



OFFICE OF THE GOVERNOR
ECONOMIC DEVELOPMENT & TOURISM



TEXAS BIOTECHNOLOGY INDUSTRY REPORT

MAY 2008



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The Texas Biotechnology Advantage

Texas continues to provide fertile ground for the biotechnology marketplace. A majority of the top global biotechnology and pharmaceutical companies have Texas locations, underscoring the state's vitality. The Lone Star State is nationally ranked in the top 10 for the number of traditional biotechnology companies located in-state and for the number of life and physical scientists employed. Texas is home to approximately 944 traditional biotechnology, biomedical research, business and government consortia, medical manufacturing companies, and world-class universities and research facilities, employing approximately 32,677 at an average annual salary of \$84,370. With the inclusion of the expanded and more broadly defined biotechnology areas, the Texas marketplace includes approximately 3,229 establishments employing approximately 84,416 at an average annual salary of over \$70,460. Most of the state's core biotechnology manufacturing establishments are located in the Houston, Dallas-Fort Worth, Austin, and San Antonio metropolitan areas.

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BIOTECHNOLOGY OVERVIEW

According to the Biotechnology Industry Organization (BIO), biotechnology is “a collection of technologies that capitalize on the attributes of cells, such as their manufacturing capabilities, and put biological molecules, such as DNA and proteins, to work for us.” Included in this definition are portions of the medical, pharmaceutical, chemical, agricultural, defense, and environmental industries. Biotechnology also cuts across manufacturing, services, and research activities. Because of this broad definition, general terms like “biosciences” and “life sciences” are applied to the biotechnology industry.

Biotechnology is a fairly new term, but it is not a new concept. People have manipulated the genomes of plants and animals for approximately 10,000 years, beginning with the domestication of livestock, the use of fermentation to produce foodstuffs and fuel, and the development of agriculture. Scientific discoveries emerging in the early 20th Century, notably the discovery of DNA’s structure, now allow for manipulation of genomes through single genes. Examples of biotechnology products and research include the Human Genome Project, biofuels, subunit vaccines, AIDS research, cloned animals, and genetically modified foods.

The biotechnology industry is not distinctly classified in the North American Industry Classification System (NAICS). Biotechnology can be categorized using the following NAICS industry codes, which are considered to be the traditional and major biotechnology industry breakouts.

NAICS 54171	Research and Development in the Physical, Engineering, and Life Sciences
NAICS 3254	Pharmaceutical and Medicine Manufacturing

Broader definitions of biotechnology go beyond the traditional biomedicine/pharmaceuticals and research breakouts, including the following NAICS codes:

NAICS 3391	Medical Equipment and Supplies Manufacturing
NAICS 3345	Electrical Instruments Manufacturing
NAICS 6215	Medical and Diagnostic Labs

GLOBAL BIOTECHNOLOGY MARKETPLACE

The research firm Datamonitor defines the biotechnology marketplace as the development, manufacturing, and marketing of products based on advanced biotechnology research, not including pharmaceuticals. In 2006, the global biotechnology marketplace grew 12.6 percent to an estimated \$153.7 billion, representing a compound annual growth rate (CAGR) of 13.4 percent for the period 2002 through 2006. Datamonitor forecasts this marketplace will reach \$271.4 billion by 2010. The global biotechnology industry’s strong growth continues to be spurred by fresh investments and new products. Medical products accounted for \$96.2 billion or 62.5 percent of the 2006 global market’s value, followed by agriculture and food products, which accounted for \$17.7 billion or 11.5 percent of the 2006 global market’s value.

Because of biotechnology’s costly and research-intensive nature, industry activities are centered in industrialized urban areas with excellent bioscience educational institutions, a well-educated workforce, and

healthy entrepreneurship. These criteria helped establish the United States (U.S.) as the primary global biotechnology marketplace. Growing secondary industry clusters in Western Europe and Asia, along with merger and acquisition trends, are creating strong biotechnology concentrations around the world. Asia-Pacific, the world's second largest biotechnology market, grew 10.1 percent in 2006 to an estimated \$36.8 billion, and 23.9 percent of the global market share. The European biotechnology market grew 9.8 percent to an estimated \$27.3 billion and 17.8 percent of the global market share. Although the U.S. dominates the global biotechnology marketplace, it may not remain No. 1 much longer if China and India's runaway growth continues. Currently, a small number of U.S.-based multinational companies lead in the global biotechnology marketplace. Strict, slow-moving governmental regulations and high funding requirements have restricted new entrants and encouraged industry specialization. Most biotechnology companies are spin-offs and academic commercialization startups, which are small- to medium-sized.

The global pharmaceuticals industry is the largest part of the global biotechnology marketplace, and is also one of the world's largest industries. Datamonitor defines pharmaceuticals as the development, manufacturing, and marketing of prescription drug products for medicinal use and separately defines "over the counter" (OTC) pharmaceuticals as consumer healthcare drugs. Neither area includes animal healthcare drugs or references biotechnology. In 2007, global pharmaceuticals grew by 5.5 percent to an estimated \$577.2 billion while global OTC pharmaceuticals grew by 4 percent to an estimated \$84.7 billion, for a combined total of \$660 billion. Cardiovascular drugs were the most profitable 2007 pharmaceuticals segment, accounting for \$112.8 billion or 19.5 percent market share, closely followed by central nervous system drugs estimated at \$107 billion or 18.5 percent market share. Cough and cold preparations dominated the 2007 global OTC pharmaceuticals market, generating revenues of \$15.6 billion or 18.4 percent market share, followed by vitamins and minerals sales, which generated approximately \$11.3 billion or 13.4 percent market share. While the U.S. is the largest global pharmaceuticals marketplace at 47.9 percent market share, Asia-Pacific leads in the global OTC pharmaceuticals marketplace with 38.8 percent market share. Mergers, outsourcing and multinational companies dominate the global pharmaceuticals and OTC pharmaceuticals marketplaces. Rigorous governmental regulations, high risks, low new drug success rates, and high funding requirements have restricted new entrants. Despite these factors, smaller firms dominate the industry and achieve success by partnering with larger firms.

