Sacred Cells?

Why Christians Should Support Stem Cell Research

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ROWMAN & LITTLEFIELD PUBLISHERS, INC.
Lanham • Boulder • New York • Toronto • Plymouth, UK

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Preface

Misunderstandings about ethics are like TV commercials and online pop-ups. They are everywhere, it seems. They are pesky. They interrupt. They annoy because they divert attention. Replacing misunderstanding with clarity and focus is the goal of this book.

We start with five misunderstandings. The first is this: *Science is fast, whereas religion is slow; religion is always lagging behind science.* One cartoon from the late 1990s depicted giant black footprints labeled "science" leading off toward the horizon. A little man was pictured running to catch up. He was labeled "ethics." Another cartoon pictured two horses, the faster one escaping from the slower. The faster one was labeled "cloning and stem cell research" and the slower one "ethics."

Sometimes, this is true: Religion chases science and tries to catch up hastily by throwing some ethics at it. But by no means is this universally the case. The stem cell controversy is a good example of a case in which science and ethics worked hand in hand from the beginning.

The three authors of this book are connected with the Center for Theology and the Natural Sciences (CTNS) at the Graduate Theological Union in Berkeley, California. When the worldwide Human Genome Project commenced in 1990, so did CTNS's monitoring of the research in the name of theological and ethical interests. A national team of geneticists, theologians, and philosophers worked on a U.S. National Institutes of Health–funded project, "Theological and Ethical Questions Raised by the Human Genome Initiative."

Nearly two years before the first human embryonic stem cells were isolated and characterized, two CTNS theologians were busy drawing plans for an ethics advisory board to work in tandem with the laboratory scientists. We tell this story here, seeking to convey this point: The full story of stem cell research cannot be told without the chapters on ethics and religion being told with it. In this case, science and ethics coordinate.

The second on our list of misunderstandings is this one: *The stem cell war is one more example of the conflict between science and religion*. Again, this is wrong. Yet, it is widely believed. Take for example an article in one of the world's most respected science journals, *Nature*: "The tension between faith and science never fully subsides. And as these realms regularly come into contact, over everything from Darwin to Dolly the cloned sheep, they sometimes collide with explosive force."[1]

This is wrong for two reasons. First, all relevant religious voices sing praises to the advances of medical science. All encourage science to strive for the betterment of human health and well-being. Some theologians even see scientific research as a divine vocation. No categorical rejection of science exists in mainline Christianity or Judaism, despite the popular image of warfare. Second, in the middle of the ethical debate over stem cell research, some theologians argue for ethical approval of stem cell research. We authors of this book belong in this camp. The disagreements over stem cell research are not due to a conflict between science and faith. Rather, they are due to honest yet differing interpretations of what faith requires at the present moment. While some religious people may oppose specific scientific advances, most welcome and support them. We are among those people of faith who welcome and support stem cell research.

The third widespread misunderstanding is this: *The principal job of the ethicist is to say "no" whenever possible*. As ethicists, we are often asked *ad nauseam*, "Where do you draw the lines?" We presume that "lines" mean fences, and scientists should not jump fences. Not only does ethics *chase* science, but its role is to *chastise* science. The presumption is that to be an ethicist is to put fences around scientists. Where did this image come from?

To our chagrin, the laboratory scientists with whom we work complain all too often that their contacts with ethicists are routinely negative. The job of the ethicist is to put up a "no trespassing" sign, so it seems to them. When such scientists see an ethicist coming, they run to hide. They are understandably reluctant to engage us in conversation.

The three coauthors of this book have asked ourselves: "Is this really what we as ethicists want to do? Is it our job to say 'no'?" Certainly not. The job of the ethicist is to display with as much rigor as possible the important ethical

issues at stake and to work with people in making ethical decisions. Sometimes this *does* mean saying "no." But just as often, it means saying "yes." We conceive of ethics as providing helpful guidance to scientists and others faced with difficult problems and oriented toward a better future.

The fourth and related misunderstanding presumes that *every religious ethicist says "no" to stem cell research*. The job of the religious ethicist, it seems to many, is to describe stem cell scientists as baby killers who are cannibalizing early embryos to make spare body parts. If you are a religious ethicist, it is assumed that the only question you ask is: What is the moral status of the embryo? However, we believe other important questions need to be asked as well, especially this one: How can medical science improve human health and well-being? In the case of stem cell research, the potential for a dramatic leap to increased human health is significant. In our considered judgment, saying "no" to stem cell research would be immoral. We seek to provide ethical justification for a positive affirmation of this particular line of scientific research.

