise physiology', which was used by Frank Booth more than 15 years ago (Booth, 1988). A possible, admittedly narrow, definition of the field is: Molecular exercise physiology is the study of signal transduction and genetics in relation to exercise. Molecular exercise physiologists aim to characterise the mechanisms that are responsible for the adaptation of cells and organs to exercise and to identify the genetic determinants of human performance on a molecular level.

To make it less abstract and to more clearly show its relevance, here are three current MEP questions:

1) Why do muscles grow in response to resistance but not endurance training?

2) What are the genetic variations that partially explain the performance of elite athletes such as Paula Radcliffe compared to 'normal' persons?

3) How does exercise improve insulin sensitivity?

All three questions have in common that they are 'black box' problems, i.e., we know that resistance training makes muscle grow, that Paula Radcliffe has a talent for marathon running and that exercise is good for type-2 diabetics, but we do not know yet the mechanisms responsible. The function of MEP is to use its powerful array of tools to replace these black box 'gaps' in our knowledge with well-understood mechanisms.

Why should we teach MEP?

David Hood, a leading researcher on mitochondrial biogenesis, proposed ten years ago to train students of sport and exercise sciences in cellular and molecular biology. We agree, because if we choose not to include new and challenging areas such as MEP then we will rightly be accused of teaching science that is out of touch. We would also be excluding many eye-opening findings that stimulate the creativity, scientific thinking and the intellectual challenge in our students. Moreover, we would be failing to prepare the best of our students for a rewarding research career. After all, oxygen uptake and lactate measurements methods have been around for a hundred years or so, it is unlikely that we are able to discover something 'big' using solely these techniques. In contrast, there are tools, such as DNA microarrays (used to measure whether thousands of genes are 'switched on' or not) and single nucleotide polymorphism chips (SNP chips, used to check for thousands of gene variations), that will enable future sport and exercise science postgraduates to search for new ways of knowing and understanding. We do not need to teach all these techniques, but we can help our students to take the first steps.

MEP can be taught in sport and exercise science-related degrees. For example, we currently teach a MEP module at Level 3 as part of a BSc Sports Biomedicine at the University of Dundee. The students learn first about endurance and resistance training methods, then the known adaptations to these types of training, and finally about the signal transduction and gene regulation mechanisms responsible for and associated with these adaptations. The students also undertake various practicals, including some on bioinformatics and Western blotting (used to measure the concentration of specific proteins).

Getting to grips with MEP techniques

Those planning to teach MEP topics will need to overcome several barriers. First, no comprehensive low-jargon textbooks are currently available, although some books will undoubtedly be published in the years ahead. A good way forward would be for BASES to run specific teaching workshops in MEP to introduce the field to sport and exercise scientists and to share good teaching practice.

The second problem is that practical MEP techniques, such as Western blotting and reverse transcriptase polymerase chain reaction (RT-PCR; used to measure messenger RNA, the substance that indicates whether a gene is switched on), are challenging for sport and exercise scientists. Support is needed for using these techniques in teaching practicals and research. Again, BASES workshops are a good way forward. We ourselves have run a BASES workshop on MEP and participants, all trained in sport and exercise science, successfully carried out a Western blot and learned about the mechanisms that make muscles adapt to exercise.

And what if no such BASES workshop is offered? Many biology departments teach Western blotting or polymerase chain reaction (PCR) to their students and it is possible to tweak these practicals for sport and exercise science students. For example, PCR could be used to determine a gene variation and Western blotting could be used to measure the activation of a kinase that is suspected of mediating the adaptation to exercise.

How expensive is it?

There is no upper limit, but one can probably get all the minimal hardware for a Western blot for £2,000, plus about £200 per antibody and another £1,000 for consumables. You might also need to start collaborating with a partner organisation that can provide some samples. Western blots are two-day procedures but no more difficult than cooking a turkey, especially if the safer pre-cast gels are used. RNA work is trickier; specific machinery is required, it is more expensive and some chemicals are toxic. Therefore, it is probably better to start with Western blotting.

Taken collectively, we believe BASES should promote and offer training programmes for teaching and research in MEP because ignoring this field would mean ignoring one of the key future areas of sport and exercise science. ■

Reference

Booth, F. W. (1988). Perspectives on molecular and cellular exercise physiology. *Journal of Applied Physiology*, **65**, 1461-1471.

Dr Henning Wackerhage & Philip J Anderton

Henning is a lecturer in molecular exercise physiology at the University of Dundee.

Philip is a PhD student investigating skeletal muscle adaptation to exercise on a molecular level.

■h.wackerhage@dundee.ac.uk