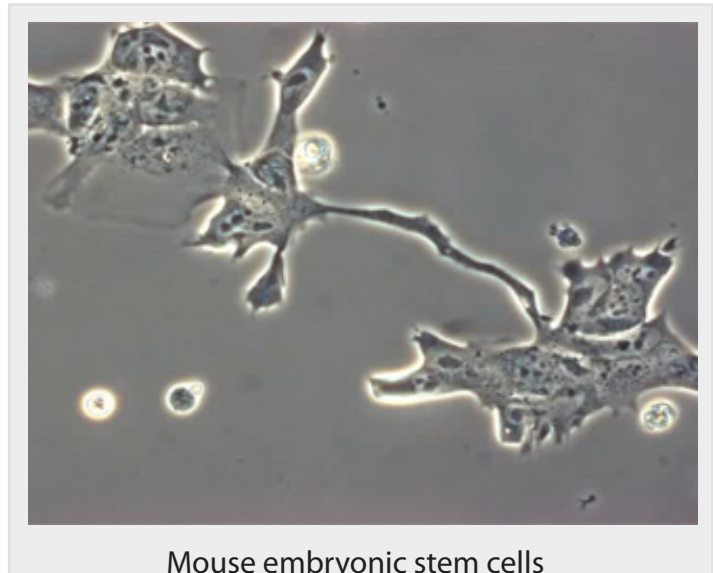


Stem Cells: Cells with Potential

What are stem cells?

Your body contains over 200 types of cells, each with a specific job: blood cells carry oxygen; muscle cells contract so that you can move; nerve cells transmit chemical signals. The job of a stem cell is to make new cells. It does this by undergoing an amazing process—differentiating, or changing into another type of cell. Each time a stem cell divides, one of the new cells might remain a stem cell while the other turns into a heart, blood, brain, or other type of cell. In fact, stem cells are able to divide to replenish themselves and other cells without any apparent limit.



Mouse embryonic stem cells

Stem cells are the source, or “stem,” for all of the specialized cells that form our organs and tissues. There are many kinds of stem cells, but two types have made frequent appearances in the news: embryonic stem cells are present in very early—and very tiny—embryos, and produce the first cells of the heart, brain, and other organs. They have the potential to form just about any other cell in the body. Adult stem cells are found in many tissues of developed organisms, and even in embryos after they’ve begun to grow. (A newborn baby’s body contains adult stem cells). They’re also found in the placenta and umbilical cord. Adult stem cells can replenish some tissues lost through normal wear and tear or injury. However, adult stem cells are only able to generate a few specific cell types. Adult stem cells in bone marrow, for example, make new blood cells, and adult stem cells in the skin make the cells that replenish layers of the skin.

Why invest so much in studying stem cells?

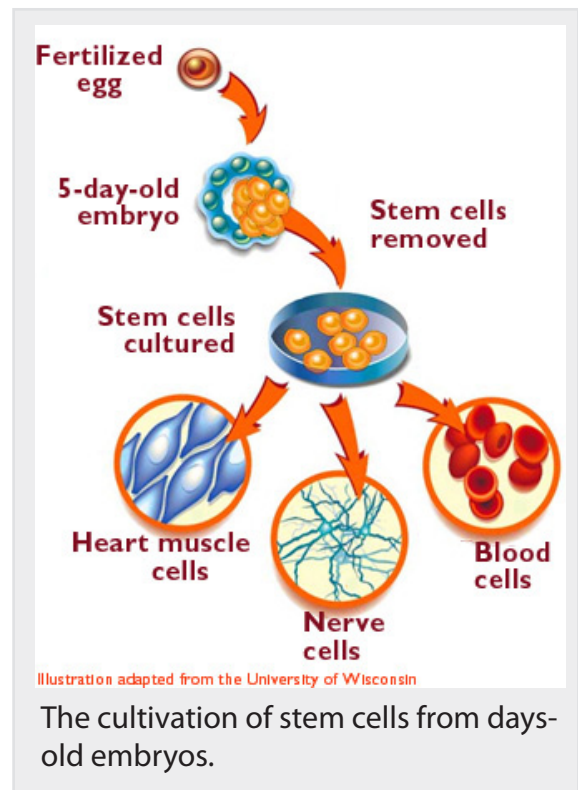
Stem cells have captured the public's attention because of their potential to revolutionize our treatment of many debilitating diseases and injuries. Using stem cells, we may someday be able to repair spinal cord injuries or replace diseased organs, although such therapeutic treatments are probably a long way off. The study of stem cells is relatively new—they were discovered in 1976, and human embryonic stem cells finally isolated in 1998—so scientists still have much to learn about them.

Right now, researchers are still learning how to generate and grow stem cells. But simply knowing how to culture the cells in the lab isn't enough. Scientists also need to understand and control how stem cells differentiate to become specific cell types. If researchers can decode the signals that govern differentiation, they may be able to take charge of the process, directing a culture of cells to become a specific cell type—heart, neuron, skin, liver, or whatever kind is needed.

