

STEM CELLS – THE SCIENCE



What Are Stem Cells?

Stem cells are very immature, unspecialized cells that have the potential to form many different specialized cells in the body. They are truly unique and different from all other cells in the body because they are unspecialized:

- 1) They are capable of dividing and renewing themselves, or proliferating many, many times over and,
- 2) They give rise to specialized cells or they are able to differentiate.

Why Are Stem Cells Important?

Basically stem cells have the potential to replace any kind of diseased cell or organ, like a liver or kidney, in the body. In fact, *Totipotent* stem cells could form an entire human being if they were separated and implanted into a woman's uterus.

Additionally, stem cells could be used to create the cells that are responsible for fighting diseases (like sending in reinforcements in a battle) or replacing defective cells.

What are the Types of Stem Cells?

- a. *Totipotent* – These stem cells can differentiate into any cell type as well as the placenta. Examples are a fertilized egg and cells produced in the first few divisions of the fertilized egg.
- b. *Pluripotent* - These cells are descendants of Totipotent stem cells, which develop at about four (4) to five (5) days after fertilization; they can develop into any cell type except Totipotent cells and Placental cells.
- c. *Multipotent* – These stem cells are descendants of Pluripotent cells that can form specialized cells in particular tissue, e.g. Hematopoietic stem cells, which can become red blood cells or white blood cells or platelets.
- d. *Progenitor* - These stem cells are Unipotent, that is they can produce only one (1) cell type.

What are the Sources of Stem Cells?

- a. Embryonic Stem Cells come from eggs that are fertilized in in vitro fertilization clinics. They are derived from “surplus” embryos used in those clinics. The cells are from a four (4) to five (5) day old embryo. At this stage, the embryo is spherical and is called a “Blastocyst”.
- b. The Blastocyst consists of an outer layer of cells, a fluid filled cavity, and of a group of approximately 30 Pluripotent cells inside the cavity.
- c. Amniotic Fluid-Derived Stem Cells are the most recently isolated stem cells. They are found in the fluid that surrounds the embryo in the womb; they too are Pluripotent.
- d. Adult Stem Cells are undifferentiated stem cells found in small numbers in most adult and children tissues, and umbilical cord blood. These stem cells are considered Multipotent, however some adult stem cells may be Pluripotent.
- e. Embryonic Germ Cells are Pluripotent stem cells that are found in an embryo in an area where the gametes (sperm and egg) form. They are Pluripotent and come from embryos that are deliberately aborted. They are difficult to work with because they frequently differentiate spontaneously.

What are the Challenges With the Different Types of Stem Cells?

- a. Embryonic Stem Cells are plentiful; in fact there are probably over 400,000 unused frozen embryos in United States fertility clinics. They are very easy to grow. After six (6) months of dividing without differentiating, as long as they remain Pluripotent and genetically normal, they are called an embryo stem cell line. However, they are difficult to control as they grow somewhat wildly and sometimes form tumors. Additionally, there is a potential problem with the immune response as in any donor situation.
- b. Amniotic Fluid-Derived Stem Cells also expand very quickly. They are not as “wild” as embryonic stem cells because they are not quite as early and they apparently do not form tumor cells. This of course is an advantage. Additionally no embryo is harmed.
- c. Adult Stem Cells have the potential advantage of the patient using his own cells that are grown in culture and proliferate. These cells can be re-introduced and there would not be an immune problem. It is felt that perhaps their purpose is to maintain and repair tissue. Their disadvantages are that they are quite rare, found in small numbers, are more difficult to grow, and primarily are Multipotent.
- d. Embryonic Germ Cells are difficult to maintain in culture because they differentiate spontaneously. Consequently, much less research has been done on them and the issue of abortion makes them less likely to be important in the future.

Challenges related to all the above stem cells include the difficulty involved in identifying the stem cells among thousands of other cells. Additionally, growth factors need to be found which can cause these stem cells to differentiate into the type of cell that is desired. Once that is determined, the cells must then be integrated and must learn to do what is requested of them. The question of tissue rejection, and the risk of cancer, an uncontrolled division of cells, is also a potential problem. Adult Stem Cells gone array

may in fact be at the heart of many cancers. And finally the risk of passing some type of disease (genetic) still needs to be addressed.

The Present and the Future

The Present

Stem Cells are already being used in bone marrow transplants. Stem cells from a donor's marrow are used to replace blood cells of victims of Leukemia and other types of cancers.

Additionally, there are experimental studies being done grafting new skin cells to treat burn victims, and grafting cornea cells for people with sight impairment.

Many other experiments are being done.

The Future

There are numerous possibilities for the future. The most exciting at the present time are treatment of Parkinson's disease, and Type 1 Diabetes Mellitus. These two diseases are caused by the loss of a relatively small amount of tissue; in the case of Parkinson's disease there are neurons in the brain that produce dopamine, and if these could be replaced with normal cells, the hope is that the Parkinson's Disease would be cured. And in the case of Diabetes Mellitus Type 1, there are insulin-producing cells in the pancreas and if these could be replaced with cells that function properly, the Diabetes would be cured.

Other diseases that are being investigated include Kidney Disease, Multiple Sclerosis, Macular Degeneration, spinal cord injuries, heart disease, Crohn's Disease, genetic diseases, and some types of cancers where specific cells would actually kill the cancer.

References:

Web MD
National Institute of Health
Scientific America
Stem Cell Research Foundation
Up to date