Chapter Five

Bioethics of Reproductive Cloning: Patenting a Designer Human Being

Introduction

Somatic cell nuclear transfer technology (SCNT) can be used for either reproductive or therapeutic/research cloning. As discussed in the previous chapter, reproductive cloning involves generating an exact genetic copy using a donor cell and the enucleated oocyte obtained from the same individual (oocytes may alternatively be obtained from the donor's mother, sister, or grandmother). Since mitochondrial DNA (mtDNA) comes from the oocyte, obtaining an enucleated oocyte for nuclear transfer, from any donor other than a maternal relative, will result in progeny that is not an exact genetic clone because the embryo will possess nuclear DNA identical to the donor cell's and mtDNA identical to the oocyte's. Although mtDNA represents less than 1% of the total DNA in a cell, it contains critical information regarding the energetics of a cell. Another problem with generating an exact genetic clone using SCNT is understanding how gene expression is related to epigenetic instability.[1] This is the reason why identical twins may have the same genetic information, but are not precisely identical in behavior, health, and even physical traits.

There are various situations that elicit profound ethical debates related directly to reproductive cloning. The most obvious is whether and how cloning technologies should be applied to humans. Employing SCNT to generate embryos from multiple parental donors is one ethically challenging example of using this technology.

Academic Arguments Against Human Reproductive Cloning

Current research in animals indicates that the success rate of reproductive cloning is quite low; therefore, many fertilized zygotes or embryos will be destroyed or discarded during any attempts to clone human beings. While Chapter 4 provided some scientific reasons to support research in reproductive cloning, there several cultural, morality-based arguments, and science-based arguments to oppose reproductive cloning.

[1] Epigenetics effects refers to changes in gene expression that are not determined primarily by the underlying DNA sequence. Epigenetic regulation refers to the mechanisms, mainly DNA methylation and histone modifications that license regions of the genome for expression while shutting down others.

Cultural and Moral Arguments: The first morality-based argument against reproductive cloning is the belief that life begins at conception and that all human beings therefore possess, from the moment of conception, intrinsic and unique value. Individuals advancing this argument oppose human cloning on the grounds that human zygotes and embryos, whether generated by cloning technology or IVF, deserve "full moral respect." They support the view that, as in "natural fertilization," a cloned embryo produces a new and complete human organism whose development into a child follows a genetic-based cellular protocol. These embryos possess a unique genome and the epigenetic primordial for self-directed growth into adulthood. Since SCNT involves the destruction of many pre-implanted embryos in order to generate one viable organism, opponents of reproductive cloning believe there should be a ban on reproductive and therapeutic cloning research, because pre-implanted and implanted embryos are considered to be potentially viable human beings.

The second morality-based argument for banning reproductive cloning is that this technology is unnatural and beyond the ethical boundaries of human experimentation. There is both a theological and secularist perspective to this argument. The theological argument is that reproductive cloning is immoral because human beings should not "play God". The argument is that scientists should not tamper with nature in an inappropriate manner, e.g., genetically manipulating God's creations (Savulescu 2009). The secularist argument stems from the idea that nature should not be manipulated into potentially harmful situations. The argument focuses on the fear of the unknown. Nature has a "natural" way in which it evolves and scientists should not be creating situations that typically would not have occurred without intervention.

Scientific Arguments Banning Human Cloning: From a scientific or medical perspective, reproductive cloning is associated with a high medical risk and potential dangers inherent in the SCNT process. Opponents of reproductive cloning cite the many animal studies that associate reproductive cloning with many harmful side effects, such as spontaneous miscarriages as well as birth defects in the newborn animals. Cloning experiments in animals also document increased damage to the immune system, risk of death from pneumonia, development of tumors, and risk of liver failure. Almost half of all cloned animals suffer from a condition known as *Large Offspring Syndrome* (LOS), which can cause terminal problems including enlarged placentas, fatty livers, and underdeveloped vital organs. In addition, some cloned animals (especially mice) may appear healthy at birth, but in fact have a reduced life expectancy as compared to animals generated by natural reproductive processes. While there is no clear data on the potential medical risks of reproductive cloning in human beings, many opponents of reproductive cloning believe that the high risks in animals are a valid indicator for similar high risks in humans.

