Stem Cell Research

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About stem cells

Stem cells are undifferentiated, or “blank,” cells. This means they’re capable of developing into cells that serve numerous functions in different parts of the body. Most cells in the body are differentiated cells. These cells can only serve a specific purpose in a particular organ. For example, red blood cells are specifically designed to carry oxygen through the blood.

All humans start out as only one cell. This cell is called a zygote, or a fertilized egg. The zygote divides into two cells, then four cells, and so on. Eventually, the cells begin to differentiate, taking on a certain function in a part of the body. This process is called differentiation.

Stem cells are cells that haven’t differentiated yet. They have the ability to divide and make an indefinite number of copies of themselves. Other cells in the body can only replicate a limited number of times before they begin to break down. When a stem cell divides, it can either remain a stem cell or turn into a differentiated cell, such as a muscle cell or a red blood cell.

Potential uses of stem cells

Since stem cells have the ability to turn into various other types of cells, scientists believe that they can be useful for treating and understanding diseases. According to the Mayo Clinic, stem cells can be used to:

- grow new cells in a laboratory to replace damaged organs or tissues
- correct parts of organs that don't work properly
- research causes of genetic defects in cells
- research how diseases occur or why certain cells develop into cancer cells
- test new drugs for safety and effectiveness

Types of stem cells

There are several types of stem cells that can be used for different purposes.

Embryonic stem cells

Embryonic stem cells come from human embryos that are three to five days old. They are harvested during a process called in-vitro fertilization. This involves fertilizing an embryo in a laboratory instead of inside the female body. Embryonic stem cells are known as pluripotent stem cells. These cells can give rise to virtually any other type of cell in the body.

Non-embryonic (adult) stem cells

Adult stem cells have a misleading name, because they are also found in infants and children. These stem cells come from developed organs and tissues in the body. They're used by the body to repair and replace damaged tissue in the same area in which they are found.

For example, hematopoietic stem cells are a type of adult stem cell found in bone marrow. They make new red blood cells, white blood cells, and other types of blood cells. Doctors have been performing stem cell transplants, also known as bone marrow transplants, for decades using hematopoietic stem cells in order to treat certain types of cancer.

Adult stem cells can't differentiate into as many other types of cells as embryonic stem cells can.

Induced pluripotent stem cells (iPSCs)

Scientists have recently discovered how to turn adult stem cells into pluripotent stem cells. These new types of cells are called induced pluripotent stem cells (iPSCs). They can differentiate into all types of specialized cells in the body. This means they can potentially produce new cells for any organ or tissue. To create iPSCs, scientists genetically reprogram the adult stem cells so they behave like embryonic stem cells.

The breakthrough has created a way to "de-differentiate" the stem cells. This may make them more useful in understanding how diseases develop. Scientists are hoping that the cells can be made from someone's own skin to treat a disease. This will help prevent the immune system from rejecting an organ transplant. Research is underway to find ways to produce iPSCs safely.

Cord blood stem cells and amniotic fluid stem cells

Cord blood stem cells are harvested from the umbilical cord after childbirth. They can be frozen in cell banks for use in the future. These cells have been successfully used to treat children with blood cancers, such as leukemia, and certain genetic blood disorders.

Stem cells have also been found in amniotic fluid. This is the fluid that surrounds a developing baby inside the mother's womb. However, more research is needed to help understand the potential uses of amniotic fluid stem cells.

Stem cell research controversy

Adult stem cells don't present any ethical problems. However, in recent years, there has been controversy surrounding the way human embryonic stem cells are obtained. During the process of harvesting embryotic stem cells, the embryo is destroyed. This raises ethical concerns for people who believe that the destruction of a fertilized embryo is morally wrong.

Opponents believe that an embryo is a living human being. They don't think the fertilized eggs should be used for research. They argue that the embryo should have the same rights as every other human and that these rights should be protected.

