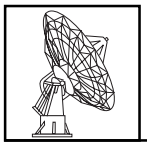

Science

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Cells, genes and the Bible

Alan Fowler

MANKIND'S INCREASING ability to manipulate cells and genes, which are the basic units of God's living world, raises controversial ethical and moral issues. It is proposed in this article to examine these issues in the light of Scripture.

The nucleus of every cell of the human body, with the exception of eggs and sperm, contains forty-six chromosomes arranged in twenty-three matching pairs (Fig. 1). Chromosomes consist of intensely folded strings of DNA (deoxyribonucleic acid), on which are imprinted the 30,000 or so genes that determine the structure and function of the human body. In this way each cell contains a complete genome or set of genes, and therefore each cell contains the code for the formation of the whole body.

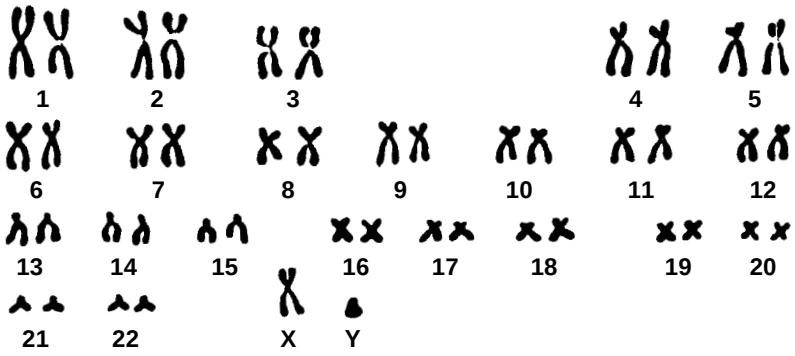

Fig. 1. The forty-six chromosomes in a human male cell

As shown in Figure 2, sperm reach the end of the Fallopian tube within twenty-four hours, and fertilisation takes place there. The fertilised egg divides into two cells, and by repeated divisions a ball of cells is formed, called a morula. This slowly migrates along the tube, reaching the uterus after three or four days.

It then develops a cavity and becomes a blastocyst, which attaches itself to the lining of the uterus. Most of the cells of the blastocyst form the placenta and lining membranes which contain the amniotic fluid in which the embryo and foetus develop. The definitive human being arises from a group of cells on the inner lining of the blastocyst.

Advances in microbiology mean that scientists can manipulate individual cells and locate and manipulate individual genes within cells. We shall examine ethical aspects of four kinds of cell and gene technology:

- embryo selection
- cloning
- gene therapy
- gene modification.

A. Embryo selection

There are about 5,000 genetically linked disorders, but until recently science could only offer genetic counselling, in which prospective parents are advised concerning the degrees of risk to their offspring. Now that scientists can locate the sites of many genetic defects on the chromosomes they can offer prevention or cure by means of embryo selection. But in order to achieve this they need to be able to procure a number of fertilised eggs that can be handled outside the body. This is achieved by the techniques used for in-vitro fertilisation.

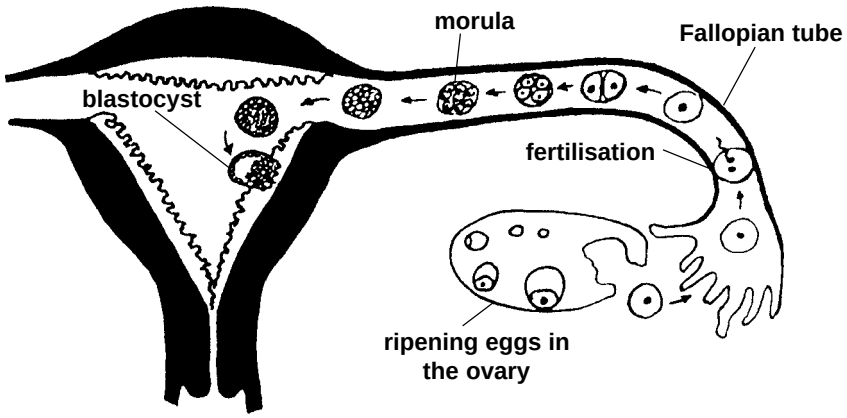

Fig. 2. Fertilisation and implantation

In-vitro fertilisation (IVF)