There are also reported risks to animals carrying cloned fetuses. For example, animal welfare organizations point to the fact that even the Food and Drug Administration's (FDA) report in 2007, just prior to their approval of using cloned farm animals for food, states that "weak or non-existent uterine contractions, poor mammary development and failure to lactate" were found in animals carrying cloned fetuses.[2]

Textbox I. The use of cloning technology to produce children has been described as a dangerous experimental procedure. Firstly, there is no possibility for its subjects (the children created by it) to provide informed consent. Secondly, giving adults the opportunity to have what has been called the "ultimate 'single-parent child'" may also contribute to the commodification of children, and could deny children the possibility of a relationship with both a genetic mother and father. Finally, reproductive cloning may lead to generating designer babies with specific personality traits that burden them with the expectation that they will be like the individuals from whom they were cloned.

How would you address these issues?

Emotional Arguments Banning Human Cloning: Another argument presented by opponents to human reproductive cloning is psychological and emotional in nature. Opponents argue that cloning is a threat to human individuality. Normal human reproduction is designed to combine genetic elements from two parents to form a single progeny. In contrast, reproductive cloning can generate an identical DNA-copy of one parent, which could create a great psychic burden on the cloned child. Opponents of reproductive cloning believe that children should be valued for how they develop as individuals, not according to how closely they meet their parents' genetic expectations. In other words, each child has a right to develop naturally from their unique set of genetic information and not to develop into his or her genetic progenitor. There also is a concern of the impact this will have in familial relationships. How will society view and treat cloned children? Will cloning create new family structures? Reproductive cloning technology also has the potential to allow for the design of babies to alter gender preference, appearance, athletic potential, or behavioral characteristics. Designing babies for purposes of vanity could affect the nature of the family unit and parent-child relationships. This could, in turn, affect the psychological pressures on the cloned child. Anti-reproductive cloning bioethicists supporting this argument cite studies showing that naturally conceived identical twins may exhibit increased psychological problems related to their inability to define their unique individuality (Sutcliffe and Derom, 2006).

The emotional argument, first publicized by Dr. Leon Kass states that reproductive cloning should be banned because we intuit and we feel, without

[2] http://www.fda.gov/AnimalVeterinary/SafetyHealth/AnimalCloning/ucm124840.htm.

argument, the violation of things that we rightfully hold dear (Kass 1997). In various pieces, Kass describes human cloning for reproductive purposes as revolting, grotesque, repugnant and Frankensteinian. He urges us to ban the cloning of human beings, as it is a 'clear fork in the road' where the wrong choice could lead us into a dystopian 'Brave New World'. Moreover, Leon Kass, states that reproductive cloning is "the first step toward a eugenic world in which children become objects of manipulation and products of will."[3] Cloning will destroy the idea of the "unique humanness" of human life and the meaning of our embodiment, our sexual being, and our relations to ancestors and descendants. In fact, Leon Klass employs the "yuck factor" as an ethical argument to ban cloning. Dr. Kass defined the bioethical "yuck factor" as being an unethical technology based on an intuitive negative response rather than on concrete ethical or moral values.

How significant are emotional arguments in bioethics and cloning? In 2016 several hundred participants were surveyed about their attitudes towards human reproductive cloning (May 2016). Most participants condemned human cloning as immoral and illegal giving anxiety as their most common reason. Only about a third of participants selected "disgust" or "repugnance" as the emotional reason for banning human cloning. One could therefore conclude from this one small study that the "yuck" factor reaction to cloning is not widespread.

Arguments that Promote Reproductive Cloning Research

One of the main reasons for developing reproductive cloning technology is the belief that the current proscription against reproductive cloning may not be immutable if advances in technology yield a process superior to traditional assisted reproductive techniques used to treat infertility. In addition, those who favor research in reproductive cloning believe that the science-based arguments against reproductive cloning are weak. More importantly, they are confident that, as this technology improves, the gain in scientific knowledge will outweigh most ethical concerns.

Bioethicists who favor reproductive cloning research believe, first and foremost, that a fertilized zygote or pre-implanted embryo does not constitute a human being and does not confer personhood status. They believe that SCNT resembles tissue culture technology. Any replicating cell contains the genetic information required to develop into a potential fetus, but this information is suppressed. Unless implanted into a uterus, the zygote or pre-embryo cannot develop into a human being and, therefore, does not have personhood status. Thus, the destruction of many pre-implanted zygotes and pre-implanted embryos, required for human reproductive cloning, do not present an ethical problem for these bioethicists. Indeed, most oocytes fertilized in vivo fail to generate a viable child and are subsequently discharged from the woman. Thus, sperm and oocytes

[3] http://www.bioethics.gov/transcripts/feb02/feb13session4.html

can be functionally and morally identified as any other cellular components of the male or female body. In fact, sperm or oocytes are not the only biological sources for genetic donation in cloning. Fibroblasts or blood cells can be de-differentiated into oocytes or stem cells that can serve as genetic donors for cloning.

