Embryonic Stem Cell Research

By Heather Brant, Southern Baptist Ethics & Religious Liberty Commission - March 14, 2006

In the long list of bioethical topics, stem cell research is one of the most relevant and prevalent topics. Hardly a day passes without the mention of stem cells somewhere in the media, whether in the morning paper or on the evening news. Despite the long hours of discussion and deliberation, the debate seems to stand at a deadlock.

As Christians, we have the responsibility to be God's ambassadors in our society and culture. We must be prepared to address current cultural topics, such as stem cell research, from a solid biblical perspective. To do this, we must first gain an understanding of the science and terminology behind stem cell research and then look to God and His Word as the ultimate source of truth and guidance in this issue.

Technical Background

Brief History

Although stem cells were rarely discussed outside of the scientific community until the 1990's, they are certainly not new. As early as the 1950's, scientists began work on cloning and bone marrow transplantation, both of which rely upon stem cells. By 1981, researchers had isolated embryonic stem cells from mice embryos. Advances and legislation in 1994 and the years that followed began to bring stem cells into public view. In 1994, United States researchers reported the ability to maintain stable, proliferating embryonic stem cell lines in the laboratory, something previously unachieved. That same year, in response to the growing ethical debate and confusion, the government placed a moratorium on federal funding for human embryonic stem cell research. Despite the moratorium, research finally isolated the first human embryonic stem cells from the inner cell mass of a human embryo in 1998. For a brief period, the Department of Heath and Human Services (DHHS) lifted the moratorium, allowing federal DHHS funds to be used for human embryonic, pluripotent stem cell research. The National Institutes of Health (NIH) then issued a set of Guidelines for Research Using Human Pluripotent Stem Cells, stating, "Studies utilizing pluripotent stem cells derived from human embryos may be conducted using NIH funds only if the cells were derived (without Federal funds) from human embryos that were created for the purposes of fertility treatment and were in excess of the clinical need of the individuals seeking such treatment (Section II[1])." Effective on August 25th of 2000, these guidelines propelled research, leading scientists to inject stem cells into immuno-deficient mice and to attempt directed differentiation of stem cells in vitro, both vital steps toward achieving application of stem cells. Most recently, however, the ethical debate has led lawmakers to stop federal funding on embryonic stem cell research. In August 2001, President George W. Bush limited federal funding to already established embryonic stem cell lines. This decision alone has sparked unprecedented discussion and debate on stem cell research and forced all parties involved to determine

how far they are willing to push ethical lines to potentially advance the science of healing. It is this debate that we will attempt to decipher.

What is a stem cell?

Stem cells are defined by three main characteristics. First, stem cells are unspecialized, meaning that they have no tissue-specific features that allow them to perform a specialized function. However, stem cells are capable of differentiating into specialized cells, including nerve, cardiac, and pancreatic cells among many others. The most versatile type of stem cell, a pluripotent stem cell, is actually capable of developing into any one of the specialized cell types found in the body. Various internal and external signals determine which type of specialized cell a given pluripotent stem cell will become. Finally, stem cells are capable of long term self-proliferation, meaning that they continually divide to create exact replicates of themselves. If a cell exhibits these characteristics, then it is a stem cell.

The 3 major types of stem cells addressed in the current debate are embryonic, adult, and hematopoietic stem cells:

- Embryonic Stem Cells—As the name suggests, embryonic stem cells are derived from a developing embryo. Specifically, stem cells are extracted from the inner cell mass of a blastocyte, the four to five day old stage of the embryo consisting of a small ball of cells. From the moment that an egg is fertilized by the sperm, the embryo contains all the genetic material necessary to develop into a full-grown human being and, given the right environment, the embryo will naturally develop into a baby human. As will be discussed later, the loss of this embryonic life is the main ethical concern surrounding embryonic stem cell research.
- Adult Stem Cells—Adult stem cells are unspecialized cells found within the specialized tissues after birth. At this point, adult stem cells have been identified in the bone marrow, blood, brain and spinal cord, skin, cornea and retina, gastrointestinal tract, liver, and pancreas. Most often, adult stem cells produce cell types associated with the origin tissue. However, recent research has shown that adult stem cells from one type of tissue can give rise to specialized cells of an unrelated tissue, further increasing the therapeutic potentials of adult stem cells.
- Hematopoietic Stem Cells—Hematopoietic stem cells (HSCs) are a specific type of adult stem cells derived from bone marrow and circulating blood that most commonly develop into blood and immune cells. Their sources include bone marrow, peripheral blood, and umbilical cord blood. These stem cells are highly productive, constantly replacing worn out blood and immune cells at a rate of billions of cells each day. Over the past few years, HSCs have proven to be especially plastic (i.e. capable of differentiating into specialized cells of a tissue distinct from the origin tissue). Several studies have demonstrated capability of HSCs to replace damaged skeletal muscle, cardiac muscle, and liver cells, making HSCs a promising option for treating muscular dystrophy as well as heart and liver disease.

