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Stem Cell Research: Medical Ramifications vs. Ethical Risks

Background

Stem cells are the basis for every organ, tissue and cell in the human body. Unlike a regular cell that performs its specific job and dies, the stem cell is capable of self-renewal and matures into other cell lines in the blood (Gifford). There are two broad types of mammalian stem cells- embryonic stem cells and adult stem cells (“Stem Cell”). Embryonic stem cells can develop into any kind of cell type or tissue, and for that reason have the potential to reverse various diseases and injuries. Adult stem cells are found in tissues that

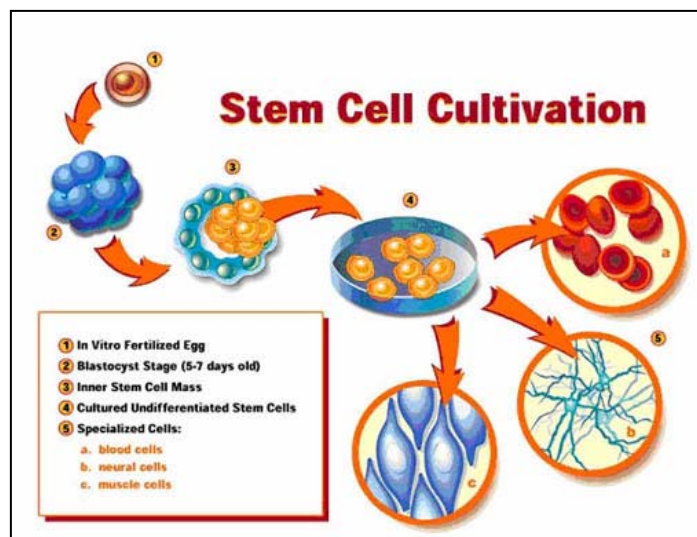


Image 1: Stem cell cultivation can be summarized into 5 steps, which are shown in the figure above.

have already developed, and can only be used to repair the types of organs or tissues they come from. Also, adult cells can only grow inside the body and have to be immediately frozen or transplanted into the patient, whereas embryonic stem cells can be replicated outside the body, eventually helping many patients (Gifford). Embryonic stem cell research

begins by extracting stem cells from the inner cell mass of a blastocyst. A fertilized egg, called the zygote, divides and forms two cells; each of these cells divides again, and so on. Eventually, the divisions form a hollow ball of about 150 cells called the blastocyst (a microscopic clump of cells that could hypothetically develop into a fetus if attached to a uterine wall). The blastocyst contains two types of cells: the trophoblast and the inner cell mass (“Frequently Asked Questions”). At this stage, researchers destroy the embryo and extract its stem cells, which are valued because they are extremely flexible, capable of turning into any type of cell in the human body. Opponents say such research is immoral because it involves creating and then killing human life in the name of scientific advancement. Supporters of research, however, say that the blastocyst is not equivalent to a human being; they believe embryonic cells have great potential to cure a wide range of diseases, such as Parkinson's, diabetes and Alzheimer's (Simon).

Scientific Progress

In 1908, the term “stem cell” was proposed by Alexander Maksimov, a Russian histologist, at congress of hematologic society in Berlin (“Stem Cell”). Human embryonic kidney cells were first used in 1954 when Nobel Prize winner John Enders managed to cultivate poliovirus inside them. In 1964, researchers discovered that a single cell in teratocarcinomas (a type of cancer) could be isolated and remain undifferentiated in culture. These types of stem cells were named embryonic carcinoma cells, or EC cells.

Hematopoietic stem cells were discovered in 1978. These self-generating cells, found in cord blood, can form multiple cell types. In 1981, the first isolation of embryonic stem cells in mice was performed. Gail Martin, a researcher at the University of California, named them

“embryonic stem cells”. James Thomson reported the first successful isolation and culturing of human embryonic stem cells in 1988.

In 1991, a cord blood stem cell transplant was completed on Natalie Curry, a young girl suffering from Fanconi anemia (a genetic disease resulting in bone marrow failure). Since none of her relatives were positive matches for a bone marrow transplant, Natalie had cord blood successfully transferred to her from her neonatal sister Emily.

