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Marianne Talbot
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Part I

Bioethics and Ethics

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Biotechnology and bioethics: what it's all about

Objectives

In reading this chapter you will:

- reflect on the nature of bioethics;
- familiarise yourself with the definition of biotechnology that we will use in this book;
- reflect on the interdisciplinary and multi-disciplinary nature of biotechnology;
- consider the place of biology in biotechnology;
- consider briefly the history of biotechnology;
- reflect on how bioethics is generated by biotechnology;
- acquire an understanding of the different biotechnologies that generate social and ethical issues.

Bioethics is the study of the ethical and social issues generated by biotechnology.¹ In Box 1.1 you will find the definition of biotechnology that we will use in this book.



Box 1.1 Definition: Biotechnology

Biotechnology is the application of science and technology to living organisms and their parts, or to products and models of living organisms, in the hope of producing understanding, goods or services.

Examples of work in biotechnology:

- physicists and engineers working together to produce nano-vehicles, vehicles small enough to enter the bloodstream and deliver drugs to cure various diseases;
- geneticists and information technologists helping to eliminate adverse drug effects and make personalised medicine a reality;
- engineers and biologists working together to engineer organisms that will alert us to, and even remove, pollutants from the environment.²

This definition of biotechnology makes it clear that the 'bio' of biotechnology refers to the subject matter of biotechnology, not the disciplines involved. Biotechnology is *multidisciplinary* in that it involves many different disciplines, all the pure and applied sciences in fact, and *interdisciplinary* in that all these sciences and technologies work together to achieve biotechnological ends.

The 'bio' bit is important because in biotechnology, these different sciences and technologies are all applied to biological organisms: to living organisms, their parts and products, and to models of such organisms. Biology is central to the pursuit of biotechnological ends because biotechnology is the application of science and technology to biological organisms.



Box 1.2 Activity: Conceptual analysis

Put 'Def: "biotechnology"' into a search engine. Choose two definitions that differ from the one in Box 1.1, and compare and contrast the three definitions.

Can you think of a situation in which the definition of 'biotechnology' would be important?

Biotechnology, arguably, has been practised continuously since the Sumerians discovered how to use yeast to brew beer in 1750 BC. Modern biotechnology emerged in the twentieth century as we acquired the understanding and ability to manipulate organisms at the molecular level, specifically as we acquired the understanding and skills needed to manipulate an organism's genes.³

This understanding, and the skills we have developed as a result of it, enables us to do many things our ancestors never dreamed of. Our ability to manipulate the characteristics of plants and animals, for example, no longer depends on the techniques of selective breeding. We can directly engineer the genes of organisms to produce the traits that interest us, clone animals that possess these traits, or even create synthetic organisms capable of performing desired functions.

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Figure 1.1 Sequencing human DNA. © iStockphoto.com/dra_schwartz.

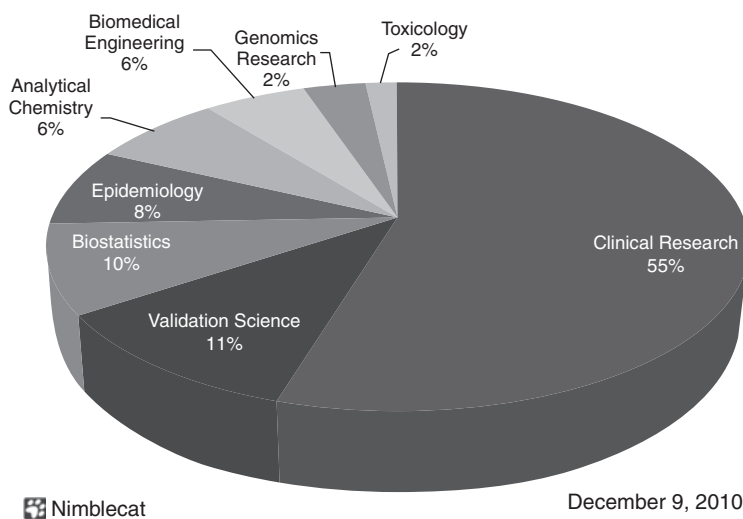


Figure 1.2 The people that biotechnology companies in the USA were hiring in November 2010. Image courtesy of nimblecat.com. (<http://nimblecat.typepad.com/thecareerists/2010/12/55-of-new-biotech-jobs-in-clinical-research.html>).

Biotechnology in relation to human beings received a huge boost from the completion in 2003 of the Human Genome Project,⁴ which sequenced and mapped the 25–26 000 genes in the human genome.

Current projects involve attempts (many already very successful) to:

- discover the function of the various genes;
- map the locations of common variations between individuals;
- correlate these bio-markers with phenotypical traits of interest;
- develop techniques to detect the presence of important bio-markers;
- develop techniques by which to manipulate gene expression.

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Biotechnology is advancing at a breathtaking pace, facilitating the development of numerous potentially life-enhancing and life-saving techniques.⁵



Box 1.3 Case study

In 2009 a private company in the UK started marketing an 'over-the-counter' paternity testing kit. Customers send samples of their own DNA and that of the child whose paternity is in doubt and, for a fee, get results within 5 days (or 24 hours for a higher fee).

