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Genetic engineering in God's world

by Denis Alexander

Summary

This paper provides a brief summary of genetic engineering (GE) and considers some ethical issues raised by applications of GE to humans. GE is distinguished from novel reproductive technologies, such as cloning, which are not discussed. The doctrines of Creation, Fall and Redemption provide a Christian framework within which to evaluate the appropriate goals and limitations of GE. As God's 'earth-keepers' Christians have a responsibility to use all the tools he has provided to tackle disease and feed a hungry world. But knowledge of the world's fallen state also makes Christians wary of exaggerating the benefits of new technologies, and acutely aware of their potential for evil.

Introduction

DNA, with its double-helical structure, has become one of the cultural icons of the late twentieth century. In books, films and everyday speech genetic metaphors are used to express diverse and even contradictory concerns[1]. Genetics is used to justify both social harmony (based on common ancestry), and social division (based on race). The DNA of popular culture is surrounded by mystique. The genetic engineers have become media constructs, either with two horns, bent on subverting the natural order, or as genetic wizards delivering the future to humankind on a plate as they sweep away hunger and disease.

DNA and genetic engineering

The DNA of biology is very different from the DNA of popular culture, yet even stripped of its mystique it remains a remarkable molecule[2,3]. Each of the 10^{13} somatic cells in our body contains six feet of DNA, packaged with proteins to form 23 pairs of chromosomes. If all the DNA in all the cells in a single human being were stretched out, it would reach to the moon and back 8,000 times. As millions of our cells divide every second, each individual produces thousands of miles of newly-copied DNA every minute.

Human DNA contains three thousand million nucleotides, the 'letters' which comprise the genetic alphabet, encoding about 50–100,000 genes. There are only four 'letters' in this alphabet. Each gene consists of a sequence of nucleotides which encodes a different protein. Only about 3 per cent of human DNA encodes genes – the function of the rest is not yet well understood. The Human Genome Project (HGP) aims to determine the complete DNA nucleotide sequence, a task which should be accomplished soon after the year 2000. If this information were printed in books of 200 pages each, 5,000 books would be required. Only when the HGP is complete will we be sure how many genes our DNA encodes. But we already know that DNA sequences in different individuals (except identical twins), vary to such an extent that everyone alive today is different, not only from everyone else, but from everyone who has ever lived or ever will live. On average, two people differ in about one DNA letter per thousand, or about three million nucleotides in total, due to naturally occurring mutations. DNA is not a static molecule but is in a state of flux. Fortunately this flux is not very fast, otherwise we would not be here to discuss it.

The genetic code is essentially identical for all living organisms from bacteria, yeasts and viruses to dandelions, kangaroos and humans. This is the most powerful argument for the unity of all living things and is what makes genetic engineering (GE) possible. GE refers to the techniques whereby recombinant DNA, that is hybrid DNA made by artificially joining pieces of DNA from different sources, is produced and utilised. Strictly speaking, therefore, novel reproductive technologies, such as those used in the cloning of sheep like Dolly[4], do not involve GE. Instead such techniques involve the manipulation of whole cells or nuclei, rather than the generation of novel DNA as in GE. Reproductive technologies raise important issues beyond the scope of this paper.

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1 D. Nelkin & M.S. Lindee, *The DNA Mystique – the Gene as a Cultural Icon* (W.H. Freeman, Oxford, 1995).
2 S. Jones, *The Language of the Genes* (Flamingo, 1994).
3 E. Russo & D. Cove, *Genetic Engineering – Dreams and Nightmares* (W.H. Freeman, Oxford, 1995).
4 I. Wilmut *et al.*, 'Viable offspring derived from fetal and adult mammalian cells'. *Nature* 385, 810–813 (1997).

All the 'tools' of the genetic engineer are natural products, such as the various enzymes which act like scissors to cut the DNA at precise points and then paste the pieces together again. Recombinant DNA by itself can do nothing unless it is incorporated into a cell to make a protein. To do this the DNA is packaged into a carrier, normally a plasmid or virus, disabled so that it cannot damage the host cell. Thus, GE mimics processes already occurring in the natural world, in which DNA is transferred into new cellular locations.

