faith SEEKING UNDERSTANDING

CHARLES SIGLER, D.PHIL.

Stem Cell Research and Our Inward Parts

Scientists largely agree that stem cells hold potential for the treatment, and possible cure, of many serious medical conditions such as Parkinson's disease, cancer, diabetes and heart disease. While the use of adult stem cells in biomedical research is widely accepted, many religious groups oppose embryonic stem cell research, which involves the use and destruction of human embryos. The Catholic Church and many evangelical Protestant groups have called for a ban on all embryonic stem cell research, believing that "embryos constitute life."

Stem cells have been called the "building blocks of nature" because they have the potential to develop into many different types of cells in the body. When a stem cell divides, each new cell has the potential to either 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 nerve cell. In this way, stem cells serve as a sort of repair system for the body, as they can theoretically divide without limit to replenish other cells as long as the person or animal is still alive. Finding the way to unlock the bio-mechanism involved in this metamorphosis would make them potentially invaluable in treating many diseases and injuries.

There are two basic kinds of stem cells: those found in certain adult tissues (brain, bone marrow, muscle, skin, blood and liver tissue) and those found in the cells of three- to five-day-old embryos. All stem cells have three general properties: they are capable of dividing and renewing themselves for long periods; they are unspecialized; and they can give rise to specialized cell types. Adult stem cells are limited in the types of cells they can generate by specialization and typically generate only cell types of the tissue in which they reside. For example, a blood-forming adult stem cell in the bone marrow normally gives rise to the various types of blood cells such as red blood cells, white blood cells and platelets. But embryonic stem cells are pluripotent, meaning they have the unique ability to develop into any of the 220 cell types in the human body.

Scientists are still learning about the specific circumstances or conditions that allow stem cells to remain unspecialized without spontaneously differentiating into specific cell types. So an important area of continuing research is to understand the signals in a mature organism that causes a stem cell population to proliferate and then remain unspecialized until the cells are needed to repair a specific tissue. Such information is critical for scientists to be able to grow large numbers of unspecialized stem cells in the laboratory for further experimentation and therapeutic treatments. In addition to their versatility, large numbers of embryonic stem cells are easier to grow in the laboratory than adult stem cells; the methods to easily multiply adult stem cells in a cell culture have not yet been developed.

Adult stem cell lines proliferate only for a limited time, while embryonic stem cells potentially can continue dividing forever. It took almost 20 years to learn how to grow human embryonic stem cells in the laboratory after the initial success of growing mouse embryonic stem cells in the early 1980s. In 1998, a research team lead by James Tomson from the University of Wisconsin was the first to successfully harvest stem cells from human embryos donated by fertility clinics. Since then, scientists have developed some 400 stem cell lines.

Embryonic stem cells are gathered in two ways: from existing human embryos and from embryos that were created using a cloning process known as somatic cell nuclear transfer (SCNT). The embryo is ultimately destroyed in both cases, which opponents of embryonic stem cell research argue is immoral. The SCNT process was developed by the same Scottish scientist who cloned Dolly the sheep in 1996. During the process, the nucleus of a human egg cell is removed and replaced with the nucleus from an adult donor cell, which contains the donor's DNA. The egg is then stimulated to begin subdividing and eventually it grows into an embryo with stem cells that can be harvested. Many scientists consider SCNT a very promising technique because it creates an embryo with stem cells that have the same DNA code as the person who donated the cell nucleus. These stem cells can then be used to create therapies that would potentially be compatible with that particular donor's immune system. So for example, if doctors grew new heart tissue to treat someone with heart disease, using the patient's DNA could greatly reduce the likelihood of the patient's body rejecting the new tissue.

In late 2007, researchers in the United States (Thomson and his team) and Japan succeeded in reprogramming adult skin cells to revert to pluripotent, embryonic stem cells by inserting a tiny DNA-containing virus. The resulting stem cells, known as induced pluripotent stem cells or iPS cells, appear to have the same makeup and properties as embryonic stem cells, potentially allowing scientists to create pluripotent cells without destroying embryos. If perfected, the new skin cell technique could eliminate the need to create embryos using SCNT in order to produce compatible stem cells. And because it would eliminate the unwieldy process of acquiring donated eggs and embryos, some scientists say the skin cell technique may be more efficient than using embryos. In other words, this new procedure could eventually end the controversy surrounding stem cell research. But many scientists and supporters of embryonic stem cell research caution that this advance is still not yet ready for therapeutic use.