Normally the human ovaries produce one egg per cycle, but by injecting hormones the ovaries can be induced to produce a large number of eggs. These are collected through the uterus and transferred to a glass vessel, where they are fertilised by mixing with sperm. The fertilised eggs are incubated until they have developed into balls of cells (morulae). Up to three of these morulae are then inserted into the uterus, and there is a thirty-per-cent chance that a pregnancy will result. However, if IVF is being used for embryo selection then the morulae will need to be examined before being implanted into the uterus.

There are three types of embryo selection: preventative, therapeutic and eugenic. As we shall see, the first two aim to treat disease whereas the third aims to modify normality.

Preventative embryo selection

In most inherited diseases some of the conceptuses (fertilised eggs) will be healthy. A cell from each morula is examined for the genetic defect and one or two healthy morulae are implanted into the uterus. In this way it should be possible to prevent disorders such as haemophilia, cystic fibrosis, thalassaemia and muscular dystrophy being transferred to the next generation.

With regard to the ethics of this procedure, there appears to be no objection to the use of man's God-given talents to achieve the conception of a normal child in preference to a disabled one. Indeed, it could be argued that there is a moral obligation for those at high risk of passing on hereditary disorders to use available techniques of embryo selection.

Against this view it is argued that, when Moses pleaded that he was not eloquent enough to lead Israel out of Egypt, God replied: "Who has made man's mouth? Who makes him dumb, or deaf, or seeing, or blind? Is it not I, the LORD?" (Ex. 4:11, RSV). Does this mean that all cases of congenital deafness or blindness are God's will, and that we should do nothing to prevent these disabilities—for example, refraining from having our daughters vaccinated against rubella? Surely this declaration is telling Moses that God is all-powerful. And in the next verse God shows this by promising Moses that He will remedy the problem.

Therapeutic embryo selection

IVF can also be used for another kind of embryo selection in which morulae are screened, as described above, and a healthy morula is chosen in order to produce a baby to treat a sibling who has a genetic defect or life-threatening illness. The chosen embryo is implanted in the uterus and suitable stem cells can later be obtained from the umbilical cord at the birth of the donor baby. Stem cells are undifferentiated cells with the potential to divide into many types of specialised cells. With appropriate stimulation the stem cells may be induced to develop into the cells which are absent or diseased in the sibling.

Ethical objections to the conception of a baby to provide benefits to a sibling are based on the notion that the procedure violates the 'autonomy' of the baby and that it treats the baby as a commodity. But surely these somewhat pedantic objections are outweighed by the fact that both the donor baby and the recipient of its cells would

be able to lead healthy lives. Is not this a case where the end justifies the means?

Eugenic embryo selection

A third type of embryo selection involves its use in healthy people. IVF combined with genetic selection could be used to provide a wide variety of preferences, such as sex, eye colour and intelligence. If scientists can locate a gene for any characteristic then they can select an embryo with that characteristic. This opens up the possibility of attempts to produce 'designer babies' or a master race. Bearing in mind the essential selfishness of human nature, this is a frightening prospect. There are therefore powerful reasons for placing an embargo on any attempt to make man in his own imagination.

B. Cloning

Cloning (from the Greek *klōn*, plant cutting) is asexual reproduction. Since every cell in a body contains the genetic code for the whole body, it is possible to build a body from a single cell. This is done by removing the nucleus from an ovum, and replacing it with the nucleus of a body cell. With appropriate stimulation the egg behaves as if it had been fertilised and starts developing as an embryo. By inserting cloned embryos into the uterus, scientists have succeeded in producing cloned sheep, pigs and cats. But our interest lies in human cloning, of which there are two kinds, therapeutic (tissue) cloning and reproductive (adult) cloning.

