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## Is it stem cell research or therapeutic cloning

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When Ron Reagan Jr. spoke at the Democratic convention last month, it was not to talk about jobs or the Iraq war. Instead, the son of President Ronald Reagan spoke about an issue in which he has taken a personal interest: stem cell research.

During his speech, Reagan described this research as "what may be the greatest medical breakthrough in our, or any, lifetime." Criticizing partisanship on the issue, he urged Americans to choose between "reason and ignorance, between true compassion and mere ideology" in stem cell research. Yet when Reagan described what he called "stem cell research" in his speech, the description he gave was actually closer to therapeutic cloning. The two are related but they are not the same.

Let's start with some basics. Cloning in molecular biology and genetics means making a copy. That copy is not necessarily a whole organism; it can be a bit of DNA or an entire gene. It just means identical copies. However, when most people talk about cloning, they generally mean cloning the whole organism, as in the case of Dolly the sheep, the kind of cloning that yields an offspring.

This kind of cloning actually has more than one type, depending on the goal, although both types yield a clump of cells that has the potential to grow into a whole organism. In reproductive cloning, the goal is to produce a baby. The nucleus, with its DNA, is removed from a host egg and replaced with a nucleus, with DNA, from a cell from the donor. The egg is stimulated to begin dividing and developing, and the embryo is then implanted in a womb. This embryo is genetically identical to the source for the DNA. The baby has only one genetic parent with whom it shares all its genes. The DNA is the same, just like for identical twins, which occurs when a developing embryo essentially splits into two embryos and yields two distinct people with the same DNA.

For therapeutic cloning, the goal is to produce a source for embryonic stem cells. Just like the procedure above, the nucleus with its DNA is removed from an egg and replaced with a nucleus with donor DNA and the egg is stimulated to begin dividing. But in this case, the cells are never implanted in a womb and are never going to produce a baby. Embryonic stem cells are taken from the very early stages of development of an embryo, when it is a ball of just a couple of hundred cells. If the donor DNA comes from a patient to be treated with the stem cells produced, then the stem cells have the same DNA as the donor and are genetically identical. Therapeutic cloning yields embryonic stem cells. The goal of reproductive cloning is a baby. The cells of therapeutic cloning are never going to be a baby. A stem cell is the undifferentiated cell that has the potential to become any kind of cell. All embryos start with embryonic stem cells. Embryonic stem cells have the potential to become any type cell in the body. In children and adults, organs and tissues throughout the body also have stem cells but these somatic stem cells are more specific for that tissue. When a person gets a bone marrow transplant to treat leukaemia, they are being seeded with new somatic stem cells for blood. But there are problems with using somatic stem cells. For one thing, they are hard to find. They look like any other cell in the tissue and are few in number. For some tissues, like spinal



cord, it is not even known if the adult stem cells exist, since these are tissues that do not add more cells or grow in that sense in adults. Blood cells are continually replaced so the body needs stem cells to generate these new blood cells.

The number of neurons in your brain is thought to be fixed. As adults, our bodies still have somatic stem cells to replace cells and repair tissues throughout our lives but these somatic stem cells are generally less flexible than those original embryonic stem cells. In stem cell research, researchers are attempting to unlock the secrets of how stem cells can be stimulated to produce particular types of cells and tissues. The eventual goal is to understand and control the process and have cells that can be transplanted into patients to treat or cure diseases such as Parkinson's, Alzheimer's, diabetes, or spinal cord injury. Researchers also hope to gain a greater understanding of genetic diseases and perhaps development.

Therapeutic cloning and reproductive cloning both can raise ethical and moral questions. With reproductive cloning, the issue is clearer. Do we want to allow this kind of reproduction or not? However, we do have to be aware that banning such procedures in the U.S. would not stop them from happening in the rest of the world. Still, many countries have already banned this kind of human cloning. With so many other reproductive options, it is much harder to justify.

Therapeutic cloning is another matter. Stem cell research has the potential to cure many now incurable diseases and reverse the damage of injuries. Embryonic stem cells give rise to all the cells of the body. If one has a spinal cord injury, nerve cells have been destroyed, cells an adult body cannot replace on its own. Using one's own DNA to create genetically identical stem cells to give rise to replacement neurons has the potential to make recovery possible. This kind of therapeutic cloning tailor-makes stem cells for individual patients.

