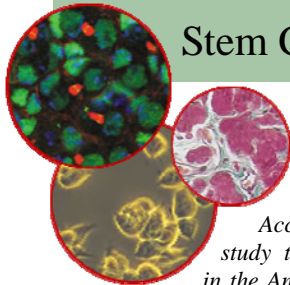


The Pressure Point

Penn Study Find

Stem Cell Mobilization by Hyperbaric Oxygen



According to a study to be published in the *American Journal of Physiology-Heart and Circulation Physiology*, a typical course of hyperbaric oxygen treatments increases by eight-fold the number of stem cells circulating in a patient's body. Stem cells, also called progenitor cells are crucial to injury repair.

The study currently appears on-line and is scheduled for publication in

the April 2006 edition of the *American Journal*.

Stem cells exist in the bone marrow of human beings and animals and are capable of changing their nature to become part of many different organs and tissues. In response to injury, these cells move from the bone marrow to the injured sites, where they differentiate into cells that assist in the healing process.

The movement, or mobilization, of stem cells can be triggered by a variety of stimuli -- including pharmaceutical agents and hyperbaric oxygen treatments.

Where as drugs are associated with a host of side effects, hyperbaric oxygen treatments carry a significantly lower risk of such effects. "This is the safest way clinically to increase stem cell circulation, far safer than any of the pharmaceutical options," said Stephen Thom, MD, Ph.D., Professor of Emergency Medicine at the University of Pennsylvania School of Medicine and lead Am J Physiol Heart Circ Physiol (November 18, 2005). doi:10.1152/ajpheart.00888.2005

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A Closer Look

What
Are
Stem
Cells?



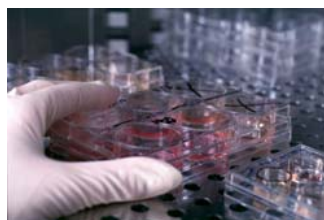
Stem Cell Speak

Stem cells are primal undifferentiated cells which retain the ability to differentiate into other cell types. This ability allows them to act as a repair system for the body, replenishing other cells as long as the organism is alive.

Medical researchers believe stem cell research has the potential to change the face of human disease by being used to repair specific tissues or to grow organs.

Adult and embryonic human and animal model stem cells are studied by nurturing the cells in specialized culture trays.

These culture trays (below) containing human embryonic stems cells being stored in heat-controlled storage and studied by a developmental biologist at the University of Wisconsin.



Cells must be carefully nurtured to prevent loss

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Penn Study Find

Stem Cell Mobilization by hyperbaric oxygen

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ABSTRACT

We hypothesized that exposure to hyperbaric oxygen (HBO2) would mobilize stem/progenitor cells from the bone marrow by a nitric oxide (.NO) dependent mechanism.

The population of CD34+ cells in the peripheral circulation of humans doubled in response to a single exposure to 2.0 atmospheres absolute (ATA) O2 for 2 hours.

Method

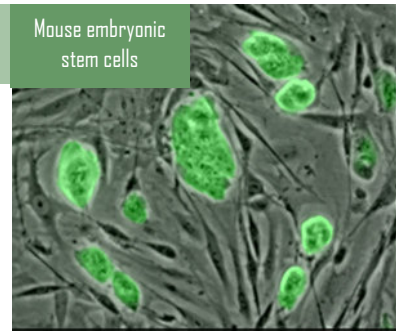
Over a course of twenty treatments, circulating CD34+ cells increased eight-fold, although the over-all circulating white cell count was not significantly increased.

Results

The number of colony-forming cells (CFCs) increased from 16 ± 2 to 26 ± 3 CFCs/100,000 monocytes plated.

Elevations in CFCs were entirely due to the CD34+ sub-population, but increased cell growth only occurred in samples obtained immediately post-treatment. A high proportion of progeny cells express receptors for vascular endothelial growth factor-2 and for stromal derived growth factor.

