



the science
behind

THE NEWS

THE GAMMA SERIES OF THE ROYAL SOCIETY OF NEW ZEALAND

GENETIC ENGINEERING AND ETHICS

The development of gene technology has prompted more calls for moratoria than any other branch of research. Genetic engineering differs from other scientific disciplines in that it modifies organisms. No other research tool has come this close to understanding – and changing – the essence of life and many applications of GE have therefore sparked a wide range of ethical concerns.

Although many would describe genetic engineering as a logical extension of conventional breeding, most genetically modified organisms are unlikely to have evolved naturally. The discovery of the structure and role of DNA was the first step towards understanding the difference between living beings and inanimate objects (although there are living RNA viruses that do not contain any DNA). Scientists are now inching their way closer and closer to figuring out how these molecular building blocks work. This knowledge is making deliberate changes possible, some of which cross larger distances between species than nature could in only one step.

Gene technology is a modern science. Many experiments carried out over the last fifteen years or so were designed to increase fundamental understandings of biological systems. Other more recent and higher profile mammalian studies have been more closely associated with possible applications. While many of the immediate concerns refer to the public health and environmental safety of GMOs, the debate surrounding genetic engineering has widened to include ethical and moral challenges. Maori concerns about the disruption to essential belief systems and the exploitation of indigenous knowledge add a unique aspect to the ethical debate in New Zealand.

New choices, new challenges

Biotechnology will add choice to people's lives. For example, genetic testing of embryos will give prospective parents more options about which children they want to conceive or bear, or how to respond to known increased risks of some disease. New birth technologies will allow people to deal differently with fertility issues and xenotransplantation will give some individuals new therapies to prolong life.

But these added options also mean that people will have to grapple with the issue of how many of the choices are for the individual to make and which ones should be regulated by the wider public or community. While many options will have clear benefits for the individual, they affect more than the immediately involved person and have wider social ramifications. Recent examples include the use of embryonic stem cells in research and medicine. The advantage of embryonic stem cells is that they are capable of developing into any kind of specialised tissue and could therefore be useful for growing replacement skin, nerve tissue, or any other organ. Scientists also use such cells to study the genetic regulation of early development and to work out how these cellular all-rounders grow into highly special-

ised cells which may perform only one of a myriad possible functions. As each cell contains a copy of the entire human genome, vast parts of it must be silenced in any type of specialised cell and understanding the mechanisms behind the process will add to our options of treating conditions such as cancer and a range of inherited diseases. However, ethicists warn that parallel to such progress, life will lose a lot of its mystery and spiritual depth and could become nothing more than a commodity.

The British government has already put regulatory frameworks in place for the use of embryonic stem cells in research and medicine – in New Zealand that debate is yet to happen.

Speedy change

Biotechnology is stimulating fast social changes, putting pressure on traditional configurations of social relationships that have been assumed for a long time. For instance, fertility clinics in New Zealand are now asking for access to the latest technologies for testing embryos before they are implanted in the womb. So far, if any genetic tests were done at all, it would happen in utero, at a point where the embryo was already well established. The advantage of

pre-implantation tests is that any genetic defects are detected early and parents are spared the pain of having to consider a termination. But the ethical dilemma of such early intervention was highlighted recently when an American couple designed a baby to produce a suitable donor for their older child who was suffering from a genetic disease. The couple produced as many embryos as necessary to find the optimal gene combination to make their new child a perfect genetic match for the older sibling. The couple concerned assured doctors that they wanted another child anyway, but decided to use technology to make sure the new family member was also useful. Such development will create new dynamics in social relationships and will inevitably shape society's attitudes towards disease and disability.

In another example, the social role and economic future of small farmers is changing rapidly through the expanding role of large multi-national companies in seed production and their control over seed development through patenting of any newly developed material.

Changes in family structure, attitude to health and disability, and the social role of farmers have been taking place at all times and have continued to shift society values, but biotechnology is accelerating the process.

Ethical frameworks

There are two main strands of ethics that have developed around life sciences. Bioethics emerged in the 1970s in the context of medical developments; environmental ethics is a more recent area associated with the increasing awareness of the functions of ecosystems.