Table 1 in the Appendices lists some of the top global biotechnology and pharmaceutical companies. The majority are U.S.-based and have locations in Texas. ⁱⁱ

U.S. BIOTECHNOLOGY MARKETPLACE

The U.S. biotechnology marketplace is the largest in the world. In 2006, it grew 13.7 percent to an estimated \$77.9 billion or 50.7 percent of the global market, according to Datamonitor - which defines the biotechnology marketplace as the development, manufacturing, and marketing of products based on advanced biotechnology research, not including pharmaceuticals. Between 2006 and 2011, the U.S. biotechnology market is forecast to have an estimated CAGR of 14.3 percent and to grow to \$152.2 billion by 2011. Revenues generated from the development and sales of medical sector products accounted for \$52.4 billion, or over 67.2 percent of the 2006 U.S. market's value. The agriculture and food segments followed with 2006 revenues of \$3.4 billion. The U.S. is also the world's largest producer of and market for genetically modified (GM)/biotechnology crops. The nation had an estimated 57.7 million hectares of GM crops under production in 2007, according to the International Service for the Acquisition of Agri-Biotech Applications (ISAAA). The U.S. biotechnology industry has experienced strong growth in recent years, spurred by fresh investments, government funding, company consolidations, and new products. This growth comes despite strict, lengthy, and costly U.S. governmental regulations, which have restricted some new entrants and encouraged industry specialization. The majority of U.S. biotechnology companies are spin-offs and

academic commercialization startups, which are small- to medium-sized. Most of the multinational companies dominating the global biotechnology marketplace also dominate the U.S. biotechnology marketplace.

The U.S. pharmaceuticals industry is the largest in the world and the largest part of the U.S. biotechnology marketplace. In 2007, the combined U.S. pharmaceuticals/OTC pharmaceuticals segments totaled \$296.8 billion, according to Datamonitor. U.S. pharmaceuticals grew by 6 percent in 2007 to an estimated \$276.4 billion or 47.9 percent of the global market. Revenues generated from sales of central nervous drugs accounted for \$64 billion or 23.2 percent of the 2007 U.S. pharmaceuticals' market share, closely followed by cardiovascular drugs at \$55.5 billion or 19.7 percent of the market. The U.S. was the second largest OTC pharmaceuticals market in 2007. U.S. OTC pharmaceuticals grew by 3.2 percent in 2007 to an estimated \$20.4 billion or 24 percent of the global market. Revenues generated from cough and cold preparations accounted for \$4.2 billion or 20.8 percent of the 2007 U.S. OTC pharmaceuticals market share, followed by vitamins and minerals at approximately \$4.1 billion or 20.3 percent of the market. The U.S. pharmaceuticals and OTC pharmaceuticals markets have experienced stable to strong growth in recent years; however, they are forecast to decelerate. Most of the multinational companies dominating the global pharmaceuticals marketplace also dominate the U.S. pharmaceuticals/OTC pharmaceuticals marketplace.

In 2006, the U.S. biotechnology marketplace included approximately 1,452 U.S. biotechnology firms, according to Ernst & Young. Most of these firms were small, and only about 336 were publicly held. However, it is the few large firms that account for most of the industry's revenues. From 1996 to 2006, the U.S. biotechnology industry's revenues increased over 263 percent to a total of \$55.5 billion. The following U.S. biotechnology industry chart tracks 11 years of revenue growth for all U.S. publicly-traded companies, as well as other biotechnology industry statistics. The chart data originate from Ernst & Young, whose analysts define biotechnology in the traditional fashion. Note the recent upturns and downturns in the total number of companies and employment in the chart, reflecting consolidations within the industry.

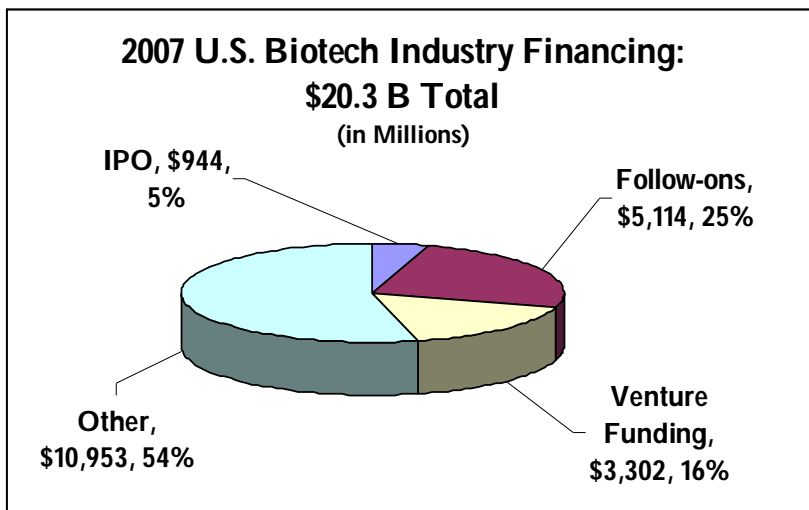
U.S. BIOTECHNOLOGY INDUSTRY STATISTICS: 1996–2006											
(U.S. DOLLARS IN BILLIONS)											
Year	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Sales	10.8	13	14.5	16.1	19.3	21.4	24.3	28.4	28.1	42.1	45.3
Revenues	14.6	17.4	20.2	22.3	26.7	29.6	29.6	39.2	43.8	51.8	55.5
R&D Expense	7.9	9.0	10.6	10.7	14.2	15.7	20.5	17.9	19.6	20.8	22.9
Net Loss	4.6	4.5	4.1	4.4	5.6	4.6	9.4	5.4	6.5	3.6	3.5
Number of Public Companies	294	317	316	300	339	342	318	314	331	331	336
Number of All Companies	1,287	1,274	1,311	1,273	1,379	1,457	1,466	1,473	1,444	1,475	1,452
Industry Employees	118,000	141,000	155,000	162,000	174,000	191,000	194,600	177,000	187,500	170,500	180,800