Thomson and others noted that the apparently pluripotent skin cells need to be tested in comparison with the gold standard of human embryonic cells in order to determine whether they do indeed have the same unique qualities. There also appears to be some biological limitations with the utility of adult stem cells in comparison to embryonic stem cells. Another concern is that the virus used to induce regular cells to become pluripotent stem cells could lead to cellular mutations that, in turn, could cause cancer in patients. According to Jonathan Moreno, a Professor of Medical Ethics and the History and Sociology of Science at the University of Pennsylvania, “If you talk to any of the stem cell biologists, they’ll tell you that the need for human embryonic stem cells continues and will continue for the foreseeable future for a number of reasons. . . . At this point it is still too early to tell exactly what this news means.”

During a ceremony at the White House on March 9, 2009, President Obama fulfilled a campaign promise to relax federal restrictions on embryonic stem cell research when he

signed an Executive Order overturning President Bush's 2001 restrictions: "Today . . . we will lift the ban on federal funding for promising embryonic stem cell research. We will also vigorously support scientists who pursue this research." His hope was for America to lead the world in the discoveries that this research may one day yield.

Anticipating this moment in late January 2009, the California-based company Geron received FDA clearance to begin the first human clinical trial of cells derived from human embryonic stem cells for patients with acute spinal cord injury. Thomas Okarma, Ph.D., M.D., Geron's president and CEO, said "This marks the beginning of what is potentially a new chapter in medical therapeutics - one that reaches beyond pills to a new level of healing: the restoration of organ and tissue function achieved by the injection of healthy replacement cells . . . . directly into the lesion site of the patient's injured spinal cord."

In response to Executive Order 13505 on March 9, 2009, the National Institute of Health (NIH) has published a draft of proposed Guidelines for human stem cell research. The Guidelines provide the policies and procedures under which the NIH will fund research in this area; and also to help ensure that "NIH-funded research in this area is ethically responsible, scientifically worthy, and conducted in accordance with applicable law." The NIH is soliciting public comment on these Guidelines which must be submitted within 30 days of their publication in the Federal Register. The new Guidelines were released on April 17th. They include strict regulations that make sure people donating their unused embryos for research know what they are doing and why they are doing it; and that they were not coerced or paid in any way. These Guidelines will not affect what scientists do using private or state funds.

> Current plans are to finalize them in July of 2009.
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> > These draft Guidelines would allow funding for research using human embryonic stem cells that were derived from embryos created by in vitro fertilization (IVF) for reproductive purposes and were no longer needed for that purpose. Funding will continue to be allowed for human stem cell research using adult stem cells and induced pluripotent stem cells. Specifically, these Guidelines describe the conditions and informed consent procedures that would have been required during the derivation of human embryonic stem cells for research using these cells to be funded by the NIH. NIH funding for research using human embryonic stem cells derived from other sources, including somatic cell nuclear transfer [SCNT, a cloning technique], parthenogenesis [creating stem cells from a human egg only], and/or IVF embryos created for research purposes, is not allowed under these Guidelines.[1]

Pew Research Center on Stem Cell Research

In his announcement, President Obama said that a majority of Americans have come to a consensus to pursue this research; "that the potential that it offers is great, and with the

