

**First Universalist Parish of Chester**  
**Stem Cells and Human Potential**  
**January 16, 2011**

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**The Miracle of Stem Cells**

- A German man has been cured for 3 years of both his leukemia and HIV positive status
- A diabetic man was able to give up insulin when pancreatic cells were created from his own spermatogonial cells
- A company has begun trials investigating a cure for age related macular degeneration that leads to blindness
- A small child at a Minnesota children's hospital is being successfully treated for a rare and awful skin disease that causes blisters to appear spontaneously all over his skin.

What do all of these diverse diseases have in common? The potential to be cured and/or treated with some sort of stem cell therapy.

**What are Stem Cells, Anyway?**

Stem cells can be thought of as the body's master cells from which all other cells arise. Cells are the building blocks that form tissue and organs such as the brain, heart, skin etc. Stem cells have the remarkable potential to develop into the many different cell types that our bodies need to function. They are distinguished from other cell types by three important characteristics. First, they are unspecialized cells meaning that they have no special function such as a brain cell or neuron does. Secondly, they can differentiate or develop into a specialized cell type and thirdly, they are capable of renewing themselves through cell division. This is called proliferation. They can divide essentially without limit to replenish other cells as long as a person is still alive. When a stem cell divides, each new cell has the potential either to remain a stem cell or become another type of cell with a more specialized function, such as a muscle cell, a red blood cell, or a brain cell.

There are different sources of stem cells, all of which are a bit different and all of which are being researched today.

*Adult stem cells.* As adults today, we all have stem cells in many of our tissues where they reside in a quiet state until they are 'turned on' to repair and replace worn out or damaged tissues. There are small numbers of these adult stem cells, one of their main disadvantages. Usually they differentiate into the cell types of the tissue where they hang out. For instance, hemopoietic stem cells are found in bone marrow and can turn into any type of blood cells including white blood cells which fight infections, red blood cells which carry oxygen to the entire body, or platelets, which are critical for clot formation. There are also other types of stem cells that differentiate into nerve cells or skin cells or other types of cells the body needs to do its work.

There may be many opportunities for therapies utilizing adult stem cells especially in the area of transplantation. In fact, stem cell transplants have been performed for decades. Many of you may know someone who has had a bone marrow transplant which is basically a form of stem cell therapy. This procedure is used to treat patients with leukemia or other blood cancers and autoimmune disorders. Recently scientists have been able to 'reprogram' some stem cells through gene therapy and turn them into other types of cells such as insulin secreting pancreatic cells. One advantage of these types of potential therapies is that harvesting stem cells from the target patient would eliminate rejection issues encountered when cells from a donor are used.

*Embryonic Stem Cells.* Another type of stem cells is embryonic stem cells. I am sure you have heard of these since they are in the news frequently since their use is controversial. This is because they are cultured from blastocytes or embryos. When an egg is fertilized, the first 3-5 days of cell division result in a blastocyte. Before these first cells develop into all of the other specialized cells they are called embryonic stem cells. Human embryonic stem cells used for research are obtained from blastocytes created during in vitro fertilization that are not going to be used for implantation and have been donated with informed consent. They are NOT obtained from eggs fertilized in a woman's body. We'll talk more about ethics in a bit.

An embryonic stem cell line is created by culturing the cells from a blastocyte. Establishing a culture can be a little iffy, but once established a culture can yield millions of cells. A cell line must be nurtured carefully to ensure that the cells remain undifferentiated or they will differentiate spontaneously. Once scientists are sure a line is going to continue to replicate, the cells are tested vigorously for many factors—a process called characterization. The really, really cool thing about embryonic stem cells is once a line is established without differentiation, the cells are pluripotent—a word we will be coming back to. And it is this characteristic that makes HESCs so exciting for medical science.

*Umbilical Stem Cells.* Another source of stem cells is from umbilical cord blood and/or the placenta. Actually, this may make the (to me) perfectly revolting idea of eating the placenta not sound so stupid after all! This source is not as plentiful as from embryos but more so than from adult tissue. Cord stem cells are also biologically younger than adult cells which could be an advantage. Harvesting them is also less controversial than harvesting embryonic stem cells since cord blood and placentas are normally discarded. There are many commercial and some non commercial banks that will store cord blood indefinitely (for a fee, of course).

*IPSC.* There is another type of stem cell that medical science is very excited about and that is an induced pluripotent stem cell or IPSC. In 2007 scientists were able to create stem cells from regular differentiated adult cells. This is akin to making something grow younger. Think about that for a few seconds! To have an unlimited source of pluripotent cells without the controversy of using embryos would be a great boon to medicine. But at this point there are many, many unknowns about these cells such as their ability to function like a HESC and, most particularly, their safety since they are created by introducing new genes

into adult cells using a virus as a vehicle. But they are already proving useful in the lab in drug development studies and in modeling disease states.