How do researchers obtain embryonic stem cells?

Embryonic stem cells are extracted from the inner cell mass of the blastocyte, the four to five day stage of development of the human embryo. This extraction process destroys the embryo. Upon removal of vital cells from the inner cell mass, the embryo can no longer develop into a full-grown baby. Following extraction, stem cells are purified, cultured, and allowed to increase in number. Eventually, scientists attempt to direct the stem cells to differentiate toward a specific cell type by exposing them to signals that mimic the environmental signals seen by cells in vivo. Theoretically, the resulting specialized cells could

then be implanted into a recipient for tissue repair or used in the laboratory for research and drug screening.

What are the potential medical applications of stem cells?

According to the scientific community, stem cells offer great promise for repairing and replacing tissues damaged by disease, injury, or natural aging. Through a process known as therapeutic transplantation, or cell-based therapy, stem cells could be extracted, proliferate, and then directed to differentiate into a desired cell type. The then specialized group of cells could be directly implanted into the suffering area of the patient. This ability of stem cells to differentiate into specialized cells from almost any tissue or organ in the human body could be used to treat Parkinson's, Alzheimer's, heart disease, diabetes, and traumatic spinal cord injuries. In addition, specialized tissues developed from stem cell cultures could be used to test prospective drugs and screen for potential toxins[2].

Practical Research Problems

Although none of these promises have been proven, media coverage and dinner table talk have turned stem cells into a medical fairy tale with the prospect of ending human disease and ailments. However, stem cell research is actually in its infancy and several flaws and problems still linger in the research. According to the 2001 NIH Stem Cell Report, all stem cell therapy is "still hypothetical and highly experimental" at this point. One of the major setbacks in stem cell research is directed differentiation. In order to be used for therapeutic transplantation or drug and toxin screening, unspecialized stem cells must be directed to differentiate into a specific, specialized cell type. Although research is underway, scientists have not yet mastered this skill. Typically, efforts lead to a heterogeneous mixture of multiple cell types, rather than the desired homogenous line of cells[3]. To achieve successful directed differentiation, researchers must first understand the complexities of cell signaling pathways that lead to differentiation, as well as the internal and environmental signals that initiate these pathways in vivo. This research alone may require years of investigation.

Beyond the preparation process, transplanting stem cells into the human body presents some serious threats, including tumor formation and immune rejection. Transplantation of embryonic stem cells has been shown to lead to tumors called teratomas. Teratoma formation is partially due to the presence of undifferentiated cells in the graft, but scientists have been unsuccessful in fully purifying transplant populations.4 In addition, because populations developed from embryonic stem cells are seen as foreign to the recipient's body, transplants are often rejected and attacked by the recipient's immune system. Foreign embryonic stem cells do not exhibit the same class I major histocompatability antigens (MHC), the surface markers that indicate that cells are native to the body, as the recipient's own cells. As a result, the recipient's immune cells attack the transplanted embryonic stem cells, leading to rejection of the transplant and potential harm to the recipient. In contrast, adult stem cells circumvent this problem. Because they can be extracted from the patient's own body or a matching donor, adult stem cells can be selected so that they naturally exhibit the recipient's native surface markers[4]. Together, these two problems alone currently prevent the use of stem cell technology in real medical applications.

