

## The Impact of the Genetic Revolution and its Ethical Significance

- Sarita Nazareth'

*Abstract: Genetic engineering (GE), has taken the centre-stage of research for almost half-century and has made itself felt not only in the field of industry and environment, but very particularly in that of medicine and life. GE has been performed with microorganisms, plants, animals and – the Human system! Genetic engineering technologies have given tremendous benefits. Still the author cautions the need to remind ourselves of the ethical consequences of such research. We need to be careful of our desire to be gods. Without belittling or disparaging genetic research, the author hopes that our efforts and resources were spent on enhancing the life situation of all peoples in the basic essentials of life: food, water, shelter, education, employment, health, before we can think of scaling the heavens! She reminds us that great achievements have been accomplished and great disasters have been caused alike by humankind. The human person has the capacity to make or to break. The final plea of the author is: So then let us choose LIFE that we may LIVE.*

- Editor

*Key Words: Transgenics, Genetic engineering, cloning, DNA, In vitro fertilization, Human genome project, Amniocentesis, Human-animal chimera, Senescence, Ethics.*

### Introduction

The genetic revolution has taken the world by storm and has revolutionised the thinking and expectations of not only the scientific community but also of the entire world. The field of genetic engineering has been a great boon to humankind in various fields of industry,

agriculture and medicine, but has also posed grave ethical concerns, particularly in the matter of human cloning. Genetic engineering (GE), has taken the centre-stage of research for almost half-century and has made itself felt not only in the field of industry and environment, but very particularly in that of medicine and life. GE has been performed with microorganisms, plants, animals and – the Human system! Gene manipulation which is a method designed to change the genetic information of a cell / an organism by deliberate, controlled manipulation of the genes in the organism - which is made possible even *across species barriers* that cannot be done by conventional breeding - with the intent of making that organism better in some way, extends itself to the process of transgenics and cloning.

## **Transgenics**

**Transgenics** involves the creation of a transgenic organism, sometimes called a chimera, that contains a transgene (that is, a combination of genes from different organisms) introduced by technological methods rather than through selective breeding, which can now express a novel trait not normally found in the species. The process involves the isolation of the gene of interest from the tens of thousands of other genes in the genome of a donor species. Once that gene is isolated, it is usually altered so it can function effectively in a host organism. That gene is then combined with other genes to prepare it to be introduced into another organism, to give a transgene. These can include plant-animal-human / animal-animal / animal-human combinations.

**Cloning** may be defined as a technology that will:

- produce multiple, exact copies of a gene or segment of DNA, using specialized DNA technology, to obtain enough material for further analysis.
- produce a lineage of cells each containing one kind of DNA fragment of interest derived from a population
- produce genetically identical animals such as the famous Scottish sheep, Dolly

## **Genetic Revolution vis-à-vis Religious Beliefs**

The following discussion on the genetic revolution vis-à-vis religious beliefs and ethical concerns is based on the basic religious doctrine / truth, that the human person is created in love, to love and to be loved; we are therefore called to respect and uphold and promote the dignity of every human person and the whole of creation, rendering it in a thanksgiving offering back to the Creator. All basic research has its value if the discoveries made are applied for the betterment of human existence, within the limits of ethics and respect for human life and the whole of creation at large. A previous article dealt with the benefits and ethical concerns of gene manipulations in food, agriculture and environment. The following presentation deals with the area of medicine and human life.

Genetic engineering technologies have given tremendous benefits. Besides the use of DNA analysis in the food industry in the assessment of the quality and potential hazards in the food industry such as to detect/ identify pathogens, by techniques involving amplification of minute amounts of DNA, further enzymatic treatment and observation of DNA patterns obtained. This DNA “fingerprinting” has been of extremely great importance in circumstances of crime and justice, for example in providing evidence:

- For acquittal of those unjustly imprisoned or sentenced to death for lack of evidence.
- To convict the criminal as in cases of sexual molestation and / or homicide
- In determination of paternity specially in cases of settlement / custody claims

It has also gained tremendous importance in the detection of genetic defects in embryonic cells as shall be seen below.