So what are some of the potential uses and obstacles for use of stem cells?

Researchers are already gaining a better understanding of cell division and cell differentiation through studies of stem cells. These studies are key to understanding different kinds of cancers, which is basically a disease of unchecked cell proliferation. They may also be used in cell-based therapies for treatment of diseases such as diabetes, parkinsons, stroke, cardiovascular disease (the #1 killer in the US throughout the 20<sup>th</sup> and thus far in the 21<sup>st</sup> century), spinal cord injuries and more. In other words, a real game changer.

But there are obstacles as well. To be useful they must be able to proliferate and differentiate reliably. They must be able to survive after transplant in a recipient. Rejection must be overcome if donor cells are used. They must be able to integrate into surrounding tissue and function appropriately. And, this is the biggie, they must not harm the patient. These are significant technical obstacles that must be overcome.

## **Ethics**

Let's get back for a minute to ethical considerations. I am sure this could be the topic of a whole service in itself but I am going to just touch on it briefly.

HESC lines are created from embryonic tissue that is less than 8 weeks old. These embryos are obtained with informed consent from couples who have undergone IVF, a procedure that usually results in 'extra' embryos that are not implanted. Normally, these are either discarded immediately or put into a deep freeze. A Rand study in 2003 estimated that there are ~ 400,000 of these embryos in frozen storage. The vast majority of these embryos will be destroyed at some point. Social conservatives oppose the use of these embryos for stem cell research and therapy since they believe that they are essentially human and should be afforded all the rights of a fully formed human being. Most scientists and bioethicists do not hold this view and in fact, feel that NOT using these frozen embryos that will be discarded is a travesty. All agree that any research using embryonic tissue should be carefully monitored. Most scientists, including Francis Collins, the well known born again Christian who heads up the NIH, believe that research should continue on all of the types of stem cells.

Last year, the NIH issued guidelines for their use. There was a one month review period during which comments could be made. They received 49000 comments in that one month! Obviously a hot button issue.

So where are we now? In 2001 then president George W. Bush issued an executive order severely restricting the use of embryonic stem cell research. In 2009 Barack Obama issued an

EO rescinding the previous one. In August 2010 a federal judge issued a ban on federal funding which was subsequently lifted on an interim basis until ruled upon by a higher court. So stay tuned.

### **Biology and Human Potential**

So far we have been sticking to the paved path of science as I have given you a very brief and introductory overview of stem cells. Now I'd like to step off the paved path and wander into some fields of fancy that are pretty unscientific.

When I first learned about biology, it puzzled me that all cells of the body (well, essentially all cells, there are, as usual, exceptions) contain your entire DNA. Yes, every cell contains all 48 chromosomes with their genetic material. This seemed very inefficient to me and I couldn't understand the advantages inherent in this arrangement. Why would a brain cell need the DNA that instructs a stomach to digest food and vice versa? Now that I understand stem cells a bit, I get that this makes sense. After all, if a cell can be anything, it will need the instructions to become anything.

So let's go back to a word used to describe stem cells: pluripotent. I don't know about you, but this was a new word to me. In fact, it is not recognized by the WORD spell check function. Obviously the root is "potent", but what does pluripotent mean? Merriam Webster defines it as "not fixed at to developmental potentiality". (This site, thankfully, also has an audio function, so I can be sure I am pronouncing it correctly.) As previously discussed, this means a cell can become any type of cell needed by the body. And often those needs change. If the body is invaded by bacteria, for instance, the body very quickly arms itself by producing gobs of white blood cells to fight off the invader. The body adapts in other ways as well. If you become blinded, your other senses develop to compensate. We adapt to environmental changes etc. etc. It is really quite amazing. It seems to me that the ability to adapt and develop is in the very essence of our biology. Since the building blocks (cells) of our bodies have this ability, it seems to me that our entire organism does as well.

When I was talking to Tina about the service and describing what I was going to talk about, she said, oh stem cells sounds like holographs. And she's right! University of London physicist, David Bohm has described holographs as being all that is, where everything is connected and there is an infinity of further developmental potential. This also sounds a lot like the Buddhist concept of emptiness or untapped potential.

In the words of John Polkinghorne who is a physicist and theologian, “Things on the surface that are easy to believe are not the whole story. There is a deeper, stranger and more satisfying story to be found, both in science and religion”.

Thank you.