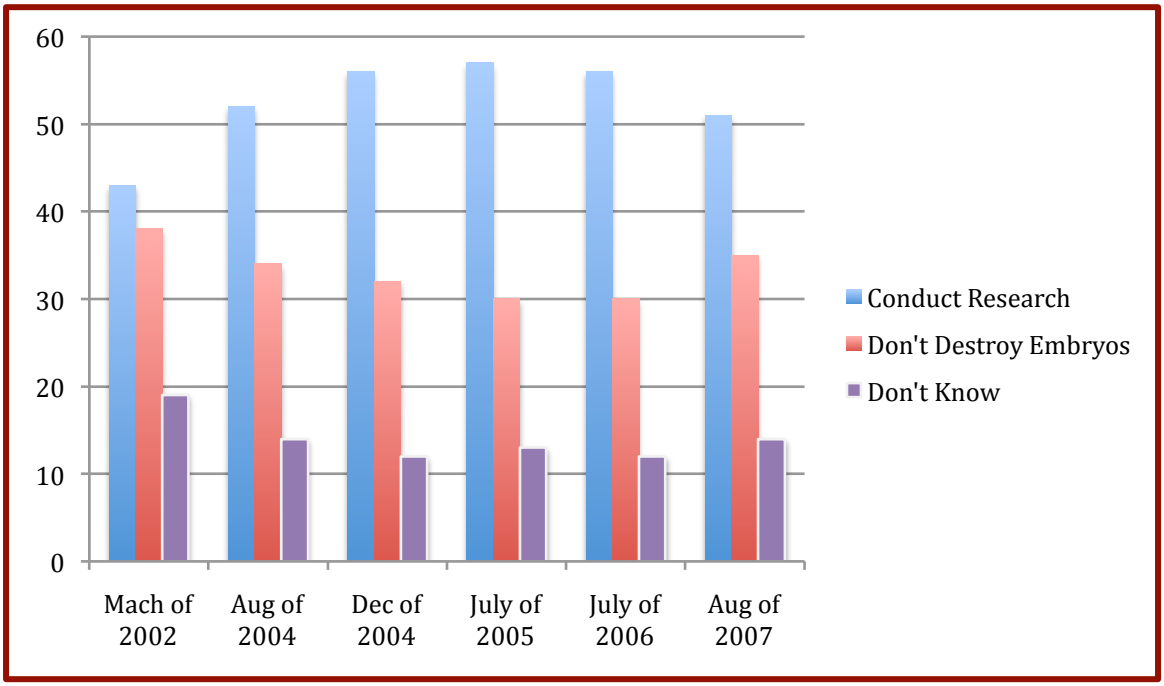
[1] The Dickey Amendment (also known as the Dickey-Wicker Amendment), attached to a bill passed by United States Congress in 1995 and signed by former President Bill Clinton, prohibits the Department of Health and Human Services (HHS) from using funds for the creation of human embryos for research purposes or for research in which human embryos are destroyed. HHS funding includes the funding for National Institutes of Health (NIH).

proper guidelines and strict oversight, the perils can be avoided." While a bare majority of Americans do favor embryonic stem cell research, the size of that majority has declined in recent years. In surveys conducted by the Pew Research Center in August of 2007 (before the announcement of success in reprogramming adult skin cells to revert to embryonic stem cells), only 51% of Americans felt that conducting stem cell research was more important than not destroying the potential life of human embryos involved in this research. A little more than one-third of Americans (35%) opposed embryonic stem cell research, saying that protecting the potential life of embryos was more important than conducting the research; 14% weren't sure.

Pew Research Center surveys conducted since March of 2002 have shown some variation in the support for stem cell research. See Figure 1 below for the Pew data. The wording of the question was as follows: "All in all, which is more important, conducting stem cell research that might result in new cures OR not destroying the potential life of human embryos involved in this research." The lowest approval rating for the research was in March of 2002, when 43% supported the research and 38% opposed it. The most recent data from August of 2007, approximates the percentages in August of 2004, when 52% supported the research and 34% opposed it. As the chart shows, there was essentially no difference in the three remaining surveys from the July 2005 results of 57% in support and 30% opposed. Consistently throughout the research, approximately 13 to 14% didn't have an opinion on the issue.

Politics does seem to influence support for stem cell research. According to the 2007 Pew survey, more Democrats (60%) and political independents (55%) say it is more important to conduct stem cell research than Republicans (35%). "Moreover, in the same poll, self-identified liberals (69%) and moderates (61%) are nearly twice as likely as conservatives (35%) to support stem cell research."

Figure 1
Conducting Stem Cell Research



Differences among religious groups was also quite large; and it seems that the frequency of church attendance in religious groups had an effect on their position. Solid majorities of the religiously unaffiliated (68%) and white mainline Protestants (58%) support stem cell research. A similar trend was found among white, non-Hispanic Catholics (59%). Among those who attend Mass at least once a week, however, this level of support drops to 46%.

White evangelical Protestants showed the opposite trend with 31% favoring embryonic stem cell research, and 57% opposing it. Opposition to stem cell research rose to 68% among white evangelical Protestants who attend church at least once a week. Black Protestants remain split over the issue, with 40% favoring it, 40% opposing it and 20% expressing no opinion. See Table 1 below for the data.