One of the prominent examples of GE in medicine is the production of human hormone insulin; the gene for insulin is inserted into the microroganism *E. coli* which can then be produced in a short span of time and in greater amount proportionate to the rapid growth and

multiplication of the microorganism. Therefore today, insulin produced by genetic engineering is much more freely available, and costs have come down. The gene for insulin has also already been successfully cloned into the guinea-pig to synthesize insulin in the absence of natural insulin production. It is now left to be seen whether this can be reproduced in humans. Similarly, plant cells have been genetically engineered to produce the cancer drugs vincristine and vinblastine, the natural products of the periwinkle flower.<sup>2</sup>

The plant–animal–human **transgenic combination** in the production of a potential vaccine against non-Hodgkin's lymphoma uses the DNA of the mouse and human tumor fragments inserted into tobacco DNA which then produces the desired protein.<sup>3</sup> Other transgenic plants have been used to create edible vaccines. By incorporating a human protein into lettuce, bananas, potatoes, and tomatoes, researchers have been able to create prototypes of edible vaccines against hepatitis B, cholera, and diarrhoea.<sup>4</sup> The vaccines are proving to be successful in tests on animals and humans. Another example of a human-animal chimera that is widely accepted is the routine replacement of faulty human heart valves with ones taken from cows and pigs.<sup>5</sup>

***In vitro* fertilisation (IVF)** is another technique which has been advanced by gene manipulation. IVF in itself appears to have offered hope to many childless couples and now even to unisex unions! And now, in a new IVF technique, women advanced in age have hope. When the normal means of IVF fail because the mitochondria of the ova mutate and become sterile, in an alternative to using donor ova, researchers have "reinvigorated" the prospective mother's ova but left intact the mother's genes, so that fertilization is made possible.

However the process of IVF<sup>6</sup> which involves a drug-induced superovulation, each egg having its own separate risk for inheriting the gene, collection of these ova which has a 40% success rate, an *in vitro* fertilization, followed by two to four of these embryos being then implanted in the womb, has a mere 17% success rate, the **difficulty being not in getting fertilisation to occur, but rather in getting the transferred embryos to implant in the uterus and result in a pregnancy.** The rest of the embryos are discarded or frozen!

## Human Genome Project and Stem Cell Research

Human gene manipulation has received a boost with the completion of the **Human Genome Project (HGP)** which has succeeded in unfolding the genetic base sequence of the 23 chromosomes. The location of specific genes responsible for individuals and varied reactions in the body will hold forth immense scope for treatment of diseases and perhaps even more importantly for prevention of diseases. The HGP will greatly enhance the outcome of genetic engineering techniques involving **amniocentesis** and of **pre-implantation genetic determination (PGD)** linked with IVF, used for determination of genetic defects and / or sex.<sup>7</sup>

Amniocentesis is done on a floating cell in the amniotic fluid withdrawn. PGD, as the name suggests, is done on an IVF embryo prior to implantation in the womb. Genetic determination will help identify the presence of any aberration on specific genes on the chromosome which will indicate the existence of inborn errors of metabolism such as haemophilia, sickle cell anaemia, xeroderma pigmentosum, and many others. It can also indicate the predisposition of individuals to certain diseases or illnesses such as cancers. Reports indicate that the gene responsible for inherited colon cancers have been located on chromosome 2.<sup>8</sup> One can also conceptualise a means of prevention and therapeutic remedies to specific illnesses. A genetic aberration could conceivably be modified with the correct sequences, so as to nullify the undesired mutation. This is a great challenge ahead which will provide tremendous opportunities in the field of health and medicine.

However, the painful truth is that genetic determinations which offer great hope, are also fraught with many ethical problems, and are being done so as to eliminate the “imperfect” embryos. In its entirety, the process involves

- i) The discarding of surplus embryos in the case of IVF procedures,
- ii) The consequent destruction of unwanted “defective” embryos, including those that might never have manifested the disease because of the presence of allelic genetic variations, ignoring the fact that the ‘perfect’ embryos can acquire genetic mutations and

defects as all cells, and that culturing of IVF embryos is done in the presence of nonhuman serum which could therefore pose health risks.

