

## **CLONING: A DILEMMA PRACTICED BUT NOT SOLVED**

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**On 27 February 1997, the scientific community was taken by surprise to read in the prestigious scientific journal *Nature*, a Letter to the Editor entitled “Viable offspring derived from fetal and adult mammalian cells” by Wilmut et al from Rosalin Institute, Scotland, United Kingdom<sup>1</sup>. In this paper the first cloning of a mammal was described, shown on the front page of the same journal and subsequently appeared to the eyes of international media. The mammal was a sheep known internationally as “Dolly”. Since then mice, rats, goats, mules, monkeys, calves, cows, pigs, horses, rabbits, and gaur have been successfully cloned, thus making human cloning an eminent possibility<sup>2</sup>. But this possibility also generated worldwide interest in cloning technology particularly aspects related to scientific, potential use, ethical, religious, risks, and social implications.**

**The concept of cloning is not new and has been under experimentation using frogs and plant embryos since the 1970s. But, the reproductive biology of these species is different from those of mammals. As such, there was no international debate regarding the current dilemma which led to the creation of Dolly.**

**The aim of this study is to review the scientific basis and types of cloning and to examine the arguments and perspectives related to this subject particularly those related to religious, ethical, social, political and commercial issues.**

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### **Types of Cloning**

Cloning is a general term traditionally used by scientists to describe different processes for duplicating biological material. Thus, cloning of a gene produces multiple copies of the same gene<sup>3</sup>. Furthermore, using a technique called polymerase chain reaction (PCR) millions of copies of any gene or any specific piece of the DNA can be produced<sup>3</sup>.

Cloning is a different process compared to natural fertilization which takes place when an ovum is fertilized by sperm (sexual reproduction). In this way, the developing embryo has the genetic make up (i.e. DNA) of both parents: 23 chromosomes from the female

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and 23 from the male. The embryo is a unique biological organism with a unique genetic make up and with a potential to grow normally into adulthood in accordance with growth factors which control human growth. Nonetheless, cloning is a form of “asexual reproduction” which means that an embryo can be produced without fertilization of the ovum by the sperm. In fact it nullifies the need of a sperm.

Most of the international debate on cloning is related to the arguments aroused with the so called “Reproductive Cloning”, employing the technique which led to the “creation” of “Dolly” by Wilmut et al<sup>1</sup>. There are however, two other types: recombinant DNA technology and therapeutic cloning<sup>2,3</sup>. However, it is important that in order to appreciate the logic behind the arguments of the debate one must describe first the scientific basis of these three types of cloning.

### **1. Recombinant DNA Technology (Synonym: DNA Cloning, Molecular Cloning, Gene Cloning)**

This technology involves the transfer of a particular and a specific DNA fragment from one individual to a self-replicating element such as a bacterial plasmid. This DNA can then propagate in a foreign host cell<sup>3</sup>. This technique has been employed in many biological research laboratories since the 1970s. Bacterial plasmids are extra-chromosomal circular DNA molecules distinct from the normal bacterial genome and can be used to obtain multiple copies of the same gene<sup>3</sup>.

Plasmids and other types of cloning vectors, such as viruses and yeast, are used in the “Human Genome Project” to copy genes and other pieces of the chromosomes in order to generate sufficient identical material for further study<sup>2,3</sup>. As such, this form of “DNA Cloning” received worldwide scientific, government, and international support with no objection from any group because (1) It is designed to study the DNA fragment of a particular gene of interest for the purpose of discovering the structure and any abnormalities. (2) It is totally an in-vitro technique using hosts and does not involve the transfer of the cloned DNA back into the human body (3) It replicates one or more genes and not an embryo.

