ECONOMIC IMPACT
OF
STEM CELL RESEARCH IN TEXAS

Prepared for
The Alliance for Medical Research
Houston, Texas

By

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Executive Summary

Recent scientific advances have generated tremendous excitement in the burgeoning field of regenerative medicine, which focuses on developing therapies to restore or replace damaged cells and tissues in the human body. Stem cell research has proven to be one of the most promising areas of research, offering the opportunity to revolutionize medical treatment, drug development and biomedical research.

From heart disease and diabetes, to Parkinson's disease and spinal cord injuries, stem cell research in its many forms holds the key that could potentially unlock the secrets to treatments and cures that have long eluded patients suffering from some of the most devastating diseases.

This study measures the economic impact, as well as the humanitarian and economic benefits to Texas, from the research of all types of stem cells and finds:

- ***Potential Benefits for those Suffering from Many Diseases:***
  The study only addresses: Heart Attack; Stroke; Type 1 Diabetes; Parkinson's Disease and Spinal Cord Injury; but it should be noted that those with cancer and other debilitating diseases and conditions not discussed here would also benefit.

- ***Over 1.2 million Potential Beneficiaries:***
  More than 1,225,000 Texas residents are afflicted with conditions that could benefit from treatments that could be enhanced by stem cell research.

- ***Potential Cost Savings to Texas of Almost $140 Million per Year:***
  The estimated costs of treatments for the five conditions noted are nearly $14 billion per year. The potential benefits from stem cell enhanced treatments that reduce these costs by as little as one percent would save almost $140 million each year. Over a thirty-year period, these cost reductions would sum to $4.2 billion.

- ***Reduction of Spending on Medicaid:***

  Total state Medicaid outlays in the 2008-2009 biennium are estimated at $39.6 billion with a sizeable share going to treat victims of chronic diseases and spinal cord injuries.

- ***Potential Increased Revenue and Jobs***

  If Texas' share of the industry should grow from 2.9 percent to 6 percent by 2014, the biotechnology sector could be a $62.5 billion industry. According to IMPLAN, (see p.23 for analytical methods used) a $62.5 billion biotech industry would contribute $87.4 billion to state economic activity and support over 230,000 direct, indirect, and induced jobs (compared to 33,000 today) paying over $12.8 billion in salaries, wages, benefits and proprietors' income.

- ***Additional Increased Revenue to Texas***

  Property income from rents, royalties, dividends and corporate profits would rise to almost $7 billion, and state and local indirect business tax revenues would increase to $1.3 billion.

Unlike Texas, many other states are making strong commitments to stem cell research, not only to improve public health but also to capitalize on its economic development potential. Institutions in California, New Jersey, Massachusetts and Wisconsin have been the leaders in this field, in part because of state laws that ensure the legality of embryonic stem cell research.

Even without explicit state support for embryonic stem cell research, Texas possesses a biotechnology sector comprised of about 950 private companies as well as world-class universities and research facilities and the largest medical center in the world. Nonetheless, in the race among the states to find cures using embryonic stem cell research, Texas is currently a minor player and is at a serious disadvantage. With eight percent of the nation's population, and 7.8 percent of its gross domestic product (GDP), Texas currently accounts for only 2.3 percent of the nation's biotech employment and under three percent of total output.

If Texas is to be a leader in stem cell research, including embryonic stem cell research (understanding that, **from a research perspective, embryonic stem cells cannot be separated from adult stem cells because of the symbiotic relationship between the two**), it will have to invest more of its own resources, just as many other states are doing.

<u>The future of biotechnology can follow one of these paths:</u>

Scenario I: If Texas retains its current market share of 2.9 percent, the state's biotech industry will grow to $30.4 billion by 2014. An industry of this size will contribute $42.5 billion to state economic activity and support 112,000 direct, indirect and induced jobs. State and local tax receipts would increase by $632 million annually.

Scenario II: If Texas' share of the nation's biotechnology spending rises from 2.9 percent to 6 percent by 2014, the state will possess a $62.5 billion industry contributing $87.4 billion to state economic activity, supporting 230,000 jobs, and generating $1.3 billion in new state and local tax revenues annually.

To realize Scenario II, Texas must create a legislative and regulatory environment that encourages researchers and industry to remain in the state. That means passing a law or referendum that ensures state policy toward stem cell research, including embryonic stem cell research, is no more restrictive than that at the national level.

Scenario III: Continuing threats to or a ban on embryonic stem cell research, a critical tool in adult stem cell research labs, could draw most of the biotech completely away from the state, creating a loss of the billions of dollars, hundreds of thousands of jobs, and more than half a billion dollars in tax revenues.

John Mendelsohn, M. D., President of M. D. Anderson Cancer Center, testified at the Texas Legislative Stem Cell Forum, January 26, 2005 Austin, Texas ***"…Texas is clearly behind with ESC research.*"**

A more restrictive environment will make it extremely difficult to attract new researchers and biotech companies into the state and will force talented researchers to leave Texas, such as Dr. Dennis Roop, who took 5 National Institutes of Health grants totaling $3.8 million and Baylor faculty members.

Mary Pat Moyer, at the Texas Legislative Stem Cell Forum, January 26, 2005 Austin, Texas testified ***"As the CEO of INCELL Corporation, a San Antonio-based biotechnology company, I confirm that competition is stiff and incentives are meaningful. I am continually offered money to move my company to another state."***

An industry with the potential to support more than 230,000 jobs in Texas, generate $88 billion in economic activity, and provide over $1.3 billion in state and local tax revenue would be put at risk should the legislature impose restrictions on stem cell research above and beyond any federal restrictions.

If Texas is to be a leader in the biosciences, with all the anticipated health and economic benefits that will follow, the state must maintain a hospitable environment for research and development. At a minimum, Texas needs to be known as a "safe haven" for regenerative medical research, including embryonic stem cell research. What's more, if Texas is serious in its desire to become a major player in the global bioscience arena, it should invest some of its own resources into this cutting-edge research.