Table 1
Religious Affiliation and Stem Cell Research

	Conduct Research	Don't Destroy Embryos	Don't Know
Unaffiliated	68	21	11
Mainline Protestant	58	28	14
White Protestant	44	44	12
Black Protestant	40	40	20
Evangelical	31	57	12
Wkly Attend	23	68	9
Less often	47	37	16
non-Hisp Cath.	59	32	9
Wkly Attend	46	46	8
Less often	67	22	11

There was also an interesting link between perceived knowledge about the debate and support for the research. Overall, 45% of Americans said they have heard a lot about the issue, while 43% have heard a little and 12% have heard nothing at all. Among those who said they have heard a lot about the issue, fully 62% support conducting research, compared with just a third (33%) of those who have heard nothing at all. See Table 2 below for the data.

Table 2
Knowledge Divide Over Stem Cell Research

Heard about stem cell debate	Conduct Research	Don't Destroy Embryos	Don't Know
A lot	62	30	8
A little	45	40	15
Nothing at all	33	39	28

The ethical heart of the controversy is whether it is right to use embryos, that by donor instructions, would never enter a uterus, for ongoing embryonic stem cell research. The goal of such research, to relieve human suffering is not in dispute. But the means is. Are embryos persons, fully endowed with the rights and privileges of a living, breathing human being? Where does the personhood that constitutes these rights and privileges begin? If not from the very beginning of the biological processes that ultimately lead to the development and birth of an individual, then when? Does it only begin in the womb, or can it be attributed to the in vitro fertilization of a human egg? Does personhood begin at the the blastocyst stage (around five days after fertilization); or does it only begin with implantation of the blastocyst in the uterus, which generally occurs 6-12 days after fertilization? Does the fact that embryos currently used for stem cell research are no longer intended for implantation in a woman's womb make a difference in its permissibility?

Religious organizations vary on their support for stem cell research from having no official policy to explicit support of embryonic stem cell research or outright rejection of it.[2] In general, even those religious organizations supportive of embryonic stem cell research qualify that it should not be for profit; that it should be restricted to embryos that would otherwise be destroyed; and that it should be done only for medical or therapeutic purposes. Here is a summary of the positions of various American religious organizations:

> **American Baptist Churches in the USA**: has no explicit policy on the issue, stating that: "one must be guided by one's own relationship with God and Scripture."
> Buddhism: its teachings do not directly address the issue. However, two main tenets – the prohibition against harming or destroying others (ahimsa), and the pursuit of knowledge (prajña) and compassion (karua) – divide Buddhist scholars and communities on the issue. Some Buddhists argue that stem cell research is in accordance with the Buddhist tenet of seeking knowledge and ending human suffering, while others argue that it is a violation of the notion of not harming others.

[2] The following was taken from the Pew Research Forum report entitled: "Religious Groups' Official position on Stem Cell Research."

Catholicism: In accordance with their anti-abortion stance, the U.S. Conference of Catholic Bishops supports adult stem cell research but opposes embryonic stem cell research since it creates or destroys human embryos.
Episcopal Church: In 2004, the church's governing body, the General Convention, declared itself in favor of stem cell research as long as the embryos used would have been destroyed otherwise, the embryos were not created solely for research purposes and the embryos were not bought or sold.
Evangelical Lutheran Church in America: The ELCA does not have an official position on the issue. In 2005, the Churchwide Assembly, the governing body of the church, created a task force to study the issues of genetics and biotechnology and to present a report in 2011.
Hinduism: believes that life begins at conception, but the religion has no official position on stem cell research.
Islam: There is no explicit Islamic ruling on the issue of stem cell research. While some Muslim leaders allow for stem cell research on the ground that, according to Islam, an embryo in the early stage of pregnancy does not have a soul, others argue that the termination of an embryo at any stage of pregnancy is morally impermissible.
Judaism: All major Jewish denominations – including the Reform, Conservative, Orthodox and Reconstructionist movements – support both embryonic and adult stem cell research as long as it is for medical or therapeutic purposes.
Lutheran Church-Missouri Synod: In 2005, the group reaffirmed its opposition to embryonic stem cell research, advocating instead for adult stem cell research.
Mormonism: The Church of Jesus Christ of Latter-day Saints has not issued a statement on the issue of stem cell research.
National Council of Churches: After an evaluation in 2006 of the debate surrounding stem cell research, the National Council of Churches' Human Biotechnologies Policy Development Committee adopted a position stating that "as a result of a lack of clear consensus [among ethicists, academia and scientists], the National Council of Churches neither endorses nor condemns experimentation on human embryos."
Presbyterian Church (U.S.A.): In 2004, the Presbyterian Church's governing body, the General Assembly, reaffirmed its position in favor of stem cell research that is intended to "[restore health] to those suffering from serious illness."
Southern Baptist Convention: In 1999, the Southern Baptist Convention reaffirmed its "opposition to the destruction of human embryos … [and] support for the development of alternative treatments which do not require human embryos to be killed."
United Church of Christ: In 2001, the United Church of Christ ruled in favor of research on embryonic stem cells that would otherwise be discarded from in vitro fertilization.
United Methodist Church: In 2004, the United Methodist Church asserted its support for therapeutic cloning in which spare embryonic stem cells resulting from in vitro fertilization are used. The church also maintained its opposition to the use or creation of embryonic stem cells solely for the purpose of research.