- iii) The destruction of the unwanted fetus in the case of amniocentesis methods.

And till such time that remedies will be available for the treatment of inherited and / or life threatening genetic disorders, the detection of these in individuals could pose a serious problem. While on the one hand, the finding that one has a serious genetic defect, for instance xeroderma pigmentosum or haemophilia, one can prepare oneself and take every precaution to avoid life threatening situations; on the other hand, it could have serious adverse repercussions: (i) This discovery made in the fetal stage gives to most people the one obvious option to abort the life within. (ii) It could create a psychological trauma of anxiety, insecurity and fear even prior to the development of the illness itself which could in fact also aggravate the potential to develop the disease such as cancer, or Parkinsonism, or Alzheimer's disease.

One can consider all this research good if it does not involve the killing of life in the embryo. We might ask: what makes it permissible to take the life of an innocent, helpless unborn through discarding the embryo in IVF or killing of the fetus through abortion when euthanasia is perceived as unacceptable, a suicide is made a police case, and a homicide or murder is punishable by law! Are these not all concerned with taking of life either by oneself or by another? But yet the murder of an unborn child is not on the list of crimes punishable by law! It is in fact protected and lauded by the scientific world and by society!

And now, stem cell research<sup>9</sup> for the cloning of humans and of their organs is the "in" topic! Stem cells, the primitive cells which first appear in the yolk sac of the developing embryo, then in the fetal liver, and after birth in the bone marrow, are self renewing and have an inherent capacity to differentiate and to develop into specialised cells or multiple tissue types. Differentiation is triggered by signals: interiorly, from the cells' genetic structure; externally, from the environment, by chemicals secreted by other cells and by physical contact of neighbouring cells.

Stem cells can be extracted from very young embryos, and from adult bone marrow, but also from umbilical cords and placentas. Extraction from the embryo is more difficult and yields are less. It has also been generally believed that embryonic stem cells have greater potential for differentiation. However, researchers have proved that adult stem cells are well capable of differentiation, and research has been going on to study the factors triggering this differentiation. Risk factors of cell cultures and non-human growth substances used in the process demand serious attention. If therefore there exists an alternative to the use of embryonic stem cells (ESC) for medical research, it is clear that there is no need to generate and then destroy life in the embryo for obtaining ESC, even if the use of other sources of ESC may be more painstaking; we will at least not destroy life!

The mixing of human stem cells with embryonic animals to create new species has given cause for serious debate on ethical issues.<sup>10</sup>

<sup>10</sup> Mott, M. (2005). Animal-Human Hybrids Spark Controversy. National Geographic News, January 25. Glenn, L. M. 2004. Ethical issues in genetic engineering and transgenics.

AnActionBioscience.org original article.

Biotechnology: medical biotechnology.

For example, pigs are often chosen as transgenic animals because their physiology and organ size are so similar to humans. The hope is that pig organs can be used for organ transplantation, known as xenotransplantation, alleviating the shortage of human hearts and kidneys

Scientists have begun blurring the line between human and animal by producing hybrid human-animal chimeras. Chinese scientists at the Shanghai Second Medical University in 2003 successfully fused human cells with rabbit eggs. The embryos were reportedly the first human-animal chimeras successfully created. They were allowed to develop for several days in a laboratory dish before the scientists destroyed the embryos to harvest their stem cells. Researchers at the Mayo Clinic, Minnesota, created pigs possessing human blood. And at Stanford University's Institute of Cancer/Stem Cell Biology and Medicine in California, director Weissman has already created mice with brains that are about one percent human, and plans to conduct another experiment

soon where the mice have 100% human brains, by injecting human neurons into the brains of embryonic mice, to see if the structure of a human brain can be formed. If it is formed, he'd look for traces of human cognitive behavior. His hope is that the experiment will lead to a better understanding of how the brain works, which would be useful in treating diseases like Alzheimer's or Parkinson's disease.