Introduction

Embryonic stem cell research represents one of the most promising fields for medical researchers seeking cures and treatments for a wide range of diseases and injuries. But stem cell research involves much more than possible cures for serious diseases. It means jobs, income and economic development.

According to the Biotechnology Industry Organization in Washington, DC, the bioscience industry employs 1.2 million Americans in more than 40,000 firms across all 50 states. In Texas alone, biotechnology is estimated to generate almost 50,000 jobs, not including researchers at hospitals, medical schools and clinical research institutions. But in the race to find cures using embryonic stem cell research, Texas is at a serious disadvantage.

Unlike Texas, many other states are making strong commitments to stem cell research in order to capitalize on its economic development potential. Most notably, the voters of the state of California approved proposition 71 in 2004 authorizing the expenditure of up to $3 billion to support stem cell research at the state's hospitals, medical schools, universities and other research institutions over a 10-year period. By contrast, bills have been introduced in the past three legislative sessions in Austin that would have criminalized or banned the use of state money for embryonic stem cell research.

President-elect Barack Obama has stated his intention to remove the current federal limitations on stem cell research. Against the backdrop of these changes, it is up to the state of Texas to decide whether it wants to continue to be a major player in the life sciences or relegate itself to a minor role with the attendant loss of economic development potential and prestige.

Scientific Background

Stem cells have the ability to develop into every type of cell in the body, as well as to replicate themselves for very long periods of time. Thus, stem cells could be used to treat diseases or injuries by replacing the damaged or aged cells with newer, functioning ones, or by repairing the dysfunctional cells. Stem cells could also be used to greatly speed up the process of drug development, allowing researchers to test the effects of drugs on specific human cells in the laboratory, rather than in human subjects. These cells provide a unique opportunity for researchers to study the development of diseases, as well as general human development, which could lead to novel therapies and treatments for a host of diseases. The study of embryonic stem cells will also teach scientists about the biological programs that regulate human development from embryos to newborns as needed in the prevention of birth defects and various pediatric diseases.

Popular discussion has tended to distinguish stem cells into two types: adult stem cells and embryonic stem cells. Adult stem cells are multipotent (meaning they can develop into a limited number of cells), are able to divide for a shorter period of time, and are derived from the cells of human beings. Embryonic stem cells are pluripotent (meaning they can develop into any of the cells in the human body), are able to divide for extended periods of time, and are derived from early stage embryos, undifferentiated clumps of a hundred or so cells no bigger than the head of a pin.

Scientists can also derive embryonic stem cells through a process known as somatic cell nuclear transfer (SCNT). The nucleus of an adult somatic cell, such as a skin cell, is placed in an enucleated egg, which is then stimulated to divide as if a sperm and egg had fused, although conception has not occurred. This procedure allows researchers to create stem cell lines that match a person's DNA, enabling them to study specific diseases as well as decrease the chance that the patient's immune system will reject clinical treatments using the cells.

As the science has advanced, researchers have come to believe that the dichotomy between embryonic and adult stem cells does not fully capture the range of stem cells; rather, stem cells are a continuum of cell types stretching from pluripotent stem cells to multipotent stem cells.[1] Stem cells are akin to a medical tool kit, with different stem cells likely to be useful to treat different injuries or diseases depending on the cells' different characteristics.

For example, scientists at Wake Forest University recently have discovered that stem cells in amniotic fluid show the potential to develop into more cell types than adult stem cells, but less than embryonic stem cells.[2] Researchers at the University of Michigan have done further work that demonstrates fetal stem cells are distinctly different from adult or embryonic stem cells.[3]

Scientists also have developed additional means of deriving stem cells that appear to be pluripotent or near-pluripotent. Researchers at Advanced Cell Technology in Massachusetts have developed a means of deriving pluripotent stem cells from a single biopsied cell from the embryo, leaving the rest of the embryo intact.[4] Scientists at Lifeline Cell Technology in Wisconsin have claimed to produce pluripotent stem cells through parthenogenesis, in which an unfertilized egg is stimulated to begin to develop as if it were an embryo.[5] And three teams of researchers from the U.S. and Japan were able to reprogram adult mouse cells that resemble embryonic stem cells.[6]

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[1] Weiss, Rick. "Scientists See Potential in Amniotic Stem Cells," *Washington Post*. January 8, 2007.
[2] Swaminathan, Nikhil. "New Source of Stem Cells: Amniotic Fluid," *Scientific American*. January 7, 2007.
[3] "Gene That Regulates Blood-forming Fetal Stem Cells Identified," *Science Daily*. July 27, 2007.
[4] Wade, Nicholas. "New Stem Cell Method Avoids Destroying Embryos," *New York Times*. August 23, 2006.
[5] "Stem Cells Developed from Unfertilized Eggs," Associated Press. June 28, 2007
[6] Wade, Nichols. "Biologists Make Skin Cells Work Like Stem Cells," *New York Times*. June 6, 2007

All of these advances represent significant steps forward and demonstrate the great promise of the field. **<u>None, however, will replace embryonic stem cell research.</u>** Single cell biopsy needs further work to improve the safety and efficacy of the technique, and there are worries that it does not truly solve the ethical issues surrounding embryonic stem cell research but merely creates new ones. Parthenogenesis can only produce pluripotent stem cells genetically matched to women and there are worries that the cells themselves will be genetically abnormal and unusable in humans. Adult cell reprogramming, called induced pluripotent stem (iPS) cells, has also been demonstrated. **James Thompson,** the "father" of embryonic stem cell research as well as the principal U.S. investigator of the study and author of the paper on iPS cells, states ***"...work by both the U.S. and Japanese teams that reprogrammed skin cells depended entirely on previous embryonic stem cell research...we're at square one, uncertain at this early stage whether souped-up skin cells hold the same promise as their embryonic cousins do."***[7]