The guidelines adopted by the National Association of Evangelicals on March 11, 2005 "as the core ethical and moral tenets regarding future research and application of

biotechnology" are of the most direct interest to this discussion and are given here in their entirety.

- Embryos constitute human life.
- All human beings are made in the image of God and given the breath of life by God alone.
- Respect for human dignity is paramount in the development of biotechnologies.
- Cloning human embryos, whether for research or reproductive purposes, must be prohibited.
- Inheritable genetic modifications [germline changes] must not be allowed.
- All bioethics research should be motivated by a desire for advancing the health of mankind and not for financial gain.
- Patent law must not allow for human embryos, genes, cells, and other tissues to become commodities.
- Genetic information is private to the individual and must never be the basis for discrimination.
- Fundamental changes in human physiological nature using biotechnology, genetics, nanotechnology, artificial intelligence, and other means must be prohibited.
- Government funding for research on the ethical, legal, and social issues raised by these new biotechnology developments is essential and must include vigorous oversight and dissemination.

When Do We Receive the Breath of Life?

Definitively, the National Association of Evangelicals stated that embryos constitute human life; and that all human beings are made in the image of God and given the breath of life by God alone. But even here, there are questions to raise and perhaps some ethical vagueness. Is "human life" the same as the personhood of a "human being"? Has God so constituted the breath of life so that it corresponds with the moment of conception? If your answer is yes, then personhood begins with conception; and the embryo should be seen as having the full rights and privileges of a living, breathing human being. But ultimately, there is no test we can do to determine whether an embryo is a person or at what stage of development God gives the breath of life, enabling it to become a person.

Ancient religious texts like the Bible provide minimal guidance to us in answering these questions. At the time that they were written the science of embryology, the ability to create and nurture embryos in the laboratory, could not have been imagined as possible. So its most direct statements on human development fall short of the precision we need for the questions we grapple with here. One of the most direct Biblical statements on human development would seem to be Psalm 139:13, where God is acknowledged as forming us in our mother's wombs: "For you formed my inward parts; you knitted me together in my mother's womb." Formed (*qā·nā*) and knit together (sā·*k̲ă̄k̲*) have a parallel structure in the verse that describes a type of creation or formation of the "inward parts" or *kilyah*, which itself can mean kidney, mind or inmost being. So the obvious reference is to God's activity in prenatal development; but without any more precise information about a process that we now know has a series of distinct stages from conception to actual birth.

Genesis 2:7 states that "the Lord God formed the man of dust from the ground and breathed into his nostrils the breath of life, and the man became a living creature." So we are formed (yā·ṣăr) or fashioned out of existing material or within a specified period of time; and given the breath of life, thus becoming a living creature. There seems to be a stage of formation that is followed by God's gift of the breath of life. Again, there is not the preciseness to say when this actually occurs. So at the moment of conception, or at the formation of the blastocyst or when the blastocyst is implanted in the womb––or some other stage––could equally be the moment in which God breathes into us the breath of life.

We have a slippery moral and interpretive slope to stand on here; and there is much to be said for a clear stand that the breath of life is given by God at conception. So experimentation with or the harvesting of embryonic stem cells is a violation of the sanctity of human life. But others, even other Christians disagree. Do they stand outside the true church; do I need to call them to repentance? I think not, for the reasons just discussed. There is no definitive Biblical declaration in this matter. We fall, I think, within the exhortation in Romans 14 to not pass judgement upon one another; to pursue what makes for peace and mutual edification, remembering that whatever does not proceed from faith is sin (Ro 14:19, 23).