Supporters of stem cell research, on the other hand, believe that the embryos are not yet humans. They note that researchers receive consent from the donor couple whose eggs and sperm were used to create the embryo. Supporters also argue that the fertilized eggs created during in-vitro fertilization would be discarded anyway, so they might be put to better use for scientific research.

With the breakthrough discovery of iPSCs, there may be less of a need for human embryos in research. This may help ease the concerns of those who are against using embryos for medical research. However, if iPSCs have the potential to develop into a human embryo, researchers could theoretically create a clone of the donor. This presents another ethical issue to take into consideration. Many countries already have legislation in place that effectively bans human cloning.

Federal regulations on stem cell research

In the United States, federal policy regarding stem cell research has evolved over time as different presidents have taken office. It's important to note that no federal regulation has ever explicitly banned stem cell research in the United States. Rather, regulations have placed restrictions on public funding and use. However, certain states have placed bans on the creation or destruction of human embryos for medical research.

Stem cell policy under former President George W. Bush

In August 2001, former President George W. Bush approved a law that would provide federal funding for limited research on embryonic stem cells. However, such research had to fit the following criteria:

- The harvesting process, which includes the destruction of the embryo, was started before 9 p.m. on August 9, 2001.
- The stem cells were obtained from an embryo that was created for reproductive purposes and was no longer needed.
- Informed consent was obtained for the donation of the embryo, and the donation didn't involve financial reward.

Stem cell policy under President Barack Obama

In March 2009, President Barack Obama revoked former President Bush's statement and released Executive Order 13505. The order removed the restrictions on federal funding for stem cell research. This allowed the National Institutes of Health (NIH) to begin funding research that uses embryonic stem cells. The NIH then published guidelines to establish the policy under which it would fund research. The guidelines were written to help make sure that all NIH-funded research on human stem cells is morally responsible and scientifically relevant.

Examples of stem cell research

Stem cell research is ongoing at universities, research institutions, and hospitals around the world. Researchers are currently focusing on finding ways to control how stem cells turn into other types of cells.

The process of cell differentiation

A primary goal of research on embryonic stem cells is to learn how undifferentiated stem cells turn into differentiated stem cells that form specific tissues and organs. Researchers are also interested in figuring out how to control this process of differentiation.

Over the years, scientists have developed methods to manipulate the stem cell process to create a particular cell type. This process is called directed differentiation. A recent studyalso discovered the first steps in how stem cells transform into brain cells and other types of cells. More research on this topic is ongoing.

Cell-based therapies

If researchers can find a reliable way to direct the differentiation of embryonic stem cells, they may be able to use the cells to treat certain diseases. For example, by directing the embryonic stem cells to turn into insulin-producing cells, they may be able to transplant the cells into people with type 1 diabetes.

Other medical conditions that may potentially be treated with embryonic stem cells include:

- traumatic spinal cord injury
- stroke
- severe burns
- rheumatoid arthritis
- heart disease
- hearing loss
- retinal disease

- Huntington's disease
- Parkinson's disease

California's Stem Cell Agency provides a detailed list of the disease programs and clinical trials currently underway in stem cell research. Examples of such projects include:

- injecting modified stem cells directly into the brain after a stroke
- using stem cells to replace damaged cells in the inner ear that detect sound, helping to restore hearing
- altering the genes of stem cells to make them resistant to diseases, such as AIDS, and then inserting them into people with the disease
- cultivating stem cells to repair the fragile bones of people with osteoporosis

Using stem cells to test new drugs

Researchers are also using differentiated stem cells to test the safety and effectiveness of new medications. Testing drugs on human stem cells eliminates the need to test them on animals.

The takeaway

Stem cell research has the potential to have a significant impact on human health. However, there is some controversy around the development, usage, and destruction of human embryos. Scientists may be able to ease these concerns by using a new method that can turn adult stem cells into pluripotent stem cells, which can change into any cell type. This would eliminate the need for embryonic stem cells in research. Such breakthroughs show that much progress has been made in stem cell research. Despite these advancements, there's still a lot more to be done before scientists can create successful treatments through stem cell therapy.

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