

I continue to hold in principle — as do many Americans and governments of several Western nations — that using in vitro fertilization to generate harvestable cells and tissues represents a seriously problematic, life-disowning use of biologic science. But I also appreciate that practice with human embryonic stem cells has raced ahead of principle and that the President’s compromise — restraining the practice but not banning research that could bring great benefits — was a wise one.

I’m asked what I would say if some other country’s scientists, using methods unsupported in the United States, discovered a cure for parkinsonism, diabetes, or Huntington’s disease. But that’s easy. First, I’d celebrate. I’ve not spent 50 years working and praying for such a victory to meet it without a welcome.

Then, after we’d drunk all the champagne, I’d surely ask, “What price this glory?” If we could reap the benefits using adult stem cells or SCNT, I’d lose no sleep over the methods that revealed them. If the therapies depended on trophic factors that we could

extract and synthesize, I’d salute them. If the only effective therapies came with cells manufactured in factories where women were treated like battery hens, vats of sperm and ova bubbled and brewed, and human embryos were chopped and diced, I’d fret — as I fret over any product made under inhuman conditions.

But, even for bioethics, such matters lie too far in the future. The method I followed in arguing for SCNT remains compelling. Know the technical features through and through when working out the rightness or wrongness of a medical procedure. “God is in the details,” noted the architect Ludwig Mies van der Rohe. Never has that truth echoed more loudly in the arena of biologic enterprise than it does now.

1. Gearhart J. New human embryonic stem-cell lines — more is better. *N Engl J Med* 2004;350:1275-6.
2. Human cloning and human dignity: the report of the President’s Council on Bioethics. New York: PublicAffairs, 2002.
3. Jaenisch R. Testimony: President’s Council on Bioethics, July 24, 2003. (Accessed June 22, 2004, at <http://www.bioethics.gov/meetings>.)

## BUSINESS AND MEDICINE

## The Business of Stem Cells

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On February 12, 2004, a team of Korean scientists made global headlines. Using somatic-cell nuclear transfer (therapeutic cloning), they removed the nucleus of a human egg cell and replaced it with the genetic material from a single adult cell. They then stimulated the newly transformed egg cell and prompted it to begin dividing. Several days later, they had produced a line of human embryonic stem cells — the first ever created in a laboratory.

Scientifically, the impact of this procedure was immense. The Korean team had demonstrated the practical ability to manufacture stem-cell lines from scratch. They had shown that it was physically possible to grow stem cells from the genetic material of a single person and then — theoretically at least — to produce other cells or tissues that would match those of the original donor perfectly. From these identical matches could come whole new ways of treating human illness: nerve cells for patients with Parkinson’s disease, brain cells for patients

with Alzheimer’s disease. Accordingly, the Korean success was greeted with scientific delight and a flurry of accelerated research activity. In Canada, a parliamentary committee voted to legalize the use of excess embryos for stem-cell research. Sweden announced that it would support the cloning of embryos for therapeutic purposes, the United Kingdom authorized a private firm to begin deriving embryonic stem cells, and Singapore forged ahead with plans to spend \$300 million on Biopolis, a cutting-edge science park focused on stem-cell technology.

In the United States, by contrast, recent policy has moved sharply in the opposite direction. Following an August 2001 announcement by President George W. Bush, federal funding for stem-cell research has been restricted to roughly 19 stem-cell lines — those created before the President’s announcement from embryos donated after in vitro fertilization. No federal funds may be used to investigate other lines or to create new ones. Although

federal law remains silent on the topic of therapeutic cloning, the President's Council on Bioethics has recommended a moratorium on the practice.

If such restrictions remain in place, they will almost certainly curtail stem-cell research in the United States. Accordingly, organizations such as the Coalition for the Advancement of Medical Research and the Juvenile Diabetes Research Foundation have argued strenuously against existing U.S. policy, pleading instead for more public funding of stem-cell research and greater support for the technologies involved in therapeutic cloning. Together with a growing band of congressional supporters, these groups have asserted that limiting funding for stem-cell research means squelching promising lines of medical inquiry and strangling technologies that could lead to new hope and cures for some of society's most dreaded diseases. Opponents of stem-cell research, however, stand equally firm, declaring that the willful creation and destruction of living embryonic cells violate the fundamental sanctity of life. The argument, therefore, is suspended between extremes. How do we balance existing lives against the purported rights of embryos and the fears of unnatural creation? Under what rules can we sanction using some forms of life to save others? At the moment, the moral debate seems destined to stalemate.

There is another lens through which to view the stem-cell controversy, however — a less obvious but also a less controversial one. And that is the lens of the market, a lens through which stem cells are seen not as life-or-death projects but rather as the basis for a set of highly promising but still unproven technologies. They are technologies that — like satellite television in the 1980s or Web browsers in the 1990s — seem to be standing on the cusp of history, eliciting a complicated mix of commercial interest and social concern. They are technologies, moreover, whose evolution will be shaped by business as well as science — by the markets they create, in other words, and the people who clamor for their goods.

