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Engineering Life: Ethics and Genetic Engineering

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In debating the ethics of genetic engineering it is essential to develop an appropriate ethical framework for the discussion. This will demand a major shift away from the almost exclusively human or homocentric focus which has been so pervasive in the Western ethics and wider cultural tradition for almost two thousand years.

Since the 16th century the writings of scientists like Francis Bacon, Rene Descartes and Isaac Newton and philosophers like Hobbes, Locke and Jeremy Bentham have further fuelled this human-centred focus. They viewed science, and its handmaiden technology as tool which allowed human beings to dominate and manipulate the earth in whatever way they saw fit in order to secure human well-being and betterment.

The sad irony is that human technology has wrecked havoc on the planet and, even today, threatens the future of many life forms including humankind. This, in turn, is challenging the capacity of our anthropocentric Western ethical norms to address these vital contemporary moral issues, especially in the area of ecology.

Any adequate ethical framework for dealing with genetic engineering must be based on our contemporary understanding of the relationship between humans and the rest of the natural world. Our evolutionary history makes it very clear that humans are not separate from the rest of nature. Rather we are an integral part of the community of living beings and non-living reality. Each of us depends on the well-being of the whole and so we have to have respect for the community of living beings, for people, animal, plants and for the preservation of earth, water and soils.

Fr. Thomas Berry, an American priest who has reflected on ecological issues for decades writes that contemporary ethics must focus its concerns on the larger community of the living. He states that "the human community is subordinate to the ecological community. The ecological imperative is not derivative from human ethics. Human ethics is derivative from the ecological imperative. The basis ethical norm is the well-being of the comprehensive community, not the well-being of the human community. The earth is a single ethical system, as the universe is a single ethical system. (_). This is the first principle of an ecological ethic. Such an ethic would demand a legal framework where the rights of the geological and biological as well as the human component or the earth community are protected.

Genetics

Before examining the ethical issues involved in genetic engineering it might help to briefly, and in a very simplified way outline what is involved. Genetic engineering is a by-product of the relatively young science of genetics. The science emerged out of the pioneering work of the Austrian, Augustinian priest, Gregory Mendel. In a paper published in 1865 he developed his theory of organic inheritance from his work on the hybridisation of green peas. Unfortunately, his work remained unrecognised until the early 1900s. By the 1920s genetics was being used to help plant breeders improved their crops.

Genetics took another leap forward in the 1950s when two young scientists, James Watson and Francis Crick, discovered the physical make up of DNA (deoxyribonucleic acid), the fundamental molecule of life. They discovered that the DNA structure was a double helix. The two strands were twisted around each other like a spiral staircase with bars extending across the connecting strands. These units composed of four different chemical nucleotides arrange themselves in an endless variety of patterns that form the genes. It is the precise ordering of the chemical base in the DNA molecule which makes each life for unique. Simple life forms like bacteria are composed of a few hundred genes. A more complex organism, like the human body, is composed of more than 100,000 genes.* In the light of Watson's and Crick's discovery, biologists began to realise that by changing the ordering pattern of the genetic material they could change or modify life forms.

But this discovery, through crucial, was not sufficient to enable scientists to cut up, delete, or recombine genes. They needed tools to cut the genes and, once cut, they required a suitable mode of conveyance or a vector to insert the genetic material into another organism. The cutting tools were discovered in a group of enzymes which are called "restriction enzymes". They have the ability as part of their defence mechanism to splice up DNA. In 1973 Drs. Stanley Cohen and Annie Chang inserted genes from a South African clawed toad into a bacterium -e-coli. When the e-coli reproduced themselves they also reproduced the toad gene that had been inserted into the bacteria. Today plants and animals with genes taken from completely unrelated species are being engineered in the laboratories of biotechnology companies and

released into the environment.

Much of the moral debate in this area concentrates on the impact of genetic engineering on human beings . But the ethical issues involved are much wider. For example a report commissioned by the Marine Institute of Ireland discusses "the nature and current status of transgenetic salmon". The document states that as a result of introducing growth hormone genes into a wild North Atlantic salmon the transgenetic fish grows rapidly and reaches enormous size. Studies show that within a period of 14 months the transgenetic salmon can weigh 37 time more than the ordinary salmon. This increase probably will deliver huge economic benefits to salmon producers. The cost to the salmon is horrendous. In its technical and unemotive language the report notes that the experiment produces "profound morphological abnormalities" in the transgenetic salmon. "These included a "disproportionate growth of the head and operculum cartilage, disimproving appearance and leading ultimately to respiratory problems" (_).

There are many other current examples of such experiments in the food and pharmaceutical industry. These include extending the shelf life of tomatoes in the genetically engineered Flavor Savor tomato; creating leaner and more cost effective pork though the genetically engineered pigs even though the pigs experienced extensive arthritis. On the medical side genetic engineering has created the first patented mammal, called the Onco-Mouse. This creature was genetically engineered with a human gene to express cancer in the mammary gland. New organisms are coming on the market on a daily basis. The biotechnology industry promotes this new enterprise by pointing to the benefits it will bring to human beings in the area of food production and health care. They also, of course, are poised to make huge profits as biotechnology prospers and replaces other more traditional technologies in agriculture and medicine.