Therapeutic (tissue) cloning

This is used to obtain tissue to replace diseased or damaged tissue. For example, it is possible to grow nervous tissue that might be used to repair a damaged brain or spinal cord. As with animal cloning, a cloned embryo is formed, but in this case it is only allowed to grow into a morula with eight to sixteen cells. It is then sacrificed and used as a source of stem cells from which various kinds of tissue cells can be developed.

Because the tissue is obtained from the patient's own nucleus, it has the advantage that it will not be rejected by the patient. Although human tissue cloning is outlawed in some countries, there appears to be no ethical problem in allowing a patient to provide a cell to cure himself, although in the process a *potential* human body is formed.

Reproductive (adult) cloning

Regrettably, scientists are not content to use cloning only to procure matching stem cells, but continue to speculate on the possibility of cloning humans. Cloning creates an 'identical twin', which is an almost exact copy[1] of the body of the donor of the nucleus. It might be possible to use cloning to provide a child for a childless couple, or even for a single woman. So if a cell nucleus from a sterile husband were inserted into an egg from his wife, their child would be an 'identical twin' of his father. And in the case of a single woman cloning herself, her daughter would be the 'identical twin' of her mother.

Such bizarre relationships are entirely out of step with the created order, and a cloned child would be likely to have serious identity problems. Furthermore, experience with animals suggests that cloned humans would be likely to have serious defects, and, having been derived from adult genes, they would suffer from premature ageing.

Can a person be cloned?

It is commonly believed that human cloning would produce two almost identical people. In fact it would only produce two almost identical bodies of different ages. Scientists cannot clone the character of a 'loved one' because genes carry no moral qualities.[2] Genes carry nothing of what we have learnt from our environment—our upbringing, education and experience. They carry nothing of the characters we have forged by the exercise of our free will. God alone can recreate a person; that is the miracle of the resurrection.

Genes, environment and free will

What roles do genes, environment and free will play in shaping our characters? They are complementary. Our bodies and brains (as distinct from our minds) are determined by our genes. Bodies vary in size, strength and agility, and brains vary in capacity and ability in, for example, mathematics, music or art. The extent to which we develop our inborn talents depends considerably on environmental factors, such as

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1. The slight differences arise from the presence of a few genes located on small particles called mitochondria, which are within the egg but outside the nucleus.
2. If there were genes for altruism and criminality then how could we be responsible for our lives at the Judgement Seat?

parental instruction, discipline, education and moral guidance.

And because we are humans, we have a crucially important third factor that controls our development, namely, free will. Free will gives us the capacity to control our genetically driven instincts and to influence the effects of our environment. It is the exercise of our free will that makes us who we are; without free will we would be powerless victims of our genes and upbringing. These facts provide a basis for further consideration of the ethics of cell and embryo technology.

Are embryos sacred?

The uses of IVF for infertility, embryo selection and therapeutic cloning all involve the loss of embryos that would have the potential to grow into adults. So a more fundamental ethical question is whether scientists are justified in sacrificing potential human beings in the process of helping living people. An obvious answer is that these embryos would not have existed apart from totally unnatural interventions, and that both the unwanted and the sacrificed embryos are lost at the morula stage of development when there is only a very small pinhead-sized ball of undifferentiated cells with no recognisable structure. Nor is there a pregnancy, because the uterus is empty. Moreover, nature itself discards innumerable embryos; in women trying to conceive, about a quarter of conceptuses are spontaneously lost in either observed or missed abortions, and less than half of spontaneously aborted foetuses have serious abnormalities. However, these arguments do not satisfy those who believe that all human life is sacred from the moment of conception.