Many scientists who support reproductive cloning research also believe there is nothing immoral in man “playing God”, especially when medical benefits are to be gained from this research. Moreover, reproductive cloning is not an unnatural event in biology, as it occurs in several species. For example, the little fire ant, *Wasmannia auropunctata*, and the lizard *Leiolepis ngovantrii*, can clonally reproduce (Schwander and Keller, 2012).

The risks of fetal defects and spontaneous miscarriages associated with cloning in animals is of concern to all parties in this debate. However, many scientists believe that further experimentation will greatly reduce these medical risks. Almost all proponents for reproductive cloning believe that human experimentation should not begin until the known side effects of cloning in animal models are more significantly reduced to minimize potential health risks. In fact, several recent studies have shown that calves and pigs cloned using SCNT are born healthy, and do not express many of the aforementioned medical problems seen in other animals (Lanza et al., 2003). Scientists who support reproductive human cloning have also suggested that many of the defects observed in animal cloning are, de facto, due to poor culture conditions, and that cultural conditions have been improving and becoming more optimized for human embryos and cells over the past 36 years of assisted reproductive technologies (Zavos 2003). Additionally, scientists have also noted that LOS (*Large Offspring Syndrome*) appears to be correlated with incorrect imprinting of the *IGF2R* gene (Young et al., 1998) and that this gene is not imprinted in humans or other primates (Killian et al., 2001), suggesting the absence of this gene in humans will render human cloning technologies safer. As of 2016, there is no consensus on the safety of human cloning because various cloning studies in animals claim minimal side effects while others report serious health concerns with this technology.

The argument that cloning challenges definitions of individuality, or that it may influence the psychology of the cloned individual, does not present a real problem to proponents of human cloning. They claim that this argument ignores the normality of naturally born identical twins. Nurture is of equal, if not greater, importance as nature in the development of human personality. Moreover, using SCNT technology for human cloning will generate offspring that will have significant differences in their mtDNA from the person providing the donor cells. However, if the oocyte is obtained from the same person as the donor cell, or from a female blood relative of the cell donor, this will not be the case. Even an exact genetic clone may not necessarily develop the same personality as the parent. Epigenetic events during embryonic stages, and environmental factors during development and growth of the child, are major impacts that shape personality and behavior. The psychological normalcy observed in many naturally born identical

twins argues against the possibility that a cloned child will experience psychological harm emanating from a diminished sense of individuality and personal autonomy.

Historical Insights of Cloning

A historical review of the medical risks associated with IVF is relevant to the debates surrounding reproductive cloning. One historical lesson from IVF is that it takes decades to assess the medical risks associated with reproductive technologies. Almost five million IVF generated babies have been born worldwide and over five hundred thousand in the United States since its inception in 1978. Yet, only in the last several years have studies examined prenatal complications associated with the procedure. In general, there are no significant medical risks to babies born via IVF technology. The major malformation rates ranged from 0% to 9.5% for IVF and 0–6.9% in the control groups (Hyrapetian et al., 2014). There are a few studies (Hansen, Kurinczuk et al., 2002) that claim that IVF technology is associated with increased birth defects, but it has been difficult to arrive at any definite conclusion as to whether the birth defects reported are due to the age of the parents or to IVF. Some of the reported risks to the mother are thought to result from the hormones taken to induce ovulation and to maintain the pregnancy, rather than the actual IVF procedure. Other risks to the mother are easily managed, such as infections and a risk of hemorrhaging. If there is a medical need to engage in reproductive cloning, then care will be taken to begin human trials only after animal studies have shown its safety.

Another question is whether reproductive cloning will lead us down the slippery-slope road to eugenics. Actual IVF outcomes weaken any slippery-slope arguments, as the universal use of IVF technology has neither created legions of less-than human children, nor contributed to a disintegration of the nuclear family. Nonetheless, whether or not these historical lessons regarding IVF can be applied to human cloning still remains controversial.

Reproductive cloning is fundamentally different from IVF in one respect. The goal of IVF is to produce a genetically unique human being that carries genetic information from two parents. In contrast, nuclear transfer technology produces offspring that may only differ in their mtDNA and possible epigenetic variation, while remaining essentially genetically identical to their donor cell. Attempting to ascribe a percent difference between the donor and genetic clone can be uninformative since human beings and chimpanzees differ in their DNA by about 1-2%. DNA homology from a human male, however, more closely resembles the DNA of a male chimpanzee than the DNA from a human female, because of the Y chromosome. In clones where only mitochondrial differences exist, genomic differences could account for less than 0.1% difference between donor and clone.