To do this, a nucleus from a patient's cell would be injected into an egg that had its own nucleus removed. As the resulting embryo develops in culture, stem cells with the patient's DNA could be harvested and injected into the patient. Other replacement cells could also be produced, cells to produce insulin for diabetics, a new liver or heart for transplant, and so forth. Because the DNA is identical, there are no issues about organ rejection and no need to find an organ donor. The promise of stem cell research is enormous but the promise is only possibilities, because there are more unknowns than known for embryonic and somatic stem cells. The only remedy for this situation is research.

We can see the potential but research science is all about exploring the unknowns, which means sometimes you do not find what you expected. Gene therapy was once regarded as a technique to treat diseases that was expected to produce miracle cures. However, it has not yet lived up to its promise because gene regulation and expression, the way genes get switched on or off or how they interact within the body, is far more complex than researchers once thought.

Somatic stem cell research is the preferred option of some groups but scientists are aware that somatic stem cells and embryonic stem cells are not the same. Research really needs to occur on both fronts. Embryonic stem cells can have disadvantages. Sometimes, transplanted embryonic stem cells grow into tumours, rather than the target cells. Somatic stem cells present different challenges. There are intriguing differences between adult stem cells and embryonic ones.

In 2002, one researcher, Catherine Verfaillie of the University of Minnesota Medical School in Minneapolis, found adult stem cells in bone marrow that could give rise to all other cells, as could embryonic stem cells. Would that finding circumvent the moral issues involved in cloning or would finding the adult stem cells prove too impractical to do? What is also unknown is any therapeutic differences between the adult stem cells and embryonic ones. In order to know the real benefits of stem cells, we have to do the research. Models and animal research can only take us so far, at some point we will need human stem cells and will have to include experiments using the source of those embryonic stem cells. One way to do this is to produce embryos to provide those stem cells for research. But therein lies the problem for some folks. Potentially, embryonic stem cells could come from sources that already exist or the cells could be created using the DNA of particular patients.

The Bush administration endorsed one solution in 2001, by limiting government funded research to established lines of stem cells but restricted other options. Using the few already existing lines of cells that the Bush administration has created a barrier to research, by creating a bottleneck and restriction the DNA patterns that can be examined. Other developed nations will not have this restriction and will be able to move ahead more quickly with their research. Restricting to this few lines seems an artificial barrier. Curiously, we have actually

already crossed the barrier of producing embryos that are never going to become babies. There are thousands of them in fertility clinics. In vitro fertilization techniques use an excess of eggs and sperm to ensure fertilization. Many more embryos are produced than are needed, even though several are implanted at a time and often more than one attempt is needed. The extra, unneeded embryos are stored frozen, in an uncertain limbo.

Do they belong to the parents, or to the lab, or something else? In their frozen state, they are just small clusters of cells and most of which will never move beyond that stage. Until they are implanted in a womb, they have no chance of developing into babies. So here we get into difficult ethical, moral, and legal territory. As a society, we will need to decide to use these cells in limbo or not? Or is it better to create embryonic stem cells for use in research?

Some lean toward using embryos that are discards from fertility treatments over those created specifically to harvest the cells but either sparks fears over the ethics of such procedures. The populace is divided and legislators are frozen on how to deal with the issues of both perpetually frozen embryos and stem cell research with great but unexplored potential for health benefits for those already suffering from disease. It is not an easy decision but we need to be aware that the whole developed world is looking at the same issue and may come to different conclusions than we will. However we decide to proceed, or not, here in this country, other nations are already moving forward.

In fact, Britain already has, by moving this month to license a facility to do therapeutic cloning for research into stem cells. The United Nations is also moving towards looking at the issues of both reproductive cloning and therapeutic cloning. By licensing this kind of research, the UK makes clear its position on therapeutic cloning, before the discussion on human cloning at the United Nations scheduled for October 2004. During that discussion, U.N. member countries could agree to ban both human reproductive and therapeutic cloning.

Britain has already banned reproductive cloning and many countries, including Britain, and 67 of the world's national science academies are calling for an agreement to outlaw human reproductive cloning but to permit individual countries to make their own decisions about whether therapeutic cloning should be allowed or not.