Sources: BIO's *Guide to Biotechnology 2007* and Ernst & Young's *Beyond Borders: Global Biotechnology Report 2007*

Using the broader definition of biotechnology, U.S. Bureau of Labor Statistics data indicate that in 2006 the U.S. biotechnology industry directly employed over 1,798,000 at 54,411 establishments with an average annual salary of approximately \$59,520. BIO data indicate that there were an additional 5.8 million indirect jobs related to biotechnology in 2004, the latest data posted.

Most U.S. biotechnology industry financing comes from public sources, such as government grants from the National Institutes of Health (NIH), which is the largest single source of U.S. biotechnology research funding. The NIH's budget has risen from almost \$18 billion in Fiscal Year (FY) 2000 to over \$28.9 billion in FY2008.

In 2006, U.S. biotechnology industry financing totaled \$20.3 billion, according to the following chart based on Ernst & Young data. The year's financial results were boosted by the industry's "supercharged" merger and acquisitions activities, which helped make 2006 one of the best years on record for biotechnology financing. The Other category, which includes debt, warrants, and private investments in private equity (PIPEs), was top ranked at \$10.9 billion or 54 percent of the U.S. biotechnology financing total. Large debt offerings propelled this category. The second largest source of industry funding, historically the No. 1 category, was public funding. The public funding breakout, which includes IPOs and Follow-ons, totaled \$6.1 billion or 30 percent of the U.S. biotechnology financing total. Many state governments, including Texas, are providing substantial amounts of public funding for the biotechnology industry. Venture funding was the third and last source of industry funding at \$3.3 billion or 16 percent. All of this industry funding is vital, since the U.S. biotechnology industry spent \$27.1 billion on research and development alone in 2006, according to Ernst & Young. ⁱⁱⁱ



Source: Ernst & Young

TEXAS BIOTECHNOLOGY INDUSTRY MARKETPLACE

Texas continues to provide fertile ground for the biotechnology marketplace. A majority of the top global biotechnology and pharmaceutical companies have Texas locations, underscoring the state's vitality. The Lone Star State is nationally ranked in the top 10 for the number of traditional biotechnology companies located in-state and for the number of life and physical scientists employed. Texas is home to approximately 944 traditional biotechnology, biomedical research, business and government consortia, medical manufacturing companies, and world-class universities and research facilities, employing approximately 32,677 at an average annual salary of \$84,370. With the inclusion of the expanded and more broadly defined biotechnology areas, the Texas marketplace includes approximately 3,229 establishments employing approximately 84,416 at an average annual salary of over \$70,460. Most of the state's core biotechnology manufacturing establishments are located in the Houston, Dallas-Fort Worth, Austin, and San Antonio metropolitan areas.

Texas has committed substantial resources to the biotechnology industry. In 1987, the Texas Legislature created the ongoing Norman Hackerman Advanced Research Program (formerly the Advanced Research Program or ARP) and Advanced Technology Program (ATP) to award grants to fund scientific and engineering projects at Texas higher education institutions. In 2001, the Texas Legislature appropriated \$800 million for science, engineering, research, and commercialization activities, including \$385 million for research infrastructure. In 2003, Gov. Rick Perry and the Texas Legislature passed legislation authorizing the \$295 million Texas Enterprise Fund (TEF), a "deal closing" fund created to attract businesses and new jobs to Texas. Funds for the TEF were reappropriated in 2005 and 2007. To date, \$85 million from the TEF have

been awarded for biotechnology-related projects. In January 2002, Gov. Perry established the Council on Science and Biotechnology Development to promote the state's biotechnology industry. In October 2004, Gov. Perry announced a state industry cluster initiative to stimulate long-term growth and economic development in six key areas, one of which is biotechnology and the life sciences. In June 2005, Gov. Perry announced the \$200 million Texas Emerging Technology Fund (ETF) to promote and finance technological innovations across multiple industries, including biotechnology. The ETF was renewed in 2007 with appropriations of approximately \$180 million. The ETF has created eight Regional Centers of Innovation and Commercialization (RCIC), including the Texas Life Science RCIC, which acts as the gateway for biotechnology ETF projects. To date, \$49.23 million from the ETF have been awarded for biotechnology-related projects. In November 2007, Gov. Perry appointed 29 public and private sector leaders to the Governor's Competitiveness Council to identify the global market competitive issues and opportunities arising from the follow-up research on the six targeted industry clusters and make recommendations to address them. The Council's recommendations will be complete in August 2008. Government support, a highly trained work force, excellent educational and research institutions, a first-rate transportation and logistics infrastructure, and a top ranked business climate all strengthen the state's status as a biotechnology leader.

A few Texas biotechnology-related industry highlights follow:

- As of April 2008, the ETF has awarded \$49.23 million for biotechnology-related projects. \$16.23 million were awarded to commercialize sixteen biotechnology start-up companies and \$33 million were awarded to universities or university-related consortiums. For ETF award details, see Table 2 in the Appendices.
- As of March 2008, the TEF has awarded \$85 million for biotechnology-related projects. The following chart details how these projects will create 8,737 jobs.