Researchers have extensive experience deriving and manipulating embryonic stem cells, and they continue to show its medical potential. Scientists have used these stem cells in lab animals to treat paralysis,[8] reduce vision loss,[9] and reverse some of the symptoms of Parkinson's disease.[10] And new research suggests that scientists have found embryonic stem cells in rodents that are more similar to cells in humans, thus speeding the transition from animal models to human cures.[11]

Researchers have coaxed human embryonic stem cells to become cardiovascular precursor cells that could become cardiovascular precursor cells that could lead to

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[7] "Standing in the Way of Stem Cell Research," *Washington Post*, December 3, 2007.
[8] "Stem Cells Help Paralyzed Rats Walk," *CBS News*. June 20, 2006.
[9] Weiss, Rick. "Stem Cell Experiments Slow Vision Loss in Rats," *Washington Post*. September 21, 2006.
[10] Weiss, Rick. "Stem Cell Work Shows Promise and Risks," *Washington Post*, October 23, 2006.
[11] "Missing link' stem cells may speed race for cures," *Reuters*. June 27, 2007.

treatments for heart diseases,[12] T-cells that could lead to a cure for AIDS,[13] and insulin-secreting cells that could be used to treat diabetes.[14] Scientists plan to use embryonic stem cells to treat common forms of blindness in patients within the next five years.[15]

Furthermore, research into embryonic stem cells is crucial for the advancement of other types of stem cell research, as it provides powerful insights into stem cell development at their earliest stages.

According to Dr. Larry Denner, UTMB-Galveston, lead author of a paper detailing a study that engineered cord blood (adult) stem cells to produce insulin, *"embryonic stem cell research was absolutely necessary to teach us how to do this."* Embryonic stem cells have been engineered to produce cardiac, neural, blood, lung and liver progenitor cells that perform many of the functions needed to help replace cells and tissues injured by many diseases, according to the paper published by Denner's group. Among the insights into cell and tissue engineering gained from work with embryonic stem cells, the study adds, are those "*relevant to the engineering of functional equivalents of...cells to treat diabetes*." [16]

Research into all of these types of stem cells should be pursued vigorously, not only because they are interconnected, but also because, as **Dr. Story Landis,** the Chair of the National Institutes of Health Stem Cell Taskforce, has said, **"science works best when scientists can pursue all avenues of research. If the cure for Parkinson's disease or juvenile diabetes lay behind one of four doors, wouldn't you want the option to open all four doors at once instead of one door?"**[17]

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[12] Aldhous, Peter. "Heart stem cells discovered by three teams," *New Scientist*. November 22, 2006.
[13] "Researchers Develop T-cells from Human Embryonic Stem Cells, Raising Hopes for a Gene Therapy to Combat AIDS," *Science Daily*. July 5, 2006.
[14] "Geron says embryonic stem cells produce insulin," *Reuters*. May, 17, 2007.
[15] "Scientists aim to kill blindness with stem cells," *Reuters*. June 5, 2007.
[16] June 2007 issue of the medical journal, *Cell Proliferation*.
[17] Weiss, Rick. "Stem Cell Policy Hampering Research, NIH Official Says," *Washington Post*. January 20, 2007.

Ethical Issues

Although economic benefits are important, ethical concerns should also be considered in choosing whether to support stem cell research. While both advocates and opponents of stem cell research underscore their respect for and commitment to the enhancement of life through easing human suffering and respecting human life potential, the use of embryonic stem cells in medical research raises a number of ethical concerns, bringing strongly held values into conflict.

With their potential for curing chronic debilitating diseases, such as heart disease and Parkinson's disease to spinal cord injuries and diabetes, embryonic stem cell research still holds the key that could potentially unlock the secrets to treatments and cures that long have eluded millions of suffering people.

The recent research efforts that reprogram adult skin cells to induced pluripotent stem cells (iPS) cells that *resemble* embryonic stem cells not only could not have been accomplished without the knowledge gained from embryonic stem cells, but iPS cell research lags 10 years behind. These promising cells will still require a great deal of time and work to become the equivalent of embryonic stem cells, which are referred to as the "gold standard."

Should Texas commit to becoming a major force in stem cell research, strict ethical guidelines as developed by the National Academies of Science (NAS) should be applied to the derivation of stem cell lines, ensuring that donors are provided with adequate information about their choice and that no coercion is involved. Similarly, any stem cell research proposals funded in or by the State of Texas would have to be of substantial potential scientific value.

Currently, there are more than 400,000 embryos in IVF (in vitro fertilization) clinic freezers across the United States, many of them left over from couples that have completed their families and no longer need them. These excess embryos, now slated for destruction and disposal as medical waste, are collections of about 100 cells with no organs or limbs, no ability to feel pain, and no ability to think. 60 percent of couples with excess frozen IVF embryos have expressed a willingness to donate them for stem cell research.[18] They have determined that embryo donation is a means for demonstrating respect for human life by providing a pathway for curing chronic diseases and disabilities.

[18] Results of a 2007 survey of over 1,000 fertility patients conducted by researchers at Johns Hopkins University and Duke University.

Humanitarian Benefits

Diseases included in this study

At the present time, more than 1.2 million Texans are afflicted with one or more major debilitating diseases or injuries that may prove treatable from the results of stem cell research (see Table 1). These conditions noted include stroke, heart attack, diabetes, Parkinson's disease and spinal cord injury, but cover every cellular disease and injury. The possible relief of suffering for these individuals would be reason enough to forge ahead, but potential medical cost savings for families, the insurance industry, and Texas taxpayers constitute another set of benefits that could be realized.

