The increasing significance of ethics in the bioscience curriculum

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One of the most striking aspects of recent curricula developments within UK Science has been the growing prominence of bioethics. From University-level Bioscience, through A level and GCSEs, and as early as Key Stage 3 Science (in the revised Programme of Study, commencing September 2008) the ethical and moral implications of scientific and technological discoveries are being identified as core knowledge. Here we reflect on what is meant by bioethics, outline some of the ethical content being introduced within the UK and further afield, and examine some of the controversies surrounding these developments.

Origins of Bioethics

By popular consensus, the word "bioethics" was first used by American cell biologist Van Rensselaer Potter in the early 1970s. Despite the fact that the term has frequently been employed as though it were synonymous with "medical ethics", Potter original perceived bioethics more broadly as being "*a new discipline which combines biological knowledge with a knowledge of human value systems*" (Potter, 1971).

Ethical reflection on life and medicine was not, of course, newly invented at that time; many traditions have long histories of thoughtful contemplation concerning, for example, abortion and euthanasia or mankind's interaction with the natural world. However, a number of sociological and scientific changes in the years following the Second World War laid the ground for the emergence of bioethics as a discipline in its own right. These are documented more fully elsewhere (e.g. Bryant *et al*, 2005; Mepham, 2008) but include: the Nuremberg war crimes trials; increased questioning of the moral authority of both traditional religions and the medical establishment; concern for the environment, as exemplified by Rachel Carson's 1962 book *Silent Spring*; and developments in molecular biology which were just taking shape at that time, but have subsequently reached a point at which humans can, in a very real sense, exert control over the genetic basis of life. In line with Potter's broader definition, bioethics today can be seen to have three overlapping components: environmental ethics, biomedical ethics and research ethics.

Higher Education

Although universities have far greater autonomy than schools to design and examine their own programmes, the Quality Assurance Agency (QAA) is charged with establishing and maintaining academic standards in higher education qualifications across the UK. As part of this role, the QAA makes recommendations concerning appropriate content via a set of subject-specific Benchmarking Statements. The initial statement for Bioscience was published in 2002, and it received light revisions in 2007 (QAA, 2002; QAA; 2007). Both iterations of the statement contain the same set of expectations regarding the opportunities for undergraduate Bioscientists, whatever their particular field of study, to "*be confronted by some of the scientific, moral and ethical questions raised by their study discipline, to consider viewpoints other than their own, and to engage in critical*

assessment and intellectual argument" (Section 3.1). Bioscience students should be able to: "*recognise the moral and ethical issues of investigations and appreciate the need for ethical standards and professional codes of conduct*" (Section 3.5) and "*undertake field and/or laboratory investigations of living systems in a responsible, safe and ethical manner*" (Section 3.6). By the end of their degree, a typical honours graduate emerging from any bioscience programme should "*be able to construct reasoned arguments to support their position on the ethical and social impact of advances in the biosciences*" (Section 5.8).

A Level

From September 2008, a new series of A level Biology courses will be available. These will be taken by the first cohort to have passed through the revised GCSE specifications introduced in 2006 (see below). All boards have included substantial elements of bioethics in their curricula (summarised in Table 1 and, in an interactive form, at www.le.ac.uk/ge/bioethics). This newer emphasis is reflective of changes already seen in the Salter-Nuffield A level Biology course (SNAB) which was extensively piloted from September 2002 and has been available as an option since September 2005.

GCSE

The major revisions introduced in September 2006 for 14 to 16 year olds in England and Wales have been discussed more fully in previous articles (see, for example, Burden and Hall, 2006; Zolle, 2006). The main features, however, have been a reduction in the breadth of prescribed factual content and an increased emphasis on the nature of scientific endeavour and the place of science within broader society. The Programme of Study for this expanded *How Science Works* component includes the requirement that pupils should be taught "*to consider how and why decisions about science and technology are made, including those that raise ethical issues, and about the social, economic and environmental effects of such decisions*" (QCA, 2005). Each of the exam boards has embraced this ethical dimension and offer copious opportunities within the curriculum where these aspects can be discussed (see www.le.ac.uk/ge/bioethics for summary tables).

Key Stage 3

The National Curriculum for 11 to 14 year olds is also undergoing significant change. From September 2008 major revisions are being enacted across all subjects with the intention of introducing greater flexibility in delivery of the material and increasing 'real world' relevance. Echoing developments in the earlier round of GCSE revision, the Science curriculum will now have a strong emphasis on *How Science Works*. In addition to specific content, six foundational concepts have been identified including "*Examining the ethical and moral implications of using and applying science*" (QCA, 2007). "*Scientist, individuals and society*", continues the explanatory notes in the revised documentation, "*need to think about the balance between the advantages and disadvantages of new developments before making decisions (e.g. examining issues relating to selective breeding and genetic engineering of plants and animals …)*". They continue by highlighting the ethical and moral tension exemplified in the use of animal in research that will benefit humankind.

Ethics in Science Curricula elsewhere

Although bioethics provision is probably more embedded in UK education than anywhere else in the northern hemisphere, the heritage is actually longest in New Zealand, where social and ethical issues have been part of the core curriculum since 1993 (Conner, 2004). Given the prominent involvement of American philosophers in the development of bioethics as a discipline, it might be imagined that schools in the USA would also have bioethics as a compulsory subject. This is counteracted, however, by the absence of a national curriculum; content is therefore determined at the state and local district levels and may or may not include ethical issues.

A systematic review of bioethics provision in Europe has not been undertaken, but an overview of biotechnology education, including some discussion of bioethics, was published in 2002 (EBE, 2002). Almost inevitably, the report found wide variability in the provision of biotechnology education in different countries and noted that the cross-curricular nature of the topic made it difficult to decide within which subject the issues ought to be discussed. Where biotechnology was discussed in science lessons the emphasis was frequently on the technology alone, without consideration of the wider societal issues.