Assessment of any reproductive technology will require decades of observations on human development, from infancy into old age, to determine the medical and psychological risks of such a procedure to the individuals involved and to society. It is interesting that, on a theoretical level, one would have expected the FDA to engage in these long-term studies before approving IVF procedures, in order to ensure that there are no effects on the mother or child. Nonetheless, one could speculate that political pressure, from the >12% of couples in the United States who are infertile, have influenced FDA decisions, even though there is already an array of alternate methods for treating infertile couples.

Religious Beliefs Regarding Human Cloning - Introduction

Different religious beliefs concerning when human life begins, and whether human beings should engage in “unnatural biological processes for conception”, deter consensus on controversial issues such as cloning and stem-cell research (Frazzetto 2004). Yet, current human reproductive cloning technologies may challenge the boundaries of parenthood and social responsibility as they were described in the Bible. For example, who is the cloned child's genetic mother or father? As we understand those terms from a biblical perspective, if a woman cloned herself, would the child be that woman's daughter or her twin sister? Will the cloned child be “fatherless?”

Not surprisingly, organized religions, such as the Catholic Church, have taken a strong interest in the cloning debate. Many Catholic scholars have issued strong words of caution, or outright condemnation, of any research that creates, uses, or destroys human embryos.[4] The impact of their campaign against cloning can affect public opinion and has indeed influenced scientific policy. Many Western countries with primarily Catholic populations have banned human cloning and/or the creation of human embryonic stem-cell lines, or at the bare minimum, have issued strict regulations on such research. Aside from the issue of when an embryo attains human status, many of the major religions strongly reject reproductive cloning because it is unnatural, and they consider life to be a “gift”' from God. They also hold the belief that the creation of human life is to come from both a “unitive and procreative act of sexual intercourse” and that therefore, IVF or reproductive cloning is never permissible because it is not a unitive act between a husband and wife.

Nevertheless, religious leaders rarely speak with a unified voice. Although some faiths hold irrevocable positions against cloning, other religions have found room in their beliefs and traditions to accommodate the potentially beneficial aspects of this technology. In essence, different attitudes towards human cloning center on a few fundamental questions: Does an embryo hold the status of a

[4] Catholic doctrine according to the Vatican bans all embryonic cloning. http://www.vatican.va/roman_curia/secretariat_state/2004/documents/rc_seg-st_20040927_cloning_en.html

person? Is its destruction during research a murder? Does cloning corrupt family relationships? And, ultimately, does cloning mean tampering with God's creation and millennia of human ethical, social, and sexual arrangements?

Varying Religious Views on Reproductive Cloning

In order to prepare for the bioethical dialogue concerning cloning, one must be able to address a significant population that has a stake in the debate – the followers of various religions. Although polls have already shown that a great majority of Americans oppose cloning, this opposition is mostly representative of religious people. An ABC poll carried out in 2001 asked a random national sample of American adults whether human cloning should be legal (Bainbridge, 2003): 95 percent of evangelical Protestants wanted it to be illegal, compared with 91 percent of Catholics, 83 percent of non-evangelical Protestants, and 77 percent of non-religious respondents.

As stated above, the Catholic Church has become the leading voice against any form of human cloning, and even against the creation of human embryonic stem-cell lines from “excess” IVF embryos. Their prohibitive stance is based on a 1987 document entitled “Instruction on Respect for Human Life in its Origin and on the Dignity of Procreation (Donum Vitae),” published by the Congregation for the Doctrine of Faith. Roman Catholics believe that cloning is contrary to moral and natural law, since it is in opposition to the dignity of both human procreation and the conjugal union. Any attempts at cloning are therefore a violation of the dignity of the human embryo, which, in Catholicism, is granted the status of a person from the moment the oocyte is fertilized (also referred to as the moment of conception).

The above Catholic doctrine provides a relatively recent definition of personhood in the Christian tradition. The medieval church, in line with Aristotelian doctrine, believed that an embryo acquired a soul only when it took recognizable human form. Consequently, abortion was only considered to be a venial sin in the Middle Ages, not a mortal sin comparable to murder. A drastic change took place in 1869 when Pope Pius IX, who, most likely influenced by advances in embryological research, declared that an embryo bore full human status from the time of fertilization (Lachmann 2001). Since then, the Catholic Church has upheld the position that the destruction of an embryo after conception is a mortal sin. No distinction is made between embryos conceived naturally and those created through IVF or cloning, although many Catholic leaders strongly oppose unnatural methods of reproduction and prohibit any procreative act that is not unitive between a husband and a wife.