Table 1

Prevalence of Selected Medical Conditions in Texas – 2008

Condition	Prevalence Total Population	Estimated Number Afflicted	Texas Population
Stroke	1.84%	439,841	**23,904,380**
Heart Attack	1.68%	401,594	
Type 1 Diabetes	1.16%	278,481	
Parkinson's	0.33%	78,884	
Spinal Cord Injury	0.11%	26,295	
Total		**1,225,095**	

Sources: Bureau of the Census; American Heart Association; Centers for Disease Control; National Spinal Cord Injury Association; and Parkinson's Disease Foundation.

In 2008, the cost for treating Texas victims of stroke, heart attack, Parkinson's, spinal cord injuries, and Type 1 diabetes totaled nearly $14 billion (see Table 2). Without question, medical costs of this magnitude impose serious financial burdens on the families of victims, both through higher health insurance premiums and out-of-pocket expenses. The potential benefits from stem cell enhanced treatments that reduce these costs by as little as one percent would reduce treatment costs by almost $140 million each year. Over a thirty-year period, these cost reductions would sum to $4.2 billion.

Number of cases and treatment costs

Texas has the highest percentage of uninsured residents in the nation, with a large portion of these costs borne by the state Medicaid program and county hospitals like Parkland in Dallas and Ben Taub in Houston. **Total state Medicaid outlays in 2008-2009 biennium are estimated at $39.6 billion, with a sizeable share going to treat victims of chronic diseases and spinal cord injuries.** The fruits of stem cell research can help reduce this huge burden on Texas taxpayers.

Table 2

Annual Treatment Cost per Person Afflicted in Texas (current dollars) – 2008

Condition	Cost/Person	Number Afflicted	Total Cost
Heart Attack	$12,653	401,594	$ 5,081,363,618
Stroke	$ 7,892	439,841	$ 3,471,221,952
Type 1 Diabetes	$11,290	278,481	$ 3,144,050,490
Spinal Cord Injury	$59,676	26,295	$ 1,569,169,559
Parkinson's	$ 5,215	78,884	$ 411,283,428
Total		**1,225,095**	**$13,677,188,047**

Source: Cost estimates derived from *Economic Benefits of New Jersey Stem Cell Initiative*, Rutgers University, September 2005.

Texas and the biotechnology industry

The field of regenerative medical research, which includes all forms of stem cell research, is perceived as a critical element in biotech's future. Although embryonic stem cell research is not explicitly a tool for economic development, the ability to perform this research will result in treatments and technologies that, in turn, will lead to new pharmaceutical and medically related businesses.

Efforts have been undertaken to protect all forms of stem cell research in Texas since 2003, with advocates having fought several legislative initiatives that would have prohibited or severely limited this promising research. At present, all forms of stem cell research remain legal in Texas. However, ongoing committee battles and floor fights, coupled with a lack of state funding, have created a cloud of uncertainty that threatens to take Texas out of the running as a major player in life sciences research and development.

In October 2004, Texas Governor Rick Perry announced that "biotechnology and life sciences" would be one of six industry clusters targeted by the state for future growth. He pledged to use state resources, such as the Texas Enterprise Fund (TEF) and the Emerging Technology Fund (ETF) to help leverage private investment in this targeted industrial cluster. Though the $200 million Emerging Technology fund, created to improve university research and increase collaboration between the public and private sector, includes biotechnology as an "emerging technology," no specific funding is earmarked for stem cell research.[19] However, in 2005 the Texas Institute for Genomic Medicine—a public/private venture of Texas A&M University and Lexicon Genetics—received a $50 million grant from the Texas Enterprise Fund to conduct medical research and foster job growth in the life science industry.

Job impacts of the biotech sector

Even without explicit state support for embryonic stem cell research, Texas possesses a sizeable biotechnology sector. According to the *Texas Biotechnology*

[19] In February 2006, the TEF awarded a $2 million grant to Texas Tech University to help support its new International Center for Excellence in Agriculture Genomics and Biotechnology.

Industry Report, the state is home to approximately 944 traditional biotech, biomedical research, business and government consortia, medical manufacturing companies, and world-class universities and research facilities employing more than 32,000 workers at an average annual salary of $84,370.[20] A 2005 study by the Milken Institute ranked Dallas-Fort Worth as the 11th largest cluster in the life sciences (see Table 3).

In 2006, Texas ranked sixth in the nation for NIH awards, which are largely in the area of biotechnology, with $1.12 billion in grants. According to the Texas Higher Education Coordinating Board, over $104 million was spent in 2006 on specialized biotechnology R&D at Texas public universities. This resulted in the University of Texas System ranking first in the world in the number and quality of biotechnology patents generated. Hoping to commercialize the results of its research in the biosciences, the University of Texas Southwestern Medical Center at Dallas is constructing three buildings adjacent to the campus to house biopharmaceutical and bio-device companies.