**BIOTECHNOLOGY-RELATED TEF AWARDS
(ARRANGED BY COMPANY/ENTITY)**

Company/ Entity	City	Jobs	Project Description	Funding (in Millions)
Baylor College of Medicine	Houston	NA	Bovine gene-mapping project	\$2.0
Scott & White (S&W) Memorial Hospital & Scott, Sherwood, & Brindley Foundation	Temple	1,485	Expand S&W's Cancer Research Institute and other research initiatives	\$7.5
Texas Institute for Genomic Medicine (TIGM) & Lexicon Genetics	Houston & College Station	5,000	Genome mapping and "knockout" mouse cell line library	\$50
The University of Texas Health Science Center at Houston, M.D. Anderson, & G.E. Healthcare	Houston	2,252	The Center for Advanced Diagnostic Imaging	\$25
TOTALS	---	8,737	---	\$85

Source: Texas Office of the Gov., Economic Development & Tourism Division

- According to 2006 Ernst & Young data, Texas ranked thirteenth nationally for the number of traditional public biotechnology companies located *either regionally or by state*. Texas ranked sixth by individual state. Three of the top ten ranked areas were in California and five of the top twelve ranked areas were multi-state regions.

- In 2006, one of approximately every 23 U.S. biotechnology employees worked in Texas. This figure is based on the expanded definition of biotechnology and the most current data available from the U.S. Bureau of Labor Statistics.
- In 2006, Texas ranked second for the number of life and physical scientists employed by state, according to the latest data available from the National Science Foundation.

The following chart provides a snapshot of the 2007Q4 Texas biotechnology manufacturing industry, using the traditional and expanded industry codes (NAICS).

2007Q4 TEXAS BIOTECHNOLOGY INDUSTRY INFORMATION					
NAICS	Description	Employees	Establishments	Avg. Weekly Wage	Avg. Annual Pay
54171	Physical, Engineering & Life Sciences R&D	22,745	798	\$1,546	\$80,392
3254	Pharmaceutical & Medicine Manufacturing	9,932	146	\$1,699	\$88,348
TRADITIONAL SUBTOTALS / AVERAGES*	---	32,677	944	\$1,622.5*	\$84,370*
3391	Medical Equipment & Supplies Manufacturing	12,270	689	\$923	\$47,996
3345	Electrical Instrument Manufacturing	23,166	515	\$1,538	\$79,976
6215	Medical & Diagnostic Labs	16,303	1,081	\$1,069	\$55,588
EXPANDED SUBTOTALS / AVERAGES*	---	51,739	2,285	\$1,176.6*	\$61,186.6*
OVERALL TOTALS / AVERAGES*	---	84,416	3,229	\$1,355 *	\$70,460 *

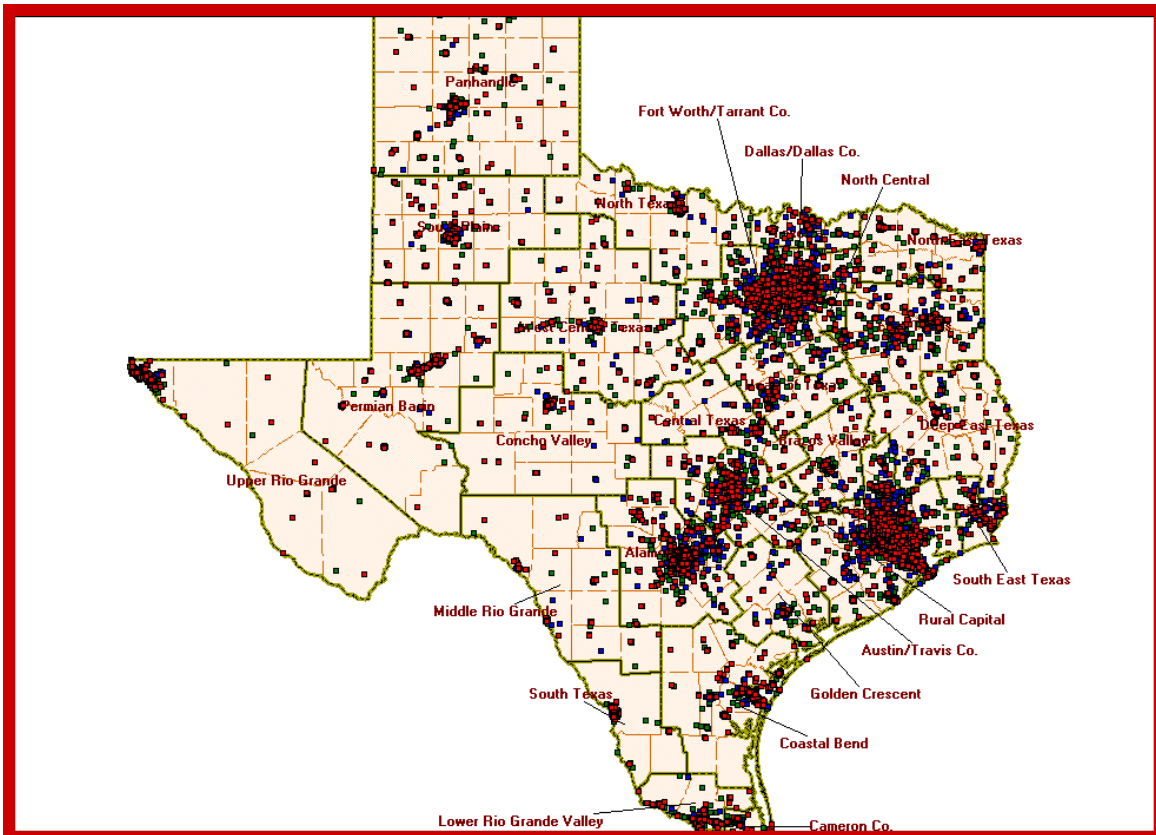
Source: Texas Workforce Commission Quarterly Employment & Wages
Private establishments only

* Averages

Table 3 in the Appendices lists some of the leading Texas-based biotechnology companies. Most are small companies; however, Irving-based Kimberly Clark ranked number 136 and Houston-based US Oncology ranked number 673 on the 2007 Fortune 1000 list. The majority of the leading Texas-based biotechnology companies listed have international locations or distributors.