With the recent death of former President Ronald Reagan, several congressman and political figures, including Senate majority leader Bill Frist (R–TN) and former First Lady Nancy Reagan, have again thrust the stem cell debate into the media. With the hope of ending the tragedy of Alzheimer's, embryonic stem cell advocates insist that limiting federal funding is not only delaying inevitable medical advancement, but is also uncompassionate and unmerciful towards the millions of families watching the slow agonizing death of loved ones at the hands of the disease. Amidst the vocal outcry, scientists admit that Alzheimer's disease is

actually very unlikely to benefit from embryonic stem cell research. Because Alzheimer's indiscriminately ravages nearly the entire brain, stem cell-based therapies are unlikely to be effective against the disease[5]. Denying this truth, advocates continually call upon the emotionally draining disease to cast a guilty shadow on those who hesitate to support embryonic stem cell research.

Despite these uncertainties, the media and supporters of embryonic stem cell research continue to laud stem cells as the solution to numerous problems in medicine without ever admitting that the research may prove futile. As interested citizens, we must be able to trust physicians and the scientific community to present truth rather than illusions. Dr. George Daley, M.D., Ph.D., and Associate Professor of Medicine at Harvard Medical School explains that, amidst media hype and public frenzy, physicians have a responsibility to "separate the hype from the reality….They've got to be able to maintain hope for patients but give them a sense of the reality that we may still be many years away from realizing treatments that will be applicable to large numbers of patients[6]." We must not only be aware of the vast potential of stem cell research, but also of the unspoken reality of the research's immature status.

Ethical Issues

According to Dr. Nigel Cameron, Ph.D., international bioethicist, and founder of the *Ethics and Medicine Journal*, the debate surrounding embryonic stem cell research has often "degenerated into an iteration and reiteration of the potential benefits of this kind of experimentation, as if those who oppose public funding for what they consider unethical research are either ignorant of or heedless toward disease and its sufferers….[This] short-circuits the moral assessment of means by the crass assertion of ends. It's an embarrassment to the cause of ethics in public policy. For the question we face is distinctly ethical in character[7]." Heeding Dr. Cameron's words, let us pause from the technicals of stem cell research to consider the ethical implications of the means of this research.

Bioethicists, religious leaders, and others concerned with the ethical boundaries in medicine do not question the morality of stem cell research itself or the use of stem cells to help heal disease and injury. In fact, they readily support the quest to heal the ill and dying, hoping that the sick may further experience the amazing God-given gift of life. The ethical dilemma arises from the necessity to destroy a human embryo each time embryonic stem cells are harvested for research. Extraction of embryonic stem cells destroys the source embryo to the point that the embryo is no longer viable for implantation or growth in vitro to yield a human child. For those, such as evangelical Christians, who strongly believe that life begins at conception, embryonic life is sacred and valuable. Because of this view, they are unwilling to sacrifice embryonic life for any purpose, no matter how beneficial the outcome may be.

As Dr. Cameron pointed out in his congressional testimony in 2001, "It is by no means necessary to take the view that the early embryo is a full human person in order to be convinced that deleterious experimentation is improper." Simply recognizing that the embryo possesses the potential to develop into a full human being or recognizing the human embryo as a small member of our species should be enough to demand "profound respect" and "to distinguish the human embryo from all other laboratory artifacts." Therefore, rejection of embryonic stem cell research as immoral should not be limited to those who view the embryo as a full human life. Even those who view the embryo as a pre-cursor with the potential of life should be very concerned with the ethical implications of embryo destruction for any ends[8].

Beyond the issues directly associated with embryos, allowing the destruction of embryos for the goal of healing others threatens to move us closer to other ethically questionable practices. Attorney Wesley Smith, an expert in the area of bioethics, explains, "Because researchers fear that a patient's body would reject embryonic stem cells in the same way it rejects a transplanted organ, many contend that it will be

necessary to manufacture a clone embryo of each patient from which to extract embryonic stem cells. The theory is that since most of the DNA from such an embryo would be nearly identical to the patient, his or her body would accept the injected clone embryonic stem cell tissues. Thus, the anti-cloning/pro ESCR approach may actually lead, as a logical next step, to human cloning. This isn't merely speculative. Four nations, which permit ESCR, now also allow human cloning for biomedical research to look into that very approach: The People's Republic of China, Saudi Arabia, Great Britain, and Israel[9]." Although the majority of Americans strongly oppose cloning, many blindly enter the slippery slope towards cloning by disregarding the inherent value of the human embryo.