This book will be both descriptive and prescriptive. First, we describe the worldwide stem cell debate in terms of competing ethical frameworks. We hope this will illuminate the debate and make the apparent impasse more understandable. Then, in addition, we provide the reader with our own prescription, namely, that religiously minded persons should support research leading to stem cell therapies.

We intend to show that public policy warfare regarding stem cell research is a cross fire coming from multiple directions. There are in fact multiple frameworks available for addressing ethical issues. One of these just mentioned is the *embryo protection framework*. This is the framework within which many religious people formulate their positions and accuse the scientists of promoting a "culture of death." Scientists respond by saying that the preimplantation embryo is not a human person, even *in potentia*. The central question—the one that currently dominates the public debate—is whether the early embryo possesses morally protectable dignity, so that destruction for purposes of research is forbidden. Is stem cell research akin to abortion? One side answers "yes." The other side answers "no." Both sides tacitly agree that the rightness or wrongness of stem cell research will be determined by the moral status of the early embryo.

Yet, this is not the only possible framework. It is a mistake to think that this is the only way in which the moral battle can be waged. At least two other frameworks appear on the moral map.[2] One of these we label the *human protection framework*. The essential question here is: How can we protect our humanity from the hubris of science, technology, and other human ventures?

What is central in this framework is the protection of a sense of what is "essential" to human life and dignity, perhaps even a reverence for what is natural in making us the human beings that we are. Human nature protectionists are driven by anxiety expressed in Aldous Huxley's novel of the early 1930s, *Brave New World*, when genetics was becoming a household word. The words "brave new world" connote a scientized and technologized civilization in which the biological sciences have placed the human race under totalitarian control. Today, whenever it appears that scientists are manipulating something internal to human nature—something we deem essential, such as DNA—the specter of the brave new world arises. Is DNA sacred, so that we should ask our scientists to keep their hands off it? Or, is DNA simply one more resource for research leading to genetically engineered improvements in medical care and human well-being?

Nobody wants to create a brave new world. The question is whether our true humanity is to be found in nature alone apart from modification by technology, or is it found in self-improvement through the science and technology we human beings have created?

The third framework is the *future wholeness framework*. Here the attention is given to the dramatic potential of regenerative medicine. What human embryonic stem cell research is leading to is a quantum leap well beyond any previous form of medical therapy. It is leading toward the actual regeneration of organs such as the heart, liver, pancreas, and even the brain. If we could do more than merely stop deterioration—if we could actually cause new tissue to grow to replace tissue damaged by disease or accident—recipients of stem cell therapy could emerge healthier and stronger than they previously were. Even though still in the theory stage with animal studies and some clinical studies, stem cell research shows promise not just for amelioration but for actual cures for many types of cancer, Parkinson's disease, heart disease, diabetes, Alzheimer's disease, and many others. According to the future wholeness framework, the promotion or blocking of such research is itself a moral issue. When such potential for relief of suffering and betterment of human life is judged to be a realistic potential, then a moral obligation to pursue it kicks in. Within this framework, arguments to shut down such research require considerable burden of proof.

From within the future wholeness framework, we ask: Is it moral for religious advocacy groups to shut down research that could lead to relieving the suffering of millions if not billions of persons in the future? We also ask questions related to justice: Recognizing that the advance of stem cell knowledge will be staggeringly expensive, how will the medical products be distributed? Will the poor persons of the world have access to the marvels of this science?

How can we structure the economics of the medical delivery system so that benefits are distributed worldwide? Such ethical questions get ignored when we presume that the question of embryo protection is the only question on the ethical agenda.

The three authors of this book place ourselves primarily within the third framework. As people of faith, our ethical commitment begins with a sense of God's promise for an abundant future and therefore with a commitment to improve the human lot in life. We believe support for medical research is support for improving human health and well-being. Regenerative medicine could lead to a much more abundant life for many among us. Having made this commitment to work primarily within the future wholeness framework, however, we still feel obligated to engage our friends and opponents within all three ethical frameworks, and we will do that in subsequent chapters.

After weighing the arguments in all three frameworks, it is our considered judgment that stem cell research should go forward. It is our further recommendation that public policy support such research on behalf of the welfare of all and on behalf of future generations who will benefit from the advance of medical science in this generation. We contend that religious believers of our own persuasion and the faithful of other traditions should hold such science in high regard and pray for its success. As Christian theologians, we say "yes" to stem cell research. In what follows we will explain why.