There is a potential for pluripotent skin cells to replace embryonic stem cells. We may live up to the high moral and ethical standards our president described when he signed the Executive Order that relaxed the federal restrictions on embryonic stem cell research. We also know that we can fail to live up to these high ideals. Look to the eugenics movement and the Holocaust for where we can go if embryonic stem cell research goes horribly bad.

All Human Life is Created Equal

In the public forum of debate on this issue, I like the approach articulated by Yuval Levin in his Pew Forum interview. He indicated that the embryonic stem cell debate was ultimately about the question of human equality in the Declaration of Independence, which states that "all men are created equal." But it's not a simple answer. Levin said this does not mean that every person is the same; or that every person is valued in the same way on every scale or measure. It does mean that humanity is something we all share; and that in turn we cannot treat a human being in certain ways that we would treat non-human beings, so:

> The protection of human life comes first. And to the extent that the debate is about whether it is acceptable to destroy a living human being for the purpose of science – even for the purpose of helping other human beings – I think that in that sense, the embryo is our equal. That doesn't mean that I would think of an embryo in the same way that I would think of a three-year-old child, but I would reject a technique that uses either of them for scientific experimentation.

He suggested the aim should be to find ways of doing the science without violating the ethics, rather than trying to force a choice between the science and the ethics. I agree with his observation that in a forced choice situation, the country was more likely to choose science over ethics; so we want to avoid that scenario.

> You don't want a situation where you've got sort of red-state medicine and blue-state medicine and people believe that the treatment their hospital is giving them is obtained in unethical ways. That would begin to break up the practice of medicine and to affect our attitudes about science – which on the whole has done a tremendous amount of good for society.

Further News

Thomson and his research team have once again announced a further breakthrough in embryonic stem cell research in the journal *Science*. They found a safer way to induce skin cells to form pluripotent stem cells. Instead of using a virus, they use a circular, double-stranded DNA molecule called a plasmid. Already important tools in genetic engineering, plasmids or vectors are used to make copies of particular genes. Unlike viruses, plasmids are "naked" DNA and do not encode genes necessary to encase the genetic material for transfer to a new host. They go into the host cell, but never get incorporated into the DNA. Over time, the plasmid naturally disappears, thus avoiding the danger posed by viruses, which can insert harmful genetic material into the target cells. According to Thomson, "That means they are less likely to form tumors, less likely to destroy the function of some important gene." While they still hold promise for stem cell treatments, Thomson said that some of the first benefits of these so-called iPS cells will be for testing the effects of new drugs on human tissue, rather than animals. He added that President Obama's relaxation of federal restrictions on embryonic stem cell research will make it easier to test the effectiveness of new iPS cells for stem cell treatments. It seems that the embryonic stem cell controversy may soon be just an historical memory; that Yuval Levin's hope that a way to do the science without violating ethics is closer than we think.

Generation of Human Induced Pluripotent Stem Cells

Another breakthrough in stem cell research was reported on May 28, 2009 in the journal Cell by Dr. Robert Lanza, the chief scientific officer at Advanced Cell Technology (ACT). His team team built on a 2006 discovery by Shinya Yamanaka, who coaxed human skin cells to revert to an embryonic state by introducing four key genes into the cells, piggybacked on viruses. However, some of those genes are known to cause cancer, which made Yamanaka's stem cells unsuitable for human use. Lanza and his team isolated the proteins made by the same genes Yamanaka used and "tagged" them with a message that allowed the proteins to slip easily into the cell. So far, the iPS cells generated using this method seem to be equivalent to those made using Yamanaka's strategy. The new method allows scientists to create stem cells using a patient's own skin cells, thus eliminating the possibility of rejection.

While developing a technique from patients without the risk of genetic alteration is a significant advance in stem cell research, the technique is still relatively inefficient. Only a very small percentage of skin cells in the study (0.001%) transformed into iPS cells over a two month time period. Dr. Arnold Kriegstein, director of the Institute for Regeneration Medicine at the University of California, San Francisco, cautioned: "How readily or quickly this technology is applied, and whether the efficiency is improved, are things that we will have to wait and see."

