Another Step for Stem Cells

Stem cell research is in its early stages of development and much is to be learned and understood about its potential for treating Canadians living with fatal diseases such as ALS.

Stem cells play a critical and essential role in the human body, from embryonic stem cells that can grow into any of the specialized cells that form the body, to adult stem cells that function within the body to repair and regenerate tissue. Understanding the basic biology of stem cells may allow the development of new therapies for spinal cord injuries, blood disorders, and degenerative conditions such as ALS.

What are stem cells?
Stem cells are primitive, unspecialized cells with the ability to multiply and differentiate into specific types of cells as the human body develops. Stem cells also function as a repair system for the body and serve to replenish damaged or aging cells. When a stem cell divides, each new cell has the potential to either remain a stem cell or develop into a cell with a specialized function such as a muscle cell, a red blood cell, or a brain cell. Stem cells can be derived from embryonic, fetal, placental and cord blood sources or from adult tissues. Through research, we will develop a better understanding of the differences between stem cell types and will be able to identify those that offer the most potential for development of therapies.

What are the differences between embryonic and adult stem cells?
Embryonic stem cells are present four to five days after fertilization when the embryo is at the blastocyst stage. The blastocyst is formed by an outer layer of placental cells surrounding an interior cluster of cells, called "pluripotent" cells, that have the potential to form virtually all the tissues of the human body. Pluripotent cells have also been derived from fetal and umbilical tissue. It is the ability to isolate cells at the pluripotent stage that has given rise to recent and controversial developments in human embryonic stem cell research. While embryonic stem cells present researchers with ethical challenges, they have the following unquestionable advantages over adult stem cells.

- They are easy to identify in the four-five day embryonic sac.
- They can be removed easily in essentially pure form.
- They are relatively easy to grow in culture.
- They have the potential to form into any cell type.

Adult stem cells occur in a variety of tissues and organs such as skin, the lining of the intestine, and blood. Once thought to be inflexible, with the ability to generate only replacement cells for the particular tissue in which they are found, recent experiments suggest that these stem cells may be able to develop into a number of different cell types. Cells that hold the potential to develop into some, but not all, tissue types are termed "multipotent". Although the use of adult stem cells holds more promise than was originally thought, these cells have limitations in comparison to embryonic cells. Some of those limitations are as follows.

- They have less flexibility in specialization.
- They are present in small quantities.
- Their number decreases as the body ages.
- They are difficult to isolate.
- They are more susceptible to mutation and genetic defects.
- They are difficult to grow in culture, and therefore it is harder to obtain clinically significant amounts.

Why are stem cells important to ALS research?
There are several important areas where research using human pluripotent or multipotent stem cells could advance the cause of ALS research.

Cell replacement therapy - it is possible that pluripotent and multipotent stem cells can be stimulated to develop into specialized cells that represent renewable sources of cells and tissues for transplantation. This form of cell replacement therapy could potentially treat injuries, genetic disorders, and degenerative conditions such as ALS.

Understanding cell specialization - stem cell research will lead to an understanding of the biochemical signals that trigger stem cells to follow pathways toward specialization. It is possible that those signals may be manipulated to engineer replacement tissue in the patient's own body, thus eliminating the risk of rejection of transplants and the need for immunosuppressive drugs. In addition, the study of cell specialization will enable scientists to reach a better understanding of normal cell development and aging, which will in turn shed light on the reasons why things go wrong.

Drug development - new drugs can be initially tested more safely and economically using human cells derived from pluripotent stem cells. Researchers will be able to study the beneficial or toxic effects of new medications on cell lines that have been developed to mimic the disease processes, and drugs that prove to be unsafe or ineffective can be eliminated from testing at an early stage.

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What are the challenges facing ALS researchers into stem cell therapy?

While stem cell research shows great promise, ALS is a complex disease, and it is unlikely that a simple stem cell therapy will present itself in the near future. Some of the challenges facing ALS researchers are as follows.

Little is known about the mechanisms of human development that trigger cell specialization. Until this process is understood, manipulating the biochemical signals that trigger specific responses will remain a challenge.

The cause of motor neuron death in ALS is not understood, so it is not certain that transplanted stem cell tissue would be resistant to the toxic environment of ALS. Scientists may have to develop a modification system for transplanted cells that will protect them from the degenerative process of ALS.

There is encouraging evidence that transplanted stem cells can survive over long periods of time in damaged tissue, and researchers have had some success with functional recovery of missing neurons in animal models of Parkinson’s disease. However, these specific types of neurons are less dependent on appropriate neuronal connections than the motor nerves affected by ALS. Those neurons depend on neural connections to the target muscles over great distances (up to a meter in length) through the axons, which makes functional recovery more difficult.

There is the potential threat that transplant tissue cultured from stem cells will face rejection by the body’s immune system.

What stem cell research is currently being funded by the ALS Society of Canada?

ALS Canada does not directly fund stem cell research. The Neuromuscular Research Partnership (NRP) is the result of an agreement between the ALS Society of Canada, Muscular Dystrophy Canada (MDC) and the Canadian Institutes of Health Research (CIHR). Collectively, the partners are committed to discovering the causes, treatments and an eventual cure for neuromuscular disorders. The NRP is currently funding the following research using stem cells.

Dr. Jacques Tremblay at the Centre hospitalier de l’Université Laval is working on the genetic modification of myoblasts, adult muscle-derived stem cells, for transplantation in the muscles of people with Duchenne Muscular Dystrophy (DMD). The goals of the research are to deliver myoblasts that can therapeutically replace the function of a missing protein, called dystrophin, in the muscles of those affected and to increase the distance of migration of the cells from their injection site to the target muscle tissue.

Dr. Neil Cashman of the University of British Columbia is conducting clinical trials to test an agent known as granulocyte colony stimulating factor (G-CSF) that activates stem cells in the bone marrow and causes them to travel throughout the body, hopefully with a therapeutic effect. G-CSF has been used successfully in the past to treat a variety of conditions including heart attacks, multiple sclerosis, and cancer, but ALS presents a special risk because there is a danger that the agent could stimulate production of microglial cells, the immune cells that are a suspected cause of motor neuron cell death in ALS. Preliminary findings from the pilot trial have demonstrated safety of G-CSF in patients with ALS, although no therapeutic benefit was observed at the dose regimen used. Further studies are planned to optimize G-CSF treatment in mice before attempting human treatments trials.

Adult stem cells such as the bone marrow cells used in Cashman’s research have the advantage of being tested on the donor, so they do not have the ethical complications of embryonic stem cells, nor do they pose the threat of rejection by the body’s immune system, making hazardous immunosuppressive drugs unnecessary.

What are the ALS Society of Canada’s guidelines for stem cell research?

The ALS Society of Canada has not funded any embryonic stem cell research and will not do so except under federally established guidelines.

The ALS Society of Canada, along with a number of other voluntary organizations, supports the Assisted Human Reproduction Act which received Royal Assent March 29, 2004. Regulatory and licensing regimes are expected to be established in 2007/2008.

Research supported by this act would use embryos created through assisted reproduction that would otherwise be discarded and destroyed and only with the free and informed consent of the donor(s). Such research may well lead to life-extending treatment for many.

We will continue to fund neuromuscular research according to the guidelines of the Canadian Institutes of Health Research (CIHR).


The Stem Cell Network and the ALS Society of Canada share a common interest in research and education in the stem cell arena and are exploring additional opportunities for our two organizations to work together. For more information, visit www.stemcell-network.ca

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