With that level of control, researchers could pursue a variety of new treatments. They may be able to grow new tissues to replace damaged ones. For example, many scientists are looking at ways of generating heart cells in the hope of replacing cardiac tissue destroyed by a heart attack. But stem cells may have an even bigger impact by giving researchers new ways to study disease. Because embryonic stem cells have the potential to be turned into almost any kind of cell, researchers can culture cells that mimic a variety of diseases. These cultures would provide an almost unlimited supply of cells that could be used to test thousands of drugs. Such rapid screening could make useful drugs available years earlier than they might be otherwise. In addition, simply watching and deciphering the development of stem cells into tissues will give researchers insight into how cells communicate with each other and form the networks used in functions like learning and memory.

Progress...and hurdles

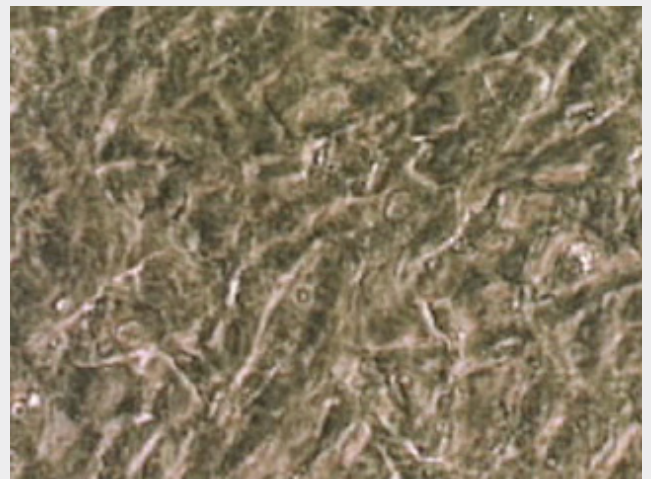
Treatments for a few particular diseases have emerged as exciting possibilities on the forefront of stem cell research. Parkinson's results from the death of a specific type of



cell in the brain. Scientists have succeeded in easing the condition in rats by injecting them with embryonic stem cells that then turned into the missing neurons. Researchers hope to develop a similar treatment for diabetes, which is caused by the destruction of insulin-producing cells in the pancreas.

Though there has been progress in developing new stem cell-based therapies, researchers caution that many hurdles remain. For example, it's unclear whether implanted stem cells can, after differentiating, revert to their previous state and then cause cancer. Another problem involves our natural immune response to foreign cells in the body. Patients currently receiving stem cell treatments, such as bone marrow transplants, must take drugs to prevent their immune system from attacking the newly introduced cells. Scientists may be able to address this problem by creating banks of embryonic stem cells, each of which is slightly different genetically. The cells best suited to a patient's genetic makeup would then be used to grow new cells for transplantation, in hopes that this would lessen the immune response.

Ideally, researchers would like to emulate the regenerative qualities of animals like the salamander. When a salamander loses a limb, cells near the injury "regress" and become stem cells. They then re-differentiate and organize themselves into tissues. If such a process could be induced in human cells, scientists could grow replacement tissue from a patient's own cells, avoiding the immune reactions that arise when foreign tissue is used in a transplant. In addition, because the patients themselves would be providing the initial cells, scientists wouldn't have to culture embryonic stem cells. But this kind of regeneration is a futuristic scenario; there hasn't yet been enough research to know whether the treatments promised by these ideas are even possible.



These heart cells were grown from mouse stem cells.

Looking forward

There's no question that stem cell research holds great potential for bringing new knowledge and treatments to medicine. In fact, the field is still so new that many of its possibilities remain unknown. As a consequence, some of the ethical issues raised by this research are also new to us. It will take time and resources to understand the many ways that advances in using stem cells will change medicine.

In confronting the need to wrestle with difficult questions, stem cell science is like many other fields of medical research. In most cases, the approach to dealing with sensitive research has been to establish regulations—often spearheaded by the United States as a leader in biomedical research—that are accepted by scientists worldwide. Dr. Bruce Conklin, who studies mouse stem cells at the Gladstone Institute of Cardiovascular Disease and the University of California, San Francisco, points out that pursuing important treatments in an appropriately ethical environment requires a solid legal framework for researchers to work within. “There are ethical land mines out there, but it’s not a reason to shy away,” he says. “It’s more a reason for us to lead with the appropriate ethical and scientific standards that we’ve worked hard to establish in other fields.”

To learn more:

Stem cell information from the NIH:
<http://stemcells.nih.gov/info/ethics.asp>

The Promise and Perplexities of Stem Cells:
Academies Weigh In on Hotly Debated Research Area of Regenerative Medicine
From the National Academies of Science
http://www.infocusmagazine.org/1.2/science_society.html

Download the National Academies booklet “Understanding Stem Cells: An Overview of the Science and Issues”
<http://dels.nas.edu/bls/stemcells/booklet.shtml>



Embryonic stem cells can be grown in culture dishes. A pinkish solution provides the sugars and other compounds the cells need to grow.