In mice, HBO2 increased circulating stem cell factor by 50%, increased the number of circulating cells expressing stem cell antigen-1 and CD34 by 3.4-fold, and doubled the number of CFCs. Bone marrow .NO concentration increased by 1008 ± 255 nM in



association with HBO2. Stem cell mobilization did not occur in knock out mice lacking genes for endothelial .NO synthase.

Moreover, pre-treatment of wild type mice with a nitric oxide (.NO) synthase inhibitor prevented the HBO2-induced elevation in stem cell factor and circulating stem cells.

Conclusion

We conclude that HBO2 mobilizes stem/progenitor cells by stimulating .NO synthesis.

This article is available on the web at: <http://ajpheart.physiology.org/cgi/reprint/00888.2005>

A Closer Look

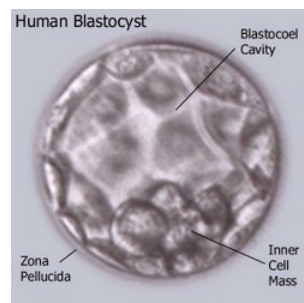
What Are Stem Cells?



Stem Cell Speak (continued)

Embryonic stem cells

Embryonic stem cells are stem cells derived from the undifferentiated inner mass cells of a *blastocyst*, an early stage embryo (approximately 1 week old in humans) consisting of 50-150 cells. Moreover, they are *pluripotent*, meaning they are able to grow (i.e. differentiate) into all derivatives of the three primary germ layers: ectoderm, endoderm and mesoderm. In other words, they can develop into each of the more than 200 cell types of the adult body as long as they are specified to do so.



This characteristic property distinguishes embryonic stem cells from adult stem cells or progenitor cells, the latter two of which only have the capacity to form a limited number of different cell types.

Research with embryonic stem cells derived from humans is controversial because, in order to start a stem cell 'line' or lineage, it requires the destruction of a *blastocyst* (human embryo), which some believe is tantamount to the destruction of a human being.

Cord blood stem cells

Blood from the placenta and umbilical cord that are left over after birth is one source of adult stem cells. Umbilical cord blood use has become so common that there are now umbilical cord blood banks that accept donations from parents. It is collected by removing the umbilical cord, cleansing it and withdrawing blood from the umbilical vein. This blood is then immediately analyzed for infectious agents and the tissue-type is determined.

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A Closer Look

What Are Stem Cells?



Stem Cell Speak (continued)

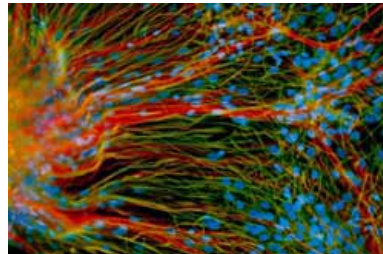
The cord blood is processed and depleted of red blood cells before being stored in liquid nitrogen for later use, at which point it is thawed, washed of the cryoprotectant, and injected through a vein of the patient.

This kind of treatment, where the stem cells are collected from another donor, is called *allogeneic* treatment. When the cells are collected from the same patient on whom they will be used, it is called *autologous* and when collected from identical individuals, it is referred to as *syngeneic*. *Xenogeneic* transfer of cells (between different species) is very underdeveloped and is said to have little research potential.

Adult stem cells

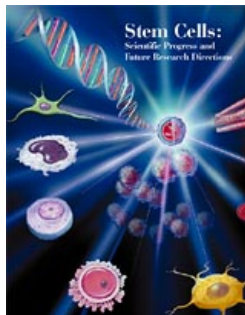
Stem cells can be found in all adults and young adults. Adult stem cells are undifferentiated cells that reproduce daily to provide certain specialized cells—for example 200 billion red blood cells are created each day in the body from

hemopoietic stem cells. Until recently it was thought that each of these cells could produce just one particular type of cell—this is called differentiation (see Morphogenesis). However in the past few years, evidence has been gathered of stem cells that can transform into several different forms. Bone marrow *stromal* stem cells are thought to be able to transform into liver, nerve, muscle, hair follicle and kidney cells. Although there is some evidence that this type of *transdifferentiation* can occur, many scientists are skeptical of these claims and we are still learning about such *trans-differentiated* cells.