This leads to the fifth on our list of widespread misunderstandings: *Supporters of stem cell research are pro-choice on abortion and generally disregard the human right to life. They violate the sacredness of life.* This misunderstanding is purveyed widely in the media when oversimplifying its reports on coalitions of Christian groups protesting alleged human rights violations. In order to divide our populace into neat factions, the media tells us that those who want to pull the feeding tube from a person in a perpetual vegetative state are also pro-choice and favor stem cell research. The news is lumpy—that is, it lumps otherwise disparate causes together as if this is accurate and informative.

We plan to show what a big mistake it is to lump together the abortion controversy with the stem cell controversy. Even though there is some overlap, these two issues have significant ethical differences. Therefore, the position one takes on one issue does not dictate how one will deal with the other issue. It is quite possible to favor stem cell research and oppose elective abortion. In fact, one of the authors of this volume would fall on what is usually called the "pro-life" side of the ledger regarding elective abortion, while the other two take the pro-choice position. The two pro-choice supporters report, "This is *because* we're pro-life." All three of us feel strongly committed to human rights; and we believe this strong commitment derives

from the fundamentals of our shared faith. Yet, we contend that the moral logic of stem cells is different from the moral logic surrounding abortion. One cannot simply lump them together under the guise of protecting the "sacredness" of life.

One of the difficulties with those who wish to equate the abortion controversy with the stem cell controversy is that they tacitly treat DNA as sacred; they treat cells as if they were persons. To treat anything as sacred means to treat it as something that cannot be violated, to treat it as a source of moral value. Tacitly, embryo protectionists treat prepersonal cells as sacred, protecting the dignity of the stem cell as if it were a person. We believe that God and God alone is sacred; and we believe that human persons should be treated with dignity. To clarify what we mean here is one of the tasks of this book.

The three of us coauthoring this book are theologians with a special interest in ethics, especially bioethics. We have studied the issues surrounding human embryonic stem cells. In fact, we have been present while the very plan for isolating these cells was being conceived and the initial discoveries made. We have examined the arguments put forth by religious leaders and others who want to shut down stem cell research. We have reviewed them carefully and respectfully. It is our considered judgment that decisive moral arguments can be lifted up in support of scientists engaged in this research, chief of which is this: *Medical research into the regenerative potential of human embryonic stem cells fulfills the principle of beneficence*—that is, it fulfills our divine mandate to improve human health and well-being—and does not violate other important principles. As theological ethicists, we want to say "yes" to stem cells.

We are all Protestants, but from different traditions. Indeed, we cover the spectrum from liberal to conservative traditions within Protestant theology. As scholars, we try to explicate the views of every perspective with accuracy, sympathy, and fairness. As ethicists, we feel obligated to render judgments and support these judgments with sound reasoning based upon our deeply held Christian commitments. Although we understand the unavoidable complications and nuances of the public policy debates over genetic research, we can say, with some qualification: "yes" to stem cell research. The book that follows will say why.

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Notes

1. Tony Reichhardt, "Studies of Faith," *Nature* 432 (2004): 666.

2. Readers following this debate will notice in this book a change in vocabulary in describing these frameworks. In previous articles and in the book by Ted Peters, *The Stem Cell Debate* (Fortress Press, 2007), the second framework was called the "nature protection framework;" we now call it the "human protection framework." What was previously designated the "medical benefits framework" we now call the "future wholeness framework." The reasons for these changes will become apparent in later chapters.

CHAPTER ONE

The Ethical Prehistory of Stem Cells

Significant events have a prehistory and a posthistory. In 1981 the mouse embryonic stem (ES) cell was discovered by scientists in Great Britain and in the United States. This discovery led to the exciting possibility that there might be an equivalent cell in the human being. An *in vitro* fertilization (IVF) clinician in Singapore, Ariff Bongso, first located human embryonic stem (hES) cells in culture but was unable to get them to replicate indefinitely. Finally, James Thomson at the University of Wisconsin, the first to find ES cells in monkeys, had the major breakthrough in 1998. Thomson isolated hES cells, and with this the worldwide controversy over stem cell ethics exploded. Or, so it seems.

This scientific prehistory of hES is well known, at least to scientists. What is less well known is that there is an ethical prehistory as well. It is commonly thought that interest in the ethics of hES cell science followed the announcement of Thomson's isolation of hES cells in 1998. But that is not so. Controversy—or at least, discussion—preceded this historic announcement.

On a spring day in Berkeley, California, in 1996, a group of theologians and scientists gathered in the Dinner Board Room of the Flora Lamson Hewlett Library at the Graduate Theological Union (GTU). This historic meeting not only represents the initiation of formal ethical discussions of stem cell research in the United States, but it also represents a new chapter in the story of the relationship between biotech research scientists and ethical advisory boards. Like streams from separate mountain glaciers first trickling and then

converging into a single flowing river, basic scientific research converged with theological ethics to create a new flow of public policy discussion.

