SCIENCE

# Mapping the human body

## DIANNE NICOL discusses ethical and legal implications of the medical and commercial spin-offs from the human genome project.

The human genome project has probably attracted more comment than any other area of science in the few years since its inception in the late 1980s. The objectives of the project are to map all of the 100,000 genes of the human genome and determine the complete sequence of the human genetic code.

The human genome is encoded on 23 pairs of chromosomes in every non-reproductive cell of the body in the form of DNA, which is the molecular basis of the genetic code itself. Each of these pairs of chromosomes carries its own set of genes, which in turn are composed of unique segments of the genetic code. The message in that segment of the genetic code which constitutes a gene is used to make a specific protein. So, the genetic code makes up our genes, the genes manufacture our proteins and it is our unique assemblage of proteins that makes us humans. If we know where each of the genes is on our chromosomes, and can read their code, we shall come close to understanding the normal functioning of our bodies and, more importantly, what happens when genetic malfunctions occur.

It is important, however, to realise from the outset that a description of the entire genetic code still will not give us enough information to construct a human (or a dinosaur for that matter) in the laboratory. Despite the limitations of the project, huge resources are being dedicated to this endeavour; an estimated $5 billion has been allocated world-wide for the 15-year duration of the project. Some scientists have expressed concern that this money might be better spent in determining the precise function of individual genes which play major roles in maintaining life, rather than concentrating on a description of the whole genome with little emphasis on function.

Public concern, and indeed concern in the legal arena, is based chiefly on the medical advances that will arise as a result of the human genome project. There is a widely held belief, for example, that we shall soon be able to select our offspring on the basis of intelligence, looks, height and so on. This is far from the truth. It is important, however, that such misapprehensions should not cloud the real legal, ethical and social issues that are likely to arise from the medical and commercial spin-offs of this project. Three such areas are of immediate concern: genetic screening, gene therapy and patenting of genetic information. It should be emphasised that these issues are not unique to the human genome project. Genetic screening of the population for particular inherited traits has been conducted for a number of years. For example, in the 1970s some US States mandated testing for the genetic disorder sickle cell anaemia in black children.

Gene therapy techniques, which involve inserting normal genes into cells with defective genes, are being developed alongside, but independent of, the human genome project. Similarly, the issue of patenting in all areas of biotechnology is a very contentious one at present. What the human genome project has done is to intensify the debate and bring it into the public domain. Theoretically, it will be possible, in the very near future, to screen the population for all of the 4000 or so known genetic diseases which are caused by a single defective gene. Such diseases include cystic fibrosis, Duchenne's muscular dystrophy, fragile X syndrome and Huntington's chorea. It may also be possible to alleviate many of the symptoms of these diseases by gene therapy. It is also likely, however, that any such treatment will be costly, particularly if the screening tests, the methodologies for therapy and the gene sequences themselves are patented.

## Genetic screening

*Pre-natal diagnosis:* This is the most obvious area where genetic screening for disorders will be of use. Cells from the foetus would be screened early in pregnancy and, if found to carry a defective gene, the parents would be given the option to abort. The application of such procedures will inevitably feed into the ongoing debate over the ethics of abortion. In addition, many genetic diseases have a range of manifestations, from minor to fatal. Foetal screening is unlikely to reveal the severity of such diseases, making the decision to abort even more difficult.

*Identification of carriers:* Where a doctor has performed a screening test and identified a patient as a carrier, it is unclear whether he/she has a duty of confidentiality to the patient or a duty of disclosure to other parties, particularly members of the same family.

*Identification of susceptibility to disease:* Some screening tests will only indicate later onset of disease, for example, Huntington's chorea, which usually only manifests itself in people aged 40 and over. Without a cure for such diseases it has been seriously questioned whether it is better not to know, given the emotional stress involved. The issues of susceptibility to, and later onset of, disease may become particularly acute in the workplace. Can employers compel employees to be tested and if so can they discriminate against them on the basis of a condition that may arise some time in the future?

*Can life and health insurers compel testing?* Insurers already discriminate against cigarette smokers and AIDS sufferers, so should people with defective genes be treated differently?

*Allocation of funds:* How should the government decide where its limited funds should go? Sufferers of known genetic disorders only make up a small percentage of the population (one in 2300 births for cystic fibrosis, one in 3000 for Duchenne's muscular dystrophy and one in 10,000 for

Huntington's chorea, although some other conditions may be more common).[1] Is it fair that they should be allocated a disproportionate amount of health care funds?