Currently, the market for stem cells is distinctly immature. Only 10 private firms in the United States were actively involved in embryonic stem-cell research in 2003, spending a total of just \$70 million. Over time, however, this still-small business is likely to expand dramatically, following along the well-trod path of similar breakthrough technologies. The economics here are simple. Already, there is a widespread, deep-seated demand for the products that stem cells may eventually provide — treatments for

diabetes, regenerative medicine, and customized therapies. As the science matures, there will also be firms with the capacity to supply these very same products. And once demand and supply exist together, they will naturally create a market. Governments can try to prohibit or constrain this market; they can push the market abroad or underground. But history suggests that such prohibitions will inevitably be short-lived, because if demand is intense enough and supply available, then would-be buyers and sellers will eventually constitute a market of their own, either by circumventing the law or by pushing the state to relax its restrictions.

We have seen this dynamic of prohibition repeated throughout history, playing itself out with regard to a range of technologies that were just as radical in their own time as stem cells are today. When the printing press was invented in the 15th century, for example, established authorities regarded it as a subversive force, since it put the power of words, for the first time, in the hands of common people. When radio emerged around the turn of the 20th century, governments tried desperately to control its use, fearful that the spread of information across the skies would create havoc on earth. And when reliable means of contraception became technologically possible, both social critics and government authorities spent decades trying to squelch their use, arguing (with a faint foretaste of current debates) that any intervention in the process of reproduction was both unnatural and immoral. In the end, however, all these technologies generated both profitable markets and more accommodating policies. Society grew accustomed to the science, customers demanded what the science could provide, and governments agreed to regulate what they no longer cared to ban.

A similar progression is likely to occur in the field of stem-cell research. Yes, the science is path-breaking, both medically and in terms of social impact. Yes, stem-cell technologies have the potential to change both how we treat disease and how we understand life. But the very potential of the science also means that markets will cluster rapidly around it, pushing stem-cell technologies out of the realm of the awesome and into the more comfortable world of the real. Government restrictions cannot prevent this transition from occurring. They can, however, exert a powerful influence on how and where the stem-cell industry develops.

In this regard, the commercial consequences of U.S. policy are staggering. Of the 14 organizations

with stem-cell lines that are eligible for federal funding, only 4 are in the United States. Nearly all the major government-funded research initiatives are overseas. A handful of state-level initiatives seem poised to buck the national trend: New Jersey, for example, has proposed establishing a \$10 million Stem Cell Fund, and California has a ballot initiative pending that would raise \$3 billion for stem-cell research. But these projects are still floating in a relatively restrictive environment, denied federal funding and the sanction of public policy.

To be sure, only the most ardent capitalist would endorse giving the market free reign over stem cells. The moral issues involved are simply too important, and the social debates too intense. At the same time, though, approaching stem-cell technologies purely from the viewpoint of science or ethics robs the debate of a critical dimension, because over the long run, stem cells — like books, radios, and birth-control pills — are likely to evolve into less contentious, more commercial forms. Mainstream firms will provide increasingly normalized prod-

ucts, reaping substantial profits in the process and carefully avoiding the areas that society finds repugnant. Pharmaceutical companies will focus on treatments for major illnesses, for example, rather than on producing hybrid offspring for a tiny segment of possible buyers. Venture capitalists will fund research into the most acceptable offshoots of stem-cell science, driving a market that runs in accordance with the wishes of society and not against them. Firms, in other words, will cluster not at the scary edges of scientific potential but, rather, where rules are transparent, and where states are essentially accepting.

Therefore, the future of stem-cell research is likely to be driven as much by markets as by science, by the demand that emerges for the products of these cells and the firms that rise to supply them. If we ignore these commercial prospects now, we risk undermining both the business and the science.

From Harvard Business School, Boston.

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## “Medicine Is My Lawful Wife” — Anton Chekhov, 1860–1904

Robert S. Schwartz, M.D.

One hundred years ago, on July 15, Russia’s most famous physician, Anton Pavlovich Chekhov, died of tuberculosis at 44 years of age in Badenweiler, Germany. His body was shipped to Moscow by train in a refrigerated car marked “For Oysters.” At the Novodevichy cemetery, Maxim Gorky and Fyodor Chaliapin joined a huge crowd of mourners for a farewell to their Antosha.

Chekhov’s remarkable life was devoted to medicine and consumed by literature. In a letter to a friend, he wrote, “Medicine is my lawful wife, and literature is my mistress. When I get fed up with one, I spend the night with the other. Though it is irregular, it is less boring this way, and besides, neither of them loses anything through my infidelity.”

Chekhov began his medical studies at the Moscow University Medical School in 1879. As a student, he wrote hundreds of short stories to support himself and his family. By the time he had graduated, in 1884, he was a well-known writer and a regular contributor to the St. Petersburg daily *Novoe vre-*

*mya*. But in 1890, depressed by his brother’s death and fed up with Moscow and himself (“seeing my works in print has for some reason given me no pleasure”), Chekhov decided to make an arduous 8000-km bone-jarring journey across Siberia to Sakhalin, a remote penal colony where 10,000 convicts and political prisoners lived in frozen exile. He sought to expose the harsh conditions of the Czar’s gulag: “I want to write one hundred to two hundred pages and thereby pay off some of my debts to medicine.” In Sakhalin, Chekhov conducted a medical census of the convicts, investigated their living conditions, drew up mortality statistics, and wrote a detailed description of “the extreme limits of man’s degradation.” His book, *The Island of Sakhalin*, prompted an official investigation but was rejected as a doctoral dissertation by the dean of Moscow Medical School (“too sociological”).

Chekhov started a general medical practice in the village of Melikhova, 80 km south of Moscow,