The SyStemix Stream

The first prehistory stream comes from ethical questions arising within the research program at SyStemix Corporation in Menlo Park, California. Founded in 1988 by Stanford University immunologist Irving Weissmann, SyStemix sought nothing short of curing AIDS, other autoimmune diseases, and cancer. No vaccine could work for AIDS, concluded SyStemix's scientists, because the HIV virus mutates every 36 hours. It would not be possible to continue revising the vaccine formula or antivirals to keep up with such rapid change. An alternative strategy would be needed. Instead of eliminating HIV, asked the researchers, could the patient continue to live with HIV that does not progress to AIDS? If the bone marrow could continue to produce new and AIDS-resistant blood—healthy blood with immune cells that could not be infected, having been rendered resistant via genetic engineering of the hematopoietic stem cell—this would be possible.

Weissmann had previously isolated hematopoietic (blood making) stem cells in mice. At SyStemix, scientists turned their attention to repeating this, to trying to create a human cell equivalent. One in every 300,000 blood cells is a stem cell. Could the stem cells be extracted from the blood, concentrated, and injected into bone marrow, where they would continue to generate new and healthy blood despite adverse conditions? The answer turns out to be yes.

This was made possible by SyStemix's use of an invention by Mike McCune, a cofounder of SyStemix. McCune had been a postdoctoral fellow in Weissman's Stanford University lab. SyStemix at its founding had licensed this invention from Stanford. The invention involved the use of the severe combined immunodeficient (SCID) mouse, a mouse without its own functioning immune system, that could therefore accept organ fragments from any species, including the human species, without rejection. When receiving human tissue without rejection, it became known as the SCID-Hu mouse. SCID-Hu made the right kind of experimentation possible.

SyStemix scientists also invented a process for harvesting and concentrating human hematopoietic stem cells and patented it in 1990. U.S. Patent number 5,061,620 covers both the method for obtaining these stem cells and for the resulting composition, the product.

In 1990 Linda Sonntag became CEO of SyStemix. By 1992 she perceived ethical dark clouds forming on the stem cell horizon. Sonntag understood

the interface between research and ethics. Back in 1986 while at Focus Technologies in Washington, D.C., she had convened a six-person panel to sort through ethical issues surrounding ownership of patient information and protection of individuals from genetic discrimination. At SyStemix in 1992 Sonntag made arrangements for two theologians working in bioethics at the GTU in Berkeley, Karen Lebacqz and Ted Peters, to visit SyStemix and discuss emerging dilemmas.

The Graduate Theological Union Stream

How did Sonntag know that resources could be tapped in Berkeley? Sonntag was a friend of one of Karen Lebacqz's doctoral students, Suzanne Holland, who at this writing teaches ethics at the University of the Puget Sound.[1] Lebacqz was then professor of ethics at Pacific School of Religion, a member seminary of the GTU.

The GTU is a consortium of theological seminaries offering a fully ecumenical and interreligious context for theological education. In addition to seminaries, the GTU also houses research centers, which include faculty both from its partner institute and neighbor, the University of California, Berkeley. One of these research centers, the Center for Theology and the Natural Sciences (CTNS), played a key role in the ethical prehistory. When Nobel Prize winner James Watson in 1987 pressed the U.S. Congress to support what would later come to be known as the "Human Genome Project," he advocated that 5 percent of the government's budget be devoted to Ethical, Legal, and Social Implications (ELSI) of genetic research. As soon as Congress passed legislation and the National Institutes of Health (NIH) established the National Center for Human Genome Research, CTNS applied for and received an ELSI grant. Ted Peters served as principal investigator for "Theological and Ethical Questions Raised by the Human Genome Project." Professor Lebacqz served as a member of CTNS's core research team, and doctoral student Suzanne Holland worked as a research assistant.[2]

It was Suzanne Holland who mediated the connection between Linda Sonntag and the two GTU professors, Karen Lebacqz and Ted Peters. The GTU stream was about to flow into the SyStemix stream, and eventually into the surging river of stem cell controversy.

The SyStemix and GTU Confluence

Sonntag presented three ethical problems to Lebacqz and Peters. The first on Sonntag's list was the use of fetal organs in a humanized mouse.