Two adults must consent to the procedure: the putative father and the mother of the child. Proof of identity is required and one adult will be telephoned to check that the consequences of possible test results have been considered.

Many have argued that such kits should be banned on the grounds that the consent requirements are too easy to get around, and that children may be summarily rejected by the man who has brought them up if he discovers he is not their biological father.

Until biotechnology came up with the techniques facilitating the development of such products paternity had to be taken on trust. Many think this was morally a more desirable situation, and that society should therefore ban or at least regulate the use of such a product. Others argue that men have the right to know their own children, and children the right to know their own fathers.⁶

Because biotechnology enables us to do many things human beings have never been able to do before, it has generated and will continue to generate many new ethical issues, issues concerning what we *should* and *shouldn't* do, and many new social issues, issues concerning what we as a society should and shouldn't allow, or should or shouldn't fund. Bioethics is the discipline that studies the actions permitted by biotechnology – actions like cloning or genetic engineering – and asks whether or not these actions are morally acceptable, and if so how we should manage them socially in order to promote citizens' welfare, protect their rights and treat them fairly.



Box 1.4 Factual information: Mapping biotechnologies onto issues in this book

The techniques of biotechnology do not map neatly onto the ethical issues that are generated by biotechnology. For example, genetic engineering produces ethical issues in respect of designer babies, GM foods and our use of animals.

If you are interested in a particular biotechnological technique this will help you find the chapter(s) in which you'll find a discussion of the ethical issues generated by it.

*The techniques of assisted reproduction*⁷

Under this heading fall all the techniques by which individuals and couples having trouble conceiving can be helped to achieve a healthy baby. There are many such techniques of which in vitro fertilisation – the mixing, in a Petri dish, of sperm and egg in such a way as to ensure the fertilisation of the egg – is probably the best known. The social and ethical issues generated by such techniques are discussed in Chapters 9, 10 and 11.

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*Cloning*⁸

Every time a cutting of a plant successfully roots the plant is cloned. We have been cloning plants by such means for centuries. In the late twentieth century, however, a mammal – Dolly the sheep – was cloned for the first time by means of somatic cell nuclear transfer. The social and ethical issues generated by cloning are discussed in Chapters 7 and 8.

*Genetic screening/testing*⁹

The techniques of genetic screening/testing include any means by which we can identify (some part of) the genetic inheritance of an individual. The most controversial of these techniques is pre-implantation genetic diagnosis. This involves taking an eight cell embryo and removing just one cell for analysis. The social and ethical issues such techniques engender are discussed in Chapter 11.

*The technology of life support*¹⁰

These technologies include techniques by which to maintain circulation when the heart no longer beats spontaneously and nutrition and hydration when a patient is unable to eat or drink. The social and ethical issues generated by such technologies are discussed in Chapters 12 and 13.

*Genetic engineering*¹¹

Sometimes called genetic modification, genetic engineering involves the introduction, elimination and modification of genes in such a way as to affect the properties or behaviour of an individual human, plant or non-human animal (and perhaps the properties and behaviours of its progeny). Such techniques and the issues surrounding them are discussed in Chapter 17.

*Bioinformatics*¹²

Bioinformatics involves the application of information technology to the various fields of molecular biology. Specifically, it involves developing methods for storing, retrieving, comparing and analysing biological data. It generates social and ethical issues that are discussed in Chapter 18.

*Pharmacogenetics/pharmacogenomics*¹³

The techniques grouped under these names, for all practical purposes interchangeable, comprise the study of the genetic variations that determine an individual's metabolism and response to various drugs. The social and ethical issues that arise from such techniques are discussed in Chapter 19.

*Synthetic biology*¹⁴

A relative newcomer to the discipline of biotechnology, synthetic biology involves the re-design and fabrication of existing organisms, and the design and fabrication of organisms that don't exist in nature. Such activities generate social and ethical issues that are discussed in Chapter 18.

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*Nanotechnology*¹⁵

A 'nanometre' is one billionth of a metre (1×10^{-9}). Nanotechnology exploits the properties and behaviours of the very small.¹⁶ Nanotechnology is sometimes characterised as 'soft' or 'hard' depending on whether it exploits a biological system ('soft') or a mechanical system ('hard'). The social and ethical issues generated by soft nanotechnology will be discussed in Chapter 18.

Before we can consider specific issues in bioethics we need to acquire some understanding of the nature of ethics in general. We will do this in the next chapter.

Summary

In this chapter we have considered:

- the fact that bioethics is the study of the ethical and social issues generated by biotechnology;
- the definition of biotechnology that we will be using in this book;
- a brief account of the history of biotechnology;
- the fact that biotechnology generates ethical and social issues by enabling us to perform actions we have never been able to perform before;
- the fact that biotechnological techniques do not map neatly onto the ethical issues;
- a list of techniques and indications of where in the book discussions of them will be found.