### **2. Reproductive Cloning (Synonym: Somatic Cell Transfer)**

This technique is used to generate an animal that has the same nuclear DNA as another currently or previously existing animal<sup>3</sup>. Dolly was created along this line in which the genetic material from the nucleus of a donor adult cell is transferred to an ovum whose nucleus, and thus the genetic material, has been removed<sup>1,3</sup>. Thereafter, the reconstructed ovum is then treated with chemicals or exposed to electric current to stimulate cell division, which once started (i.e. the formation of an embryo) is transferred to the uterus of a female host where it will continue to grow until birth<sup>1,3</sup>.

Since the creation of “Dolly” and other animals, reproductive cloning aroused an international debate on a number of issues related to prospect of the technology. These issues form part of the present presentation.

### **3. Therapeutic cloning (synonym: embryo cloning)**

The objective of this line of cloning is not to create cloned human beings, but to grow stem cells for the purpose of research which can ultimately be used to study human development and treat diseases. A stem cell, which is extracted from a fertilized ovum after it has divided for 5 days, (i.e. blastocyst phase) has the potential to grow and differentiate into any specialized cell in the human body. The extraction process requires the destruction of the original embryo.

It is hoped that investigation in stem cell research can be develop to enable scientists grow tissues and organs to replace damaged and non-functioning ones.

As in the case of reproductive cloning, stem cell studies also received opposition and obstructive legislature primarily because of the need to destroy an embryo for the purpose of extracting the stem cell. However, because of the lack of international agreement against stem cell cloning, the scientists are using various loopholes in the legal system of various countries to proceed with their stem cell research. As such, stem cell cloning is a criminal offence in some countries like the USA, permissible under restricted license in the United Kingdom, and allowed in some Asian countries.

### **Human Cloning**

Human cloning was considered scientifically impossible. However, with the “invention” of Dolly, the possibility of applying the same technology to clone humans became a possibility.

There are diverse opinions about all issues related to cloning humans. This is probably why scientists are shunning away from either attempting or declaring it. Many of these issues contain strong philosophical arguments originating from a religious and ethical background.

However, although the route to approach the religious and ethical issues of cloning is different between the various groups of theologians and ethicists, the conclusion among all of them is the same and is that cloning is incompatible with human dignity and should not be accomplished<sup>2,4-14</sup>. The community and social workers also came up with arguments about family and paternity issues<sup>4,7,14,15</sup>. Furthermore, the prospect of human cloning also became a political issue with politicians who have no scientific background let alone moral principals debating it primarily to appease their religious background<sup>14</sup>. Additionally the business executive and investors clandestinely supported the cloning technology yet did not want to clash with government or international legislation. In the background of all of this turmoil the scientists also had their views and felt ignored and sidelined from exploring the potential of cloning technology. There is therefore a clash of

views between theologians, ethicists, community and social workers, politicians, investors and business executives, and scientists.

## **Religious Arguments**

The religious arguments related to cloning stem from scripture and the writings of each faith as well as tradition and interpretations developed by scholars of the faith. There are a number of similarities between the various religious beliefs and also a number of different interpretations not only between these beliefs but between the scholars of the same faith or sect<sup>4,9,11</sup>. It is important to note here that the religious groups are active in influencing the public opinion regarding the bioethical position of cloning particularly with regards to issues concerning procreation, abortion and infertility therapy. This influence is creating confusion between secular and religious groups<sup>4,11</sup>.

The following are outlines of the Jewish, Christian and Islamic arguments regarding cloning, noting here that it is not the intention of this thesis to make comparisons between any of these nor to assert that the views of one faith are more valid than the others.

