Stem Cell Research—Potential Solutions, Practical Challenges

A news program asks viewers to vote online: “Should stem cell research be banned? Yes or no?” Some people claim that stem cell therapy will revolutionize medicine. Others believe that some types of stem cell research violate ethical standards and are not justified by the potential benefits. Between these two positions exists a wide range of ideas about what is or is not acceptable. Would you know how to vote?

Using Stem Cells

Stem cells are undifferentiated cells that can regenerate themselves and develop into specialized types of cells. Stem cell research offers the hope of understanding basic cell processes and treating or even curing many diseases. However, many technical challenges must be overcome before stem cell therapy is a realistic option, and ethical issues continue to surround stem cell research.

Potential Benefits

Stem cell research offers many potential benefits.

* Studying adult stem cells may help scientists better understand how tissues develop and what goes  
  wrong when those tissues become diseased.
* A better understanding of the properties of stem cells may give scientists more information about  
  how cancer cells replace themselves and thus help scientists develop more-targeted cancer therapies.
* Stem cells could be used to grow human tissues to test the effects of drugs and chemicals.
* Stem cells may be used to replace healthy cells that are killed by radiation treatment for cancer.
* Stem cells may be used to regenerate tissues. For example, chemotherapy kills blood– producing cells in bone marrow. To replace these cells, stem cells could be used instead of the patient’s own marrow, which may contain cancer cells.
* Stem cells may be used to treat spinal cord injuries and neurodegenerative diseases, such as  
  Parkinson’s.

Technical Challenges

Adult stem cells have been used therapeutically for years in the form of bone marrow transplants. Nevertheless, many technical challenges must still be overcome before stem cells can be used to treat a wide range of disorders. Examples are highlighted below.

**Supply**Stem cells can be taken from a variety of sources, including an embryo, a patient in need of treatment, a patient’ relative, or an established embryonic stem cell line. Embryonic stem cells are taken from embryos fertilized in an in vitro fertilization clinic, whereas established stem cell lines are cultures of embryonic stem cells used to grow additional stem cells that match the ones that came from the original embryo. Each source presents its own special set of ethical considerations.

**Transplantation into the target area**The delivery of stem cells to targeted tissues can be complex, especially if the tissues are deep inside the body. And once delivered, stem cells must “learn” to work with other cells. For instance, inserted cardiac cells must contract in unison with a patient’s heart cells.

**Prevention of rejection**Stem cells may be rejected if a patient’s body sees them as foreign. This problem can remain even when certain identifying proteins are removed from the cells’ membranes. The development of SCNT technology in humans could help solve this problem so that patients would not have to take drugs to suppress their immune system.

**Suppression of tumor formation**By their very nature, stem cells remain undifferentiated and continue to divide for long periods of time. When transplanted into an organism, many embryonic stem cells tend to form tumors. This risk must be removed before the cells can be used therapeutically.

Unanswered Questions

Stem cell research and therapy do not only involve questions of what we can do. They also involve  
questions about what we should do, who should benefit, and who should pay.

* Should human embryos be a source of stem cells?
* How should stem cell research be funded?
* How can the benefits of stem cell research best be shared by all people, regardless of income?
* Should insurance cover costly stem cell procedures?

Somatic Cell Nuclear Transfer

Somatic cell nuclear transfer (SCNT), also called therapeutic cloning, is a method for obtaining stem cells that has been used to clone animals. The process is still under development, however, and it has not yet been used to produce stem cells for humans. SCNT offers the hope of using a patient’s own DNA to produce stem cells that can form many types of specialized cells. Many SCNT studies have been done in mice and pigs; the diagram to the right shows how the SCNT process might be applied in human  
cells.

1. An unfertilized egg is taken from a female’s body, and the nucleus—containing the DNA—is removed. A cell is then taken from a patient’s body. The nucleus is removed and inserted into the egg.
2. The egg is given a mild electrical stimulation, which makes it divide. The DNA comes from the patient’s nucleus, and the materials needed for division come from the egg.
3. The stem cells could then be cultured and caused to differentiate into any tissue or organ needed by the patient.

Once a stem cell line is established, in theory it can continue to grow indefinitely. Researchers could use these cell lines without having to harvest more stem cells. The cell lines also could be frozen and shipped to other researchers around the world.

Cell Biologist in Action

[](http://biologybiozine.com/wp-content/uploads/2011/08/career_021.jpg)

**Dr. Gail Martin**

**Title:** Professor, Anatomy, University of California, San Francisco  
**Education:** Ph. D., Molecular Biology, University of California, Berkeley

In 1974 Dr. Gail Martin was working at the University College in London when she made a huge advance. She developed a way to grow stem cells in a petri dish. These fragile cells were hard to work with, so Dr. Martin’s breakthrough removed a big obstacle to stem cell research. Seven years later, she made another key discovery while working in her own laboratory at the University of California, San Francisco—how to harvest stem cells from mouse embryos. Her work has helped other scientists develop ways to harvest stem cells from human embryos and explore their use in treating disorders.

Dr. Martin likes to point out that her work shows how small advances in basic biology can pay off years later in unexpected ways. She states that many people focus on cures for specific diseases, not realizing that these cures “may come from basic research in seemingly unrelated areas. What is really going to be important 20 years from now isn’t clear.”