The following Texas Workforce Commission (TWC) map shows that the state's core biotechnology manufacturing facilities, using the expanded biotechnology industry codes (NAICS), are located in or near the Dallas-Fort Worth, Austin, San Antonio, and Houston metropolitan areas. The map also indicates that biotechnology manufacturing facilities are distributed across the state, from the Texas Panhandle to the Rio Grande Valley and from El Paso to Texarkana. ^{iv}

Texas Biotechnology Manufacturing's Core and Ancillary Facilities



Source: TWC Clusters Geographic Information System (GIS) at <http://www.texasindustryprofiles.com/apps/gis/clustersgis/> Accessed April 2008 Red = core; Blue = ancillary

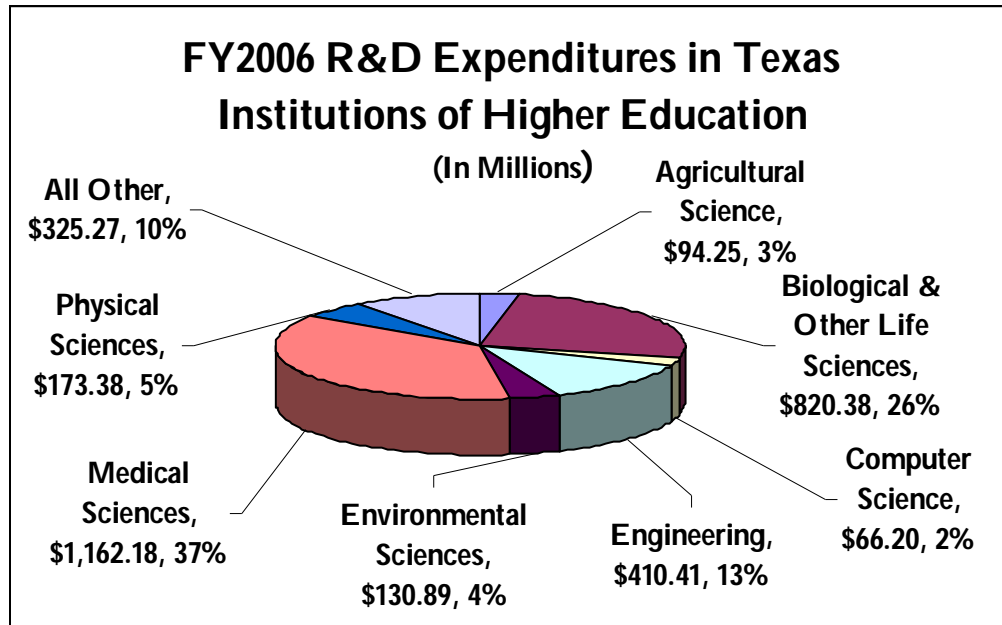
TEXAS BIOTECHNOLOGY EDUCATION, RESEARCH, AND PATENT INFORMATION

Texas public universities and health-related institutions are heavily invested in biotechnology research and development (R&D) and intellectual property activities, leading to continual discoveries in the field. The Lone Star State is top-ranked nationally in many R&D and educational statistical breakouts. This is important since biotechnology has the highest R&D costs of any major industry. Nine Texas-based biotechnology scientists and researchers are Nobel Laureates and national award winners, including the "Father of the Green Revolution," Dr. Norman Borleng. Texas is also home to a number of world-class independent and nonprofit applied R&D institutions engaged in the biotechnology industry.

Some Texas biotechnology-related education, research, and patent highlights follow:

- Table 4 in the Appendices lists the nine Texas-based recipients of biotechnology-related Nobel Prizes, National Medals of Science, National Medals of Technology, and other major prizes and awards. Four active Nobel laureates, more than at any other medical school in the world, are currently working at The University of Texas Southwestern Medical Center at Dallas.
- The Southwest Research Institute (SwRI), headquartered in San Antonio, provides contract research and development services to industrial and government clients across industries, including biotechnology. SwRI's headquarters employs over 3,000 and occupies almost two million square feet of office and laboratory space on over 1,200 acres in San Antonio. SwRI's FY2007 revenues were \$501 million. During 2007, SwRI provided \$6 million to fund innovative research through its internally sponsored R&D program.
- The Southwest Foundation for Biomedical Research (SFBR), one of the world's leading independent biomedical research institutions, is also headquartered in San Antonio. SFBR has a \$53 million annual budget, employs almost 400, and is located on a 322 acre campus adjacent to SwRI. The SFBR is home to the Southwest National Primate Research Center and the world's largest colony of baboons for biomedical research; to the nation's only privately owned biosafety level 4 (BSL-4) laboratory; and to the AT&T Genomics Computing Center, which houses the world's largest computer cluster devoted to statistical genetic analysis.
- In FY2006, over \$104 million were spent on specialized biotechnology R&D at Texas universities, according to the Texas Higher Education Coordinating Board (THECB). Also in FY2006, over \$557 million were spent on specialized cancer R&D and over \$126.6 million were spent on specialized cardiovascular R&D at Texas health-related institutions.
- In FY2006, Federal agencies provided 60.2 percent of all R&D funding to Texas health-related institutions of higher learning, according to the THECB. The State of Texas provided 12.9 percent, private funding provided 16.8 percent, and Institutional funding provided the remaining 10.1 percent.
- In FY2005, Texas ranked fifth nationally for NIH Small Business Innovation Research (SBIR) awards, with \$26,609,761 in awards to Texas businesses.
- In FY2005, the U.S. Department of Health and Human Services (HHS) supplied 68 percent of the federal research support for science and engineering at Texas higher education facilities. The NIH, which is part of the HHS, is the primary Federal agency for conducting and supporting medical research.
 - In FY2006, Texas ranked sixth in the nation for NIH awards with \$1.116 billion in grants to Texas institutions and businesses.