Driven in part by the United Nations Educational, Scientific and Cultural Organization (UNESCO), the global trend has been towards increased promotion of ethics education. UNESCO's Universal Declaration on Bioethics and Human Rights states "*In order to promote the principles set out in this Declaration and to achieve a better understanding of the ethical implications of scientific and technological developments, in particular for young people, States should endeavour to foster bioethics education and training at all levels as well as to encourage information and knowledge dissemination programmes about bioethics*" (UNESCO, 2005: Article 23). To this end, UNESCO has an Ethics Education Programme aimed at initiating and supporting teaching in varied aspects of ethics, including bioethics and professional standards.

Controversies and ongoing quandaries

Ever since the Educational Reform Act of 1988 heralded the introduction of the National Curriculum and the elevation of Science to a compulsory subject for all pupils to age 16, there has been a tension concerning the purpose of science education. On the one hand the scientists of tomorrow are the students of today and their schooling is important in order to put in place the building blocks upon which their later studies will be constructed. At the same time, however, the vast majority of pupils taking Science up to and including GCSE will not continue to study science beyond the compulsory years and a curriculum designed primarily with proto-scientists in mind will offer them little benefit. At risk of sweeping generalisation, the traditional syllabuses have had their focus on training the scientists of tomorrow, whereas the newer courses, including their emphasis on the ethical and moral implications of science, are aimed at promoting scientific literacy for all, whilst allowing the most interested to develop deeper factual knowledge via the appropriate Additional Science units. In this way it is hoped that a

greater proportion of the population will be equipped to understand real life science and to distinguish science for pseudo-science.

Pub science? Many people have welcomed the introduction of these changes, but their adoption has certainly not been universally popular. Shortly after the introduction of the new GCSEs, Sir Richard Sykes, Rector of Imperial College, and Baroness Warnock accused them of being "more suitable to the pub than the schoolroom". A number of Independent Schools, able to operate with greater curricular freedom than state schools, have elected to switch their pupils onto International GCSE programmes, which have a more traditional tenor.

Ethics without substance? The criticism has also been raised that students need to have adequate grasp of the underlying science before they can discuss the ethical issues arising from the scientific breakthroughs. For example, it is necessary to have some understanding of normal cell division in order to properly evaluate the merits of stem cell research. We have always maintained the importance of scientific and ethics education going hand in hand, and can see the validity of criticisms if the science knowledge is left languishing behind. On the other hand, it is important that students are equipped not only with answers to the ethics of a particular issue, but with an appropriate toolkit to know how to address new ethical conundrums that arise outside of their formal schooling.

Ethical theory? To this end, a different question arises, namely how much moral philosophy is required in order to fairly represent an ethical discussion? The consensus, when debated by bioethics enthusiasts, seems to be not a lot, but almost certainly more than most students are currently receiving. They should probably know, for example, that arguments can arise from first principles or from outcomes, even if they do not use the terms deontological or consequentialist, nor know anything of Immanuel Kant or John Stuart Mill.

Assessment? Another persistent question involves appropriate assessment of bioethics. Unlike our colleagues in the humanities, we are not familiar with awarding marks for construction of argument and are more used to checking that the factual content was present and correct. Exam boards at GCSE appear to be partially side-stepping this difficulty by offering credit based on a student's ability to describe arguments presented from more than one perspective (without the necessity to come off the fence and defend their own views on the matter).

Methodology? Even for those who are enthusiastic about increased ethical content in the bioscience curriculum, the changes have frequently necessitated the development of approaches to teaching that have hitherto been unfamiliar within science teaching, such as debate and role play. Dealing with opinions rather than 'fact' has also left some teachers feeling uncomfortable (as noted by Lewis (2006) in her report on the experience of teachers involved in the pilot programme for the SNAB course).

Will the myriad of changes achieve their goal of developing a scientifically literate public? The sheer frequency with which ethically-important stories are reported in the

media makes this a vital task, and one made urgent by evidence that the public are generally poorly equipped to understand the issues (see, for example, the now infamous Eurobarometer survey in which 35% of Europeans agree to the statement, "ordinary tomatoes do not contain genes while genetically modified tomatoes do" and a further 30% declared that they did not know; Europa, 1999).

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Table 1: Ethical content within new A Level specification (for teaching in England and Wales, commencing September 2008)

Ethical issue	**AQA** Biology (AS 1411 / A2 2411)	**AQA** Human Biology (AS 1406 / A2 2406)	**Edexcel** (Concept/context led Approach) (AS 8BIO1 / A2 9BIO1)	**OCR** Biology (AS H021 / A2 H421)	**WJEC** Biology (AS 2071 / A2 3071)
Ageing		●			
Agriculture	●●			●	
Animal research			●	●	
Antibiotics	●	●●			
Biofuels		●			
Cloning	●			●	●
DNA fingerprinting	●		●		●●
Drug trials			●		
Enhancement			●		
Gene ownership		●			●
Gene therapy	●		●	●	●
Genetic counselling	●	●			
Genetic engineering	●	●●	●	●	●
Genetic screening		●	●		●
Genetic testing	●●	●	●		●
Genetically modified crops	●	●●	●	●	●
Genetically modified organisms	●	●●	●	●●	●
Human Genome Project			●	●	●
In vitro fertilisation		●			●
Lifestyle & genetic disease		●●●	●		
Neuroethics			●		
Preimplantation genetic diagnosis			●		●

Prenatal testing			●		
Research ethics	●●	●●	●		
Stem cells	●		●	●●	●
Transgenic animals	●	●	●	●●	
Transplantations				●	●
Vaccinations	●	●		●	
Xenotransplantation				●	