In a single year the giant agribusiness Monsanto invested $750 million buying up a dozen biotech companies in order to gain control of their research patents. Naturally they are anxious to see genetically engineered products on the market as soon as possible so as to recoup their investment. Having put all their eggs in the biotechnology basket, they would face serious financial difficulties if the biotechnology venture slowed down or failed (_). Shares would tumble on the stock market.

Most of the discussion about genetic engineering centres on health, financial and legal matters. Very few people raise the fundamental moral questions involved in creating genetically engineered organisms. Do human beings have the right to interfere in such an intrusive way by introducing exogenous DNA into the genome of another species ?

Viewed through an exclusively anthropocentric moral framework the answer is probably, yes. Charles McCarthy an ethicist with the Kennedy Institute for Bioethics at Georgetown University in Washington D.C. writes that " In a utilitarian context, efficiency in food production and ability to compete for world markets stand as high values which must be weighed against our recognized obligations to provide for the interests of the animals" (_).

The ethicist James A. Nash, whose ethical horizons go beyond the anthropocentic boundary, disagrees. He argues that, since in the Christian tradition other species are deemed to have intrinsic value, the creation of transgenetic species should "not be the norm but the rare exception on which the burden of proof rests. The genetic reconstruction of some species may be justified for compelling human needs in medicine, agriculture or ecological repairs (e.g. oil eating microbes), so long as it can be reasonably tested and verified that tolerable alternatives are not available, genetic diversity is not compromised and ecosystemic integrity is not endangered" (_). In the light of this principle it would be impossible to justify the experiment on the genetically engineered salmon and many of the other genetically engineered foods which are presently being vigorously promoted by the biotechnology industry today.

The dangers which are posed by the tidal wave of biotechnological activity are real. At a meeting in Asilomar in 1975 a group of scientists drawn from the Committee on Recombinant DNA of the US National Academy of Sciences, which included the Nobel Prize winner James Watson warned about the dangers of genetic engineering. They stated that "there is serious concern that some of these artificially recombinant DNA molecules could prove biologically hazardous" (_).

DO
HUMAN BEINGS HAVE THE RIGHT TO INTERFERE IN SUCH AN INTRUSIVE WAY...?

Almost 20 years later an international group of scientists meeting in Malaysia in July 1994 called attention to the scientific flaws inherent in the genetic engineering paradigm. According to them genetic engineering is based on the false premise that a each specific feature of an organism is encoded in one or a few specific, stable genes and that the transfer of these genes results in the transfer of these discrete features. These scientists reject this extreme form of genetic reductionism. They point out that the development of any trait results from many complex interactions between genes and their cellular, extracellular and external environment. They insist that it is impossible to predict the consequences of transferring a gene from one type of organism to another in a significant number of cases. Furthermore, genetically modified organisms especially micro-organisms may migrate, mutate and be transferred to other organisms and species. In some cases the stability of affected organisms and ecosystems could be affected and threatened (_).

There are also recognisable health risks. People with allergies will not be able to protect themselves, especially if the genetically engineered foods have not been labelled as such. The corporations are loath to have genetically engineered products labelled because they know that most people would avoid buying them even when the natural product is more expensive. The allergenic effect can be carried in a number of ways, either with

the transgene or it might be stimulated by the imbalance induced in the chemistry of the host plant or organism.

Proponents of genetic engineering claim that all the experiments are closely monitored and that the risks are minimal. In reality the monitoring period is usually very short, whereas it might take years before a significant problems comes to light. It took decades for scientists to become aware of the carcinogenic effect of DDT. Studies by Professor Sukopp at the University of Berlin demonstrate that the full impact of introducing new plants into an ecosystem can have a delay period of between 5 and 100 years. The need for extensive testing is vital given the milieu of technological triumphalism allied to the search for corporate profits which has gripped the biological enterprise in recent years. Writing recently in the New Scientist (_) Phyllida Brown states that " America's health officials are under attack for allowing animals organs to be transplanted into humans, despite mounting evidence that they may bring viruses with them". This criticism comes after two teams of researchers found that pigs -the most promising source of organs for transplant- carry a virus that can infect human cells. Although the researchers have told the US Food and Drug Administration of their concerns, the FDA continues to allow transplants to take place. As a result Jon Allan a virologist at the South west Foundation for Biomedical Research in San Antonio, Texas has called for a ban on such transplants.

Precautionary Principle

Given that these risks are potentially so destructive, research and production of genetically engineered organisms ought to be governed by the precautionary principle. This asserts that an action which is risky and could possibly cause widespread and irreversible damage should not be pursued, especially when there is lack of full scientific certainty about the outcome of the action on the organism itself and the wider environment.