## **Jewish Arguments**

The Jewish opinion of cloning is based principally on tradition and interpretation of scholars rather than scripture. The general observation shows sympathetic views towards assisted reproductive practice including cloning<sup>4,11</sup>. This is summarized by Rabbi Eliot Dorff: “the Jewish demand that we do our best to provide healing makes it important that we take advantage of the promise of cloning to aid us in finding cures for a variety of diseases and in overcoming infertility”<sup>4</sup>. This view is supported by the following:

1. “Human cloning could be justified in some circumstances, however few they may be”. This consideration stems from the emphasis that man is in partnership with God as seen in the story of Genesis which stipulates that Adam and Eve were “to work it (i.e. Genesis) and preserve it”. This means that man was compelled to care, preserve and improve upon his creation to satisfy human needs.
2. Some Jewish thinkers believe that cloning does not represent a potential violation to human dignity. As such, the benefits of developing cloning technology must outweigh other factors provided that man achieves commitment to reduce all possible violation to human dignity. This requires an obligation to care for “mistakes” resulting from technological errors so as to ensure that the society will respect the children of these “mistakes”. Another form of commitment is to restrict cloning to a family member rather than a donor insemination or ovum donation so as not to raise apprehension over consanguineous relationships.

On the other hand, other Jewish thinkers fear that human cloning may disrupt family values and changes roles governing the relationship and responsibilities between family members. This view stems from the premise that in Judaism religious status is passed

through the mother while the tribal designation through the father and as such a child needs both parents.

## **Christian Arguments**

### **Roman Catholic Church**

The official opinion of the Roman Catholic Church is that “every possible act of cloning humans is intrinsically evil” thus, reflecting the medieval traditional belief to associate all “unwanted” or “unapproved” with the devil<sup>4,11</sup>. This opinion however is largely based on the Church’s interpretation of the “Creation Story” citing the following supportive views.

1. The story of creation infers that humans are responsible for maintaining and preserving what nature has created. Nature dictates that humans are the result of fertilization of ovum and sperm and any departure from this path is abnormal.
2. Human cloning is a temptation to compromise the sanctity of life which dictates that all mankind is equal and created by God. The fear here is that clones, invested with “life” and “equality”, may be considered “less equal” to provide their organs and tissue for transplantation. As such, they may be destroyed for the benefit of their creator thus compromising not only on “equality” but the “right to live”.
3. Cloning “jeopardizes the unique and personal identity of the clone (or clones) and also the person from whose genome was thus duplicated”. This is against principals of human dignity and may result in compromising the respect and uniqueness of individuals.
4. Men have dignity because they are created in the image of God and cloning violates this ruling because: (a) clones are manufactured in the image of their existing creators (i.e. somatic cell) and not that created by the “unique creative act of God” (b) clones will be identified as different and may be treated differently than other children.
5. Cloning is immoral and the purpose of cloning, whether to help infertile couples or use the cloned tissue and organs to treat diseases does not justify that an immoral procedure is done for a moral objective.

### **Protestant Church**

The views of the Protestant Church are not different from those of the Jewish opinion or that of the Roman Catholic Church arguments and stems from interpretation of the Bible particularly with regards to such issues as marriage, parenthood and childhood<sup>4</sup>.

1. Cloning allows humans to select and design the genes of their children rather than leaving it to God. In this context the humans are playing the role of God.

2. The teaching in the Bible is that children should be conceived by marital union between a male and a female. In this context cloning violates this divine command to allow man to reproduce without a sexual partner.
3. Human cloning will turn children into “projects” whose genes and all the future dictated in them can be altered to our liking and desire.

On the other hand some protestant thinkers share a milder view regarding cloning stemming from their interpretation of the “Creation Story” in that humans are created as “co-creators”. Accordingly, man has a responsibility to participate with God in shaping a better future”. From this one can stipulate that human cloning can be allowed but within a framework of ethical restrictions.

### **Islamic Arguments**

The Holy Koran governs every aspect of Muslim life and is believed to contain the words of God. It covers a wide range of issues including law, ethics, genesis, and instruction into every day life. There are several interpretations regarding human cloning<sup>4,9</sup>.

