A genomic science bootcamp

Teaching genetics

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How can school teachers get hands-on training in using DNA-based methods? Here, we highlight the availability of a free course, supported by the Goldsmiths' Company, which provides the opportunity for educators to get back into the laboratory and gain confidence with molecular genetic techniques.

Given the pace of the molecular genetic revolution, educators face the challenge of instructing students about molecular and genomic methods in which they themselves have little training, yet alone practical experience. Many instructors received their qualifications more than 15 years ago[1,2] at a time when the large-scale effort to sequence the human genome had not begun, and many methods for probing gene function, which are widely utilized nowadays, had yet to be discovered. Consequently, it is unsurprising that the majority of teachers, and therefore the public, describe themselves as ill-informed about genomic and biotechnological topics[3–5]. The provision of resources and professional development opportunities for such training has been recognized as a key challenge by many organizations[3,6], and is especially acute as societal implications of technologies such as genetic screening have an impact on the general public. In this brief article, we wish to publicize the availability of a training resource for school teachers — a laboratory-based course that provides a 'hands-on' opportunity for participants to use equipment and gain experience in basic molecular genetic methods, from PCR screening to DNA sequencing.

A 'Genetics' Course has been run every July for the past 8 years as one of the 'Science for Society' Courses introduced by the Goldsmiths' Company. It is based in laboratory space generously made available by the Wellcome Trust at the Genome Campus at Hinxton, with participants residing a few miles away at Villiers Park in the village of Foxton, south of Cambridge. The charitable sponsorship of the Goldsmiths' Company and Villiers Park Educational Trust ensures that the course is free of charge for all 20 participants. Activities are primarily laboratory-based and no prior practical competency is assumed — the goal is simply to generate awareness, enthusiasm and practical competency for this area of biology. Benchwork is reinforced by short seminars and thematically expanded through talks given by visiting scientists and clinicians, in areas relevant to 'A'-Level teaching. The overall goal is to provide contemporary information, and where possible resources and material, to help enhance the teaching of genetics in schools.

Participants at the Sanger Institute

During the 5-day programme, laboratory activities encompass a variety of experiments. These include exercises in basic DNA manipulation (methylation and restriction digestion[7]) and a variety of PCR exercises (amplification of mitochondrial DNA[8], allelic PCR of Alu insertions[8], molecular diagnostics of genetically modified foodstuffs[9] and phenotype/genotype correlation of ability to taste the bitter chemical phenylthiocarbamide with single nucleotide polymorphisms in the TAS2R taste receptor family[10]), as well as bacterial transformation assays with fluorescent protein variants[11]. Each of these experiments is supplemented with web-based exercises, which can be used to underscore the key biological principles in the absence of experimental resources[4]. Basic variants of these exercises are all available in 'kit' form from educational suppliers, such as Carolina Biotechnology or through the BioRad Explorer program.

During the week, teachers became very familiar with newer, more classroom-friendly, options for agarose gel electrophoresis by comparing both traditional equipment with more recently introduced pre-cast electrophoretic cassette systems, such as those marketed by Invitrogen (E-gels®)[12] and Lonza (FlashGel® DNA system)[13]. These newer systems afford advantages in terms of speed (with running times of approximately 5–30 minutes they are better suited for lesson timetabling), safety (enclosed cassette-systems, use of blue-light illumination and SYBR® Safe DNA stain, rather than UV illumination with ethidium bromide), equipment costs (built-in power supplies for the E-gel® system), as well as ease of loading and handling for students. Depending on the equipment used, both of these systems can potentially permit students to safely watch DNA fragments migrate through the gel in real-time, which dramatically enhances student learning.

Practical work in the laboratory is interspersed with a tour of the sequencing facilities, as well as informal talks from the

Participant 'modelling' the results

scientific staff of the Sanger Institute. These have included overviews of ongoing sequencing projects (Bronwyn Tyrrell, Project Manager, Communication and Public Engagement at the Sanger Institute), human evolutionary genetics (Dr Chris Gilson, Human Evolution Team), and the implications of microbial sequencing projects (Dr Matthew Holden, Pathogen Sequencing Unit). A number of additional lectures are also included to update teachers on some of the pathological processes detailed in different A-Level syllabi. In the past, we have hosted guest speakers on cystic fibrosis, cancer biology, HIV/AIDS, Huntington's disease and tuberculosis. This year teachers visited St Bartholomew's Hospital and enjoyed an overview of the pathobiology and current treatment strategies for tuberculosis and HIV/AIDS. These lectures were given by Dr Veronica White, a respiratory physician, and Dr Sanjay Bhagani, an infectious disease consultant.

In summary, teachers gaining responsibility for teaching A-Level biology, or simply looking to refresh and expand their knowledge of molecular genetic approaches, should consider attending this course which is advertised each spring through the Goldsmiths' Company.

For further details of the course, visit www.teachgenetics.org and www.villierspark.org.uk

I attended this course after a number of years away from the laboratory bench. I acknowledged that I needed to reinforce my knowledge and understanding of both theoretical and practical elements of biotechnology and techniques used in current research labs if I was going to be able to teach this part of the A-Level curriculum. I also wanted to make the introduction of the topic on 'Genetics and DNA' at GCSE more interesting and relevant for my students.

This course offered an excellent balance of practical techniques using equipment which was robust and cost-effective enough to use with small groups of A-Level students in order to bring the subject to life for them.

Having the opportunity to tour and work at the Sanger Institute and make use of their wonderful facilities was also a rare privilege for a teacher who has in the past been used to teacher training involving small conference rooms, hours of PowerPoint presentations and little opportunity to really discuss the issues with teacher colleagues and experts in the field. The residential aspect of the course allowed the group time to discuss practical questions we had with our tutors outside of the formal lecture and laboratory setting and exchange ideas with each other regards how best to deliver the subject matter to our students. The accommodation and catering at Villiers Park were also second to none and facilitated discussion and collaboration among delegates and course leaders.

An important aspect of the course in terms of disseminating knowledge to students was the availability of information and resources as a result of our work with the education team from the Wellcome Trust. We were provided with journals, website links and were given suggestions of places to apply for other relevant and often free materials which may really open up this subject and move it away from being so textbook led. I would recommend contacting the public engagements team at the Sanger Institute with any questions you might have regarding any aspects of the human genome project as the team there was not only knowledgeable, but also very approachable and understood the level teachers need to pitch their lessons at.

I can't thank the tutors enough however for agreeing to give their time and expertise to not only deliver informative lectures and organize interesting external speakers, but to allow us to perform a range of relevant and cost-effective laboratory techniques, as well as organizing the course logistically with the kind support of the Goldsmiths' company. This course was a once in a lifetime opportunity which I feel would be of benefit to any teacher attending in the future.

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