Canada has passed the Assisted Human Reproduction Act, which bans chimeras prohibiting transferring a nonhuman cell into a human embryo and putting human cells into a nonhuman embryo. Cynthia Cohen, a member of Canada's Stem Cell Oversight Committee, which oversees research protocols to ensure they are in accordance with the new guidelines, and is also the senior research fellow at Georgetown University's Kennedy Institute of Ethics in Washington, D.C., believes that mixing human and animal gametes (sperms and eggs) or transferring reproductive cells, diminishes human dignity and that "It would deny that there is something distinctive and valuable about human beings that ought to be honored and protected." Weissman, is against a ban in the United States, and opines that "Anybody who puts their own moral guidance in the way of this biomedical science, where they want to impose their will—not just be part of an argument – if that leads to a ban...they are stopping research that would save human lives." Cheshire, associate professor of neurology at the Mayo Clinic, Florida, and a member of Christian Medical and Dental Associations, supports research that combines human and animal cells to study cellular function. But he draws the ethical line on research that would destroy a human embryo to obtain cells, or research that would create an organism that is partly human and partly animal. He says, "We must be cautious not to violate the integrity of humanity or of animal life over which we have a stewardship responsibility."

Some of the ethical issues that emerged on scientific research were:

- What ethical, social, and legal controls or reviews should be placed on such research?
- What are the health risks associated with transgenics?



- Will transgenics facilitate transmission of zoonotic diseases (eg. “mad cow” disease?)
- What are the long-term effects on the environment when transgenics are released in the field?
- Are we inflicting pain on sentient creatures when we create certain types of chimeras?
- Will transgenic interventions in humans create physical or behavioural traits that may or may not be readily distinguished from what is usually perceived to be “human”?
- Will society manipulate the genetic traits of children?
- Will it also increase the widening gap between the “haves” and the “have-nots”?

And in the process of achieving a clone, one must consider the number of “failed attempts” before one hits upon a “chance” success! It took 276 failures before ‘Dolly’ was successfully cloned (15). Is the cloning of a human being to follow suit?!

As for cloning oneself so as to get an identical copy for posterity, one can think again! In the process of cloning, the ovum must be denucleated and the nucleus of the desired ‘Specimen’ must be introduced. However it is possible to remove only 99% of the nucleus. So the resulting progeny cannot be a pure clone of the specimen of choice. This is made more clear when we are aware that there is only 1.6% differences between DNA of chimpanzees and that of humans, and that as little as 0.1% of DNA accounts for the variations or uniqueness between human beings (16). And even should a physical clone be successfully produced, it is highly debatable whether the clone would be a replica of or even resemble the “parent”. We must bear in mind that the social environment plays a very significant role in the development of the human personality, and it is well known that the facial expression is a reflection of the interior soul. And should even this be successful, we shall have clones with no individuality and uniqueness of ones own that is the hallmark of God’s creation. Imagine a race of identical features. We will perhaps need identity marks to distinguish one from another!

And with the human desire for constant change, one might begin to find that the uniformity is a 'bore'! The attempt to play god might just backfire!

At the human level we may well ask: Why clone a human being? It surely cannot be to propagate. We consider that our planet is already overpopulated. Further, parents have no time for their children because they are too busy at work either in pursuing their career, and / or finding fulfillment in their lives, or affording the amenities that good living entails, or simply making both ends meet, with the children often becoming delinquents or misfits and criminals. In fact mothers are getting rid of their unwanted unborn babies either through contraceptive measures or through violent measures during the gestation period, silencing their cry before it can be heard, and especially that of the girl child. Female infanticide has not been uncommon. There will come a time when there will be a serious disproportion in the sex ratio! And this phenomenon will become worse, if clones are to be made mainly of the male species, which can be well expected.

It is also debated that cloning will provide homosexuals an opportunity to have their very own progeny. Who shall be willing to bear the nine-month "burden" for a clone of someone, devoid of her own characteristics, except for financial gains or perhaps "fame"? Will it not be another means of "selling" one's body? One might ask again if the woman must have no self-respect and dignity, and become yet another instance of abuse!