GE is routinely used in research in thousands of laboratories worldwide. Most manipulations are carried out on cell-lines or bacteria, applications which have raised little ethical controversy. In the human context the handling of GE by the media has often been alarmist and sensationalist, deflecting attention from that small proportion of situations in which the new technology does raise serious and immediate ethical issues. It is these which form the focus of this paper. Safety issues, important as they are, will not be discussed since questions of risk are common to all novel technologies.

A Christian framework for thinking about genetic engineering

Three doctrines are crucial:

The doctrine of Creation reminds us that God, the almighty Creator, is not only distinct from his creation (transcendence), but also actively involved in sustaining it moment by moment (immanence). God made the universe through his Son and it is the Son who now in the present 'sustains all things by his powerful word' (Hebrews 1:2–3). 'All things were created' by Jesus and 'in him all things hold together' in the present (Colossians 1:16–17). Peter wanted his listeners to know that they had 'killed the *author* of life' (Acts 3:15, cf. also John 1:3).

So the DNA which underlies all biological diversity is as much the product of God's authorship as any other of creation's myriad aspects (Genesis 1). The Bible invites us to see God's handiwork in every detail of its biological diversity, whether mundane or exotic (Psalm 104). DNA in God's world is no icon but just one more example of his creative handiwork, demythologised of any mystique that popular culture might wish to bestow. Furthermore, human beings are 'made in God's image' (Genesis 1:26–27), and therefore have a special value independent of the genetic variation which exists between them. The value and special status of humans is reflected in the weighty responsibility that God has given us to care for his creation (Genesis 1:26–28; 2:15), using our God-given gifts to explore his world (Psalm 24:1).

The doctrine of the Fall reminds us of how far the world is from what God intended. The entry of sin into the world has ensured that human earth-keeping will never be fully as God intended, at least not in this present evil age (Genesis 3:16–19). The exploration of God's created order for the good of humankind is one of the joys and privileges of being a scientist, but Christians are acutely aware that human knowledge tarnished with sin can be used for evil purposes. Christians will therefore be suspicious of arrogant or naively optimistic attitudes towards the exploitation of the natural world.

The doctrine of Redemption reminds us that God's plan is not only for the salvation of individuals, but encompasses the whole created order. Why is the creation which has 'been groaning as in the pains of childbirth' waiting 'in eager expectation for the sons of God to be revealed' (Romans 8:19, 22)? Surely one answer to this question is that 'the sons of God', his new family, are being redeemed to become the kind of earth-keepers that God intended. As God's people join in his work of liberating creation from its bondage to decay, so they act as an eschatological signpost pointing forward to the new earth which God is one day going to bring into being (Revelation 21:1). Earth-keeping in the present is only a pilot-project compared to the full redemption which God promises in his new earth, but it is that future full redemption which gives the present pilot-project both its rationale and its hope.

Objections to genetic engineering

The implications of these theological reflections can be illustrated by considering some common objections to GE.

'Genetic engineering is dangerous'

There is no doubt that GE, as with any other technology, has great potential for misuse. Humanistic science has not been immune from arrogance in its utopian ambitions. The history of the eugenics movement provides many unfortunate examples of such human folly. Earlier this century, for example, 30 states in the United States enacted eugenic laws that included directives for compulsory sterilisation. It is therefore vital that the debate about GE remains firmly in the public domain, and that Christians in particular remain active and well-informed in their contributions.

'Genetic engineering is unnatural'

Ironically, in marked contrast to other recent technologies, the 'toolkit' of the genetic engineer is entirely derived from products found naturally within the created order. What people mean by 'natural' often turns out to mean 'what I am personally used to'. Flying, watching TV and car-driving all appeared unnatural at first. Furthermore, 'naturalness' does not necessitate desirability. Pathogenic viruses, bacteria and mosquitoes are all natural but people generally approve of destroying them whenever possible. 'Naturalness' is therefore irrelevant to the ethical debate about GE.