Bioethics

Bioethics emerged in response to the impact of technology on medicine and the abuse of human subjects during research. In New Zealand this has led to the development of ethics committees and the requirement for any new health research proposal to gain ethical approval before any funds are granted. The patient-doctor relationship is marked by the inequity of power, but it is also bound by the ethics of care and the do-no-harm principle, which underlies all medical professions.

Animal ethics

Animal welfare has also become an issue in the context of gene technology. Animals are being used both as research objects and as living factories for the production of new pharmaceuticals. Several such applications have raised concerns, but the strongest criticism is expressed against projects that use animals not commonly used in research. For example, scientists at the Crown Research Institute AgResearch have been granted approval by the Environmental Risk Management Authority for a field trial of genetically engineered sheep. The animals are designed to have a deletion in the myostatin gene which is involved in the regulation of muscle tissue development. The gene defect occurred through natural mutation in the Belgian Blue cattle breed, which grows up to twice the amount of muscle in some areas. Apart from creating the same double-muscling effect in sheep, the scientists hope to learn more about muscle development with a view towards new therapeutics for muscle wasting diseases such as muscle dystrophy. However, the double-muscling is causing birthing problems for the cattle, resulting in a higher number of Caesarian sections, so the likelihood of the same problems occurring in sheep was one of the issues that ERMA had to consider during the application process.

Other bodies dealing with animal ethics in New Zealand are the animal ethics committees that operate under the Animal Protection Act and the Australian and New Zealand Council for the Care of Animals in Research and Teaching (ANZCCART), whose mission is to promote excellence in the care of animals used in research and teaching and to ensure that the outcomes of scientific uses of animals are worthwhile.

Environmental ethics

People have always looked for better ways to cope with nature and to enhance their survival and health. Gene technology adds a new tool to this quest, but because it creates new living organisms its impact will be on the entire biosphere. Environmental ethics draws on definitions of nature and creation, which differ for almost every culture, so in contrast to bioethics, environmental ethics is more influenced by religious and spiritual traditions. Environmental ethicists are often critical of the focus on the

individual that dominates much of bioethics, as they pay more attention to the consequent changes to wider social groupings and the well-being of the non-human world. Environmental ethics is also more concerned about consequences across time, most clearly illustrated in considerations about how we change the world, and what options we leave for future generations.

Maori concerns

Maori and other indigenous peoples are increasingly raising concerns about the misappropriation of indigenous knowledge and the use of genetic resources by biotechnology companies. In New Zealand, this led to the Waitangi Tribunal 262 claim on indigenous flora and fauna. The claim was lodged in 1991 and argues that the Crown has failed to protect the rangatiratanga (sovereignty) of Maori over both their genetic resources and the cultural knowledge linked to those resources.

Such concerns echo those voiced by other indigenous groups who fear that researchers are taking advantage of traditional knowledge and are accessing plants and animals that may be useful for developing new pharmaceuticals or other products.

In addition to this general concern, Maori are calling for wider and more thorough consultation, for the sharing of benefits (monetary and skill transfer) arising from any research, and the ability to maintain intellectual property rights.

Many Maori also have strong objections to gene technology because they see it as a breach of their spiritual belief systems and therefore as a moral and cultural offence.

In Maori mythology plants and people have a common origin, both being offspring of Tane as the controller of forests and fertilisation. Maori see trees as living forms senior in status to people because Tane created plant life before people. They are therefore respected as relatives, as the link between people and their sacred ancestors.

This sense of relatedness between people and nature creates a feeling of belonging to nature as an integral part, rather than being a separate element. The basis for many of the Maori cultural objections varies among iwi, but most arise from concerns about breaches to whakapapa (genealogy), mauri (life forces), kaitiakitanga (guardianship) and rangatiratanga (chieftanship, sovereignty).

A field trial of genetically engineered cows raised particularly strong objections within the Maori community. The cows are engineered to carry a human gene so that they produce a human protein in their milk. The protein is being investigated as a possible therapeutic for people with multiple sclerosis. But for many Maori such crosses from humans to animals are offensive because they disrupt the line of whakapapa.

Other projects, such as the gene mapping of tuatara, kokako and the saddleback, have sparked criticism because they are seen as a breach of Maori sovereignty over native species.

The legislation covering ERMA requires that the authority take advice on Maori issues. The body providing such advice is Nga Kaihau Tikanga Taiao.