1. Cloning affects kinship, a major concept in Islamic Law. As such, cloning would result in loss of kinship since created children may not have either a mother or a father and this is contrary to Islamic laws. Loss of kinship will also affect identity of the clones and therefore their dignity. The consequences here are looked upon as to what happen when the clones want to marry or how and what they are going to inherit from their mothers or fathers.
2. Cloning affects the “soul” since the soul belongs to God and He is the one who gives life and takes it. In the cloning process the “soul” is given by other creators.
3. “God plans and writes the future of individuals” and since cloning can guarantee eternal life of clones this is considered “interference in God's writings and God's will”. Only “God determines life and death”.
4. Human cloning is similar to “playing God”. As such, it would be a manipulation of God’s creation because the cloning scientist should not become God or replace God.
5. Islam recognizes that human conception can only take place after sex and that “semen” (i.e. sperms) is involved in the processes. As such, cloning is looked at as a departure from instructions of God.
6. Furthermore, the moral status of the life of the embryo must also be respected.

7. Cloning is against social and family life since a birth of a child will be outside “the recognition of marriage” as a basis and nucleus for growth of families and societies.

Nonetheless, there are also many Islamic thinkers who believe that “there should be no limits to research since knowledge is bestowed on us by God”. Research must therefore be encouraged and this is a fundamental issue in Islamic teaching. Furthermore, many Islamic jurists distinguish between reproductive and therapeutic cloning<sup>9</sup>. This recognition of therapeutic cloning is interpreted positively since it is directed to alleviate human suffering from diseases.

### **Ethical Arguments**

While the disputes related to religious arguments about cloning remain to be settled and agreed upon not only by all beliefs but also by sects within the same faith, there is an equally important argument made by the ethical and social groups in the society which also indicate another unsettled common understanding about the moral issues of cloning<sup>4,7,8,12,14</sup>. Most of these arguments are secular in nature and many others are equal to religious views. It is important that while considering the moral issues related to cloning one must separate the influence of these two major factors.

There are two principal ethical issues in all arguments (a) What are the ethical limits of human cloning and how and who is responsible for setting these; the individuals choice, society, social groups, religious background, scientists, legislature, professional societies, commercial organizations, or any other allied group (b) It is not important to establish how is responsible for any possible error in the process cloning in as much as what to do in such circumstances?<sup>2,4,7,12</sup>.

The following viewpoints have been put forward for discussion and debate, all of which reflect fears and anticipations of the future and also possibilities of harm should cloning procedures be put into practical application even though the procedure itself is still theoretical and not yet attempted nor scientifically perfected.

#### **1. Physical and organic harm to the embryo**

Since the creation of Dolly, until now, when at least a dozen or so mammals have been cloned scientists still agree that cloning technology is still in its infancy and therefore unsafe to apply on humans. It is also new to allow the follow up and survival of the very few animals cloned so far. To provide reliable data a large group of cloned animals of diverse species are required for this study and at present this is not scientifically viable or economically justifiable. Principally there is a fear of accelerated aging process (i.e. progeria) as in the case of “Dolly”, but other possibilities such as early death of clones and the occurrence of high rates of congenital abnormalities are high on the list<sup>2,7</sup>. Against this view is a scientific sound noting that with additional experimentation the margin of errors can be reduced. Another argument is that no human activity is immune from accidental death.

## **2. Psychological harm to the child**

Clones may suffer diminished sense of individuality, personal autonomy and subsequently diminished responsibility towards themselves and the society. Opponents to this view feel this is merely a speculative opinion and that on the contrary a clone may have an advantage of knowing early in their life what will happen to them.

## **3. Degradation of quality of parenting and family life**

Cloning may encourage one or both parents to value their children according to how they meet expectation as dictated by their genetic or ancestral background. In this way the quality of parenting and love to the children is affected. Antagonists to this view feel that cloned children can still be loved unconditionally as in the case of children adopted by infertile couples.

## **4. Objectification of children**

Cloning may lead parents and society to consider clones as objects “not worth themselves” since they are merely “cultivated” for use of their tissues and organs for the purpose of transplantation and donation to other individuals. The opponents to this view argue that to avoid this from happening, an enlightening legislation must be introduced.

