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Cloning Stem Cells

Abstract

Adult human stem cells are undifferentiated cells that can be found in the body of children and adults. They can be shared to replace dying cells and regenerate damaged tissue. They are also known as somatic stem cells, and can be found in children and adults. Use of adult stem cells for research purposes is not as controversial as embryonic stem cells because adult cell production does not require embryo destruction. The stem cell possesses characteristics of self-replication - the cell's ability to pass through several cell division rounds while retaining undifferentiated state and characteristics of unlimited potentials cell ability differentiates into any type of adult cells. Unlimited potential means the potential for differentiation (ie., the potential to differentiate into different cell types) of the stem cell. Potent stem cells are produced by joining eggs and sperm.

Keywords

Stem Cells, DNA, Cloning, Science

Introduction

In some ways, cloning is remarkably simple [1]. The process can be described in just a few words: scientists (in the early twenty-first century) start with a healthy unfertilized egg and an adult cell. They remove the genetic material from the egg and replace it with the genetic material from the adult cell. They then trick this reconstructed embryo into developing as if it were a newly fertilized egg. If all goes well, this cloned embryo is transferred into the womb of a surrogate mother and develops normally. This simple description raises many questions. What is the genetic material inside a cell? Where is it located? Will any adult cell work for cloning or is a specific type required? What is it about an unfertilized egg that allows it to re-program an adult nucleus and lead to normal development? What is normal embryonic development and how can you tell if a cloned embryo is developing normally?

Cloning science incorporates insights gained by biologists working in a wide range of fields and, as we build this parts list, we will review a number of important biological concepts, including heredity, DNA, cells, and mammalian development, and see how important discoveries in these areas paved the way for cloning. Cloning can be used for therapeutic purposes and therapeutic cloning holds out the promise of new medical interventions and cures [2]. The damage done by degenerative disorders such as Parkinson's disease or Alzheimer's disease might be reversed, that is, therapeutic cloning is looking for new ways to provide regenerative cures for degenerative disorders.

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Siniša Franjić*

Faculty of Law, International University of Brcko District, Brcko, Bosnia and Herzegovina

***Address for Correspondence**

Siniša Franjić, Faculty of Law, International University of Brcko District, Brcko, Bosnia and Herzegovina, Europe

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There are supporters and opponents for therapeutic cloning. Most of the supporters are in the camp of biomedical and healthcare research while most of the opponents are in the religious camp. In fact, many in the community of therapeutic cloning are feeling the stigma of being associated with cloning. Its proponents fear that the two kind of cloning - therapeutic and reproductive, have merged in the public's mind. At least some leaders in therapeutic cloning have voiced not to call the field "therapeutic cloning," but anything else such as nuclear transplantation or stem cell research.

Cloning can also be used for reproductive purposes. This is where there is a lot of confusion. When people say they are against reproductive cloning, they fail to draw a clear distinction between purposefully cloning of a whole individual and cloning used in assisted reproduction. Cloning of whole individuals is a distasteful idea to most people, so is the idea of purposefully propagating a family of clones. But cloning may be justifiable in cases where a woman may not be able to reproduce successfully on her own. Eventually research may prove that human cloning used as a form of assisted reproduction can be done at no greater risk to the child than in vitro fertilization (IVF). In fact, reproductive cloning can be a part of IVF: cloning technique such as artificial twinning can be used to increase the number of embryos for implantation, thus increasing the success rate of IVF.

DNA

Although “like begets like” is a truism dating from ancient times, it was only recently, in the twentieth century, that scientists started to understand the mechanism of heredity, or how junior ends up with his father’s jaw and his mother’s curly brown hair, not to mention grandpop’s knack for numbers and grandma’s not-so-reliable memory [1]. This understanding, incomplete as it is, relies on the identification of deoxyribonucleic acid, DNA, as the genetic material and on the understanding of DNA that scientists have developed since

its structure was first described in 1953. Just as identical twins are identical because they share a DNA sequence, clones are clones because they share a complete (technically, a nearly complete) set of DNA. For this reason, we will examine the basics of DNA, focusing on its structure and how its sequence codes for proteins.