Pprecursor neural cells grown in a lab dish generate mature neurons (red) and glial cells (green), in the lab

Adult stem cells may be even more versatile than this. Researchers at the New York University School of Medicine have extracted stem cells from the bone-marrow of mice which they say are *pluripotent*. Turning one type of stem cell into another is called *transdifferentiation*.



How are embryonic stem cells stimulated to differentiate?

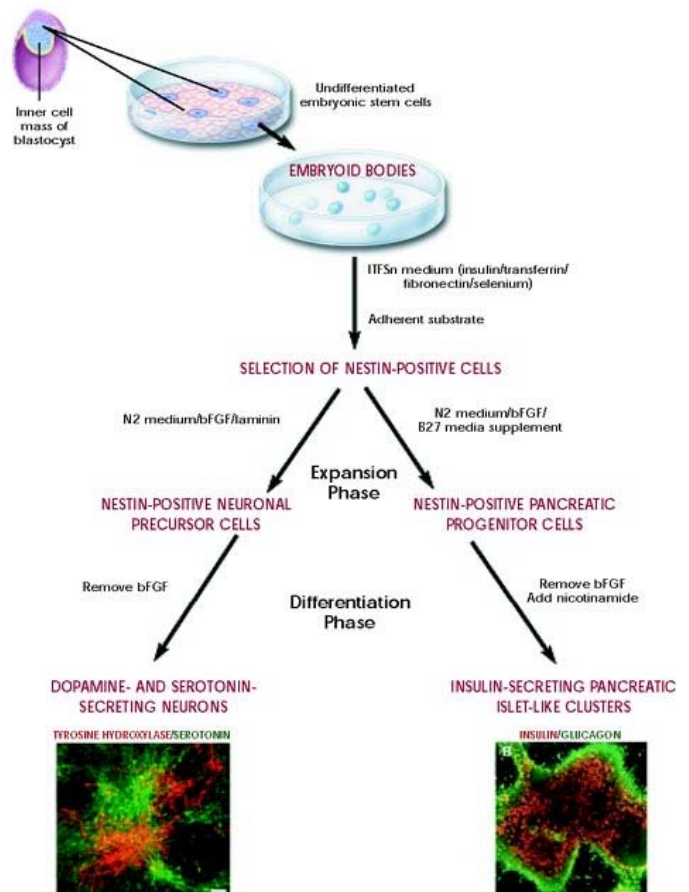
Figure (right). Directed differentiation of mouse embryonic stem cells

As long as the embryonic stem cells in culture are grown under certain conditions, they can remain undifferentiated (unspecialized). But if cells are allowed to clump together to form *embryoid bodies*, they begin to differentiate spontaneously. They can form muscle cells, nerve cells, and many other cell types.

Although spontaneous differentiation is a good indication that a culture of embryonic stem cells is healthy, it is not an efficient way to produce cultures of specific cell types.

So, to generate cultures of specific types of differentiated cells—heart muscle cells, blood cells, or nerve cells, for example—scientists try to control the differentiation of embryonic stem cells. They change the chemical composition of the culture medium, alter the surface of the culture dish, or modify the cells by inserting specific genes.

Through years of experimentation scientists have established some basic protocols or "recipes" for the *directed differentiation* of embryonic stem cells into some specific cell types (See Figure).



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The International Hyperbarics Association is a coalition of doctors, parents, patients, corporate chamber-industry professionals, hyperbaric center owners, and above all members who are committed to the cause of medical hyperbarics.

Our members come to us from all geographical areas with one common goal— to share their knowledge and information regarding the latest hyperbaric news.

Our driving force is our members, who are committed to do all we can “to give life to the world.”

— “Mundo vitam dare”



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