## **5. Social harm**

Further developments in cloning technology particularly in the field of recombinant DNA methods may encourage a form of eugenics as people will decide which traits and genes are desirable. Furthermore, over the years cloning may be established as the preferred method of having children as compared to the “old fashioned reproduction”. In this respect, supporters of these opinions view cloning as a “respect to personal autonomy”, and that couples should have the personal freedom to select the method of reproduction. In addition, supporters of these views maintain that the society may benefit from this because cloning of famous scientists and intellectuals will outweigh the potential harm<sup>12</sup>.

## **6. Moral status and moral rights of the embryo**

It has been asserted that the embryo whether in the stage of blastocyst or even an earlier developmental phase is potentially human and therefore possesses full moral rights and ethical status of personhood<sup>8</sup>. Furthermore, the idea of a person as a dual combination of body and spirit correlates naturally with the assertion of absolute personhood from conception<sup>8</sup>. There are no convincing counter arguments to these statements and this means that an embryo, whether cloned or conceived naturally, should possess the same spiritual, moral rights and ethical status of personhood and therefore survival.



## **7. The soul**

Unlike the religious views on the role of soul in human cloning, there is an equal argument, though philosophical, about the ethical issues of effect of soul transfer to clones such as those related to personhood, inherited characters, intrinsic moralities, habits, etc<sup>8</sup>.

## **8. Use of scarce resources**

Large sectors of the world community recognize that research towards the development and perfection of cloning procedures will only benefit infertile couples who form less than 5% of the world adult population<sup>12</sup>. This is seen as unfair practice and that research resources must be directed to areas of good cause with no world controversies so as to benefit all and not a certain sector of the society. Furthermore, the perfection of cloning technology may open frontiers for the cure of diseases, and provide tissue and organs as spare parts for damaged ones.

## **9. Government Control**

Supporters of cloning believe that interference of governments by world bodies to stop it either by stopping funding its research or introduction of legislature to ban it is unethical. This is considered to be against human rights values which guarantee “free thinking”. Opponents to these views however, believe that governments have the authority to override these rights as they did in many countries with polygamy and abortion for example.

## **Social Perspectives**

From one extreme the social perspective of cloning can be regarded as a benefit to the society and from another as a potential risk to society<sup>4,8,12</sup>. These include:

### **1. Eternal life**

With cloning an individual can start new life again and the procedure can be repeated endlessly. Similarly a child within the family or any loved person can be raised again to live eternally.

### **2. Reproductive guarantees**

Using cloning technology, infertile couples will be guaranteed reproduction of any number of children they want so that a family design can be built and planned<sup>12</sup>.

### **3. Megalomania**

Individuals will be able to completely reproduce not only their biological systems but also their qualities. It is argued here that the freedom to use cloning is a form of procreative freedom and, as such, deserves respect<sup>12</sup>.

### **4. Cloning of Dead**

It is important to emphasize that the original cloning procedure of “Dolly” was performed on frozen sheep cells and not fresh cells. This means that the DNA of the donor needs to be present or alive. As such, a dead member of the family or loved one can be created to live again eternally. Similarly, famous individuals in history can also be created to live again and continue their production to the society.

### **5. Catalogue of Designed Children**

It is possible to show a picture of designed children born from cloned embryos long before they are born. These can be published to prospective parents together with a short description of the traits and body qualities for the purpose of selection and order. It is anticipated however, that this may lead to misuse and the appearance of black-market for damaged, diseased, infected, expired and histoincompatible embryos.

### **6. Sale of body tissue and organs**

A market could develop for the sale of designed histocompatible tissues and organs for whoever wants a guaranteed rejection free transplant. As in the case of cataloguing of designed children discussed above an abuse of this sale is also anticipated. On the other hand it is feared that the material used for therapeutic cloning and stem cell technology will come through exploitation of women from the developing countries and this by itself is unethical.