Although the discovery of DNA's role in heredity was a key step in the development of cloning technology, understanding DNA is not enough. What really matters is the relationship between DNA and cells, the building blocks of life. The smallest organisms consist of just a single cell, while humans are made up of countless trillions. Almost without exception, every cell contains a full complement of an organism's DNA. Further more, when a cell replicates and divides, its DNA, in a carefully choreographed dance, replicates and divides as well.

It is probably impossible for a person to commit a crime without leaving behind a trace of his or her DNA [3]. Hairs, spots of blood, and even conventional fingerprints contain traces of DNA, enough to be studied using the polymerase chain reaction (PCR). The analysis does not have to be done immediately, and in recent years a number of past crimes – so-called 'cold cases' – have been solved and the criminal brought to justice because of DNA testing that has been carried out on archived material. So how do these powerful methods work?

The basis to genetic fingerprinting and DNA profiling is that identical twins are the only individuals who have identical copies of the human genome. Of course, the human genome is more or less the same in everybody–the same genes will be in the same order with the same stretches of inter genic DNA between them. But the human genome, as well as those of other organisms, contains many polymorphisms, positions where the nucleotide sequence is not the same in every member of the population. They include restriction fragment length polymorphisms(RFLPs), short and emrepeats (STRs), and single nucleotide polymorphisms (SNPs), the latter being positions in the genome where either of two different nucleotides can occur. All three types of polymorphism can occur within genes as well as in inter genic regions, and altogether there are several million of these polymorphic sites in the human genome, with SNPs being the most common.

Stem Cells

Stem cells are the body's cellular repair mechanism [1]. They are a specialized class of undifferentiated, or partly differentiated, cells, whose role is to replenish the population of mature differentiated cells. Many stem cells are partially differentiated and under normal circumstances give rise to only a small subset of differentiated cell types. Embryonic stem cells, in contrast, are a special class of stem cells, found only in the inner cell mass of developing embryos. They are undifferentiated and can give rise to all the cell types of a mature organism. Scientists refer to this ability of one cell type to give rise to any other type as "totipotency" and the ability of a cell type to give rise to many, but not all, other cell types as "pluripotency." Scientists typically classify human embryonic stem cells as pluripotent, since in normal development they do not give rise to the placenta or other extra-embryonic cells. During normal development, embryonic stem cells quickly differentiate and lose their trademark developmental flexibility. However, it is possible to isolate these cells from developing embryos and grow them in culture. These cultured embryonic stem cells can, if carefully tended, remain in their undifferentiated state almost indefinitely, allowing scientists to grow large numbers of them; a key step toward the development of any stem cell based therapies.

Stem cells can be isolated in the early embryo (whether created through standard fertilisation or through cell nuclear replacement); the fetus; and also from blood taken from the umbilical cord [3,4]. Stem cells may also be isolated from tissues in children and adults. Stem cells represent arichre source for research because of the irpotential to develop foral ongperiod of time while stun differentiated. They may also develop into particular specialist cells such as nerve cells, muscle cells or cells which produce insulin. Embryonic stem cells are a particular rich resource because they are "pluripotent". This means that they can develop into any one of a range of 200 cell types. Stemcell technology is being developed with the aim of creating replacement tissue or cells, and treatment of serious chronic conditions such as chronic heart failure and stroke or spinal cord injuries. Considerable publicity has been given to the interest expressed in this technology by the well-known actor Christopher Reeve, who was paralysed after a riding accident. There are considerable ethical issues that arise consequent upon this technology. Whilst this technology is far more restricted in terms of ethical impact than reproductive cloning, nonetheless use of embryonic stem cell technology will mean the destruction of human embryos, which is regards being ethically objection able by those who are associated with "pro-life" groupings.

