

## **Embryonic Stem Cell Research**

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Stem cell research is a controversial issue that has received considerable attention over the last three decades. Stem cell research began in the early 1980's, when stem cells were obtained from mice embryos and utilized to understand the functioning of stem cells (Grivennikov, 2008). In 1998, researchers discovered techniques for obtaining embryonic stem cells from human and growing them in laboratories. Since then, substantial research has been conducted on stem cells and their potential uses, which includes increasing our understanding of diseases and how they occur, treating various diseases, and testing new medications for safety and efficacy (Taylor, 2005).

Stem cells possess unique properties that differentiate them from other types of cells. Most cells in the body are specialized and have specific functions, such that they play a specific role in the body. Stem cells are unspecialized; they do not serve a specific role in the body (National Institutes of Health, 2016). Stem cells can, however, give rise to specialized cells through a process called differentiation. Differentiation is a normal process that occurs prenatally, however it can also occur in childhood and adulthood. When a zygote develops, it begins as one cell. The cells begin to divide, and give rise to an embryo. The cells begin as undifferentiated or unspecialized cells (stem cells), and eventually give rise to specialized cells, which form various organs and structures of the body. Stem cells are cells which have not gone through differentiation (National Institutes of Health, 2016).

Another unique property of stem cells is that they are able to proliferate (National Institutes of Health, 2016). This means that they are able to divide and replicate themselves for a long

period of time. Other cells in the body, such as muscle, blood, or nerve cells, cannot replicate themselves or can only replicate themselves a limited number of times before wearing down. Stem cells may divide and replace themselves with another stem cell or with a differentiated cell. If a stem cell is able to continuously replace itself with undifferentiated cells, then the stem cell has a quality known as long-term self-renewal (National Institutes of Health, 2016).

There are two main types of stem cells: embryonic stem cells and adult stem cells.

Embryonic stem cells are obtained from embryos. For embryonic stem cell research, the embryos come from eggs that have been fertilized in vitro, that is, they do not come from eggs that have been fertilized in women's bodies (Taylor, 2005). Many embryos are obtained from individuals seeking services at an in vitro fertilization clinic. With the donor's consent, researchers are able to use leftover eggs from in vitro procedures. Other methods of obtaining embryos are possible, however they must adhere to strict guidelines set up by the International Society for Stem Cell Research. The National Institutes of Health (NIH) also has guidelines for human stem cell research that outlines current policy and funding information for stem cell research in the U.S.

Adult stem cells are undifferentiated cells that are found in a tissue or organ of an individual (National Institutes of Health, 2016). They can renew themselves to create differentiated cells of the given tissue or organ. The main purpose of adult stem cells is to maintain and repair the damaged cells of the tissue or organ they are found in. Adult stem cells are found throughout the body, including the heart, brain, skin, blood, teeth, and bone marrow. A limited number of stem cells exist in each tissue, and when they are removed from the body, their ability to divide is limited. This makes it difficult for researchers to grow large enough samples of adult stem cells to study them. While adult stem cells generally differentiate into cells of the tissue in which they reside, there is some evidence that transdifferentiation is possible (Lo

& Parham, 2009). Transdifferentiation is when adult stem cells differentiate into cells from other types of tissues. Transdifferentiation has been observed in other species, however it is unknown as to whether transdifferentiation can occur in humans. Adult stem cells can, however, be genetically modified to become another type of cell, or to become an embryonic-like stem cell (National Institutes of Health, 2016). An undifferentiated cell created by an adult stem cell is known as an induced pluripotent stem cell (iPSC).

Stem cells have several important potential uses. Embryonic stem cells can improve our understanding about human development, the differentiation process, and how diseases occur (Taylor, 2005). For example, cancer and certain birth defects are a result of abnormal cellular division and differentiation. Understanding the differentiation process may help researchers better understand, prevent, and treat these conditions. In addition, stem cells are currently being used to test new medications, so as to assess their safety and efficiency. Finally, stem cells can be used to treat diseases, in a process known as cell-based therapy or regenerative medicine (National Institutes of Health, 2016). Because organ and tissue availability are limited for transplants, stem cells that are directed to differentiate into a specific cell can provide an alternative solution. For example, stem cells can be directed to create insulin-producing cells that can be used to treat those with type I diabetes. Other potential uses for stem cell treatment includes treating heart disease, stroke, spinal cord injury, burns, and arthritis (National Institutes of Health, 2016; Grivennikov, 2008).

