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Stem Cells

Biotechnology is used in many different fields but perhaps its greatest contribution to date has been to the field of medicine. Studies are underway to find the causes, cures, and potential treatments for various diseases. The causes of these diseases range from genetic to viral to bacterial. Biotechnology is opening doors to medical researchers through avenues such as stem cell research.

You can hardly read a newspaper or listen to the news these days without hearing about stem cells. Although you may be aware that there is great controversy about stem cells you may need to ask:

What are stem cells and what do they do?

In order to understand the possibilities of stem cell research you must first understand some of the terminology associated with the science.

Glossary of terms

A **stem cell** begins when a sperm cell fertilizes an egg which then divides and goes on to form the entire organism.

The first cells that divide have **total potential** and are therefore known as **totipotent**. Totipotent cells give rise to **all** cells including the embryonic sac, and umbilical cord.

As the cells continue to divide and specialize a blastocyst forms. The blastocyst is composed of an outer layer of cells and an **inner cell mass (ICM)**. The outer layer of cells form the placenta and other tissues necessary for fetal development. The inner cell mass will form all other tissues in the organism.

Pluripotent cells are from the inner cell mass that will form the specialized cells of the organism such as blood, muscle, and skin. Because pluripotent cells have a high level of telomerase action (which determines how many times the cell will replicate) and they express specific cell markers they can grow unlimited and undifferentiated *in vitro* making them a natural choice for research.

Fig. 1. Where do stem cells come from?

From totipotent to pluripotent blastocyst cell to research.

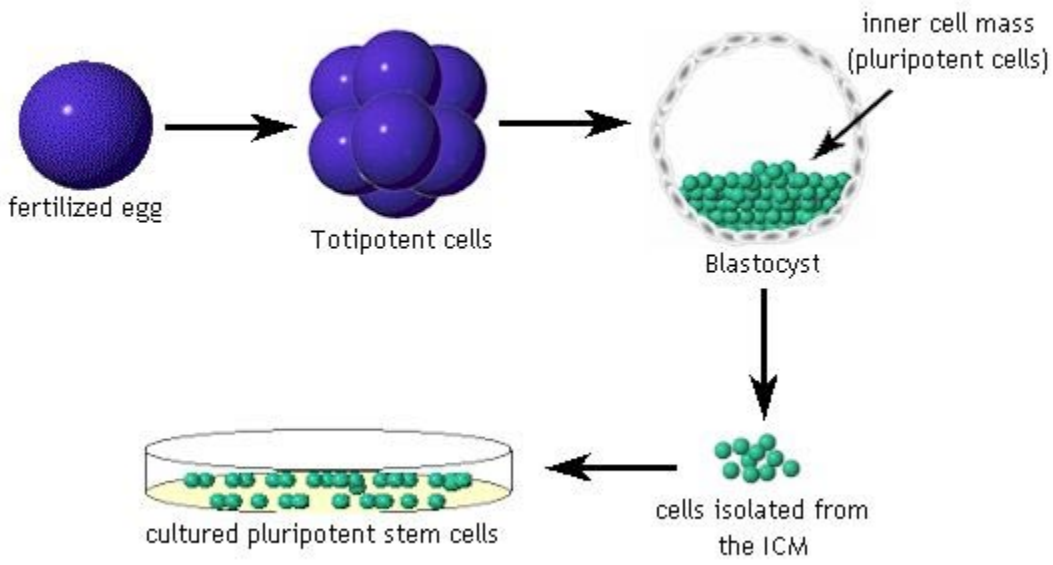

Diagram courtesy of Professor Leon Rosenberg, Princeton University.

Differentiated Cells have already specialized into such functional tissue as nerves, skin, or muscle tissue.

Where do we get stem cells?

Stem cells are cultivated from many sources such as embryos, bone marrow, neonatal cord blood, and more recently, research is being conducted on differentiated cells.

From embryos (See Fig. 1.)

Embryos provide the best source for stem cells. The inner cell masses are removed from the blastocyst through a procedure known as immunosurgery. The inner cell mass is then cultured and tested for surface markers. Cultured stem cells maintain the potential to develop into all cells.

From bone marrow

Stem cells are aspirated from bone marrow in much the same way a nurse would draw blood from your arm. Because stem cells have a lower density than other bone marrow cells researchers were able to isolate them in a centrifuge. The centrifuge spins the blood at thousands of rotations per minute. The cells that rise to the top are discarded. Using a combination of wheat germ agglutinin and fluorescent dye the cells are purified. Stem cells have high telomerase activity, which causes them to fuse with the sugars in the wheat germ agglutinin. The fluorescent dye allows sorting of the stem cells using a machine known as a fluorescence-activated cell sorter. Stem cells have a specific protein called H-2K, which enables researchers to sort them. In one case the researcher started with approximately 60 million bone marrow cells and after running the procedure to sort them ended up with l% of the original sample size.

Other sources

Another source rich in stem cells is the umbilical cord of a newborn baby. Blood is extracted and purified from the cord, which is then cultured and able to grow into any other cell. New research is looking at using differentiated cells – cells that were extracted from a human (in this case cheek cells) and then fused with an enucleated egg (an egg with the nucleus removed) using electrical impulses. Much like the technique used for cloning. The cells are then grown in a culture medium.

Just what do they do?

Because of their ability to grow into any cell type, stem cells can be used to treat and cure many diseases. There is also potential for new drug therapies. One such application is in the treatment of Parkinson's disease. Stem cells are harvested and cultured to produce an unlimited supply of Dopamine – a drug that helps control the movements in Parkinson's patients. Research using stem cells cultured to grow and differentiate into specific neural cells when injected into mice with spinal or brain injuries or strokes were observed to migrate towards the injury and began to rehabilitate the injured area. Research in treating Multiple Sclerosis (MS) has found that stem cells can help restore the protective sheathing of the spine in MS patients. In genetic disorders cells may be differentiated to produce cells that may aid in treating organs damaged by injury or disease. The research also provides scientists with more knowledge on how cells grow, differentiate and develop. This knowledge can also be applied to enhance livestock.

Stem cell research has enormous potential. The controversy lies not in the research but in the attainment of the cells. Many argue that using stem cells cultivated from embryos is morally wrong. They usggest that research should be pursued using differentiated cells or stem cells obtained from umbilical cords. Governments are working with concerned groups and researchers to find the best solution to allow continued stem cell research – research that has demonstrated great potential for everyone.

For more information:

Princeton University:
http://www.molbio.princeton.edu/courses/mb427/2001/projects/09/SObasics.htm

University of Wisconsin:
http://www.news.wisc.edu/packages/stemcells/

Stem Cell Research Organization:
http://www.stemcellresearch.org/

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