Embryonic Stem Cells

Many cells look alike and scientists must take steps to show that the cells they isolate are truly embryonic stem cells rather than similar-looking but less flexible cells [1]. Several methods exist to make this case. One approach is to show that the cells can give rise to cancerous growths, called teratomas, when transplanted into immune-deficient mice. Teratomas-literally "monster tumors" - contain a wide variety of differentiated cell types and their formation is taken as evidence of pluripotency. Embryonic stem cells will also spontaneously differentiate into spherical structures, known as embryoid bodies, in certain culture conditions. If scientists can verify that cells from all three primary tissue layers are present in an embryoid body, this is also taken as evidence of pluripotency. The most stringent method to verify pluripotency is known as tetraploid embryo complementation. In this procedure, putative embryonic stem cells are injected into a blasto cyst-stage embryo that has been modified so that it cannot develop on its own. When pluripotent embryonic stem cells are injected near the inner cell mass, they rescue this embryo and normal development can occur. In this case, the organism is derived entirely from the injected cells, while the extra-embryonic membranes are derived from the original modified embryo. This technique conclusively proves that cells are pluripotent, by showing that they can give rise to an entire organism. It

cannot, however, for obvious ethical reasons, be used with human cell lines.

Humanembryonic stemcells are of scientific and medical interest because of their ability to develop into different tissue types and because of their ability to be propagated for many generations in laboratory culture [5]. Grown in a laboratory, they might one day be used in the treatment of degenerative diseases such as Parkinson's and Alzheimer's. They could provide bone cells for the treatment of osteoporosis, eye cells for macular degeneration, blood cells for cancer, insulin producing cells for diabetes, heart muscle cells for heart disease, nerve cells for spinal cord injury. The potential for benefit to so many people is a strong argument for doing - and funding - embryonic stem cell research. Yet ESC research is very controversial because the derivation of ES cells - at least at the present time - destroys the embryo. Thus, the morality of ESC research depends primarily on the morality of destroying human embryos, raising the question of the moral status of the human embryo.

Transplant Therapy

Since all human embryonic stem cells have the theoretical potential to develop into any cell type, you might be wondering why cloned embryos are the most medically promising [1]. The answer is simple but important: stem cell lines from cloned embryos may be able to avert immune rejection, a serious problem with transplant therapies. Rejection occurs when the immune system recognizes transplanted material as foreign and mobilizes to attack it. This attack may be rapid and strong – acute rejection – or it may be milder and persist for longer – chronic rejection. Either can lead to destruction of the transplant. Transplant therapies have improved dramatically over the last half century but immune rejection remains a challenge. A key advance was the development of immunosuppressive drugs such as Cyclosporin, which was introduced in 1978. It, and similar drugs developed more recently, reduce this prevalence but at a cost. Transplant patients typically must take these drugs for life and suffer unpleasant side effects. In addition, suppressing the immune system increases a patient's risk of developing other infections.

The use of cloned embryos to create embryonic stem cell lines may overcome these immune rejection complications and simplify transplant therapy. If the transplanted material is genetically identical to the host, the immune system should not recognize it as foreign and thus immune rejection should not occur. The use of cloning by somatic cell nuclear transfer, if the technique is perfected for use with humans, should allow the development of embryonic stem cell lines genetically identical to patients. From there, scientists hope to direct the differentiation of these patient-matched cells into specific cell types that may be useful in therapies. Finally, mature differentiated cells would be transplanted to the patient.

Ethical Questions

The ethical debate over therapeutic cloning, and human embryonic stem cell research more generally, is less complex but no less contentious than the debate over reproductive cloning [1,5]. Scientists studying human embryonic stem cells and therapeutic cloning have a noble goal, the alleviation of human suffering. It is not the ends of human embryonic stem cell research but the means that generate disagreement and debate. As we have seen, to move toward this noble goal scientists use pre-implantation human embryos in their research. Although the embryos are donated explicitly for this purpose, if (against the donor's wishes) these embryos were transferred to a uterus, they might survive and develop into healthy children. This possibility, however remote, leads to the ethical question that frames the field: should embryos with some chance of life be used as a means to try to reduce the suffering of others?