Table 3
Biotech Clusters

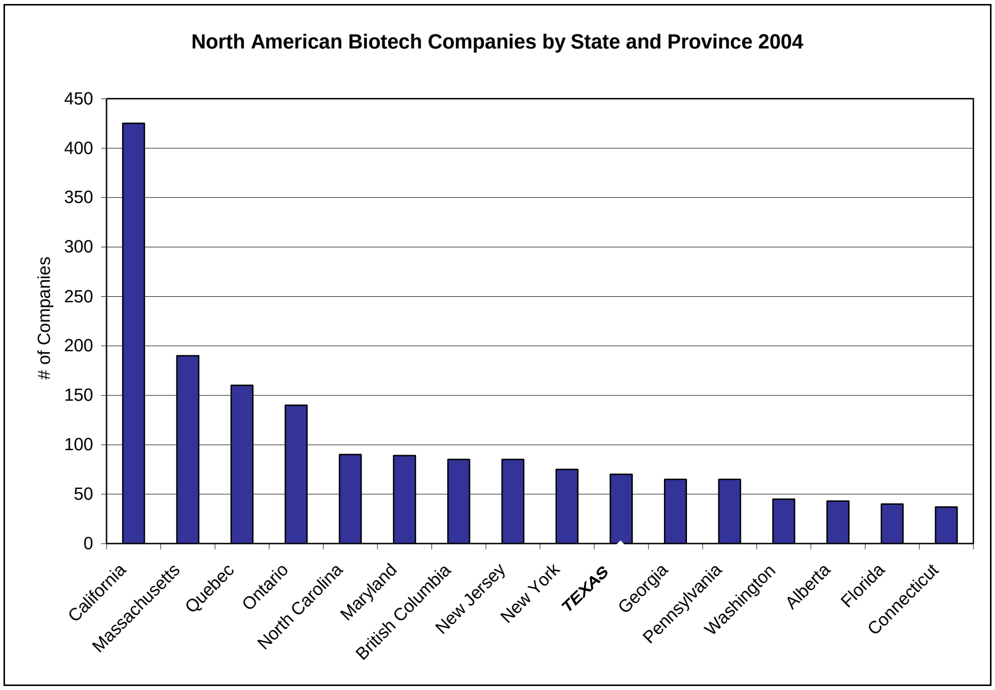
Rank	Region	Score
1.	Boston	100.0
2.	San Francisco	98.4
3.	Philadelphia/S. Jersey	97.1
4.	New York/N. Jersey	94.6
5.	Raleigh-Durham, NC	91.1
6.	San Diego	90.7
7.	Los Angeles	87.0
8.	Minneapolis	77.9
9.	Chicago	75.9
10.	Seattle	70.9
11.	**Dallas/Fort Worth**	**55.2**

Source: The Milken Institute, 2005.

[20] *Texas Biotechnology Industry Report*, Office of the Governor, Economic Development & Tourism, State of Texas, May 2008.

And yet, compared to California, Massachusetts and New York, Texas is currently a minor player in the biotechnology industry (see Figure 1).

Figure 1



Source: Biotechnology Industry Organization.

In assessing the size of the biotechnology industry in Texas, we have relied on data for 2004 available from the IMPLAN model[21] with an adjustment for that model's industry aggregation scheme. To separate research and development in the life sciences from other research and development activities in the engineering, social, and physical sciences, we examined data from the 2002 Economic Census.[22]

As shown in Table 4, **Texas fares poorly in total output and employment versus the nation as a whole. The state's share is remarkably small, with just under three percent of total US output and only 2.3 percent of employment.** When

[21] For detailed information, reference "Analytical Methods Used" on page 23 of this report.

[22] In 2002, research and development in the life sciences represented about 27% of all R&D activities in Texas and about 41% of all R&D activities in the U.S. Our assumption is that the proportion of all output and employment for R&D activities in the life sciences remained effectively constant between 2002 and 2004.

we consider that Texas accounts for about eight percent of the nation's population and 7.8 percent of its gross domestic product, the state's biotechnology sector—as defined in this report—possesses tremendous growth potential.

Table 4

Receipts (output) and Employment Biotechnology Sector, 2004

	U.S.	Texas	Texas % of U.S.
Receipts	$ 308,033,736,000	$ 8,990,763,000	2.9%
Employment	631,975	14,720	2.3%

Source: IMPLAN, U.S. Economic Census

The U.S. biotech industry grew at a compound annual growth rate of 14.5% percent. If we assume that growth rate continues for the next decade, biotech will be a $1 trillion industry by 2014. If Texas simply retains its current market share of 2.9 percent, the state's biotech industry will grow to $30.4 billion by 2014. An industry of this size will contribute $42.5 billion to state economic activity and support 112,000 direct, indirect and induced jobs. State and local tax receipts would increase by $632 million annually.

Given that biotechnology has been targeted as a growth industry for the state, presumably its share of the national market will be larger in the years ahead. ***If Texas' share of the industry should grow from 2.9 percent to 6 percent by 2014, we'll be looking at a $62.5 billion biotechnology sector.*** ***<u>An industry of this magnitude would have a tremendous economic impact.</u>***

According to IMPLAN, a $62.5 billion biotech industry would contribute $87.4 billion to state economic activity and support over 230,000 direct, indirect, and induced jobs (compared to 33,000 today) paying over $12.8 billion in salaries,

wages, benefits and proprietors' income.[23] ***In addition, property income from rents, royalties, dividends and corporate profits would rise to almost $7 billion and state and local indirect business tax revenues would increase to $1.3 billion.***

<u>In order to achieve growth of this order:</u> Texas must create a legislative and regulatory environment that encourages researchers and industry to remain in the state. That means passing a law or referendum similar to that of the state of Missouri, ensuring state policy toward <u>all forms</u> of stem cell research is no more restrictive than that at the national level.

A more restrictive environment could have the undesirable affect of discouraging talented researchers from remaining in Texas or make it extremely difficult to recruit new researchers and biotech companies into the state.

In addition, Texas will have to invest more of its own resources into biotechnology, including stem cell research, as many other states are doing.