Theologically we believe that the child is the fruit of the deepest expression of the loving union between man and woman as God had ordained it to be. In God's divine plan it was never meant to be a lustful act, and certainly not between members of the same gender! Today the world wants to acclaim the abnormal as normal, the aberrations as wholesomeness, and to reduce the wholesome and the normal to an archaic, obsolete mode of functioning. That is the perversity of our present system!!

Again, theologically speaking, we want to propagate our self, our name, through a 'clone' an identical copy of self. This smacks of a false pride. Mother Teresa will continue to be remembered, not because she

has been cloned, but because she lives on in the hearts and lives of those she touched with her life of humility, simplicity and love. Pope John Paul II will be remembered for his love for all peoples of all ages, and especially for upholding the gift of life and the dignity of the human person.

The unfolding of the human genome has led to the concept of creating an “immortality event”. Human cell cultures continue to divide for upto 50 cell divisions and then die off. Senescence and cell death have been attributed to the accumulation of unrepaired damage in cellular constituents, the increased incidence of gene mutation coupled with a reduced / impaired repair mechanism, accidental errors in translation, which all result in the synthesis of defective or non-functional proteins and enzymes. A further consequence is also the accumulation of toxic free radicals which in turn adversely affect the cell metabolic processes. It has also been found that the chromosome is initially protected from deterioration by the telomere which is a sequence of a simple repeating unit at the end of the chromosome, and the telomerase, an enzyme, which adds the individual repeating base units. Each cell division results in shortening of the telomere until it gets depleted and cell division stops. Research is on to preserve the telomeric sequence, and thus not delay the process of ageing. The mind boggles at the increased burden that will come about in all these aspects when life expectancy is increased when we still cannot prevent major illness; when even the fit and strong are dying of malaria, HIV infections, and the like; when we talk of a problem of over-population and unemployment; when we are trying to control population, or get rid of unwanted lives by abortions; when we want to legalise euthanasia because those with a terminal illness must be put out of their misery. And, is life to be “enjoyed” by the few who can afford these ‘engineering’ and worsen the situation wherein a few “fortunate” lord it over the many “unfortunate”?

It is of course assumed that this “immortality event” will also stem the process of ageing. If that were not to be so, it is to be wondered about the increased incidences of geriatric patients that will arise as a consequence, which will not only be an intolerable burden to the patients themselves, but will pose a great problem to society as to who will care for them, when already in our existing times, people have no time for them, and there is a gross insufficiency of those willing to care for them!

One might also well ask the generations: Who will make the decision for the individual and at what stage? Shall it be the child, to whom everything is a rosy picture? Shall it be the adolescent or youth, who has not yet experienced the responsibilities of life? Shall it be those in their thirties – but then the process of ageing might already have been initiated for some, depending on their life-situations, since it is evident that some age more rapidly than others, and that traumatic experiences appear to hasten the process? And what will happen if, after one opts for this “immortality” event, one sustains a brain injury and not only are the cognitive faculties reduced to that of a child, but one is also dependent on others – how terrible to be “immortal” in such a state! To borrow from the Bible, “God has shown up human wisdom as folly.” God in His infinite wisdom plans our life-span. He knows our coming and our going, our life is ever present before Him, and truly ‘in Him we live and move and have our being’ (St Augustine).

## **Conclusion**

Man wants, it seems, to rest being a picture of a creator. Human beings have this ever burning desire to be like God, the ever present temptation of the serpent in Eden, “...and it appeared that the fruit was enticing for the wisdom it could give”. The attempt to build a tower reaching to the heavens that they might make a name for themselves may lead to utter confusion. Would that our efforts and resources were spent on enhancing the life situation of all peoples in the basic essentials of life: food, water, shelter, education, employment, health, before we can think of scaling the heavens! Great achievements have been accomplished and great disasters have been caused alike by humankind. The human person has the capacity to make or to break. *So then let us choose LIFE that we may LIVE.*

## **Notes**

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