For example, ruminant animals, like cattle, produce enzymes in their gut which break down cellulose plants into basic sugar components which are then assimilated by the animal. Now biotechnologists at Newcastle University in Britain are experimenting with introducing cellulase genes directly into non-ruminant animals, like pigs and chickens. Their aim is to produce the "grazing" pig. Whether this would be good for the pigs, given that the rest of their physiology does not suit grazing behaviour, or for the soil structure is not at all clear. The presumption based on present knowledge is that it would not, and therefore the precautionary principle ought to be invoked.

Biopiracy

Furthermore, the present scramble by biotechnology corporations to manufacture pharmaceutical and agricultural products raises questions about where the genetic raw material is coming from and whether the communities in these areas are properly compensated for protecting biodiversity for countless generations. Much of the raw material comes from medicinal and food plants in Third World countries. In recent years biotechnology companies have been collecting this material, patenting their products and in the process making huge profits. Very little cash trickles back to the Third World communities where the genetic material was discovered. The knowledge, innovation and efforts of these communities is neither acknowledged or rewarded. Consequently many Third World people charge the biotechnology corporations with biopiracy. International agreements ought to drawn up to ensure that communities are properly consulted by biotechnology companies who are prospecting in their area and properly compensated by corporations that use genetic material found in their areas.

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Genetically engineered crops could devastate Third World Agriculture

Finally, there is the concern that genetically engineered crops will displace crops grown naturally by farmers in Third World countries and in the process disrupt the life of millions of poor people. In the US two biotechnology companies have produced vanilla from plant cell cultures in laboratories. The price of naturally produced vanilla is about $1,200 per pound. The biotechnology companies estimate that they can commercially produce genetically engineered vanilla for about £25 per pound. Such a development would wipe out the livelihood of about 100,000 farmers in Third World countries. 70,000 alone live in Madagascar. A development like this would constitute a economic disaster for a country where biodiversity is already under severe strain. Similar research is under way to genetically engineer crops which are crucial to Third World economies. These include coffee, tobacco, cocoa, coconut, palm oil, sugar and ginseng. Genetically engineered varieties may thrive in temperate zones and thus ravage many Third World economies which are dependent on one or other of these commodities and have no fall-back industries capable of absorbing their redundant farmers.

There are other worrying trends as more and more genetic tests become available. Close to 50 have been identified in recent years. The promotion of the ideology that our future health is exclusively locked in our genes will have undesirable consequences unless these tests are strictly monitored and the results kept absolutely confidential. We will find employers insisting that their employees subject themselves to genetic testing. Insurance companies and health providers will seek to test patients. College officials will want to test students. And those on the margins of society - the poor, migrants, prisoners and welfare recipients will be subjected to tests. This is not just the fear of the brave new Orwellian World, it is already happening.

In the United States a pregnant woman whose foetus tested positive for cystic fibrosis was told by her health maintenance organisation

that it would fund an abortion but not cover future medical costs for the child if the mother refused an abortion.

A healthy woman whose father had been diagnosed as having Huntingtons's disease was refused health insurance. The parents of a healthy young who was discovered to have a gene predisposing him to a heart disorder were unable to include the young boy on their insurance policy (_).

Given all the difficulties at present associated with genetically engineered organisms I feel that there is good reason to insist on a moratorium on the deliberate release on genetically engineered organisms until the risks are much clearly understood and there is a thorough public discussion of all the issues involved. This was more or less the conclusion reached by the Union of Concerned Scientists in Washington in their 1993 report on genetic engineering entitled "Perils Amidst the Promise". They concluded that no company should be permitted to commercialise a transgenetic crop in the United States until a strong government programme is in place that assures risk assessment and control of all transgenetic crops, and gives adequate consideration to centres of crop diversity in the US and elsewhere in the world. Austria has also imposed a two year moratorium on field trials of genetically engineered organisms.

This request for caution seems eminently reasonable given the fact that issues are so serious and the dangers of getting it wrong are so great. A car manufacturer can recall a faulty batch of vehicles and repair or place them. Not so with organic life. As humans have learned from bitter experience, it is impossible to recall the African Killer Bee. This was released accidentally into the wild in Brazil in the late 1950s and has now spread through out South and Central America and is moving north in the United States with devastating results for the environment and people.

Such dramatic failures by scientists themselves should foster caution. The experiment with the bees was carried out by a noted Brazilian geneticist, Warwick Kerr. Recombinant DNA techniques has delivered enormous power into the hands of a small group of people in the biotechnology corporations where profits often tend to take precedence over everything else. For this reason the public should make sure that a lot more is known about the safety of genetically engineered organisms before any group in society is allowed to begin to tinker in an extensive and impactful way with the building blocks of life.

**Since this article was written, scientists have determined that the number of human genesis actually approximately 30,000.*

Acknowledgment

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