In contrast, adult stem cells pose none of these problems. Unlike the extraction of embryonic stem cells, extracting adult stem cells, while sometimes laborious, does not result in the loss of life. Therefore, pro-lifers have no qualms about accepting, and even fully supporting, this potentially life-saving research.

Dr. Richard Land, President of The Ethics and Religious Liberty Commission of the Southern Baptist Convention, summarizes the dilemma as follows:

> "Our concern is not about stem cells, or their incredible promise to relieve human suffering, or the use of federal funds to further the study of stem cell therapy. We should do all we can to bring healing to people. Stem cells are one of God's amazing biological gifts that may someday help bring healing to people who until just recently were thought to have no hope of ever finding relief from their maladies. We applaud and encourage the efforts of the scientific community in their quest to improve our lives and to rescue the sick, diseased, and dying among us. We believe the use of public funds for appropriate stem cell research will help to advance the moral search for healing, which will in turn bury those who insist on immoral stem cell technologies under an avalanche of discovery and application that will discourage the use of private funds for objectionable research. The issue at this time is the price we are willing to pay in order to obtain these incredibly powerful stem cells. The debate today is whether or not scientists should be allowed to destroy human embryos in order to obtain stem cells. We believe the destruction of one human being (especially without that person's consent) for the benefit of another is morally reprehensible. To argue that one human being is more developed and therefore in greater need in no way justifies the cannibalizing of another to benefit him… "We are confident that you will agree that stem cell research is good, but that killing human embryos to conduct this research or to heal human beings is neither necessary nor moral[10]."

Clearly, the use of embryonic stem cells presents an ethical quandary that many have either dismissed or completely overlooked. As Christians, we must be cautious in light of the vast ethical implications of progressing with such research, and we must immediately turn to God's Word before forming a verdict in the case.

Biblical Perspectives

Although the Bible never uses the phrase "stem cell," God's Word presents several principles that can guide our analysis of this debate. First of all, God places a high value on human life, including the unborn child. Numerous passages imply God's view of the embryo as life. He even ordains the purpose and direction of life before the birth of a child, clearly indicating that He already values the unborn life and fully intends for that life to continue.

For example, in Psalm 139:13-16, the psalmist David paints a picture of the human embryo and his or her relationship to the Creator. Speaking to God, David proclaims, “For you created my inmost being; you knit me together in my mother’s womb. I praise you because I am fearfully and wonderfully made;…My frame was not hidden from you when I was made in the secret place. When I was woven together in the depths of the earth, your eyes saw my unformed body. All the days ordained for me were written in your book before one of them came to be.”10 As the Psalm reveals, God carefully watches over the embryo, recognizing the existence of a life from the very moment when the embryo is “made in the secret place”. By ordaining each day of the embryo’s future, God recognizes life in the embryo and unquestionably intends that the embryo be allowed to fully develop into a human being and live out the ordainment. Why else would God Himself construct and plan the future of a life that will never come to pass?

According to Isaiah 49:1-5 and Jeremiah 1:5, Isaiah and Jeremiah, two Old Testament prophets were both called before their birth. Their calling indicates that God views each of them as a unique human life long before they left the womb. Not only that, but God also valued them and planned on using them.

God also makes a specific command concerning the protection of the unborn life in Exodus 21:22-25. Verse 23 states the punishment for killing a child within the womb should be “life for life[11].” By this statement alone, God indicates His view of the unborn child as a life to be protected by society and government on the same level as more developed life.

These passages, among numerous others, provide solid evidence that the embryo possesses life and that God Himself has previously ordained the days of that life. By the law of God and the law of the nation, taking innocent human life is wrong (Exod. 20:13, Prov. 6:16-19, etc.). If God Himself has enough respect for life, even the life of an embryo, to grant it purpose and meaning, how can we justify the destruction of life, no matter what the ends? For the Christian, the conclusion is simple: Since God, the author and giver of all life, views embryos as full human life, to take this life is an act of murder that God does not approve. In light of this, we, as Christians, cannot support the destruction of embryos for embryonic stem cell research (Prov. 24:11-12). Instead we should seek alternatives that also offer promise of sparing and improving human life.