As mentioned above, SyStemix was using the SCID-Hu mouse for all of its research efforts. These SCID-Hu mice were constructs of SCID mice that were then implanted with fragments of human fetal organs, tissue derived from aborted fetuses. SyStemix was concerned about potential concerns regarding the use of abortuses for experimental purposes. The use of fetal tissue in other forms of research had already become a matter of international concern. Many ethicists could easily distinguish the decision to legalize abortion from the decision to utilize the resulting abortus as a research subject. SyStemix was not responsible for the legalization of abortion, nor was it responsible for individual women making the decision to terminate pregnancy. SyStemix would not be morally culpable in this respect. Once it had been determined scientifically that fetal tissue provided unusually valuable material for their medical experiments, they proceeded to utilize this material. If the field of ethics can be considered a helping field—that is, helping persons or societies to work through real-life moral dilemmas—then what needed to be asked here is this: In light of the existing circumstances, what is the best way forward? It was our judgment that such research should go forward.

This ethical problem confronted by SyStemix in 1992 foreshadowed one that would arise again six years later regarding hES cells. One concern in the rising controversy was the destruction of the early embryo in order to establish ES cells. Instead of aborted fetuses, however, the new wave of researchers would be using human zygotes produced through IVF and discarded by fertility clinics. Again, the researchers would not be responsible for producing the research material. The question would become: Is it morally licit to use this material for medical purposes?

The second of the three ethical problems on the Sonntag list had to do with a side implication of the successful isolation of human hematopoietic stem cells. The ability to inject such cells into the bone marrow and to guarantee continued production of healthy blood placed SyStemix on the brink of providing a decisively effective therapy for leukemia. Word having gotten out about the discoveries of SyStemix resulted in a line at the door of desperate leukemia patients seeking stem cell injections. Lebacqz and Peters momentarily celebrated the medical achievement, congratulating Sonntag. "So, what's the problem?" they asked.

"We are not ready for clinical application," Sonntag stressed. "We want to stick to our research mandate. If we were to allow one of these leukemia patients to use our concentrations of blood stem cells, and should something go wrong, and should they decide to file a lawsuit, then SyStemix would be financially crippled and we could no longer pursue our long-range goals."

"Yes," acknowledged Lebacqz and Peters, "this is a problem." How does one weigh the alleviation of immediate human hardship against long-range goals? Pressures to proceed quickly to clinical application always arise when new technologies appear to offer hope, but it is important that movement not jeopardize patient health or eventual success of the therapy.

The third ethical problem was introduced in 1992 but became a widespread public controversy in 1995. It has to do with the legitimacy of the SyStemix composition patent. In 1993 Andrew Kimbrell published a book *The Human Body Shop*, in which he describes an unnamed California company that allegedly patented human body parts. "In 1991 the Patent and Trademark Office (PTO) granted patent rights to a California company for commercial ownership of human bone marrow 'stem cells' (stem cells are the progenitors of all types of cells in the blood). The PTO had never before allowed a patent on an unaltered part of the human body."[3]

This might have gone relatively unnoticed by the reading public if it were not for the author's colleague, Jeremy Rifkin at the Foundation on Economic Trends in Washington. On May 18, 1995, Rifkin convinced 180 religious leaders to sign a statement supporting his strong stand against the alleged patenting of the human genome. At a press conference Rifkin called for a government ban against patenting genes and genetically engineered animals. One of the religious leaders, Richard Land of the Southern Baptist Convention, was quoted in the *New York Times* saying, "Instead of whole persons being marched in shackles to the market block, human cell lines and gene sequences are labeled, patented and sold to the highest bidders."[4] Both the biotech industry and the U.S. government were rhetorically indicted for crass disavowal of the sacredness of human life and for cannibalizing human bodies for spare parts in order to make a profit. Eventually attention turned in the direction of SyStemix. In a phone conversation with Peters, exasperated Sonntag expressed frustration that misunderstanding could be so widespread.

A sober review of what was happening will show that the accusations against SyStemix or the government patent office were unfounded. Nothing like body parts had been patented. What the U.S. Patent and Trademark Office has required since the days of Ben Franklin is that inventions exhibit three qualities: they must be novel, nonobvious, and useful. The term "body parts" suggests that a concentration of hematopoietic stem cells already occurs in nature and cannot be considered as the novel invention of a human artificer. However, the PTO concluded that such a concentration does not in fact occur in nature; rather, it took a sophisticated process and a machine to make purification and concentration possible.

One could appeal to the vitamin B-12 pill as a precedent. Although vitamin B-12 appears in minute quantities in the livers of cattle and in certain other microorganisms, it takes human technology to concentrate it and make a convenient pill. The purification process makes concentrated vitamin B-12 novel. Hence, the PTO felt justified in granting a patent for it, and this was sustained in the courts. This also was the case with hematopoietic stem cells in purified and concentrated form.