The following chart shows FY2006 R&D expenditure breakouts by disciplines in Texas institutions of higher education, totaling over \$3.18 billion. Medical, biological and agricultural sciences alone accounted for \$2.07 billion or over 65 percent.



Source: Texas Higher Education Coordinating Board

The following chart shows FY2006 R&D expenditures at the top ten Texas health-related higher education institutions. The ten institutions had combined R&D expenditures of over \$1.78 billion. Nine of the following are public institutions; Baylor College of Medicine is a private institution.

**FY2006 TOP TEXAS HEALTH-RELATED HIGHER EDUCATION INSTITUTIONS
(BY R&D EXPENDITURES IN MILLIONS)**

Institutions	Total R&D
Baylor College of Medicine	\$443.4
University of Texas (UT) M.D. Anderson Cancer	\$409.7
UT Southwestern Medical Center	\$333.3
UT at Houston Health Science Center	\$175.2
UT Medical Branch at Galveston	\$155
UT Health Science Center at San Antonio	\$139.8
Texas A&M Health Science Center	\$72.3
University of North Texas Health Science Center	\$23.9
Texas Tech University Health Science Center	\$21.7
UT Health Center at Tyler	\$12.6
TOTAL	\$1,786.9

Source: Texas Higher Education Coordinating Board

- Between 2002 and 2006, approximately 1,586 Texas biotechnology-related utility patents were issued, based on the patent classifications defined as biotechnology by the U.S. Patent and Trademark Office (USPTO). Pharmaceuticals accounted for the majority, with 598 patents or almost 38 percent.
- Between 2000 and 2004, the University of Texas (UT) system tied with the University of California (UC) at San Francisco as the top-ranked university in the nation for biotechnology patents, according to the Milken Institute. Both UT and UC had 219 U.S.-issued biotechnology patents.
- The following data come from various National Science Foundation (NSF) publications:
 - In 2006, Texas ranked fourth nationally for federally financed R&D expenditures at doctorate-granting institutions and third nationally for life sciences R&D expenditures at doctorate-granting institutions.
 - In 2005, the NSF nationally ranked the following seven Texas higher educational institutions in the top 100 for R&D expenditures in the life sciences:
 - Baylor College of Medicine ranked No. 10.
 - The University of Texas M.D. Anderson Cancer Center ranked No. 17.
 - The University of Texas Southwestern Medical Center of Dallas ranked No. 25.
 - The Texas A&M University System ranked No. 57.
 - The University of Texas Medical Branch ranked No. 61.
 - The University of Texas Health Science Center at Houston ranked No. 64.
 - The University of Texas Health Science Center at San Antonio ranked No. 74.
 - The University of Texas Health Science Center at San Antonio (UTHSCSA) was ranked the No. 1 Hispanic-serving institution in the nation for attracting federal research funding. UTHSCSA received \$33.8 million in federal funding in FY2005.
 - In 2005, Texas ranked third nationally for science and engineering (S&E) doctorates awarded, with 1,781 degrees conferred. Of this S&E doctorate total, Texas ranked first nationally for agricultural doctorates, with 64 degrees conferred, and third nationally for biological doctorates, with 454 degrees conferred.
 - From 2000 to 2005, Texas ranked sixth nationally for all SBIR awards.
 - In 2005, Texas ranked fifth nationally for industry R&D performance.
 - In 2004, Texas ranked fifth nationally for all R&D expenditures and fifth for total R&D performance
- In 2005, 25.1 percent of the Texas population 18 years and over held Bachelor's or higher degrees, which included biological and biomedical sciences degrees, according to the U.S. Department of Education's National Center for Education Statistics (NCES). The numbers of degrees were not included in the data.
 - In 2003-2004, Texas conferred 6,095 bachelor's degrees and 1,093 master's degrees in natural sciences, which include biological and biomedical sciences, according to the U.S. Department of Education's NCES. Texas ranked third in the nation in these categories. ✓

TEXAS BIOTECHNOLOGY INDUSTRY AREAS

LIFE SCIENCE

Life science is a broad, catch-all term which is often used instead of the term 'biology.' Life science is defined as the scientific study of living organisms and includes biology-related sciences such as botany, microbiology, and more recently, biotechnology. The life sciences have become an important driver of economic growth and development in the 21st century. Wages and salaries for life science workers in Texas are nationally competitive and outpace state averages. The number of life science patents and new intellectual properties are steadily increasing, paving the way for new products, companies, and jobs. The state also offers opportunities to commercialize products and processes conceived in university laboratories.