Alternatives to Embryonic Stem Cells

Adult Stem Cells

Although the heated ethics debate has turned the spotlight to embryonic stem cells, adult stem cells offer very similar potential, while avoiding the immoral practice of terminating embryonic life. At the outset, adult stem cells appeared to fall short of their embryonic counterparts, seeming to demonstrate a much lower level of plasticity. Based upon early research, adult stem cells were only capable of differentiating into cells of the origin tissue. However, recent studies have shown that many forms of adult stems actually have much higher plasticity and are capable of differentiating into multiple types of cells. The following research provides abundant evidence for the capability and effectiveness of adult stem cells. In contrast to embryonic stem cells, much research has been done on adult stem cells, in which they have continually proven themselves again and again to have great promise and potential. The most studied type of adult stem cells are hematopoietic stem cells, adult stem cells derived from the bone marrow and circulating that naturally replenish blood cells. Hematopoietic stem cells have been proven capable of differentiating into cardiac muscle cells, skeletal muscle cells, liver cells, neural progenitor cells, and embryonic brain cells, showing that this type of adult stem cells is actually highly pluripotent and has great potential for replacing and repairing several different types of damaged tissues. One of the most convincing evidences for the use of adult stem cells in therapeutic transplantation came in 2001 in the journal *Nature*. Following cardiac

infarct (heart attack), researchers implanted bone marrow stem cells into the muscle near the dead tissue. After only nine days, new myocardium, including proliferating myocytes, occupied 68% of infarcted area. This paper offers promise for the use of adult stem cells to restore function to infarcted hearts and alleviating the effects of coronary artery disease[12]. Similarly, according to research from the Johns Hopkins Kimmel Cancer Center, bone marrow stem cells will differentiate into healthy liver cells and help repair a damaged liver when exposed to the damaged liver tissue. When implanted into mice with liver injuries, the stem cells helped restore liver function in two to seven days[13]. Finally, a paper in the journal of *Experimental Cell Research* commented on the ability of hematopoietic stem cells to specialize into brain tissue. "The ability of hematopoietic tissue-derived adult stem cells to transdifferentiate into neural progenitor cells offers an interesting alternative to central nervous system (CNS)- or embryonic-derived stem cells as a viable source for cellular therapies applied to brain regeneration. Umbilical cord blood (CB) due to its primitive nature and its unproblematic collection appears as a promising candidate for multipotent stem cell harvest[14]." Overall, these papers, among others, attest to the great potential of adult stem cells, despite the skepticism pervading much of scientific community.

Unlike embryonic stem cells, adult stem cells are already being used successfully in everyday medical applications. Bone marrow derived stem cells are used in cancer and auto-immune disease treatments. Following chemotherapy or radiation treatments, physicians often administer bone marrow stem cell transplants to replace the patient's bone marrow. In contrast, embryonic stem cells are not currently used in medicine and the research is still in a much earlier stage.

Based upon this research alone, adult stem cells are an excellent alternative to embryonic stem cells, allowing us to avoid the unethical, immoral practice of destroying unborn human life without compromising medical advancements.

Frozen Embryo Adoption

Advocates of embryonic stem cell research often justify the use of human embryos for research by suggesting that un-implanted embryos from fertility treatments frozen in fertility clinics are simply "unwanted excess" that will only go to waste if not used in research. They argue that the embryos just sit unused in the freezers of fertility clinics waiting to be destroyed. However, these embryos do have hope of surviving thanks to the Snowflake Adoption Program[15], a program of Nightlight Christian Adoptions. The Snowflake Embryo Adoption program facilitates the adoption of un-implanted embryos by interested adoption families. Rather than being destroyed in the research lab or discarded at the fertility clinic, the embryos can be salvaged and allowed to grow into the child they were created to be. For more information on this program, visit http://www.snowflakes.org. This option completely invalidates the "unwanted excess" justification for the destruction of human embryos.

[1] The National Institutes of Health Guidelines for Research Using Human Pluripotent Stem Cells, 2000.

[2] The National Institutes of Health Official Resource for Stem Cell Research: Stem Cell Basics (http://stemcells.nih.gov/info/basics).