A more substantial argument suggests that we should not change the inviolable *ousia* (essence) or *telos* (goal) of any living organism. Both concepts come directly from Aristotelian philosophy. The GE of female turkeys to make them less broody (so that they lay more eggs), has been attacked by Jeremy Rifkin as 'a serious violation of the intrinsic value of the creature.'[5] The precise definition of this 'essence' or 'goal' is, however, problematic. The domestication of animals and the breeding of new crop strains for food has been going on for many millennia. Is the 'essence' of a species supposed to refer to its original state or its present state? Is the 'essence' of doghood better represented by a Pekinese or by a Great Dane? Both belong to the same species. If 'essence' is taken to refer to the genome of a plant or animal as if a static entity, then this is simply false. DNA is always changing, albeit slowly. In practice the applications of GE are not to change the identity of species but to introduce minor genetic modifications into plants and animals to make them more productive in farming or, as discussed below, to prevent and cure human disease.

'Genetic engineering involves playing God'

The term hubris was used in Greek philosophy to refer to the supposed impiety involved in delving into the realms of the gods[6]. Similar ideas are apparent in some contemporary ecological thinking which views nature as sacred and therefore inviolable. However, the biblical doctrine of creation has demythologised nature of these semi-divine overtones and given humankind a very specific mandate to care for the earth and its biological diversity (Genesis 1:28,30; 2:15–20), a mandate that, if anything, was made even more explicit after the Fall (Genesis 9:1–3).

We are called not to 'play God' but to be responsible stewards of all that God has given us. As Donald MacKay has written: 'In place of the craven fear instilled by a pagan theology of nature ... the Christian who finds scientific talents in his toolbag has quite a different fear – the fear that his Father should judge him guilty of neglecting his stewardly responsibilities by failing to pursue the opportunities for good that may be opened up by the new developments'[7]. We should approach such responsibilities not with the arrogance implicit in the phrase 'playing God', but with prayerful concern that we should be responsible earth-keepers under God.

5 Cited in M.J. Reiss and R. Straughan, *Improving Nature? – The Science and Ethics of Genetic Engineering* (Cambridge University Press, 1996).

6 R. Hooykaas, *Religion and the Rise of Modern Science* (Scottish Academic Press, 1972).

7 D.M. MacKay, *The Open Mind and other essays* (Inter-Varsity Press, 1988).

The applications of GE to farming provide good examples of what such stewardship can involve. About one-third to one-half of all agricultural production worldwide is lost to pests and diseases, and there is enormous scope for GE to render crops resistant to pests, drought and frost, to improve yields and to enable food to be produced in harsh environments[8]. The central Christian concern will be to utilise the new technology to feed a hungry world and to distribute its benefits more equitably.

'Genetic engineering will remove the challenge of suffering'

Some fear that GE will ultimately remove the opportunity for moral growth which the demands of caring for the sick and disabled provides. Such fears, however, are based on an exaggerated view of the scope and potential of GE. The most that GE can achieve is to generate some useful new drugs and remove some lethal genes from human populations. Even if all this were achieved, it would only represent the removal of a drop in the ocean of human suffering. Besides, Jesus did not leave human diseases untouched to preserve the moral benefits that caring for the sick might generate. Rather he drove diseases out as a demonstration of the Kingdom of God (e.g. Matthew 9:35; Luke 9:2, 10:9). We do not know whether any diseases Jesus healed had a genetic basis, but the gospel record certainly provides no basis for genetic fatalism. As members of God's new family we are called to identify with Christ in his work of 'liberating creation from its bondage to decay' (Romans 8:21).

Specific ethical issues in the applications of genetic engineering to humans

This section flags some of the weightier issues arising from the main application of GE to humans – the detection and cure of disease. There are about 5,000 different inborn diseases which are due to genetic mutations. Probably we all carry at least one lethal gene, but fortunately most of our genes come in pairs and usually both members of the pair have to be defective for a disease to develop.

Screening

The earliest immediate practical application of the Human Genome Project is likely to be an increase in the number of tests available for screening defective genes. Mass screening has usually been counterproductive, unless a particular population has a very high prevalence of a defective gene. More usually screening is carried out for families where a risk of genetic disease is already established. Different ethical issues are raised depending on whether screening is prenatal or postnatal.