Our ethical deliberations and analysis of this problem concurred that the SyStemix patent fits squarely within the two centuries of patent tradition and criteria. Accusations that human body parts or someone's private blood cells were becoming the property of a for-profit company appeared to be misguided. Lebacqz and Peters sought to distinguish ethical deliberation from political rhetoric.[5] With the confluence of the SyStemix and GTU streams, the ethical prehistory of the stem cell controversy was almost complete.

The Geron Stream

Enter the Geron Corporation. Michael D. West, founder of the Geron Corporation in Menlo Park, set out to isolate and characterize hES cells. Whereas hematapoietic stem cells are only multipotent—that is, able to generate all cell types within the blood stream—ES cells are pluripotent, making them capable of producing any and every tissue in the body. ES cells are the progenitors of hematopoietic stem cells, which are the progenitors, in turn, of new blood cells. West had previously worked with ES cells in mice. He began anticipating repeating this with human beings.

West, holding a Ph.D. from Baylor College of Medicine, founded the Geron Corporation in 1990, and until 1998 he initiated and managed programs in telomerase diagnostics and therapy. West selected the name "Geron," which in Greek means "old man." It comes from the New Testament, from the passage where an old man named Nicodemus asks Jesus, "How can a man be born again when he is old (*geron*)?" (John 3:4).[6] The name "Geron" has morphed into our modern word, *gerontology*. West's company had a primary interest in research that might extend the life span and reduce the impact of aging.

West was passionate about his vocation as a scientist and audacious about his research goal, to say the least. The goal he set for himself was nothing less than the defeat of death. West describes the moment when he realized his life's calling: "It was crystal clear to me what I had to do. I had to defeat death. . . . This was inarguably the greatest and highest calling of mankind,

to find and control the biological basis of the immortality of life, and to alleviate the suffering of our fellow human beings."[7] West wanted to know if science could win the battle against the Grim Reaper.

The first skirmish won in this battle was the discovery of the time clock that ticks away through cell division, deterioration, and demise. The clock ticks with the shortening of our telomeres. A telomere is a sequence of nucleotides on the ends of each chromosome. Literally, it is the following sequence: TTAGGG.[8] To halt deterioration of the telomeres and make the clock tick longer became the first goal of Geron. This ability was achieved during Geron's first half-decade.

Geron's telomerase research built upon the foundational work of Australian born molecular biologist, Elizabeth Blackburn, who along with her colleague at the University of California at San Francisco, Carol Greider, had done the pains taking work of sequencing the telomeres. Geron brought Blackburn in as a consultant in order to further this research.[9]

West was then asking: Might we find a form of human cell whose telomeres never shortened, cells that would be effectively immortal? With immortal cells, could we then regenerate tissue damaged by disease or trauma? Even if science cannot help Nicodemus or the rest of us to become born again, could it help our bodily organs become born again?

West turned to stem cells. If we could isolate stem cells, might we gain the ability to regenerate tissues or even organs, thus overcoming some of the most difficult diseases of aging, such as heart disease? The stem cell became the target for research because of two virtues: if immortal it could have the power to regenerate tissue, and if pluripotent, it could be directed into making any tissue we designate. What do we mean by this?

Immortality?

First, *immortality*.[10] With this somewhat surprising word borrowed from theology and imported into science, West meant a cell that would continue to divide and divide without deterioration, in principle, forever. What he had learned from his previous research into telomeres is that, as long as the telomeres are intact, a cell would continue to remain healthy and generate new tissue. The achievement of the Geron scientists was that they found a way to fire a gene producing the telomerase enzyme into a cell that would lengthen the telomeres or prevent deterioration. Telomerase positive cells had been created.

This concept of cell immortality has a most dramatic shadow side. When we turn to cancer cells, the problem is that too much telomerase activity

spawns the unlimited growth of a tumor. The tumor grows and grows until it kills the patient. This observation led Geron scientists initially to look for a way to turn off the telomerase gene. If we could turn off the production of telomerase within a cancer cell, the cell would no longer divide. Eventually it would become senescent (die); the tumor would shrink in size and the patient would recover. The devising of a method for firing a knock-out gene into a cancer cell to turn off telomerase activity was one of the achieved goals of this research. As we write, Geron is now exploring ways of turning this technology into a therapy to fight cancer.

Thus, telomerase activity needs to be shut off in the case of cancer; but it needs to be turned on in the case of regenerative medicine.[11] When turned on for purposes of tissue regeneration, the patient needs to be protected from the possibility of runaway telomerase activity and the creation of a cancer. West set this as one of his goals. By looking for a naturally immortal cell, he believed he could gain access to regenerative power without the risk of precipitating cancer.

Pluripotency?

