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# Stem Cells: What they are and what they do

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**Abstract**
Stem-cell therapy is the use of stem cells to treat or prevent a disease or condition. Bone marrow transplant is the most widely used stem-cell therapy, but some therapies derived from umbilical cord blood are also in use. Research is underway to develop various sources for stem cells, as well as to apply stem-cell treatments for neurodegenerative diseases and conditions such as diabetes and heart disease, among others.
Stem-cell therapy has become controversial following developments such as the ability of scientists to isolate and culture embryonic stem cells, to create stem cells using somatic cell nuclear transfer and their use of techniques to create induced pluripotent stem cells. This controversy is often related to abortion politics and to human cloning. Additionally, efforts to market treatments based on transplant of stored umbilical cord blood have been controversial. Stem cells are being studied for a number of reasons. The molecules and exosomes released from stem cells are also being studied in an effort to make medications. In addition to the functions of the cells themselves, paracrine soluble factors produced by stem cells, known as the stem cell secretome, has been found to be another mechanism by which stem cell-based therapies mediate their effects in degenerative, auto-immune and inflammatory diseases.

**Keywords:** pluripotent, exosomes, paracrine soluble factors,auto-immune, degenerative

## Introduction
You've heard about stem cells in the news, and perhaps you've wondered if they might help you or a loved one with a serious disease. You may wonder what stem cells are, how they're being used to treat disease and injury.

## What are stem cells?

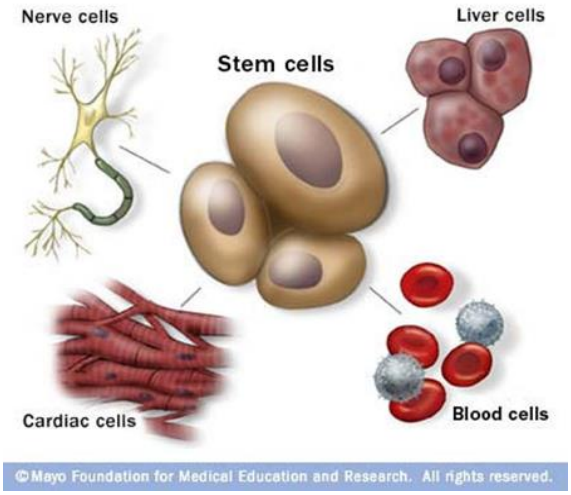


**Fig 1**

Stem cells are the body's raw materials — cells from which all other cells with specialized functions are generated. Under the right conditions in the body or a laboratory, stem cells divide to form more cells called daughter cells.
These daughter cells either become new stem cells (self-renewal) or become specialized cells (differentiation) with a more specific function, such as blood cells, brain cells, heart muscle cells or bone cells. No other cell in the body has the natural ability to generate new cell types.

**Why is there such an interest in stem cells?**

- **Increase understanding of how diseases occur.** By watching stem cells mature into cells in bones, heart muscle, nerves, and other organs and tissue, researchers and doctors may better understand how diseases and conditions develop.
- **Generate healthy cells to replace diseased cells (regenerative medicine).** Stem cells can be guided into becoming specific cells that can be used to regenerate and repair diseased or damaged tissues in people.

Stem cells may have the potential to be grown to become new tissue for use in transplant and regenerative medicine.

- **Test new drugs for safety and effectiveness.** Before using investigational drugs in people, researchers can use some types of stem cells to test the drugs for safety and quality. This type of testing will most likely first have a direct impact on drug development first for cardiac toxicity testing.

**Where do stem cells come from?**

Researchers have discovered several sources of stem cells:

- **Embryonic stem cells.** These stem cells come from embryos that are three to five days old. At this stage, an embryo is called a blastocyst and has about 150 cells.

These are pluripotent (ploo-RIP-uh-tunt) stem cells, meaning they can divide into more stem cells or can become any type of cell in the body. This versatility allows embryonic stem cells to be used to regenerate or repair diseased tissue and organs.

- **Adult stem cells.** These stem cells are found in small numbers in most adult tissues, such as bone marrow or fat. Compared with embryonic stem cells, adult stem cells have a more limited ability to give rise to various cells of the body.
- **Perinatal stem cells.** Researchers have discovered stem cells in amniotic fluid as well as umbilical cord blood. These stem cells also have the ability to change into specialized cells.

Amniotic fluid fills the sac that surrounds and protects a developing fetus in the uterus. Researchers have identified stem cells in samples of amniotic fluid drawn from pregnant women to test for abnormalitie a procedure called amniocentesis.

**Why is there a controversy about using embryonic stem cells?**

Embryonic stem cells are obtained from early-stage embryos — a group of cells that forms when a woman's egg is fertilized with a man's sperm in an in vitro fertilization clinic. Because human embryonic stem cells are extracted from human embryos, several questions and issues have been raised about the ethics of embryonic stem cell research.

The National Institutes of Health created guidelines for human stem cell research in 2009. The guidelines define embryonic stem cells and how they may be used in research, and include recommendations for the donation of embryonic stem cells. Also, the guidelines state embryonic stem cells from embryos created by in vitro fertilization can be used only when the embryo is no longer needed.

**Where do these embryos come from?**

The embryos being used in embryonic stem cell research come from eggs that were fertilized at in vitro fertilization clinics but never implanted in a woman's uterus. The stem cells are donated with informed consent from donors..

**What are stem cell lines and why do researchers want to use them?**

A stem cell line is a group of cells that all descend from a single original stem cell and are grown in a lab. Cells in a stem cell line keep growing but don't differentiate into specialized cells. Ideally, they remain free of genetic defects and continue to create more stem cells. Clusters of cells can be taken from a stem cell line and frozen for storage or shared with other researchers.

**What is stem cell therapy (regenerative medicine) and how does it work?**

Stem cell therapy, also known as regenerative medicine, promotes the repair response of diseased, dysfunctional or injured tissue using stem cells or their derivatives. It is the next chapter in organ transplantation and uses cells instead of donor organs, which are limited in supply.

Researchers grow stem cells in a lab. These stem cells are manipulated to specialize into specific types of cells, such as heart muscle cells, blood cells or nerve cells.

The specialized cells can then be implanted into a person. For example, if the person has heart disease, the cells could be injected into the heart muscle. The healthy transplanted heart muscle cells could then contribute to repairing defective heart muscle.

Researchers have already shown that adult bone marrow cells guided to become heart-like cells can repair heart tissue in people, and more research is ongoing.

**How can stem cells treat disease?**

When most people think about about stem cells treating disease they think of a stem cell transplant.

In a stem cell transplant, embryonic stem cells are first specialized into the necessary adult cell type. Then, those mature cells replace tissue that is damaged by disease or injury. This type of treatment could be used to:

- Replace neurons damaged by spinal cord injury, stroke, Alzheimer’s disease, Parkinson’s disease or other neurological problems;
- produce insulin that could treat people with diabetes and heart muscle cells that could repair damage after a heart attack; or replace virtually any tissue or organ that is injured or diseased.
- But embryonic stem cell-based therapies can do much more.
- Studying how stem cells develop into heart muscle cells could provide clues about how we could induce heart muscle to repair itself after a heart attack.
- The cells could be used to study disease, identify new drugs, or screen drugs for toxic side effects.

**What diseases could be treated by stem cell research?**

In theory, there's no limit to the types of diseases that could be treated with stem cell research. Given that researchers may be able to study all cell types via embryonic stem cells, they have the potential to make breakthroughs in any disease.

**Conclusion**

Stem cells show great promise for regenerative medicine, there is enormous potential in human stem cell research both adult and embryonic stem cell.

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