This, as in most ethical debates, is a question about which reasonable people can disagree. At its heart, this debate is about differing views of what it means to be a person and whether human embryos deserve full moral status. We grant moral status to an individual or a class of individuals when we acknowledge that their wishes, desires, and rights should be considered in our decision-making. Almost everyone grants full moral status to a healthy child: nobody argues that it is appropriate to harm such a child for our own gain but few grant any moral status to a single human skin cell or an unfertilized egg. There is a large gray area in between, particularly in the time between fertilization and birth. Some believe a fertilized egg, which in the correct environment has the potential for independent life, should be granted full moral status equivalent to that of an independently living and breathing human being. Others disagree, believing an embryo should not be granted this status until it reaches later stages of development.

The goal of therapeutic cloning or research cloning is not the birth of a new human being, genetically identical to the cell donor [6]. Instead, the long-term objective is the production of tissue structure or entire organs as a cure for serious degenerative diseases (brain and nerve afflictions, Alzheimer's, Parkinson's). The reference to research cloning conveys that, for the time being, the attainment of fundamental academic knowledge about the development and (re)programming process of pluripotent stem cells and their control is necessary. Practically, in the Dolly method, a body cell is implanted into an unfertilized egg cell hereby making it possible to breed a blastocyte, from which one, in turn, seeks to extract stem cells. These can then be further developed into replacement tissue or even organs. For the time being, only the first step is possible, as was recently demonstrated by South Korean scientists through the production of a clone embryo. The bioethical and constitutional objections correspond in part with the objections against research on (surplus or specifically produced) early embryos. They relate partly to the fact that if events had transpired differently, new ground would be broken for the general use of incriminated reproductive clones.

Uniqueness

It has been suggested that humans possess something called "a right to uniqueness," and that this profound right could be

violated by cloning [7]. The suggestion is problematic in two obvious respects. The existence of identical twins, and the fact that most cultures do not see a moral problem in their inherited similarity, seems to suggest that even if such a right existed, it would not be absolute, or even very highly valued. Further more a clone would in most cases be less of an exact genetic copy of its "sibling" than an identical twin, because the mitochondrial DNA of clones comes from the egg used, not from the nucleus transferred, and this makes the clones, even genetically speaking, unique (unless, of course, the egg and the nucleus are from the same person). Besides, a clone would also be unique, because it would be brought up in a different environment; it would be subject to non repeatable experiences in changing surroundings; and it would thus develop into an individual of its own.

Despite these problems, attempts have been made to argue that intentionally creating a genetic copy of a human being would violate the right to uniqueness, although the existence of identical twins does not. Most people holding this view seem to believe that the uniqueness of identical twins is based on their "natural" or "God-given" origins. Uniqueness is valuable to people, just like health is valuable to people. Not all people are healthy, but they are nevertheless as worthy as human beings as those who are. There is, however, something wrong about ill-health and, therefore, intentionally making others experience ill-health is wrong. Analogically, although identical twins are as worthy as other people, there is, however, something wrong in not having a unique genetic constitution, and, therefore, intentionally creating identical genotypes is wrong. However, the argument from uniqueness only works (at least in a secular setting) if we think that there is something wrong in not having a unique genotype, that is, if we think that there is something wrong in being a twin. But even if we held this rather discriminatory view, it would not follow that clones would be less valuable as persons. It is only if we thought that there is something less valuable about twins per se that we could assign a lesser value to clones, too. Since this is not the case, we should conclude that, in the light of this argument, a person born with the help of cloning processes would be as important an individual as those born through the more conventional methods of reproduction.