### **Political Perspectives**

The politicians, under pressure from religious groups, used their executive power not only to stop all funding into cloning including that coming from the private sector, but also introduced legislations to ban the procedure and its development altogether. National ethical and scientific committees were formed to discuss the issue and recommend to the legislative bodies ways to approach the impasse. To complicate the issues, many of the professional organizations took a negative stance while others remained silent to the advantage of the politicians. Meanwhile, the scientists did not want to be caught in this dilemma and instead wanted to continue their research into stem cell cloning. But this divided the stance of politicians and legislature in many countries, thus enabling research organizations to carry out their investigations in countries with no control on cloning technology. This has infuriated the research scientists from some of the renowned centers

who feel that they have been surpassed by others and therefore left behind in the scientific race.

The politicians are also under pressure from animal rights groups and consumer groups<sup>5</sup>. Thus, while the former demand that animals must not be used in experimentation in general let alone cloning, the latter feel that what people eat from genetically engineered product is not safe for human consumption and that guidelines must be established to guarantee this safety<sup>5</sup>.

In addition, the politicians also argue that the material used for therapeutic cloning and stem cell technology would most probably come through exploitation of women from the developing countries<sup>15</sup>.

### **Commercial Perspectives**

Because of opposition from politicians and legislature, the business executives and investors also believe they are denied an opportunity for development and investment particularly with regards to:

1. Opening cloning centers to help infertile couple cloning their own children or even cloning themselves or their offspring. As a result many of these centers were opened in countries lacking appropriate control thus escaping not only ethical, religious and social control but also that of proper medical care of the clone. It is assumed here that abuse, errors and probably crimes went unrecorded and unnoticed.
2. The commercial industry is denied opportunity to manufacture equipment required for the cloning technology.
3. Inventors who develop the technology in one country cannot claim the royalties from "Copyright" and "Trademark" neither in their country nor elsewhere. In the first place they cannot even register their inventions and protect the product because the patent laws of some countries do not allow registration when the invention in question is regarded as unethical and immoral<sup>13,16</sup>. This means that the patent law is not the right place to legalize or legislate the consequences of the morality of invention<sup>16</sup>.

### **The Position of the Scientists**

The scientists believe that their invention is being ignored in favor of the views of other groups namely politicians, ethicists, theologians and social workers. They understand the need to separate secular and religious issues and to recognize the importance of ethical consideration in all scientific research. They feel betrayed by these groups who instead of supporting them are staging government and international embargo against cloning by cutting the budget for their research and the introduction of legislation to ban any cloning research irrespective of its objectives.

However, the scientists want the world to explore the advantages of the potential application of the cloning techniques<sup>2,4</sup>. These include the following:

### **1. Therapeutic cloning and the Supply of spare parts**

With human cloning there will be a continuous supply of tissue and organs for use in transplantation operations. The organs can be cloned selectively to replace damaged or diseased ones. Alternatively the entire body can be cloned and its organs can be donated to other patients. The medical prospect of this “replacement” procedure is endless particularly in the treatments of diabetes, cardiac muscle diseases, Alzheimer’s disease, etc<sup>2,17</sup>.

### **2. Elimination of donor organ rejection**

With organ cloning, the genetic match and histocompatibility of tissues can be achieved so that when transplanted to a host who needs it, it can be accepted as identical to its own and will not be rejected by the immune system. This future will particularly help patients who require heart, kidney, liver and corneal transplants.

### **3. Eugenics**

Scientists believe that developments into the field of reproductive cloning can reproduce animals with special qualities. In this way cloning of transgenic animals can be produced<sup>3</sup>. For example animals that can produce drugs in their milk to help patients with deficiency diseases or those that can produce excessive milk or meat to feed people (i.e. animal husbandry).

### **4. Eradication of genetic diseases**

Embryo splitting can be used to eradicate genetic diseases. In this practice, the cloned embryos testing positive for these diseases can be destroyed, while those testing negative can be implanted to continue their growth to produce a healthy child.