[3] The National Institutes of Health Stem Cell Report, 2001. Appendix C.

[4] The National Institutes of Health Stem Cell Report, 2001. Section: The Human Embryonic Stem Cell, pg.17.

[5] Weiss, Rick. "Stem Cells An Unlikely Therapy for Alzheimer's
Reagan-Inspired Zeal For Study Continues." Washington Post June 9, 2004.

[6] Foubister, Vida. "New Rules Expand Stem Cell Research: Doctors must temper patients' expectations with the reality that treatment strides generated from embryo research may be years in coming." American Medical News September 11, 2000. (http://www.ama-assn.org/amednews/2000/09/11/gvsb0911.htm).

[7] Cameron, Nigel. United States Senate Hearing on Embryonic Stem Cell Research: Testimony of Nigel Cameron, PhD given before the United States Senate Committee on Appropriations, Subcommittee on Labor, Health and Human Services, Education, and Related Agencies. August 1, 2001.

[8] Cameron, Nigel. United States Senate Hearing on Embryonic Stem Cell Research: Testimony of Nigel Cameron, PhD given before the United States Senate Committee on Appropriations, Subcommittee on Labor, Health and Human Services, Education, and Related Agencies. August 1, 2001.

Fn9. Smith, Wesley. "Response to Governor Gray Davis' Authorization of Embryonic Stem Cell Research." (http://www.thecbc.org/stem_cell.php).

Fn10. Dr. Richard Land. "Stem Cell Technology: The Issue." The Ethics and Religious Liberty Commission.

[11] The Holy Bible: New International Version.

[12] Orlic et al. "Bone Marrow Cells Regenerate Infarcted Myocardium." Nature 410 (2001): 701-705.

[13] Johns Hopkins Kimmel Cancer Center. "Stem cells can convert to liver tissue, help restore damaged organ." Nature Cell Biology June 1, 2004.

[14] McGuckin Cp et al. "Umbilical cord Blood Stem Cells Expand Hematopoietic and Neuroglial Progenitors In Vitro." Experimental Cell Research 295 (2004): 350-359.

[15] Snowflakes Embryo Adoption Program (http://www.snowflakes.org).

An embryonic stem cell is a cell derived from the early stages of an embryo which is capable of differentiating into any type of body cell.Â Embryonic Stem Cells in Medicine. Regenerating Nerve Cells. As a Research Tool. How Are They collected. The Difference Between Embryonic and Adult Stem Cells. Quiz. Index. Embryonic stem cells are derived from embryos that develop from eggs that were created through the in vitro fertilization process. These eggs are then donated for research purposes with the informed consent of their donors. Researchers do not derive embryonic stem cells from eggs that are fertilized in a womanâ€™s body. Women do not have abortions to harvest their embryonic stem cells, nor do any providers sell fetal tissue for these cell lines to develop. Human embryonic stem cells come from a transference of cells from a preimplantation-stage embryo in a laboratory culture dish. It is mixed wi Human embryonic stem (ES) cells capture the imagination because they are immortal and have an almost unlimited developmental potential (Fig. 1.1: How hESCs are derived). After many months of growth in culture dishes, these remarkable cells maintain the ability to form cells ranging from muscle to nerve to bloodâ€”potentially any cell type that makes up the body.Â Figure 1.3: The Promise of Stem Cell Research. (Â© 2006 Terese Winslow). Human ES cells also have the potential to provide an unlimited amount of tissue for transplantation therapies to treat a wide range of degenerative diseases. Some important human diseases are caused by the death or dysfunction of one or a few cell types, e.g., insulin-producing cells in diabetes or dopaminergic neurons in Parkinson's disease. Embryonic stem cells are cells that can give rise to all of the tissues types that form the human body. These stem cells are supporting research into new drugs, being explored for disease reversal, and being utilized to create healthy new tissue to heal injuries. Embryonic stem cells are also controversial to produce, which has substantially limited their use. Learn more about these cells below. Embryonic Stem Cells and Their Uses. In this article: What are Embryonic Stem Cells? Embryonic Stem Cell Pros and Cons. Human Embryonic Stem Cells. What Is the Timeline of Harvesting Embryonic Stem Cel...