Buddhism,[5] by contrast, does not have the same fundamental opposition to cloning as the Catholic Church. "Many of these theological objections disappear

[5] Buddhism is divided into roughly three major branches: the Theravada, the Mahayana, and the Vajrayana. The Theravada claims to be the oldest school and has at its goal self-liberation. The Mahayana shares much with the Theravada but espouses the idea of saving other beings as the

when cloning is viewed from a Buddhist perspective," said Damien Keown, a Reader in Buddhism in the Department of History at Goldsmiths College, University of London, UK, and an authoritative voice on Buddhist responses to cloning and other biomedical issues. The Buddhist view of the world, and mankind's place in it, differs from that of monotheistic religions. In Buddhism, there is no supreme or divine creator whose plan might be distorted by human manipulation of nature. In addition, Buddhists believe that the creation of life is not a fixed or unequivocal process. "Buddhism teaches that life may come into being in a variety of ways, of which sexual reproduction is but one, so sexual reproduction has no divinely sanctioned priority over other modes of procreation," explained Keown. Life can, therefore, begin in many ways and therefore, theologically, cloning would not be seen as a problematic technology. Furthermore, in contrast to other larger religions, Buddhists regard human individuality as an illusion or mirage. Cloning, therefore, would not threaten or devalue the personality or character of an individual (Simpson et al., 2005).

Similarly, Hindu views adopt a somewhat neutral position towards cloning. Hindu views are incredibly diverse within the religion. There have been scriptural traditions that assert conception as the initiation of human existence, but there are also views focused predominantly on the compassion and “healing” of cloning research (Banchoff 2008).

Islamic law remains concerned with reproductive cloning procedures, particularly with respect to their impact on inter-human and familial relationships. "Islam regards interpersonal relationships as fundamental to human religious life," said Abdulaziz Sachedina, Professor of Islamic Studies at the University of Virginia (Charlottesville, VA) and a leading scholar of Islamic views on cloning. The preservation of the parent–child lineage is of utmost importance to Muslims, as are the spousal relationships that encourage parental love and concern for their children. Thus, Islam is concerned with moral issues related to the genetic replication and embryonic manipulation associated with these technologies. Will these technologies lead to incidental relationships between a man and a woman without a spiritual and moral connection between them?

According to the Muslim sacred text, the Koran, moral personhood is a process and is not granted at the embryonic stage. Unlike the Catholic Church, most Sunni and Shiite jurists would “have little problem” endorsing ethically regulated research on embryonic stem (ES) cells, because the fetus is accorded the status of a legal person only at the later stages of its development (Hug, 2006). Muslims would therefore endorse reproductive cloning to help infertile couples, only if it was within marital bounds, and would reject it if it were to break familial relationships. However, Islam does not support surrogate parenting or adoption. Therefore, under Islamic law, excess embryos or embryos generated via IVF could not be used by anyone other than the couple who created them**.**

highest goal. The Vajrayana is an occult Buddhism that emphasizes esoteric rituals and practices taught by a master.

However, it is sometimes unclear if all Muslims share this view. According to a 2001 poll by the Council on American-Islamic Relations (CAIR), 81 percent of 1008 Muslim respondents said they were opposed to human cloning. Furthermore, in 1983, the Islamic Organization for Medical Sciences (IOMS) convened a seminar on the Islamic view of human reproduction, and ultimately determined that human cloning was not permissible.[6] The Islamic Fiqh Academy had a unique view on the topic. After a conference in Casablanca, the academicians concluded that, although human cloning does not question Islamic belief and the Will of Allah, for "cloning is a cause and only through Allah's Will it can produce the effect," human cloning does bring forth "extremely complex and intractable social and moral problems."[7]

In Conservative and Orthodox Judaism, human status or personhood requires implantation of a fertilized zygote into a woman and for the embryo to develop for at least 40 days. However, reproductive cloning may challenge deeply held beliefs about creation and mankind's relationship with God. If God is seen as the only Creator, and creation of the world as being a completed act, then human beings have no right to tamper with it. Conversely, many Jewish thinkers regard God as the Power of Creation and view creation as a transformative process that invites human participation. In other words, human beings are viewed as partners in the creation process. Several Jewish scholars advocate the view that reproductive cloning represents a process that human beings should utilize to accomplish good. Dr. Edward Reichman, a leading Jewish bioethicist, commented that, "[t]he process or 'mechanical' aspects of human cloning present no major legal obstacles from a Jewish perspective" (Frazzetto 2004). He further stated that the low efficacy and potential adverse outcomes of human cloning are legal concerns that would lead society to reject any human cloning at this time. Prospectively, creating people of legally ambiguous lineage, who may suffer profound social and psychological complications, may preclude any future acceptance of cloning despite perfection of the procedure from a medical perspective (Frazzetto 2004). But unlike the Catholic doctrine, these Jewish thinkers do not believe that ensoulment occurs at conception.