Scientists discovered that leukemia originates from hematopoietic cells in 1997. In 1998, James Thomson isolated cells from the inner cell mass of the early embryo, developing the first human embryonic stem cell lines. He successfully removed cells from spare embryos at fertility clinics and grew them in a laboratory, establishing the world's first human embryonic stem cell line. Within the same year, John Gearhart of Johns Hopkins University obtained human embryonic germ cells from cells in fetal gonadal tissue (primordial germ cells). Pluripotent stem cell lines (cells that can rise to any fetal or adult cell type) were developed from both sources.

In 1999, researchers at Johns Hopkins University used adult stem cells from bone marrow and turned them into cartilage, fat and bone cells “in vitro”, or inside a lab. In 2002, Stanford University announced it that it would be using somatic nuclear transfer technology to develop a new series of stem cell lines. In 2003, Dr. Songtao Shi of the National Institutes of Health discovered adult stem cells in children's baby teeth.

In January 2007, Dr. Anthony Atala of Wake Forest University discovered stem cells in amniotic fluid. The discovery could provide a substitute for embryonic stem cells in research and therapy. In November, a team led by Shoukhrat Mitalipov of Oregon Health and Science University in Portland created cloned primate embryos and used them to make embryonic

stem cells. This led to speculation that the breakthrough might allow the same to be done with human embryos. That same month, two teams of scientists announced that they had genetically reprogrammed skin cells to take on the traits of embryonic stem cells. This discovery allows scientists to conduct stem cell research without the using embryonic cells.

In January 2008, researchers created new lines of embryonic stem cells without destroying human embryos in the process. In April, scientists in Canada managed to grow human heart cells from embryonic stem cells. Researchers hope the lab-created heart cells can be used to repair heart tissue that is damaged during a myocardial infarction, or heart attack. In August, Scientists announced the transformation of one type of pancreatic cell into another in laboratory mice. This means scientists may not have to use embryonic stem cells to achieve the same results in humans (“Stem Cells Timeline”).

Political Retrogress

In 1993, President Bill Clinton signed the National Institutes of Health (NIH) Revitalization Act of 1993, which allows fetal tissue transplant research. He also created the NIH Human Embryo Research Panel to study the ethics of fetal and embryonic research. In 1995, Clinton signed the Dickey Amendment into law. This law prohibits all federal funding for research that results in the destruction of an embryo, regardless of the source of that embryo. It specifically prohibits the creation of embryos for research purposes.

In 2000, The NIH announced new guidelines for federal funding of stem cell research. The guidelines prohibited federal funding for researchers to obtain stem cells by destroying embryos, but allowed them to conduct research on cells taken from embryos previously destroyed by privately funded sources. In 2003, the U.S. House of Representatives passed the Human Cloning Prohibition Act, which bans both reproductive and therapeutic cloning.

In March of 2004, the President's Council on Bioethics recommended a ban on reproductive cloning but supported stem cell research on embryos 14 days old and younger. In November of that same year, California approved Proposition 71, which provides state funds for human embryonic stem cell research. In 2005, President Bush signed the Stem Cell and Therapeutic Research Act of 2005, which created a federal program to collect and store cord blood.

In 2006, President Bush vetoed the legislation expanding federal funding for stem cell research. He explained his actions by saying, "If this bill would have become law, American taxpayers would, for the first time in our history, be compelled to fund the deliberate destruction of human embryos. And I'm not going to allow it. (Stem Cells Timeline’)."

Medical Advancements

There have already been various medical advancements derived from stem cell research. Hematopoietic stem cell transplantation, or bone marrow transplant, is the transplantation of blood stem cells from the bone marrow. Many recipients of bone marrow transplants are leukemia patients who would not benefit or are already resistant to chemotherapy. Other candidates for transplants include children born with defects such as severe combined immunodeficiency (a disorder which leaves its victims extremely vulnerable to infectious diseases), congenital neutropenia (a disease resulting in a low amount of white blood cells), and aplastic anemia (a condition in which the bone marrow does not produce enough new cells to replenish blood cells). Other conditions treated with stem cell transplants include sickle-cell disease (a disorder that decreases the cell's flexibility), neuroblastoma (the most common cancer of infancy), and Hodgkin's disease (a cancer that spreads from one lymph node to another) ("Hematopoietic Stem Cell Transplantation"). Autologous cord blood

transplants (where blood is reimplanted in the same individual that it came from) has been used to treat numerous diseases. Type 1 Diabetes, also known as Juvenile Diabetes, has been