- In 2007, venture capital firms invested \$90.2 million in Texas biotechnology companies, according to PricewaterhouseCoopers. From 1997 through 2007, venture capital firms invested roughly \$712.6 million in Texas biotechnology companies.
- In 2006-2007, Texas conferred 5,271 degrees from health-related institutions, up from 4,799 in 2005-2006, according to the Texas Higher Education Coordinating Board.
- In FY2006, Texas institutions of higher education's R&D expenditures were \$820.3 million for biological and other life sciences and \$1,162.1 million for medical sciences for a total of over \$1.98 billion.
- In 2004, Texas ranked third nationally for total life sciences R&D. ^{vi}

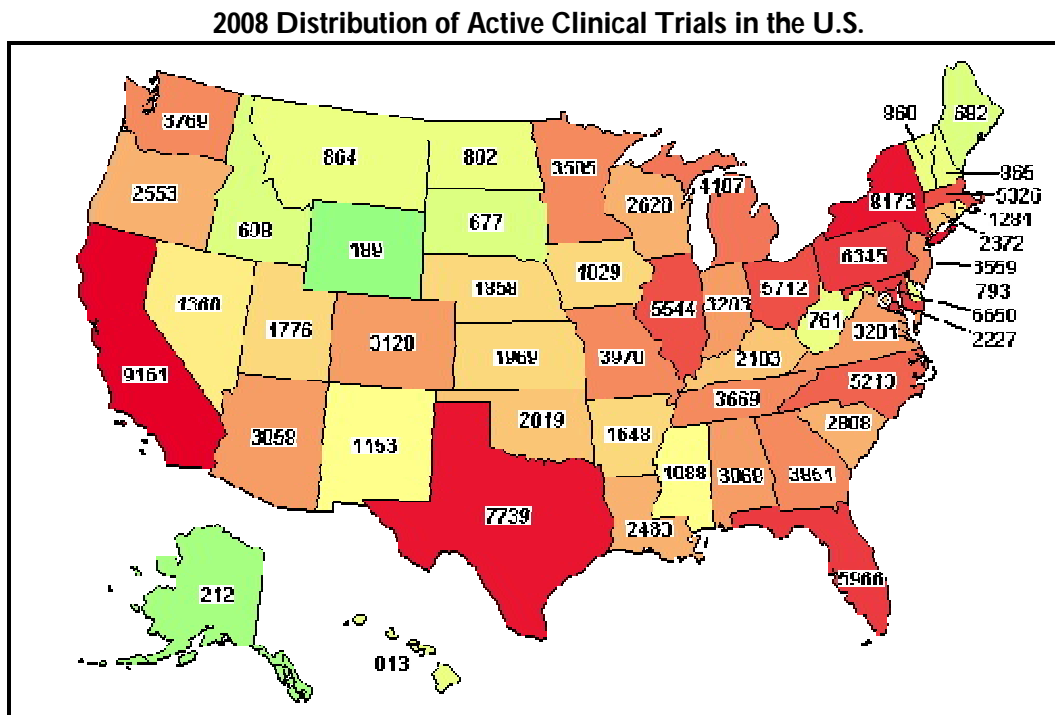
BIOMEDICINE & PHARMACEUTICALS

Biomedicine and pharmaceuticals are the largest and most-established segments of the biotechnology industry. Texas is a recognized leader in the biomedical field, with more than 55 medical research institutions and research parks and one of the world's largest medical complexes. The state is top-ranked in clinical trials for global and domestic pharmaceutical firms. Texas researchers are making great strides in the field of tissue engineering, testing new procedures for reducing infections and diseases that result from bone marrow transplants, and identifying how HIV penetrates white blood cells. Texas researchers are also pioneering in nano-medicine. Not only are the state's institutions furthering the biomedical and pharmaceutical fields, they are also training the next generation of scientists in basic and applied research and development.

- The Texas Workforce Commission reports that Texas is home to approximately 146 pharmaceutical manufacturing companies (NAICS 3254) employing 9,932 and 1,879 medical research, development, and testing laboratories (NAICS 6215 and 54171) employing 39,048.
- The Texas Medical Center (TMC) in Houston is the world's largest medical center; it is also one of the best-known and finest medical complexes. In 2007, there were over 33,000 students and 73,600 employees housed on over 1,000 acres conducting \$1 billion in research. The TMC houses 46 member institutions, including 13 educational institutions and two specialized patient facilities. The educational institutions include Baylor College of Medicine, the University of Texas M.D. Anderson Cancer Center, the University of Texas Health Science Center at Houston, the University of Houston System, Rice University, the Texas A&M University System, Texas Woman's University, Prairie View A&M University, Texas Southern University, the Houston Community College System, and the Michael E. DeBakey High School for Health Professionals (part of the Houston Independent School District).

- In FY2006, Texas institutions of higher education spent \$1.16 billion for medical sciences R&D.
- In 2007, Texas awarded 327 professional pharmacy degrees and 129 professional veterinary degrees, according to Texas Higher Education Coordinating Board staff.
- In 2006, Texas pharmaceutical and medicine manufacturing's (NAICS 3254) total value of shipments was \$3.74 billion, total capital expenditures were \$92.8 million, and value added was \$3.13 billion, with more than 5,660 employed, according to the 2006 Annual Survey of Manufactures.

The following chart shows that in early 2008, Texas ranked third nationally with 7,739 active clinical trials. ^{vii}



Source: NIH's ClinicalTrials.gov at <http://www.clinicaltrials.gov/ct2/search/map?map=NA%3AUS>, accessed May 2008

MEDICAL DEVICES

The medical devices industry is a growing area of biotechnology which is strongly associated with health care and medical research. It includes establishments primarily engaged in manufacturing medical equipment and supplies, such as surgical, dental, orthopedic, ophthalmologic, and laboratory instruments and apparatus. As a leader in the biomedical field and with its large and growing population, Texas is a natural marketplace for improving healthcare and medical research technologies. Examples of medical devices being developed and produced in Texas include surgical sutures, syringes, eye-care products, cardiac catheters, urinalysis and blood transport vials, and medication delivery systems.

- The Texas Workforce Commission reports that the state is home to approximately 1,104 medical equipment companies (NAICS 3391 and 3345) employing 35,436 skilled workers.