Questions to stimulate reflection

What is the difference between biotechnology's being *interdisciplinary* and *multidisciplinary*?

Can you think of a few of the advantages and disadvantages to be derived from biotechnology's being interdisciplinary?

What do you think might be advantageous and disadvantageous about biotechnology's being multidisciplinary?

How do advances in biotechnology generate ethical problems?

What do you think might be the difference between an *ethical* problem and a *social* problem?

Can you think of two examples each of (1) an ethical problem generated by biotechnology, and (2) a social problem generated by biotechnology?

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Additional activities

Make a list of actions that are now possible thanks to biotechnology but which weren't possible 100 years ago.

Using your list identify at least one ethical or social problem that is generated by this action.

Put 'bioethics' into a search engine and follow up anything that interests you.

Conduct an informal opinion poll amongst your friends, family and fellow students on what they understand by 'bioethics' (you might find yourself having to explain it quite often: be prepared!).

Buy yourself an exercise book in which to write your thoughts as you work through this book. Start by writing down your own understanding of the nature of bioethics.

Identify from the list in Box 1.4 a biotechnology that particularly interests you. In your diary jot down the ethical and social issues you think might be generated by it.

Put 'ethics' into the search facility of the website of the agency that funds biotechnological research in your country, and see if you can find anything interesting.

Notes

- 1 'Bioethics' can also be used more widely to cover the biomedical sciences, but we are concentrating on this aspect of bioethics (see Preface, p. viii).
- 2 http://www.biotechinstitute.org/careers/career_profiles.html. Biotechnologists talk about their careers on the website of the Biotechnology Institute.
- 3 http://www.biotechinstitute.org/what_is/timeline.html. A timeline of biotechnology from the Institute of Biotechnology in the United States.
- 4 http://www.ornl.gov/sci/techresources/Human_Genome/home.shtml. Information pages from the Human Genome Project.
- 5 <http://www.wellcome.ac.uk/Funding/Biomedical-science/Funded-projects/Major-initiatives/WTDV029748.htm>. Information about the 1000 Genomes Project from the Wellcome Trust.
- 6 <http://www.dailymail.co.uk/health/article-1200420/Fathers-30-DNA-paternity-test-counter-cost-119-results-back.html>. An article from the UK's *Daily Mail* on the introduction of paternity testing kits.
- 7 <http://www.fertilityexpert.co.uk/chapter-three-assisted-reproduction-techniques.html>. An article on the techniques of assisted reproduction from the website of Fertility Expert in the UK.
- 8 <http://www.reuters.com/article/idUSN1551320720080115>. Facts and a timeline on cloning from the Reuters website.
- 9 <http://www.ukgtn.nhs.uk/gtn/Home>. Information about genetic testing in the UK from the UK Genetic Testing Network.

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- 10 <http://www.deathreference.com/Ke-Ma/Life-Support-System.html>. Definition of 'Life Support' from the Encyclopedia of Death and Dying.
- 11 http://www.eurekascience.com/ICanDoThat/gen_eng.htm. A simple explanation of genetic engineering from Eureka Science.
- 12 http://www.bioinformatics.org/wiki/Bioinformatics_FAQ. Information about bioinformatics from the Bioinformatics Organization in the United States.
- 13 <http://ghr.nlm.nih.gov/handbook/genomicresearch/pharmacogenomics>. An account of pharmacogenomics from the US National Library of Medical Information.
- 14 <http://www.youtube.com/watch?v=XIuh7KDRzLk&feature=related>. YouTube video of Drew Endy (an assistant professor at Palo Alto) explaining synthetic biology.
- 15 <http://www.nano.gov/nanotech-101/nanotechnology-facts>. FAQ from the national Nanotechnology Initiative in the United States.
- 16 <http://cpd.conted.ox.ac.uk/nanotechnology/nanobasics/nano/accessweb/history.html>. The basics of nanotechnology from the University of Oxford.

Further reading and useful websites

Okasha, S. (2002) *A Very Short Introduction to Philosophy of Science*. Oxford: Oxford University Press.

Smith, J. E. (2009) *Biotechnology*. Cambridge: Cambridge University Press.

Stephansson, H. (ed.) (2002) *Life Sciences in Transition: A Special Edition of the JMB*. London: Academic Press.

Walker, S. (2006) *Biotechnology Demystified*. New York: McGraw-Hill Professional.

<http://wings.buffalo.edu/faculty/research/bioethics/osce.html>. Standardised Patient Scenarios for teaching bioethics from the University of Toronto.

<http://www.bbsrc.ac.uk/>. The website of the UK's Biotechnology and Biological Sciences Research Council.

<http://www.beep.ac.uk/content/46.0.html>. The website of the Bioethics Education Project funded by the Wellcome Trust and based at the Graduate School of Education, University of Bristol.

<http://www.bioethics.ac.uk/index.php>. The Biocentre, a site which examines new biotechniques from a social and ethical perspective.

<http://www.nsf.gov/about/>. The website of the National Science Foundation, who fund research in the United States.