The use of embryonic stem cells poses several advantages over the use of adult stem cells. Embryonic stem cells can differentiate into any type of cell, whereas adult stem cells differentiate into the cell in which they originate (National Institutes of Health, 2016). Embryonic stem cells can also grow easily in a laboratory culture, whereas adult stem cells are

difficult to extract from the body and grow in a lab. This limits its use for replacement therapy, as a large number of cells are needed for treatment. Adult stem cells are also more likely to have abnormalities from toxins, the environment, or cell replication errors. A major disadvantage of using embryonic stem cells for replacement therapy is that they pose a higher risk of rejection after the procedure. Adult stem cells and their derivatives are less likely to trigger a rejection by the immune system, as the cells originate from the body and not from another source. This concept is theoretical, however, as few studies have tested the safety of cells transplanted from embryonic stem cells (National Institutes of Health, 2016; Grivennikov, 2008).

### **Argument 1:**

The use of embryonic stem cells poses serious ethical dilemmas regarding the destruction of human life and the possibility of human cloning (Taylor, 2005). An embryo is an early form of life, such that an embryo is a living being that will give rise to a human. During the process of collecting stem cells from embryos, the embryo is destroyed. To utilize and destroy embryos for research purposes is ethically wrong, as to destroy an embryo is to destroy a potential human life (Taylor, 2005). Even at the embryonic stage, basic human rights need to be upheld and protected. Furthermore, with the advent of induced pluripotent stem cells (iPSCs), researchers have the potential to create human embryonic cells, which could theoretically create a clone of the individual the iPSC was derived from. While many argue that therapeutic cloning has many benefits, which involves cloning specific cells and tissues for medical interventions, researchers have not been successful in accomplishing therapeutic cloning in humans. Most countries currently have bans on reproductive cloning, or cloning an entire human, however bans on therapeutic cloning are controversial. It is unknown as to whether or not therapeutic or reproductive cloning is safe for human, as cloning has the potential to lead to numerous defects.

In addition, hundreds of cells are needed to successfully clone, making the procedure impractical (National Institutes of Health, 2016).

Very little is known about the safety and efficacy of using embryonic stem cells for treatment purposes (Taylor, 2005). Completing an embryonic stem cell transplant may possibly be detrimental for the recipient of the transplant, as it may lead to immune system rejection, formations of tumors, and unknown long-term outcomes (Lo & Parham, 2009). Medications used to treat transplant rejections, such as immunosuppressants, also have many dangerous side effects. Because the medications weaken the immune system, individuals taking these medications are at a higher risk for developing infections. They are also at a higher risk for developing certain types of cancers and for organ failure. In addition, the costs of stem cell transplants are incredibly high, and the procedures are considered experimental and are generally not approved by the FDA. As a result, many insurance companies do not cover stem cell transplants, which significantly limits the benefit-cost ratio of receiving stem cell transplants. In a study on the costs of medical treatments for those with acute myeloid leukemia, Uyl-de Groot, Gelderblom-den Hartog, Huijgens, Willemze, and van Ineveld, (2001) found that the cost of extracting stem cells cost \$6,491, and the costs of the transplant ranged from \$25,531 to \$44,087. Follow-up medical care was found to cost \$4,167.

The negative aspects associated with the use of embryonic stem cells outweighs the benefits associated with it. Embryonic stem cell research violates basic human rights, and may potentially give rise to human cloning. The safety and efficacy of embryonic stem transplants are largely unknown, and the costs of carrying out the procedure is tremendous. As a result, embryonic stem cell research should be discontinued, and other research and treatment modalities should be explored.

## **Argument 2:**

Embryonic stem cell research and its clinical application provide revolutionary possibilities for the medical world. The research provides treatment for numerous diseases and can help us better understand and prevent diseases. It provides alternative solutions to many problems faced during medical interventions and serves as a way of improving our quality of medical care.

While the use of embryonic stem cells is still underway, the use of adult stem cells has already proven to be beneficial and successful. Adult stem cell transplants have largely been used for bone marrow transplants for patients with leukemia (Uyl-de Groot et al., 2001; National Institutes of Health, 2016). Transplant success in these patients provides a promising future for the application of stem cell research, and has led researchers to explore other possible uses for stem cells and other forms of stem cells. Because embryonic stem cells can more easily differentiate into different types of cells and grow in a laboratory culture, embryonic stem cells serve as a source of renewable cells that can be used for research and treatment (National Institutes of Health, 2016). This is particularly useful for individuals needing organ transplants. Most individuals needing an organ transplant have to wait a substantial amount of time on a transplant waitlist, and many individuals die in the process. Embryonic stem cell procedure offers a viable solution to this issue.