Many of these issues will be covered by traditional common law areas of contract and tort and existing legislation, including the *Privacy Act* (Cth). It is important to assess whether these areas of law will adequately cover all potential problems in the future. In the USA, the *Human Genome Privacy Act* is currently going through the House of Representatives. It seeks to prevent the disclosure of genetic information by government agencies without the written consent of the individual, unless there is a medical emergency or criminal investigation. Consideration should be given as to whether such specific legislation will be required in Australia.

In addition to existing law, the National Health and Medical Research Council (NHMRC) has issued guidelines for use of genetic registers in medical research, and requires that institutional ethics committees (IECS) are set up to ensure conformity with such guidelines.

## Gene therapy

It is important to distinguish the two main types of gene therapy: germ line gene therapy and somatic cell gene therapy. Germ line gene therapy requires the insertion of a normal gene into sperm, eggs or early embryos. This gene will be replicated alongside normal DNA and will be passed on to daughter cells. Therefore all cells will carry the inserted gene, including cells of the germ line, and, as a consequence, the inserted gene will be passed on to future generations. This prospect has raised profound ethical concerns and germ line therapy has already been banned in Germany and France and calls for such prohibition have been made in other countries. It should be pointed out that there are also technical reasons why germ line gene therapy is unlikely to be pursued in the near future.

Somatic cell therapy is technically quite feasible, and there is already some success with this therapy in people suffering from diseases such as adenosine deaminase deficiency and cystic fibrosis. The use of such therapy has received mixed international reaction. Germany is strongly opposed to any sort of gene therapy, whereas other European countries seem to see it as just another medical treatment. The USA has taken a more cautious line and any proposals must be vetted by two separate National Institutes of Health committees. The general sentiment seems to be that although gene therapy is still very experimental, it is probably justified in special cases, particularly where there is a life-threatening disease and where no other options for cure exist.

Regulation in Australia is wholly through NHMRC guidelines which have no force of law. Germ line therapy is not allowed under the guidelines and procedures for somatic cell therapy must be complied with, as monitored by IECs. The national Genetic Manipulation Advisory Council may be called on for consultation. Two major reports have recently considered the question of genetic manipulation in all organisms. The first report was by the Victorian Law Reform Commission and, although consideration of genetic manipulation in humans was only considered briefly, the report came out heavily in favour of the IEC system without legislative intervention. The second report was by the House of Representatives Standing Committee on Genetic Manipulation. It specifically excluded human experimentation from its discussions but said that 'the possibility of applying these techniques to humans will clearly need to be considered'. It also supported the view that regulation should continue to be through NHMRC guidelines as monitored by IECs.

## Gene patenting

In June 1991 scientists from the National Institutes of Health in the USA applied for patents of gene sequences. Since then, scientists from the USA and elsewhere have applied for patents of thousands more sequences. None of these applications has yet been successful. All countries have similar legislation (in Australia, the *Patents Act* 1990) that, for something to be patentable, it must be an invention rather than a discovery, it must be novel, non-obvious, industrially useful and enabling (i.e. able to be put into practice by the average skilled person). Various molecules have been patented, as have methods of manufacture and methods of treatment.

Patenting of life forms is an area of huge debate at the moment. The chief objection to patenting of sequences of DNA is the fact that the exact function of the sequences is unknown. The general view of most governments would seem to be that it is inappropriate to patent sequences whose exact functions are unknown.

## Conclusion

In summary, the human genome project and its spin-offs raise a number of profound scientific, ethical and legal concerns. These concerns are recognised by scientists and funding agencies alike. In the USA 3% of all human genome project funding has been guaranteed to a separate program: Ethical, Legal and Social Issues. Australia, as much as anywhere else, will be affected by the medical and commercial advances arising from the human genome project. It is important that we decide now how our legal and regulatory structures will deal with potential problems. For this reason a group of lawyers, ethicists and scientists are currently addressing these issues from an Australian perspective. The group includes Professor Don Chalmers, Dr Margaret Otlowski and Dr Dianne Nicol from the University of Tasmania; Ms Loane Skene from Melbourne University; Professor Max Charlesworth; and Professor Rob Schwartz from the University of New Mexico.

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[An extensive body of literature exists in this area. A summary of relevant literature may be obtained from the author, Faculty of Law, University of Tasmania, GPO Box 252C Hobart, 7001.]

### Reference

1. From Lewontin, R.C., 'The Dream of the Human Genome' (1992) *The New York Review*, 28 May, 31-34.)