Government Regulation of Human Cloning

Governments around the world have expressed a wide range of policies on human reproductive cloning. Many countries have a complete prohibition of reproductive cloning, while others have no policies on record. Over 30 countries, including France, Germany, and the Russian Federation, have banned human

[6] http://www.islamset.com/healnews/cloning/index.html

[7] http://www.albalagh.net/qa/ifa.shtml; see Vaidyanathan, Brandon, et al. "Rejecting the conflict narrative: American Jewish and Muslim views on science and religion." Social Compass 63:478-496, 2016 for a discussion on the Jewish and Muslim views whether there is a conflict between science and religion.

cloning altogether. Fifteen countries, such as Japan, the UK, and Israel, have banned human reproductive cloning, but permit therapeutic cloning. Many other countries, such as the United States, have yet to pass any official legislation (Camporesi and Bortolotti, 2008). In the United States, various congressional bills are proposing a one million dollar fine, plus a ten-year prison sentence, for any individual who engages in reproductive cloning. However, there are only a limited number of laboratories, in either academia or corporate environments, which have reported using SCNT in animals. The restrictions of government funding for research in reproductive cloning have opened the door for entrepreneurs to support the technology via private funding. As mentioned in Chapter 4, Boyalife Group in China will begin cloning cows in 2016-2017.

Does society have the right to ban or limit scientific advancement or progress (UNESCO 2009)? There are many advocates of reproductive cloning who propose that procreative liberty and reproductive freedom are intrinsic rights within the American Constitution.[8] However, most advocates of human reproductive cloning believe that society should, at least for now, refrain from human experimentation until the medical risks seen in some animals have been reduced or eliminated.

The history of science supports the assertion that new technologies often lead to valuable benefits. Supporters of reproductive cloning believe that this technology will eventually provide both valuable basic research and the possibility for spin-off technologies that will enhance our capacity to improve animal and human reproduction. Along with improving reproduction, reproductive cloning could aid in the development of new therapies in the area of reproductive medicine and other areas concerning health. As discussed in the previous chapters, cloning technologies has led to new clinical applications in the area of reproductive medicine.

Cloning Noah's Ark

From a biological perspective, cloning may challenge biological diversity or eliminate the need for the male species since the ova and donor cells could be obtained from two women or the same woman. Large-scale cloning could deplete genetic diversity, making a species susceptible to specific diseases. Many scientists believe it is diversity that drives evolution and adaptation. However, proponents of cloning argue that the high cost of cloning would limit such a large-scale use as to threaten human biodiversity. In addition, does cloning violate the bioethical guideline of equal access or "justice", where such an expensive technology would create a divide between couples who are wealthy and those who are poor?

[8] http://writ.news.findlaw.com/grossman/20011120.html

As mentioned briefly in Chapter four, several groups have successfully used SCNT technology to clone an endangered species using members of non-endangered species as surrogate mothers. For example, in 2000, a humble Iowa cow gave birth to a rare, endangered, ox-like Asian gaur. This was the first example of trans-species cloning. Incidentally, and perhaps humorously, the newborn gaur was named Noah. It was implied, then, that Trans-species cloning could help *reincarnate* some species that are already extinct.

Several other successes at cloning exotic or endangered species have been reported. Examples are the Gaur (*Bos gaurus*), Banteng (*Bos javanicus*), and Bucardo (*Capra pyrenaica pyrenaica*). In another experiment, an African wildcat was cloned using an ordinary house cat as the oocyte donor and surrogate mother. Other endangered animals that have been cloned include the Indian desert cat, a bongo antelope, a Mouflon sheep, and a rare red deer. Efforts are currently underway to use nuclear transfer technology to clone giant pandas, the Siberian Tiger, white rhinoceros, and Arabian oryx as well.

The distinguishing feature of all these examples is that they employed trans-species cloning. In these instances, the oocyte cytoplasm being used to create the embryo was derived from common domesticated species, while the cell nucleus was obtained from the endangered species of interest. Trans-species clones, inevitably, differ from both of the parental species in their nucleo-mitochondrial characteristics. At the very least, mitochondria inherited from the recipient oocyte could influence specific functions in the trans-species organism, such as muscle development. Yet, trans-species cloning offers a method for animal conservation in situations where other reproductive technologies, such as artificial insemination, have failed. In addition, animals resulting from these trans-specific cloning efforts are scientifically valuable for their insights into the functional relationships involved in nucleo-mitochondria dialogue.