Second, pluripotency. What West would need would be a stem cell that would be at least pluripotent. What do we mean by this? A stem cell has two important qualities. First, it is clonal—that is, it can replicate or clone itself. It is self-renewing. Second, it produces daughter cells for different types of tissue. *Potency* refers to this ability to generate different cell types.

The potency of cells can be ranked. A cell is *totipotent* (totally potent) when it can make any tissue in the human body and also, under the right conditions such as existing within a woman's body, make a baby—that is, proceed through the stages of embryo development and become a human being. The next level down would be a cell that is *pluripotent*—that is, a pluripotent cell could differentiate into any tissue in the body, even if it is unable to become an embryo. Totipotency, or at minimum pluripotency, is what West was seeking; because he would need cells that could be guided into becoming any tissue or organ he might select: heart, liver, pancreas, brain, and so forth.

When West began, he could have utilized Linda Sonntag's *multipotent* blood stem cells, those affecting different forms that blood take. But this would be insufficient. Virtually useless would be *unipotent* stem cells, those that renew only one form of tissue, such as skin or hair. Unipotent cells are best called progenitors, because they derive from stem cells yet can generate new cells of their own type. West needed more versatility than what

a multipotent or unipotent cell can deliver. With all this in mind, West asked: Might he find both immortality and pluripotency in hES cells?

What, then, is a stem cell? It is a cell that is able to reproduce itself throughout the life span of an animal or person; and it will give rise to differentiated somatic cells or other stem cells, or perhaps both. The daughter cells of stem cells may be either differentiated cells or more stem cells.[12] When giving rise perpetually to more stem cells that remain healthy and do not deteriorate, the stem cells are immortal. Could such a treasure be found?

The stem cell treasure would include more than the golden egg. By regenerating new tissue, implanted stem cells in a patient following a heart attack would so strengthen the heart that it would be stronger than it had been before the attack. By teasing stem cells into becoming brain tissue we could develop therapies to overcome Alzheimer's and Parkinson's. By teasing stem cells into becoming pancreas tissue we could overcome diabetes. By teasing stem cells into becoming spinal nerve cells we could repair injuries and overcome paralysis of the lower limbs. And all of this in addition to its potential for winning the war against cancer. The therapeutic potential of regenerative medicine appears like a cornucopia of healing and human betterment.

Pursuing Venture Capital through Ethics

In 1996 West went looking for venture capital to support his endeavors in a spin-off company to be named "Primordia." His two research compatriots in this venture would be Jeryl Hilleman and Andrea Bodnar. One of the first people West spoke with was Linda Sonntag, who by then had left her position as CEO of SyStemix and had become an independent venture capitalist. The prospects of research into ES cells intrigued Sonntag. In her own mind, however, Sonntag felt she needed to think through her fiduciary responsibility to potential investors. Could such research make a profit? Was it ethical?

Now the memories of Sonntag and West differ slightly. As Sonntag recalls it, she introduced West to the ethical implications of his research proposal. In order to press her concern, Sonntag firmly stated that she would not engage in raising money until a full "ethical analysis" had been completed. Sonntag then invited West to a "round table" discussion of ethical issues. West accepted.

According to West, Sonntag did not introduce him to the ethical issues for the first time. He had previously anticipated them. He was educated in an evangelical Christian environment that had sensitized him to ethical issues.

And he had worked through the question of the moral status of the preimplantation embryo by taking the developmentalist position—the position that the moral status of the embryo increases as the embryo develops. West does agree that Sonntag told him in private, "It will never fly. Everyone will see it as unethical." West reports that he responded by defending his already established moral judgment, namely, that the developmentalist position on the moral status of the embryo would suffice.

The two memories agree about what happened next: Sonntag invited West to a roundtable discussion with theologians in Berkeley at the GTU. West welcomed the idea. Yet he reports that one of his research colleagues, Jeryl Hilleman, was "horrified" at having to speak with theologians. Still, the three—West, Hilleman, and Bodnar—consented.

Sonntag then contacted Suzanne Holland, who in turn asked Karen Lebacqz and Ted Peters to help set up the roundtable at the GTU. On an April day in 1996, 18 GTU faculty members and graduate students gathered in the Dinner Board Room of the library to greet the 3 representatives from the Geron Corporation. The faculty group included, among others, Robert John Russell from the Center for Theology and the Natural Sciences, William R. O'Neill, S.J., from the Jesuit School of Theology at Berkeley, Richard Gula from the Franciscan School of Theology, and Michael Mendiola from the Pacific School of Religion.