Is GE helping the Third World ?

The overwhelming majority of the world's population continues to rely on agriculture, animal husbandry, forestry and fisheries as the main sources of their income. The rapid population growth in the Third World is likely to intensify such activities and the rate of resource extraction from our ecosystem.

One of the arguments used by proponents of gene technology is that GE crops could alleviate world hunger because they are designed to grow in areas of low fertility or high salinity and aridity. However, critics argue that such crops would only intensify the trade barriers already in place between the First and Third Worlds. The main concern is that subsistence farmers in the Third World would sink even deeper into dependence, rather than gaining more control over their country's agricultural production.

One area of inequality arises from the fact that major First World nations have increasingly adopted the "precautionary principle" approach in relation to the environmental and food safety attributes of imports. Meanwhile, many Third World nations lack effective regulatory mechanisms to ensure that their products meet international standards. As a result, any effort to harmonise agrifood standards may, in reality, consolidate and legitimise trade barriers that have existed for centuries.

Changing role of science

The cultural interpretation of nature has undergone significant changes over the centuries, from being seen as a moral agent that may dish out rewards and punishments to being treated as a commodity that humans can mould as they wish. In the middle of the last millennium, nature had to be appeased and satisfied, and any natural disaster was seen as a sign that some transgression had taken place. From about the 17th century, developments in western science have meant that nature became something to be used, controlled, subdued and rearranged.

Parallel to these cultural shifts in western understanding there has been a shift in the role of experts. Traditionally, many concerns with nature have been dealt with by those entrusted with spiritual and sacred knowledge, but over time this has been replaced by technical expertise.

It seems the community is beginning to reconsider where to place science on this scale of authority. Some professions, perhaps most notably in medicine, have managed to bridge this gap between the sacred (or moral) and the technical (or profane). Doctors are not only carrying out the technical actions, but also judge the moral significance of their choices and carry the responsibility for them. But when it comes to bigger issues such as end-of-life decisions or prenatal genetic testing even medicine, and certainly science in general, is often challenged.

Scientific thinking is based on inquiry, curiosity, search for evidence, challenging of current theories, and the ongoing search for better explanations – so while it may not be appropriate for science to tell people what "ought" to be done, it can continue to inform the debate.

Further reading:

The Ethical Issues of Genetic Modification, briefing paper to the Royal Commission on Genetic Modification, by Barbara Nicholas, retrieved from: www.gmcommission.govt.nz

Peer reviews of the ethics briefing paper, also retrieved from: www.gmcommission.govt.nz

The Maori Aspects of Genetic Modification, briefing paper to the Royal Commission on Genetic Modification, by Bevan Tipene Matua, retrieved from:

www.gmcommission.govt.nz

Ethics and Genetics, by Donald Evans, in Designer Genes, the New Zealand guide to the issues and facts about genetic engineering, edited by Ray Prebble, Dark Horse, Wellington, 2000, p 27-36.

A Maori Response to the Biogenic Age, by Bevan Tipene Matua, in Designer Genes, the New Zealand guide to the issues and facts about genetic engineering, edited by Ray Prebble, Dark Horse, Wellington, 2000, p 97-110.

Spiritual and Ethical Considerations, by The Right Reverend Dr Tom J Brown, in Designer Genes, the New Zealand guide to the issues and facts about genetic engineering, edited by Ray Prebble, Dark Horse, Wellington, 2000, p 111-118.

Crops: Food, Environment and Ethics, by Tony Conner, in Designer Genes, the New Zealand guide to the issues and facts about genetic engineering, edited by Ray Prebble, Dark Horse, Wellington, 2000, p 141-152.

Spiritual Dimensions of Genetic Engineering, by The Right Reverend Dr Tom J Brown, in Gene Technology in New Zealand, scientific issues and implications, abstracts to Environmental Risk Management Authority seminar, May 2000.

Ethical Issues for Scientists, by Mark Fisher, in Gene Technology in New Zealand, scientific issues and implications, abstracts to Environmental Risk Management Authority seminar, May 2000.

Human Genetic Research and Whakapapa, by Aroha Te Pareake Mead, paper presented at Gene Technology in New Zealand, Environmental Risk Management Authority seminar, May 2000.

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