The major ethical questions raised in trans-species cloning include: a) Does the creation of nuclear-mitochondrial hybrid animals interfere with natural species evolution? Is it appropriate to play God or manipulate nature and create nuclear-mitochondrial hybrid animals? b) Will this technology inevitably lead to the use of large mammals, such as cows, as artificial incubators for human embryo development? c) How will these trans-species be valuable in species conservation? Many of the ethical concerns associated with genetic modifications of species are viewed in a similar vein as issues in generating trans-species clones.

There are other concerns associated with trans-species cloning. The clone would be born to a surrogate mother, most likely from a different species, and may have to be raised partially, or even entirely, by humans. More research must be done to examine the impact of one species nurturing another species. Furthermore, for many species, successful reintroduction to the wild after human rearing is rarely achieved. Therefore, this technique would be of limited use in

terms of replenishing a viable population of the endangered species. There is, nonetheless, scientific literature that suggests that certain species, including some amphibians, may benefit from restoration efforts of reproductive cloning due to their intrinsic biological systems, which have favorable characteristics that increase the likelihood of success (Holt et al., 2004).

Cloning our Neanderthal Ancestors

Since the initial extraction of the Neanderthal DNA (See chapter four), bioethical contentions, provoked by the pursuit of the Neanderthal genome, have appeared in the public. The use of SCNT and other genetic-based technologies to clone a Neanderthal being may create a situation that would be an affront to many religious and moral beliefs.

One important consideration in cloning a Neanderthal individual is identifying the scientific objectives of such a project. Will cloning Neanderthals increase our knowledge about human development? Will such clones help scientists understand how Neanderthal genes could protect modern man and woman from specific diseases (Church et al., 2013)? Do the answers to these questions justify efforts in cloning a Neanderthal individual?

Cloning Neanderthals raises not only the ethical aspects of cloning an extinct species, but the religious and moral objections against human reproductive cloning. A central issue is whether a cloned Neanderthal would be considered human. Much opposition comes in response to the uncertain behavior and cognitive abilities of the Neanderthal clone. From anthropological evidence and genetic analysis, such as mtDNA sequencing, it is postulated that the early Neanderthals would have many rational capabilities similar to those of the modern *Homo sapiens*, hence calling into question the ethical responsibilities involved in cloning Neanderthals. In fact, from mtDNA sequence analysis, the number of differences between the human mtDNAs and the Neanderthal mtDNA varied from 201 to 234, which is less than the differences between human and its closest living species – the chimpanzee (Clark 2008). Given that a Neanderthal might express human-like cognitive abilities, would it have the same rights as a human being? And does it demand us to reconsider bringing to life an individual that may very well express individualism, intelligence and autonomy? Would we be able to provide the clone with a suitable habitat, given the potential great offense people may take at its existence? Most likely, such a creature would live its existence as a research subject.

A second objection may come forth concerning the method by which a Neanderthal is gestated. Is it possible to implant a Neanderthal embryo inside a human uterus? If so, it may challenge the bioethical principle of human dignity, as well as potentially violate other principles such as non-maleficence and justice. The use of technology to create human-like organisms that may not have the same cognitive potential as human beings might be considered as violating human dignity. Biotechnologies should be used to enhance human beings, animals, and the environment, whereas, technologies that hinder human cognition or intelligence are difficult to ethically justify. **In research and medicine, biotechnological applications should be guided not by what you can do, but rather what you should do.**

Conclusions

It is always difficult to predict which innovative biotechnology will be accepted. When IVF was first introduced in 1978 many scientists and bioethicists speculated that the technology was too dangerous and would result in too many babies born with birth defects. However, as this biotechnology gained widespread acceptance as a viable alternative for infertile couples to have children, the ethical concerns dissipated.

In 2015, according to data collected by Gallup, 15% of Americans believed human cloning to be morally acceptable. That is an 8% increase from the 7% who considered human cloning morally acceptable in 2001 (Newport, 2015).

As of 2015, there are many health and psychological concerns regarding reproductive cloning. If this biotechnology were improved to demonstrate a low risk procedure, and if the medical need for reproductive cloning became established, one could speculate that the ethical concerns related to this new technology may also become diminished.