### **5. Gene therapy**

Recombinant DNA technology is important for learning about gene therapy, which can be used to treat certain genetic diseases by introducing a virus vector that carries corrected copies of faulty genes into the cell of a host organism<sup>3</sup>. This development is particularly promising in the treatment of cystic fibrosis, severe combined immunodeficiency disease (SCID), cancer, familial associated lipid diseases, etc.

### **6. Genetic engineering of organism**

Genes from different organisms that improve the taste and nutritional value and those which can provide resistance to disease can be use to produce genetically modified

crops. Similarly animals can be “genetically modified” to serve as a model for the studying of human disease.

## **7. Genome sequencing**

Fragments of chromosomal DNA can be inserted into different vectors to generate fragments of an appropriate size.

## **8. Repopulation of endangered species**

Scientists believe with development in reproductive technology, cloning of endangered animal species or those difficult to breed can be produced. There is also the potential that even extinct animals can be produced.

## **9. Cell growth and stem cell research**

One of the remarkable achievements of reproductive cloning, which created Dolly, is that the inherited genetic material (i.e. DNA) from a specialized adult cell (the mammary cell in the case of Dolly) which is genetically programmed to express only the functions of the genes in it (i.e. milk production), can with somatic cell transfer technology be reprogrammed to generate an entire organism. Before this scientists believed that once a cell became specialized (i.e. liver, heart, brain, kidney, bone, etc) then the differentiation will be permanent and all unneeded genes would become inactive. The prospect of this breakthrough is that further investigation may lead to better scientific understanding of the reprogramming of the cloned cell. It is hoped that once this is achieved, scientists may be able to take any cell in the body and reprogram it to become a stem cell which can subsequently be used in therapeutic cloning.

## **10. Open frontiers**

Cloning technology and stem cell culture research will open the frontiers to unravel many biomedical mysteries particularly those related to the understanding of regeneration of tissue, the biology of cancer cells, causes of infertility and abortion, the ageing process, synthesis of pharmaceutical drugs, inheritance of traits, genetic diseases, human genome, etc<sup>2-4</sup>.

## **Risks of Cloning**

While considering the potential use of cloning technology, scientists also recognize that human cloning presents a major risk for the production of children with congenital abnormalities who may also be stillborn, unhealthy, malformed, or disabled<sup>2,12</sup>. There is also the risk of gene mutation, abnormal gene expression, chromosomal abnormalities, faulty reprogramming of the genome, transmission of mitochondrial diseases, and the negative effects caused by the aging of genetic material. The following are additional risks:

1. Cloned animals tend to be immunocompromised and this makes them highly susceptible to infection, tumour growth and other disorders.
2. Reproductive cloning is very expensive and associated with very low success rates.
3. Cloned mice and calves live in poor health and die early. Furthermore calves also become larger than their uncloned mates.
4. The ageing process is rapid and many cloned animals of various species die at a very early age with no clear cause of death.
5. Cloned mice had 47 of the genes functioning abnormally and this is not due to gene mutation but changes in the activation or expression of certain genes.
6. Cloned animals show defects in the genetic imprints of DNA from a single donor cell leading to the development of congenital abnormalities in the cloned embryo.
7. Clones are NOT an exact genetic copy of the nucleus of the donor and this may lead to tissue rejection problems, since the cloned embryo would still have the mitochondrial DNA of the ovum. As such, the immune system may be triggered against this mitochondrial DNA leading to rejection of the transplant.

## **CONCLUSION:**

### **Should humans be cloned ?**

**Because of the associated risks of developing deformed clones, most professional medical organizations have passed public ruling advising against human cloning. This in the absence of sufficient legislation is considered cloning unethical. The religious and social groups are also against it. Furthermore, the scientists do not have enough information about the impact of cloning on the mental and biological welfare of the clones. Therefore with so many unknowns and also much opposition, it is believed that at present, the potential for human cloning is dangerous and ethically impossible.**

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