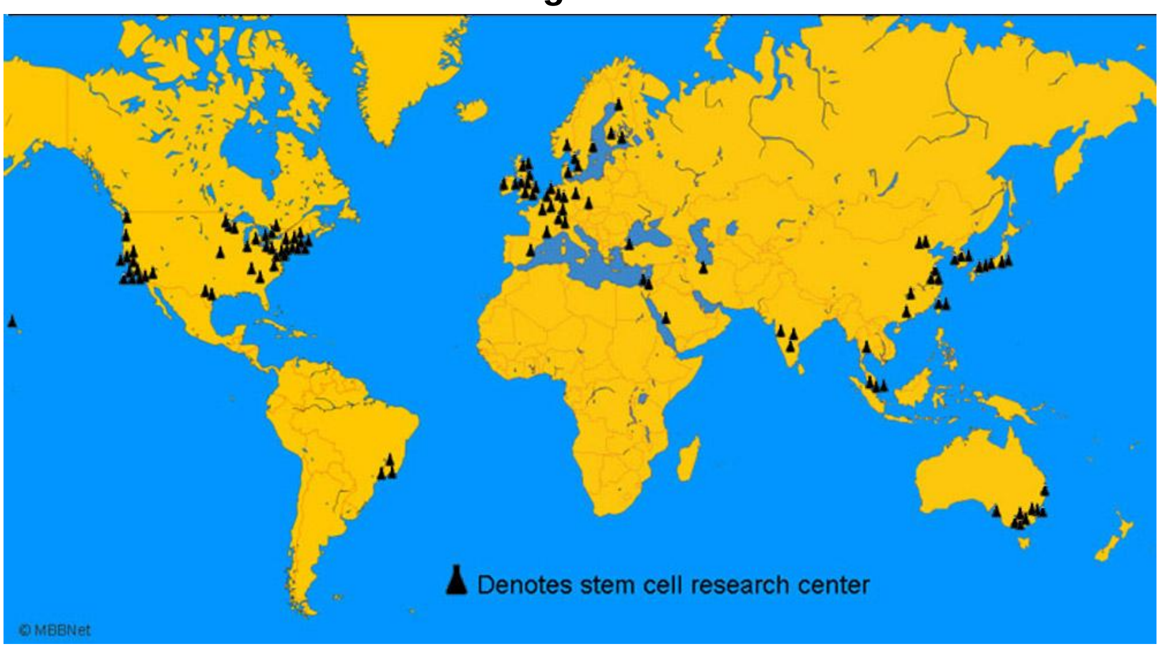
[23] The actual impacts of a $62.5 billion biotechnology industry in Texas could be larger. If the state were to become more competitive in the biotechnology sector, new businesses supplying goods and services to this industry would be created or move to the state thereby decreasing economic leakage and expanding the indirect and induced economic impacts.

The Competitive Stem Cell Landscape

An overview of global initiatives in stem cell research

Biotechnology is a large and fast-growing industry. While the moral debate over embryonic stem cell research continues in the United States, countries in Europe and Asia are pouring billions of dollars into the field (see Figure 2). For example, the British government is committed to spending $1.3 billion over the next decade to support the construction of five manufacturing facilities that will produce millions of pure stem cells for research. In Israel, scientists are changing the genetic makeup of embryonic stem cell lines by deactivating specific genes. By understanding how the genes function, researchers believe the cells can serve as a model for a human disease on which treatments may be tested.

Figure 2



Source: *Financial Times,* October 28, 2004.

Singapore spent nearly $4 billion on the biomedical sciences and plans to increase that amount to $7.5 billion over the next five years. To date, more than 10,000 jobs have been created in Singapore's biomedical industry.[24] The Chinese government is reported to be doubling its investment in stem cell research.[25] Australia recently repealed a four-year ban on SCNT, a move that could put Australia at the forefront of research into diseases such as diabetes and Parkinson's.

Recent state initiatives in stem cell research

Recognizing the promise of embryonic stem cell research, many states across our country are making strong commitments to stem cell research in order to capitalize on its economic development potential. But Texas has not laid out the welcome mat for scientists; in fact, multiple bills have been introduced in the past three legislative sessions in Austin that attempted to ban various forms of stem cell research, in addition to the use of state money for embryonic stem cell research.

California: California, recruiting more than 30 notable out-of-state stem cell scientists this past year, has been more aggressive that any other state in terms of attempting to establish leadership in embryonic stem cell research.

In their report, *An Economic Impact Analysis of the Proposition 71 California Stem Cell Research and Cures Initiative,* Baker and Deal estimate that the $3 billion bond issue, the proceeds of which are intended to fund $300 million annually in basic embryonic stem cell research over a ten-year period, will more than pay for itself through higher state revenues and health care cost savings of between $6.4 billion and $12.6 billion. In addition, they project that spending these new research dollars will create between 5,000 and 22,000 new jobs per year in California's biotechnology industry.[26]

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[24] With a population only one-fifth that of Texas, the city-state of Singapore boasts a biotech sector that is almost as large as that of Texas.

[25] The February 12, 2007 issue of *Business Week* includes an article entitled "Stem-Cell Refugees" about Americans who are traveling to China for experimental therapies.

[26] Laurence Baker and Bruce Deal, An Economic Impact Analysis of the Proposition 71 California Stem Cell Research and Cures Initiative, Analysis Group, September 14, 2004.

New Jersey: New Jersey was the first state to commit funding for stem cell research by spending $8.5 million to create the Stem Cell Institute of New Jersey, operated jointly by the University of Medicine and Dentistry of New Jersey and Rutgers University. The state also funds $10 million annually in competitive grants for stem cell research.

Massachusetts: In June of 2005, the Massachusetts legislature overturned the governor's veto of a bill backing stem cell research in the state. The law allows for creation of embryonic stem cells, including those from cloned embryos, and establishes regulatory oversight on several levels while explicitly prohibiting reproductive cloning. Though the law does not provide public funding for embryonic stem cell research, it has encouraged private initiatives by removing uncertainty about the legality of such research. In 2006, Harvard University announced the creation of a privately funded, multimillion-dollar program for therapeutic cloning that could be a source of medically promising stem cells.[27]

Wisconsin: In Wisconsin, where human embryonic stem cells were first isolated, a $750 million initiative is underway to establish the state as a key player in biomedical and embryonic stem cell research. Wisconsin's goal is to capture 10 percent of the stem cell research market by 2015, and its Department of Commerce is actively recruiting stem cell research firms. In December 2006, CellCura Inc., a Norwegian biotechnology company, announced it was opening an office in Madison to have access to ongoing stem cell research. CellCura is the fourth stem cell company to start or locate in Wisconsin over the past two years.