Bioethical Challenges: Case Scenarios

1. **An unmarried 35-year-old woman desperately wants a child. She has just read that bone-marrow or body fat-derived stem cells can be triggered to differentiate into a potential "sperm-like cell" capable of fertilizing her own ova. She would serve as the gestational mother. What are the underlying bioethical issues that she should consider in making an informed decision about whether or not to differentiate her own stem cells to generate an embryo?**

2. **In 2008, the FDA stated that milk and meat from cloned cattle was safe for human consumption. What are the bioethical issues that emerge from this FDA announcement?**

3. **A hamburger made from cow muscle grown in a laboratory was fried, served and eaten in London in 2013. The cost to prepare this hamburger was about $300,000. Research in producing lab-made meat could provide high-quality protein for the world's growing population while avoiding most of the environmental and animal-welfare issues related to conventional livestock–based meat production. What bioethical guidelines are challenged by this research?**

See the following video on YouTube produced by past students.
https://www.youtube.com/watch?v=pPpZ-ILyiwo

References

Bainbridge, W. S., "Religious Opposition to Cloning." Journal of Evolution and Technology, 13, 2003. [http://www.jetpress.org/volume13/bainbridge.html]

Banchoff, T. F., “Religious pluralism, globalization, and world politics.” USA, Oxford University Press, 2008.

Brock, D. W., "Human cloning and our sense of self." Science, 296(5566):314-316, 2002.

Camporesi, S. and Bortolotti, L., "Reproductive cloning in humans and therapeutic cloning in primates: is the ethical debate catching up with the recent scientific advances?" J Med Ethics, 34(9):e15, 2008.

Church, G., 2013. “Interview with George Church: Can Neanderthals Be Brought Back from the Dead?” Spiegel online (http://www.spiegel.de/international/zeitgeist/george-church-explains-how-dna-will-be-construction-material-of-the-future-a-877634.html).

Frazzetto, G., "Embryos, cells and God." EMBO Rep, 5(6):553-555, 2004.

Hansen, M., et al., "The risk of major birth defects after intracytoplasmic sperm injection and in vitro fertilization." N Engl J Med 346(10): 725-730, 2002.

Holt, W. V., et al., "Wildlife conservation and reproductive cloning." Reproduction, 127(3):317-324, 2004.

Hug, K., "Therapeutic perspectives of human embryonic stem cell research versus the moral status of a human embryo--does one have to be compromised for the other?" Medicina (Kaunas), 42(2):107-114, 2006.

Hyrapetian, M., et al., “Health and disease in children born after assistive reproductive therapies (ART).” *Journal of reproductive immunology*, *106*, 21-26, 2014.

Inoue, K., et al., “Sex-reversed somatic cell cloning in the mouse.” J. Reprod. Dev. 55, 566–569, 2009.

Kass LR. “The wisdom of repugnance: why we should ban the cloning of humans.” *New Repub* **216**:17–26,1997.

Killian, J. K., et al., "Divergent evolution in M6P/IGF2R imprinting from the Jurassic to the Quaternary." Hum Mol Genet, 10(17):1721-1728, 2001.

Lachmann, P., "Stem cell research--why is it regarded as a threat? An investigation of the economic and ethical arguments made against research with human embryonic stem cells." EMBO Rep, 2(3):165-168, 2000.

Lanza, R., et al., "Comment on "Molecular correlates of primate nuclear transfer failures"." Science **301**(5639):1482; author reply 1482, 2003.

May J. “Emotional reactions to human reproductive cloning.” *J Med Ethics*, **42**:26-30. 2016.

McGee, G., "Cloning, the family, and adoption." Sci Eng Ethics, **5**(1):47-54, 1999.

Newport, F., "Americans Continue to Shift Left on Key Moral Issues." Gallup, http://www.gallup.com/poll/183413/americans-continue-shift-left-key-moral-issues.aspx?utm_source=Social%20Issues&utm_medium=newsfeed&utm_campaign=tiles, 2015.

Savulescu, J., “Genetic Interventions and the Ethics of Enhancement of Human Beings.” In Readings in the Philosophy of Technology, edited by David M. Kaplan, 417-430. Lanham: Rowan & Littlefield Publishes, Inc. 2009.

Schwander, T. and Keller, L. “Evolution: sociality as a driver of unorthodox reproduction.”, Curr Biol, 22:R525-527, 2012.

Simpson, B., et al., "Contemplating choice: attitudes towards intervening in human reproduction in Sri Lanka." New Genet Soc, **24**(1):99-117, 2005.

Sutcliffe, A. G. and C. Derom. "Follow-up of twins: health, behaviour, speech, language outcomes and implications for parents." Early Hum Dev, **82**(6):379-386, 2006.

UNESCO The Right to Enjoy the Benefits of Scientific Progress and its Applications. France, UNESCO, 2009.

Young, L. E., et al., "Large offspring syndrome in cattle and sheep." Rev Reprod, **3**(3): 155-163, 1998.

Zavos, P. M., "Human reproductive cloning: the time is near." Reprod Biomed Online, **6**(4):397-398, 2003.