The Bible does not address this question directly, but it does make powerful statements on the value of human life. The Bible tells us that Adam was made *in the image of God*, which must include the potential to acquire and nurture Divine attributes. However, nowhere in the Bible are we told that human bodies or parts are sacred. The Bible equivalent is the word 'holy', which means 'set apart' or 'separate'. Separateness is not inborn, it is acquired by the exercise of free will, which enables us to rise above our genetically determined animal instincts. It is a universal conceit that man is intrinsically good and possesses an immortal soul. The unpalatable truth is that without God we perish like the animals—a truth forcibly expressed in Psalm 49: "Man that is in honour, and understandeth not, is like the beasts that perish" (v. 20). So from God's perspective the sacredness of human beings is conditional, but from our point of view all human beings are *potentially* sacred.

C. Gene therapy

So far we have been considering the manipulation of cells. But scientists can now manipulate individual genes. A specific gene can be extracted from a cell by cutting out the piece of the string of DNA in which it is located. This gene can then be used for therapy. For example, genes which code for the production of insulin, blood-clotting factors or growth hormone are inserted into yeasts, fungi or bacteria. These are then cultivated in fermentation tanks, where they produce the specific substances needed to treat diabetes, haemophilia or growth retardation respectively.

These techniques provide huge benefits. For instance, engineered human insulin has a number of advantages over insulin produced from pigs,[3] and haemophiliacs are no longer subject to life-threatening viral infections due to receiving clotting factors extracted from human blood.

Another type of gene therapy involves *replacing* a missing or defective gene. For example, babies born with immune deficiency can have the gene implanted into their defective lymph cells. This is achieved by inserting the gene into a harmless virus, which, like other viruses, has the ability to penetrate cells. The virus carrying the gene is mixed with the patient's bone marrow stem cells, which will then produce lymph cells containing the gene. In this way a single treatment may be curative and life saving.

D. Gene modification

Genetic modification involves grafting a foreign gene into a *normal* genome. This is widely practised in agriculture, as when genes from plants with resistance to pests, herbicides, drought, salinity or frost damage are inserted into food crops. But although these interventions increase yields, and although there is no apparent harm from eating genetically modified foods, we do not

3. The worldwide need for insulin today is so great that it would require the pancreases from more than 500 million pigs annually.

know the long-term effects on the environment. Since creation is in balance, there are powerful *a priori* reasons for believing that making such fundamental changes may cause serious imbalances comparable to the disastrous effects of introducing rabbits into Australia, gorse into New Zealand (for sheep-proof hedging), Japanese knotweed into Britain (for decoration!) and allowing mink to escape into our waterways.

There is a scientific consensus that attempts to alter the normal human genome would be hazardous and should be banned, and for those who believe that man was created in the image of God there are powerful ethical reasons against tinkering with the units of God's creation.[4] If we are 'fearfully and wonderfully made' then any interference with our design is likely to be harmful. But why should scientists treat plants and animals differently from men?

Fortunately there is an alternative strategy for improving crop and livestock yields, namely selective breeding—the method used by Jacob to improve his flocks (Gen. 31:1-12). Selective breeding uses naturally occurring genetic variations as the source of improvements, and, although much slower, this has resulted in the remarkable and beneficial changes which are evident when we compare modern fruits, vegetables and grains with the wild varieties. So why is mankind not content to continue working with nature in this way? But as with all human endeavours, selective breeding has been abused, resulting in freak dogs, grossly disabled 'double-breasted' turkeys, and cows with huge udders causing bow legs. We need to remind ourselves constantly that "A righteous man has regard for the life of his beast" (Prov. 12:10, RSV).

Conclusion

We may marvel at the complexity of cell and gene technology and the depth of knowledge involved, but it should be borne in mind that nothing is being created; scientists are merely rearranging the building blocks of God's creation. A single cell is staggering in its complexity, and man is no nearer to creating life than he was a century ago. Inevitably there will be differences of opinion on the ethics of some aspects of cell and gene technology. On these issues the Apostle Paul would have probably written, "Let every one be fully convinced in his own mind" (Rom. 14:5, RSV).

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4. In Leviticus 19:19 we read: "Thou shalt not let thy cattle gender with a diverse kind". Although this prohibition relates to crossing different animals, it resonates with our suggestion that genetic modification is a bridge too far.