On the other hand, Dr. Lanza is optimistic that we won't have to wait too long. "We really lucked out," said Lanza. "These iPS cells were just discovered a few years ago, and

here we are three years later with a method safe enough to actually use in people." Despite his enthusiasm, Lanza admitted researchers still need to learn about how the new iPS cells will react once inside a patient's body. The most pressing question is whether iPS cells — or the the 200 types of tissues potentially generated from them — will act the same way as human embryonic stem cells, which were not created in a petri dish. "We don't know if iPS cells can do everything that normal human embryonic stem cells can do," Lanza said. But having stem cells that are safe for human use is an important step toward finding some of those answers. His company, ACT plans to file a request for the first human trial using its cells sometime next year.

Mice Made from Induced Stem Cells

And again, there was a further breakthrough with iPS cell research reported on July 23, 2009 in the journals *Nature* and *Cell Stem Cell*. Two teams of Chinese researchers have been able to reproduce living mice from iPS cells. Since iPS cells were originally created by Shinya Yamanaka in 2006, researchers have wondered if they generate an entire mammalian body from iPS cells, as they have from true embryonic stem cells.

For the first study reported in Nature, a team of researchers using Yamanaka's method of creating iPS cells were able to reprogram a tetraploid mouse embryo (an embryo that lacks the the embryonic cells that would become the mouse's body) with the iPS cells. The developing embryo was then transferred to a surrogate mother, and 20 days later an all black mouse named Xiao Xiao (Tiny) was born into a line of all white mice. DNA tests confirmed that Tiny has arisen from the iPS cells.

Using this technique with their best cell line and optimal recipe, the team was able to generate 22 live births from 624 injected embryos, a success rate of 3.5%. The mice seemed to have a high death rate with some dying after just two days; others displayed physical abnormalities. But all 12 mice who were mated produced offspring, and the offspring showed no abnormalities. There are now hundreds of second-generation, and more than 100 thrird-generation mice.

The second team, using the same basic technique, transferred iPS cells to 187 tetraploid embryos and had two live births, a success rate of 1.1%. One of the two live births died in infancy. The researchers are now trying to mate its surviving mouse.

As a potentially easier method that produces fewer abnormalities than conventional cloning, the tetraploid work could evoke interest among some maverick researchers as a tool for human cloning. China recently strengthened its law prohibiting such clonings, so the Chinese studies can't say much about the clinical applications of pluripotent cell lines. One of the researchers did say that he hoped that researchers will take advantage of the technology as "an important model for understanding reprogramming." But then added: "It is not intended to be a first step towards using iPS cells to create a human being."

Stressing Mature Cells Produces Pluripotent Ones

The journal *Nature* published two articles in January of 2014 that describe a faster and more efficient way to create pluripotent stem cells than the iPS method—stressing them in acidic conditions. Again, it was a Japanese research team that made the discovery. Haruko Obokata, a stem-cell biologist at the RIKEN Center for Developmental Biology originated the idea. She made pluripotent cells by stressing mature T cells (a type of white blood cell) and caught the conversion on video. Obokata called the process stimulus-triggered

acquistion of pluripotency (STAP). She has already reprogrammed a dozen cell types, including those from the brain, lung and liver. This suggest that the method could work with most, if not all, cell types. Shinya Yamanaka, a pioneer in iPS cell research, said: "The findings are important to understand nuclear reprogramming. . . . From a practical point of view towards clinical applications, I see this as a new approach to generate iPS-like cells."

Obokata is now attempting to see if the process will work with cells from adult mice and humans. Stay tuned to see where this fascinating research leads us.

For more information on the topic of stem cell research:

Acid bath offers easy path to stem cells

The Ethics of Human Embryonic Stem Cell Research: the International Society for Stem Cell Research

Generation of Human Induced Pluripotent Stem Cells by Direct Delivery of Reprogramming Proteins; in Cell Stem Cell, vol. 4, issue 6, 472-476, May 28 2009.

Geron Receives FDA Clearance to Begin World's First Human Clinical Trial of Embryonic Stem Cell-Based Therapy

Nature News: Mice made from induced stem cells

NIH Guidelines for Human Stem Cell Research: Draft

Pew Forum Special Report: Embryonic Stem Cell Research

Plasmid from Wikipedia

President Obama's Announcement on Stem Cell Research

Researchers Hail Stem Cells Safe for Human Use: Time, May 28, 2009

Scientists find safer way to make human stem cells

Stem Cell Information: The National Institutes of Health resource for stem cell research.

U.S. stem cell proposals forbid funds for cloning