One such counter argument has been rooted in the notion of human dignity, together with others like uniqueness and respect [8]. These qualities appear in the introduction of the first international statement in the field of bioethics, the Universal Declaration on the Human Genome and Human Rights adopted in November 1997 by UNESCO, including a specific article taking the replication of identical human beings as an example of violation of dignity. The UNESCO declaration on the genome places human dignity in the context of uniqueness, whilst the CCNE (French National Ethics Committee) report to the French President starts with the caveat that personal identity and genetic identity are not to be confused, stressing that human cloning would totally disrupt the relation or balance between genetic and personal identity. The argument of dignity is underlined, using the Kantian categorical precept - 'to treat each and everyone as an end to them selves and not merely as a means to an end.'

Of course we know that a clone obtained by somatic cell nuclear transfer would not be totally identical to the adult donor of the nucleus, because of the recipient cytoplasm bearing the maternal mitochondria; but more importantly, the same argument can be used against reproductive cloning by embryo-splitting and transfer to different surrogate mothers at different times. To quote the report: It would be absurd to consider that an adult and his clonal duplicate who must necessarily be born much later, and is bound to have a different life history, could be to any degree presented as two copies of a single and identical person. To believe such a thing would be to fall victim to the reductive illusion which is born of the dismal confusion between identity in the physical sense of sameness(idem) and in the moral sense of selfness (ipse).

Scientific Evidence

As far as reprogramming technologies of human cells and of human cloning are concerned, scientific evidence and additional uncertainties will not allow to use either one of these technologies in producing embryonic constructs [9]. Embryonic constructs are not embryos in the traditional sense as they are not derived from the merging of two nuclei of haploid genetic property. No medical oversight or regulatory body would approve experimenting with embryonic constructs for reproductive purposes; no quality standards can yet be written; even topics and requirements for such quality features can not be formulated today. However, the actual situation of scientific ignorance in cell programming and nuclear transfer should not exclude ethical and religious discourse on using these technologies in the future for reproductive purposes; such a discourse would be useful, even warranted for self-understanding and self evaluation of individuals, communities, cultures and for eventually preparing for future national and international legislation and regulation. It has been argued that some people, particular in traditional Asian culture favoring male off springs, would somatic cell nuclear transfer techniques to produce babies, if originally developed for therapeutic purposes. However, such a suggestion underestimates cultural family quality standards of potential users of re-programming technology, expecting a "dream child" or at least "any normal child" and not a product resulting from an embryonic construct of unknown and questionable genetic mix-up and disorder.

The potential use of cell reprogramming and somatic nuclear cell transfer for therapeutic purposes and medical research represents a different set of technical and moral risk. Saving of life, the curing of diseases or at least the alleviation or reduction of pain and suffering has been one of the prime and undisputed moral goods in all cultures and in demand by individuals, communities and societies; experts in these fields have been gratefully honored and praised. Medical research and medical treatment finds religious and humanist support everywhere and is asked for and demanded by citizens as being vulnerable and mortal beings. It is out of question that medical research and treatment need to be "safe" and need to involve "informed consent or contract" of pro bands or patients, as pro bands or patients might decline participation in some or all research or refuse certain forms treatment based on their

individual understanding of moral or medical risk.

Conclusion

There is controversy over stem cell research due to the technique of creating and using these cells. Human embryonic stem cell research is particularly controversial because with the current state of technology, cell culture initiation requires the destruction of human embryo and/or therapeutic cloning. Opponents of the research emphasize that this practice is slippery ground. On the other hand, some researchers insist that it is necessary to conduct such research because new technologies discovered could have significant medical potentials and that remains of embryos created for in vitro fertilization could be donated for research. This is in direct conflict with the movement's advocates, who believe that the human embryo is also a living being. Many governments around the globe have therefore started regulating that topic. For example, former US President Bill Clinton signed a bill in 1995 that prohibits to the state financing research in which are created or destroyed human embryos.

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