[27] *Harvard University Gazette*, June 6, 2006.

Other state initiatives: In the November 2006 election, **Missouri** voters approved an initiative that ensures Missourians will have access to any stem cell research and cures that are allowed under federal law and available to other Americans. A study by researchers at the University of Missouri estimates that new private funding promised for stem cell research in the state will add about $1.25 billion to gross state product over the next 25 years as well as $47 million in new state tax revenues.[28]

In 2005, the privately funded New York Stem Cell Foundation was established to further embryonic stem cell research in **New York.** The foundation opened its first laboratory in March 2006 to serve as a "safe haven" where scientists from academic medical centers could conduct advanced embryonic stem cell research free from current federal restrictions.

The **Illinois** Regenerative Medicine Institute, located in the Department of Health, was created in 2005 and is responsible for awarding $10 million annually to state research facilities conducting stem cell research. A bill introduced in the Illinois legislature last December seeks an additional $25 million a year for stem cell research.

In **Connecticut**, a law passed in 2005 appropriated $30 million for conducting embryonic or human adult stem cell research.

The University of **Colorado** recently established the Charles C. Gates Regenerative Medicine and Stem Cell Biology Program with substantial private funding to increase the amount of stem cell research already under way at the School of Medicine. The School made national news last summer by luring away a team of prominent stem cell researchers from Texas.

[28] Joseph H. Haslag and Brian K. Long, *The Missouri Stem Cell Research and Cures Initiative: an Economic and Health Care Analysis*, August 2006.

Conclusion

The potential of biotechnology as a force for economic development

Although embryonic stem cell research is not explicitly a tool for economic development, applications from this research can help generate new pharmaceutical and medically related businesses in the state of Texas.

The primary goal of medical research is to prevent and to cure disease, thereby enhancing the quality-of-life for mankind. Biomedical research also has sizable economic impacts that result from the development of products and procedures. Concerned that past federal policy for funding embryonic stem cell research has hindered the development of important medical therapies; some states have funded or are considering funding such research on their own, hoping to benefit economically by encouraging the development of the stem cell equivalent of Silicon Valley within their borders. They hope to achieve this goal by attracting scientists, biotechnology companies, and venture capital dollars. Or, at least, they hope to prevent other states from luring away their human brainpower.

A worst-case scenario: Legal restrictions on stem cell research in Texas

Bills introduced in the Texas Legislature prohibiting embryonic stem cell research, or the use of state money for embryonic stem cell research, would have serious economic consequences for the state.

Biotech companies would not only be reluctant to locate or expand in Texas, but a flight of top researchers would likely follow the passage of such legislation. Because of continuing political battles, and a lack of specific public funding for embryonic stem cell research, Texas is already having problems holding on to some of its best talent.

One such example is Dr. Dennis Roop, formerly a professor of molecular biology and cellular biology at the Baylor College of Medicine in Houston, who left Baylor to become director of the Charles C. Gates Regenerative Medicine and Stem Cell Biology Program at the University of Colorado Medical School.[29] Dr. Roop commented, *"embryonic stem-cell research could put Colorado on the forefront of scientific research."* When he left in early January 2007, he took 5 National Institutes of Health grants totaling $3.8 million and four other faculty members from Baylor.

By studying embryonic stem cells, Dr. Roop and his team hope to learn how cancer cells operate and grow, and proof-of-concept studies have already shown that embryonic stem cells can be used to fight and repair cancer-damaged tissue. Dr. Roop said he *"expects cancer research to be among the first fields to benefit from embryonic stem-cell research."*

Later in 2007, when announcing a $3 billion state effort (SB1292 Cancer Research Institute of Texas Bill) in a bid to eradicate cancer, Governor Rick Perry stated, *"In addition to giving Texans easy access to the most cutting-edge cancer treatments, the fund will draw high-tech companies and well-paying jobs to the state."* The Texas Legislature passed the bill, but not without having to fight to take out language excluding research with embryonic stem cells.

In order to compete effectively, it is imperative that Texas plays by the same rules as the other leading biotech states. If researchers, grant-givers, and venture capitalists face limitations on stem cell research due to unreasonable government-imposed restrictions, there could be negative consequences, not only to the entire medical/industrial complex in Texas but to other areas of research and medical practice as well.

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[29] "New Gifts to Stem Cell Program Push University of Colorado Denver to Near Completion of Challenge Funding," University of Colorado Hospital, 2007.

At present, the Texas Medical Center in Houston is the largest in the world, with 42 member institutions, 74,000 employees and an annual economic impact in excess of $7 billion.[30] UT Southwestern in Dallas is another medical behemoth, supporting about 22,000 jobs across the region with a local economic impact of over $2 billion in 2002.[31] The University of Texas Health Science Center at San Antonio, with an operating budget of $470 million, is the major research university in South Texas and is the chief catalyst for the $12.9 billion biosciences and health care industry in San Antonio.[32]

Growth of these world-class institutions will be hampered if restrictions are imposed on specific types of stem cell research.

In short, ***an industry that has the potential to support more than 230,000 jobs in Texas, generate $88 billion in economic activity, and provide over $1.3 billion in state and local tax revenue would be put at risk should the legislature impose restrictions on stem cell research above and beyond any federal restrictions.*** The state would be relegated to mediocrity and would be ineffective as a competitor in the fast-growing biosciences, with the economic and fiscal benefits that could have been realized.