Prenatal screening of foetuses can involve abortion, a thorny question about which Christians have disagreements. Prenatal screening *per se* does not depend on GE and has been carried out since the 1970s. Typically it is offered to a pregnant mother in cases where both parents are known to be heterozygous ('carriers') for a specific lethal genetic disease. This means that any child born in that family has a 1 in 4 chance of being affected by that disease. Tests are carried out using a tiny sample of cells obtained from the foetus. If the foetus is found to carry the disease then the pregnancy may be terminated. Such terminations comprise less than 3 per cent of the 200,000 abortions performed annually in the UK.

Some Christians are strongly against a liberal policy on abortion and yet believe that termination of pregnancy is preferable to giving birth to a child who, in many cases, will appear normal at birth, but who is then certain to die a slow and painful death within the first decade of life. Such is the outcome, for example, of most lysosomal storage diseases.

In contrast to such 100 per cent certainties, one effect of using DNA tests for prenatal diagnosis will be to increase the number of cases in which percentage risk factors of developing a disease in later life can be estimated. It is this latter class of information which is most fraught with ethical dilemmas. Similar dilemmas are already raised by the availability of prenatal diagnosis for the chromosomal abnormality which leads to Down's syndrome, a condition with unpredictable effects ranging from mild to severe abnormality.

Ethical issues are also raised by preimplantation diagnosis (PD). As with other forms of prenatal diagnosis, this procedure is usually carried out when both parents are known carriers of a lethal disease. PD involves in vitro fertilisation (IVF)[9] followed by growth of the embryo to the stage at which it contains 4–8 cells. One or two cells can then be removed without damaging the embryo, and defective genes identified. Clearly defective embryos are discarded and only the healthy embryo is implanted in the mother. Only a few hundred PDs have been carried out so far, but this number is likely to increase markedly as more DNA tests become available. The procedure has the great advantage that it avoids the need for aborting an affected foetus post-implantation, as required by current prenatal diagnostic procedures. In assessing the ethical implications involved, it should also be kept in mind that more than 80 per cent of all embryos fail to implant following IVF or natural fertilisation. Some of these embryos demonstrate severe chromosomal abnormalities, apparently 'nature's way' of preventing the birth of children carrying genetic defects. It could therefore be argued that in PD, human intervention is merely refining this natural process of viable embryo selection.

Postnatal screening raises rather different issues. Where prevention or treatment of diseases is possible, there seems every reason to proceed. Every baby born in the UK, as in many other countries, is screened for the genetic disease phenylketonuria. If untreated this disease results in severe mental retardation, but once detected is easily prevented by minor dietary adjustments. This is a good example of a genetic outcome being radically altered by a small change of environment. Knowing that defective genes are present can enable affected individuals to change diet and lifestyle in an attempt to counteract their effects.

Where no treatment is available, different issues arise[10]. Receiving general information about the genetic basis for human disease is very different from the momentous implications of hearing that *you* personally carry a defective gene. For example, Huntington's disease develops in people aged 40 to 50. After some years of increasing loss of motor control, death occurs 10–15 years after the first onset of symptoms. A DNA test can now tell a person at risk that they carry the defective gene. Some might conclude that such information is too heavy a load for anyone to bear. However, Christians in particular might view the situation differently from the secular world. Knowledge that one is carrying a lethal gene could enable a choice not to have children and the pursuit of a different career. With professional counselling and support from the Christian community, the prospect of future suffering might accentuate the need to use the years of health even more fruitfully for God's glory. It is surely far better to have a fruitful short life than a fruitless long one, Jesus himself providing us with the perfect example.

As postnatal screening becomes more widespread two urgent ethical issues require attention. Firstly, screening may lead to people having information about their lives about which they can do nothing. Such information may increase stress and may also be misused by others if confidentiality is breached. The right *not* to know one's genetic heritage is as important, perhaps more important, than the right to know. Secondly, screening may create an underclass of carriers of deleterious genes who will become increasingly marginalised from the benefits of society, for example by being unable to obtain mortgages or life insurance. Christians, however, will view all people as having equal value, irrespective of

8 The important applications of GE to farming are beyond the scope of this paper. For a helpful survey see M.J. Reiss and R. Straughan, *Improving Nature? – The Science and Ethics of Genetic Engineering* (Cambridge University Press, 1996).