Linda Sonntag directed the meeting. She pointed to Dr. West and said to the assembled group, "Not until we get an ethical analysis that I can live with, will I try to raise the money for human embryonic stem cell research." West then assumed the position of lecturer and spent nearly an hour describing the research protocol he was planning to begin. He said he would create an "immortal line" of stem cells that could make any tissue in the human body and potentially regenerate any diseased or damaged organ. The scientific vision was awe inspiring, even to those outside science who were learning of this for the first time.

When it became clear that isolating hES cells would include the destruction of the blastocyst—the embryo between four and six days after activation—Professor Lebacqz announced, "This is an important ethical issue!"

Before the day was finished, the theologians identified what they considered to be the core ethical issues raised by ES cell research: (1) the moral status of the embryo; (2) the future unforeseen consequences of these therapeutic interventions; (3) the revolutionary therapeutic potential of the research; and (4) the economic justice concern for worldwide distribution of the medical benefits. These ethical issues would eventually explode into the global stem cell debate. In April 1996, more than two years before scientists

were able to isolate hES cells, the global controversy over the ethics of ES cell research had quietly begun.

The first of these four, the moral status of the embryo, received part but not all of the attention at the roundtable discussion that day. The Roman Catholic theologians pressed for further elaboration. In the process, the Catholics affirmed their Church's commitment to protecting the life of the early embryo. Even in the face of the prospect that such laboratory research could provide untold medical benefits, the Catholics could not in good conscience countenance the destruction of potential human beings in the service of health and medicine.

Sonntag listened carefully. She reports hearing what she discerned as "the sense of abhorrence in the Catholic reaction and an ethical stance with no apparent wiggle room." If this Catholic reaction should become a general public reaction, she thought to herself, then reception for Geron's or Primordia's program would be undercut. The funding would be undercut, and so would the market. On this day, Sonntag decided to decline West's request to raise capital to support the research. Geron would have to look elsewhere for its money.

Notes

1. Suzanne Holland, Karen Labacqz, and Laurie Zoloth, eds., *The Human Embryonic Stem Cell Debate: Science, Ethics, and Public Policy* (Cambridge, MA: MIT Press, 2001).

2. Ted Peters, ed., *Genetics: Issues of Social Justice* (Cleveland, OH: Pilgrim Press, 1998).

3. Andrew Kimbrell, *The Human Body Shop* (San Francisco, CA: Harper, 1993), 210.

4. "Religious Leaders Prepare to Fight Patents on Genes," *New York Times*, May 13, 1995, Front page, National Edition.

5. See Ted Peters, *Playing God? Genetic Determinism and Human Freedom* (New York: Routledge, 2nd ed., 2002), 120–22.

6. Michael D. West, *The Immortal Cell: One Scientist's Quest to Solve the Mystery of Human Aging* (New York: Random House/Doubleday, 2003), 90.

7. West, *Immortal Cell*, 30.

8. "The word 'telomere' comes from the ancient word *telos*, meaning 'end,' and *mere* meaning 'parts.'" West, *Immortal Cell*, 61. For a discussion of TTAGGG, see pages 79–81, 100. When the telomere becomes too short, the frayed ends of the chromosome attempt to fuse with another chromosome. It appears that the critical length is 12.8 repeats or 6 base pairs; any shorter than this and the loosened chromosome end may begin the fusion process. Heidi Ledford, "Minimum Telomere Length Defined for Healthy Cells," *Nature* 449 (2007): 515.

9. Catherine Brady, *Elizabeth Blackburn and the Story of Telomeres* (Cambridge, MA: MIT Press, 2007), 149–50.

10. Since 1996, the scientific vocabulary has shifted somewhat. "Immortal" is used less frequently. Certainly stem cells proliferate; yet "terms such as 'immortal' and 'unlimited' are probably best used sparingly if at all," at least with reference to adult stem cells. This according to Douglas A. Melton and Chad Cowan, "'Stemness': Definitions, Criteria, and Standards," in *Handbook on Stem Cells*, 2 volumes, ed. Robert Lanza (Amsterdam: Elsevier Academic Press, 2004), II: xxiv.

11. The telomerase theory is still undergoing development, and it has its critics. Stanley Shostak, for example, points out that "the roles of telomeres in cell senility and carcinogenesis seem contradictory. Telomeres should be longer in cells that divide indefinitely," but in fact telomeres in cancer cells are often shorter than their normal tissue counterparts. Stanley Shostak, *Becoming Immortal: Combining Cloning and Stem-Cell Therapy* (Albany: SUNY, 2002), 27. It appears that the length of the telomere in itself does not determine the level of cell activity.

12. See Shostak, *Becoming Immortal*, 177.