Many opponents of embryonic stem cell research argue that the destruction of embryos for research purposes is unethical. Others are against the use of cloning for therapeutic purposes. While the opposition to the destruction of potential human life is understandable, many of the embryos utilized for research purposes are embryos left over from in vitro fertilization procedures, most of which would otherwise be discarded (Lo & Parham, 2009). Throwing away

unused embryos is a terrible waste, when the embryos could instead be used for the betterment of modern medicine and to save numerous lives (Lo & Parham, 2009). In addition, because embryos used in research purposes are grown in petri dishes, they are unable to sufficiently grow into a fetus, differing its destruction from the destruction of an embryo in utero (Taylor, 2005). This is also the case for embryos created by cloning existing cells, as our current knowledge of cloning is limited and does not allow us to successfully reproduce a human safely (Taylor, 2005). As a result, bans on embryonic stem cell research should be carefully considered, as discontinuing its research may limit potential scientific and medical advances and treatments. Instead, careful considerations and regulations should be utilized when conducting stem cell research, so as to ensure the privileges and safety of all parties involved in its research and treatment. Guidelines for conducting embryonic stem cell research have already been put in place, however other avenues for conducting stem cell research may also be considered.

A recent advancement in stem cell research is the development of induced pluripotent stem cells (iPSCs). iPSCs are derived from adult cells, however they have been genetically reprogrammed to have qualities similar to embryonic stem cells (Grivennikov, 2008). Human iPSCs have been found to produce cells of various tissues and to produce cells in each of the three germ layers. iPSCs may provide a safer alternative to the use of embryonic stem cells. Because iPSCs are derived from adult cells, they are less likely to be rejected by the immune system of the individual in which the cells were derived from (Grivennikov, 2008). Furthermore, iPSCs may provide a better way of fixing damaged cells and reprogramming cells that may be predisposed to have deficits. As a result, stem cell-based therapies rely heavily on the advent of iPSCs, and research on iPSCs are necessary for the advancement of these treatments (Grivennikov, 2008).

**Conclusion:**

Embryonic stem cell research poses many potential advantages and disadvantages that require extensive consideration for future policies regarding its use. Because of the many potential benefits that embryonic stem cell research can offer, embryonic stem cell research should continue to be explored and utilized. However, further research is needed to improve our understanding and application of embryonic stem cells in clinical settings. In addition, alternatives to embryonic stem cells, specifically iPSCs, require future attention and research. Finally, clearly outlined policies regarding the implementation of stem cell research are needed, in order to carefully regulate its use and reduce ethical issues associated with it.

iPSCs are a promising addition to the future of stem cell research. Because iPSCs are artificial embryos that lack the capability to produce a fetus, iPSCs evade the ethical dilemma regarding the collection and destruction of human embryos (Taylor, 2005). iPSCs grow easily in a laboratory setting similar to embryonic stem cells, and their differentiation process is able to be directed (Taylor, 2005; National Institutes of Health, 2016). iPSCs, however, are not well understood, and their use may be accompanied by dangerous side effects. For example, studies on mice have demonstrated iPSCs to cause tumors (Grivennikov, 2008). Alternative ways of reprogramming adult cells are needed to increase the safety and utilization of iPSCs in medical settings.

Finally, future policies are needed to clearly outline embryonic stem cell research guidelines. Currently, there are no federal laws that ban stem cell research in the U.S., however there are national restrictions on the how researchers gain access to embryos and funding for their research (Taylor, 2005). Policy makers have wavered in their views towards stem cell research and its use, such that policies have changed several times over the last two decades.

The passive approach taken by the current federal policy, limitations on funding, and variations in state laws significantly hinder the implementation and application of ethical stem cell research (Taylor, 2005). Future policies are needed to clearly outline embryonic stem cell research guidelines, so as to increase its utilization in a safe, ethical, and effective manner.

In conclusion, while embryonic stem cell research poses several ethical dilemmas, it allows for numerous significant scientific advancements that may revolutionize modern medicine. As a result, embryonic stem cell research should be carefully explored and regulated, so as to allow for scientific advancements while also discovering ways to diminish the ethical concerns it poses. Future research is needed to better understand embryonic stem cells, their clinical use and safety, and ways to avoid the destruction of embryos when conducting research and stem cell treatments. In addition, other similar research avenues, such as iPSCs, should be explored in order to maximize the potential benefits gained from stem cell research.

### **Further Readings:**

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