What Texas needs today, at a minimum, to ensure the future of stem cell research and biotechnology

Given the competing demands on the state budget for the 2010-2011 biennium, and the opposition of some legislators to certain stem cell research and its funding, the passage of a stem cell initiative is highly unlikely. But in order to remove the uncertainty about Texas' legal and regulatory position regarding some types of stem cell research,

[30] *Economic Impact of the Texas Medical Center on Southeast Texas,* Federal Reserve Bank of Dallas, Houston Branch, October 2001 and Texas Medical Center.
[31] UT Southwestern Medical Center, *http://www.utsouthwestern.edu/utsw/cda/dept23608/files/83933.html*
[32] "Cigarroa says Health Science Center is 'Powerful Stimulus' to Economy," *HSC News*, March, 2005.

it is imperative that safe haven legislation be considered and passed in the 2009 legislative session.

California can serve as a model. In 2002, California became the first state to enact a safe haven for stem cell research, including the use of somatic cell nuclear transfer (or SCNT) to derive human embryonic stem cells.[33] California Senate Bill 253, declares that "the policy of the state shall be that research involving the derivation and use of human embryonic stem cells, human embryonic germ cells, and human adult stem cells from any sources, including somatic cell nuclear transplantation, shall be permitted, as specified." Texas needs a similar statute if it is to attract and retain the human talent and financial resources that will enable the state to become a national and global leader in the biosciences.

The Texas economy has outperformed the U.S. economy in just about every year since 1960. In the 1960's and 1970's, rising energy prices precipitated an unprecedented boom that created millions of new jobs, pushing the state's per capita income above the national average for the first time ever. When oil prices fell in the mid-1980s, job growth shifted to the "information technology sector" comprised of matured industries such as computers, electronic components, communications equipment and services, data processing and software. These industries still dominate the Texas economy.

Texas' growth in the 60's and 70's came about by effectively using the state's natural resources. Several decades of rising expenditures on national defense helped launch many of the new technologies commercialized in the 80's and 90's.

There is a broad consensus among scientists and futurists that biotechnology is the "next wave" that will not only improve the planet's quality-of-life but also create millions of new high-paying jobs.

[33] It should be noted that in 1997 California became the first state to enact a prohibition against reproductive human cloning. Many other states have followed.

Paul J. Simmons, Ph.D., who is a Professor and Director of the Center for Stem Cell Research, Brown Foundation Institute of Molecular Medicine (IMM), University of Texas Health Science Center at Houston, has stated, *"We have a responsibility to drive stem cell research from bench to bedside on a foundation of excellence in basic research. This is a new discipline at the juncture of stem cell biology, bioengineering and nanotechnology. New discoveries come at the interface between different disciplines and institutions.*[34]

According to a 2006 poll undertaken by Research!America, more than **90% of Texans view medical research as critical to the state's economic future while 78% support the use of state financial incentives to attract new scientific research laboratories and companies. 55% of Texans support embryonic stem cell research.**

In order for to maintain the high economic status it has historically held, Texas will have to change with the times. To be a leader in the biosciences, with all the anticipated health and economic benefits that will follow, we must create a hospitable environment for research and development. At a minimum, Texas needs to be known as a "safe harbor" for regenerative medical research, including embryonic stem cell research. If Texas expects to become a major player in the global bioscience arena, it should consider investing some of its own resources into this cutting-edge research.

[34] University of Texas Health Science Center at Houston's News Room, May 19, 2006.

Analytical Methods Used

The total economic impact of an industry is greater than the value of its output. In order to assess total impacts, economists utilize input-output models, such as the IMPLAN developed by the Minnesota IMPLAN Group. Input-output models track how spending flows through a regional economy. The estimates include direct, indirect, and induced impacts.

Direct impacts are the result of a firm or collection of firms operating in a given industry procuring goods and services in the economy. For example, a research laboratory purchases supplies, testing equipment, and building support services. These vendors and suppliers, in turn, purchase goods and services to support their local operations, thereby creating indirect effects. The laboratory-supplies-vendor hires employees, purchases office supplies, contracts with transportation services to deliver their goods, and hires professional service providers such as accountants. The induced impacts track the economic and fiscal effects of employees of the research lab, as well as these other vendors and suppliers, spending a portion of their earnings for goods and services.

Each of these impacts is adjusted to account only for purchases in the modeled economy. For example, if Petri dishes are made outside of Texas, the purchase of that particular good does not generate much secondary economic activity in the state. The remainder “leaks out” to other states or perhaps other nations. When added together, the sum of all of the activity from direct, indirect, and induced impacts is greater than the local proportion of spending by the research laboratory, which is the “multiplier effect.”

The model estimates the total level of economic activity (transactions) supported by the base spending and resulting job and income impacts. Income impacts are categorized as labor income, which includes salaries, wages, benefits, and proprietors’ income, and other property income. Other property income includes rents, royalties, corporate profits, dividends, and other income derived from direct, indirect, or induced spending. For example, an employee of the laboratory rents a house in Texas. The owner of the house realizes a portion of that rent as income available for spending.

Estimates of state and regional fiscal impacts are based on the IMPLAN model. The IMPLAN input/output model offers estimates of indirect business taxes, which include sales and use taxes, property taxes, permit and license fees, and other business taxes paid to state and local entities. These estimates do not include franchise fees that may be paid directly by the firms in the modeled industries.

In assessing the current economic and fiscal impacts of the biotechnology industry, we have combined two industries from the North American Industrial Classification System: (1) NAICS 3254, Pharmaceutical and medicine manufacturing and (2) NAICS 5417102, Research and development in the life sciences.[35] This is a fairly narrow definition of the biotechnology technology industry as it excludes medical equipment manufacturers as well as medical and diagnostic labs. It also excludes university-based R&D in the life sciences.[36]

[35] NAICS 5417102 only records R&D activities when the location is a stand-alone facility. Though NAICS is ostensibly a manufacturing classification, if a research facility is located at the manufacturing site the R&D activities are recorded in that industry.

[36] Other studies, such as those conducted by the Milken Institute and Battelle, use a broader definition of biotechnology encompassing between 13 and 27 industrial classifications. Naturally, the economic impacts from a more broadly defined cluster are much larger than those incorporated in this analysis.