9 The overall livebirth rate per cycle of IVF treatment is currently 14%. See A. Templeton *et al.*, *Lancet* 348, Nov 23rd, 1402–1406 (1996).

10 See *Genetic Screening: Ethical Issues.* (Nuffield Council on Bioethics, London, 1993). Also P.R. Reilly *et al.*, *Nature Genetics*, 15, 16–20 (1997).

their genetic inheritance, and will press for insurance practices which allow the equitable pooling of risk[11].

Therapy

There are two types of potential genetic therapy: those in which defective genes are replaced, and those in which the goal is to add additional qualities to the individual which lie beyond the normal range of genetic variation currently found within human populations.

Replacement therapies could, in principle, be carried out in either germ-line or somatic cells. Somatic cell replacement therapies have already been used with limited success since 1990, as an experimental approach for treating several genetic diseases. Ethically such procedures are no different from other novel medical technologies.

Germ cell replacement therapies are proscribed and are technically hazardous at present. In principle the therapy could involve, for example, IVF for parents who are known carriers of lethal genes, followed by genetic surgery of a defective 4–8 cell embryo. In practice, however, there would be little point in carrying out such a procedure, since PD would be available. In theory it might seem more acceptable ethically to heal the defective embryo. In practice, however, Christians who take an 'absolutist' view of the value of such very early embryos should realise that their stance may encourage development of the DNA technology for manipulation of human germ-line cells, which could increase social pressure for the use of additive therapies. A futuristic alternative is the screening of sperm and eggs for defective genes prior to fertilisation, followed by IVF using only healthy gametes. Such an advance could eventually make ethical discussions about embryos and abortions redundant.

Additive therapies, whether at the somatic cell or germ-line cell level, are currently technically impossible and are proscribed in the UK, as in other countries. The aim of such procedures would be to add to the individual specific qualities not already encoded by their genome. Additive therapies therefore represent a very different set of goals from those which aim to prevent or cure human disease. Fortunately the human genome is immensely complex and numerous genes interact to generate human capacities in ways that we understand only dimly. There is, as far as we know, no single gene 'for' intelligence, or musical ability or homosexuality. In fact any genetic contribution at all to these and many other facets of human behaviour remains hotly disputed. The complexity of the human genome remains its best protection against doomsday scenarios.

More importantly, the fact that we are now, with our current genetic endowment, made 'in the image of God' (Genesis 1:26–27), defines clear boundaries. Accepting the term 'image of God' to refer to all those qualities which distinguish humans from animals, in particular our spiritual capacity for fellowship with God, the dangers of trying to add to what God has given us become apparent. The builders of the tower of Babel (Genesis 11:1–9) thought that their improved technology would allow them to reach up to heaven using their own human wisdom, but the result was confusion (v.9). The biblical record, not to speak of human history since, makes it clear that human pretensions to self-grandeur invariably end in disaster. It is vital that we do not misuse God's good gift of GE to repeat such mistakes.

Conclusions

The creation of humankind in God's image means that every individual has an absolute value in God's sight which is independent of variations in their genetic heritage. Christians persistently need to draw attention to this fact. GE can make a significant contribution to the prevention and cure of human disease, and to the feeding of a hungry world. If used wisely it can function as yet another signpost pointing forward to the day when God will bring about creation's complete redemption. But, like other human attempts to improve healthcare and nutrition, the applications of GE, important as they may be, will never represent more than a patching-up operation, and are certainly no panacea for all ills.

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11 This complex issue is helpfully discussed in '*Human Genetics – Uncertainties and the Financial Implications Ahead*', a booklet obtainable from The Royal Society, 6 Carlton Terrace, London, SW1Y 5AG.

Next Issue

Beyond rights: A critique of rights language