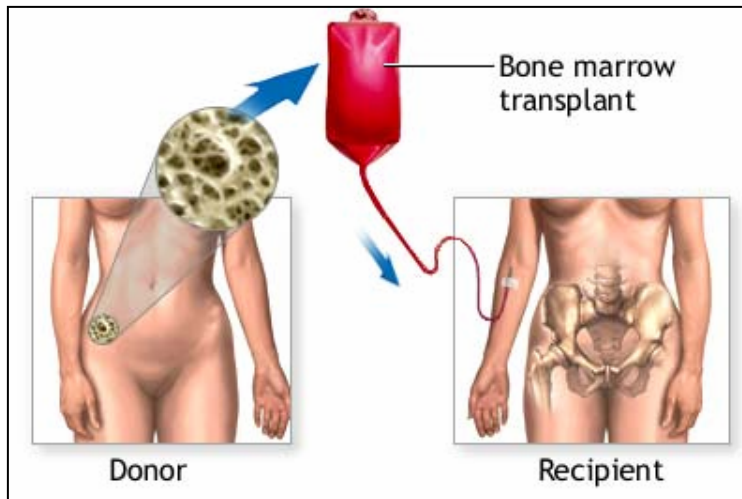


Image 2: In a bone marrow transplant, the patient's diseased bone marrow is destroyed and healthy marrow from a donor is infused into the patient's blood stream.

shown to improve if treated shortly after onset with an infusion of autologous cord blood. Neuroblastoma and aplastic anemia can both be treated with autologous transplants, and there has been one transplant for leukemia. Cerebral Palsy and other forms of pediatric brain injury have

also responded well to infusions of autologous cord blood in a clinical trial conducted at Duke University ("Cord Blood"). According to the scientists studying stem cells, victims suffering from diabetes, cancer, cardiovascular disease, Alzheimer's, Parkinson's, leukemia, and spinal injuries could all benefit from continuing research (Gifford).

Controversy

There are two conflicting views on embryonic stem cell research and the ethical questions it raises. Supporters of expanded stem cell research argue that it could lead to more therapies and cures to cancer and genetic diseases ("Leading Issues: Stem Cells"). More than 120 million Americans suffer from illness that could be aided by this research (Gifford). Opponents of stem cell research, who are "pro-life", feel that it is morally unacceptable since a human embryo (and therefore a potential human life) must be destroyed. In the article Stem

Cell Dilemma, St. Louis Archbishop Raymond Leo Burke states, "It's not morally right or just to experiment on jail populations or death row inmates. Why then let scientists kill human embryos to advance science?"

My problem, and that of pro-lifers and the pro-life community, is that we believe life begins at conception. If you bypass that concept and create a human embryo, indistinguishable from the conceived one, you're still there."

Thomas Shannon, professor of religion and social ethics at



Image 3: Pro-lifers and scientists disagree on whether or not stem cell research is morally correct.

Worcester Polytechnic Institute, disagreed. "The problem with the church view is that embryology is a process. Fertilization itself is a process. It takes about 24 hours for the sperm to penetrate the ovum, and then for the chromosomes to line up, then for the union and formation of the DNA to occur, and then to have a beginning of cell division. One thing important to me is that in the blastocyst at the beginning, the cells have capacity to become other organisms. The cells have a unity, but it is not a unity of individuality. They are going in a direction, but they are fluid. It is at this point that twinning can occur, and a number of other things that are not individual. It takes a week to two weeks before the cells are committed to body parts they will become. This is a critical time. For the first two weeks, the organism is not an individual, and there can't be a person without an individual." (Dobson).

Future

Medical researchers believe that stem cell therapy has the potential to make sensational changes in the treatment of human diseases. They predict that in the future, technologies resulting from stem cell research will be used to treat a wider variety of diseases including cancer, diabetes, Parkinson's disease, cardiovascular disease, spinal cord injuries and muscle damage ("Stem Cell"). However, opponents of the research argue that this practice will ultimately lead to reproductive cloning and "fundamentally devalues the worth of a human being." ("Stem Cell Controversy"). Pro-lifers, who advocate for the protection of human embryos, agree (Dobson). And so the question remains- is it worth the risk?

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