- In 2007, venture capital firms invested \$143.6 million in Texas medical devices and equipment companies, according to PricewaterhouseCoopers. From 2000 through 2007, venture capital firms have invested roughly \$454.9 million in Texas medical devices companies, averaging over \$64.9 million in investments per year.
- In 2006, Texas medical equipment manufacturing's (NAICS 3391) total value of shipments was \$3.44 billion, total capital investments were \$138.9 million, and value added was \$2.31 billion, with more than 13,376 employed, according to the 2006 Annual Survey of Manufactures. Texas ranked nationally in the top ten for all these breakouts.
- In 2006, Texas electrical instrument manufacturing's (NAICS 3345) total value of shipments was \$5.13 billion, total capital investments were \$153 million, and value added was \$3.24 billion, with more than 17,778 employed, according to the 2006 Annual Survey of Manufactures. Texas ranked nationally in the top ten for all these breakouts. *viii*

AGRICULTURE

Agricultural biotechnology builds upon processes that have been used for thousands of years. Modern advances include techniques utilizing genetic changes to increase crop yields; strengthen resistance to pests, disease, and climate; and enhance the nutritional value of foods. Texas is a natural choice for agricultural biotechnology enterprises because it is the nation's second ranked state for agricultural production with a multi-billion dollar agriculture industry, strong agricultural research facilities, 38.66 million acres of cropland, and top 10 national rankings for overall agricultural exports. In 2006, the receipt value of the state's top five agricultural commodities alone exceeded \$16 billion. Texas has been at the forefront of agricultural research for over 100 years, initially led by the Texas A&M University, and later joined by other research institutions.

- In 2007, Texas agricultural production surpassed a record-breaking \$100 billion in economic impact, according to the Texas Department of Agriculture. The agricultural industry employs nearly 2 million Texans and contributes approximately 9 percent of the gross state product.
- In 2007, Texas ranked second nationally for agricultural products exports. Agricultural products were the state's 7th largest export item at \$4.7 billion.
- In 2007, 79 percent of the state's corn crop and 80 percent of the state's cotton crop were genetically modified. Texas ranked first nationally for its cotton crop, and has led the nation in cotton production for many years.
- The Texas Agricultural Experiment Station (TAES) was established in 1887 as the state's agricultural and life sciences research agency, mandated to conduct research to assure the highest quality agricultural products and to support the state's agricultural industry. Texas A&M University, the state's first public institution of higher learning, opened in 1876 as the Agricultural and Mechanical College of Texas and serves as the administrator of TAES. Over the years, TAES research has led to the development of many successful products with a high return on investment. They include the "Ruby" Red Grapefruit, the first grapefruit to be granted a U.S. patent, and the Texas Grano 1015Y onion, a large sweet onion. These two products alone have contributed hundreds of millions of dollars in revenues to the state's economy.

- In 2006, Texas ranked third for overall agricultural exports according to the U.S. Department of Agriculture (USDA). The following chart provides details from the most current USDA data available.

TEXAS TOP 5 AGRICULTURAL EXPORTS IN 2006		
Agricultural Products	State Rank	Value (in Millions)
Cotton and Linters	1	\$1,246.6
Live Animals and Meat	4	\$421.1
Other	7	\$345.1
Hides and Skins	3	\$314.8
Feeds and Fodders	2	\$301.5
Overall State Rank/Value *	3	\$3,805.4 *

Source: *Texas State Fact Sheet*, USDA, Economic Research Service, <http://www.ers.usda.gov/StateFacts/TX.htm> * Value

- The following chart provides USDA data on the state's top agricultural commodities.

TEXAS TOP 5 AGRICULTURAL COMMODITIES IN 2006			
Agricultural Products	Value of Receipts (in Thousands)	Percent of State Total Farm Receipts	Percent of U.S. Value
Cattle and Calves	\$7,440,565	46.4	15.1
Cotton	\$1,906,436	11.9	30.9
Greenhouse/Nursery	\$1,496,345	9.3	8.9
Broilers	\$1,265,400	7.9	6.7
Dairy Products	\$947,492	5.9	4.0
All Commodities	\$16,026,756	---	6.7

Source: *Texas State Fact Sheet*, USDA, Economic Research Service, <http://www.ers.usda.gov/StateFacts/TX.htm>

- In FY2006, Texas institutions of higher education spent \$94.25 million for agricultural sciences R&D.
- In 2007, Texas awarded 50 doctoral degrees and 238 master's degrees in agriculture, according to Texas Higher Education Coordinating Board staff. ^{ix}

ENVIRONMENTAL BIOTECHNOLOGY & BIOFUELS

Environmental biotechnology has the potential to transform a variety of industrial processes to better conserve and sustain natural resources; reduce and prevent pollution; cut costs and increase productivity; and develop new uses for traditional agricultural crops and crop residues for use as feed stocks and energy sources. Environmental biotechnology also has the potential to create new markets and make mature industries like petrochemicals more competitive. Texas encompasses a range of biological and climatic diversity. To sustain this ecosystem, and in light of population growth and industrial development, advances in environmental biotechnology are constantly sought. Texas researchers have discovered a method for preventing an aquifer from drying out, analyzed cost-effective methods to convert agriculture biomass into useful products, and explored methods to remediate hazardous materials.

Biomass has become the fourth largest global energy source after coal, oil, and natural gas, according to the U.S. Department of Energy. Renewable biofuels, such as ethanol and biodiesel, are created from biomass,

which come from many types of vegetation, including soybeans, corn, switchgrass, and algae. Building on the state's strong agricultural production base, Texas researchers and businesses are creating new renewable energy technologies and infrastructure to maintain the Lone Star State's position as energy capital of the nation.

- Texas is the nation's largest producer of biodiesel transportation fuel, with 72.9 million gallons produced in 2007. As of January 2008, the latest data available, there were 171 commercial biodiesel production plants operating nationwide, with more plants under construction. Texas ranked first nationally with 22 biodiesel refineries and an annual production capacity of 297.58 million gallons, according to the National Biodiesel Board. The chart below provides details. In addition, Austin had the highest number of biodiesel fueling stations of any city in the nation.

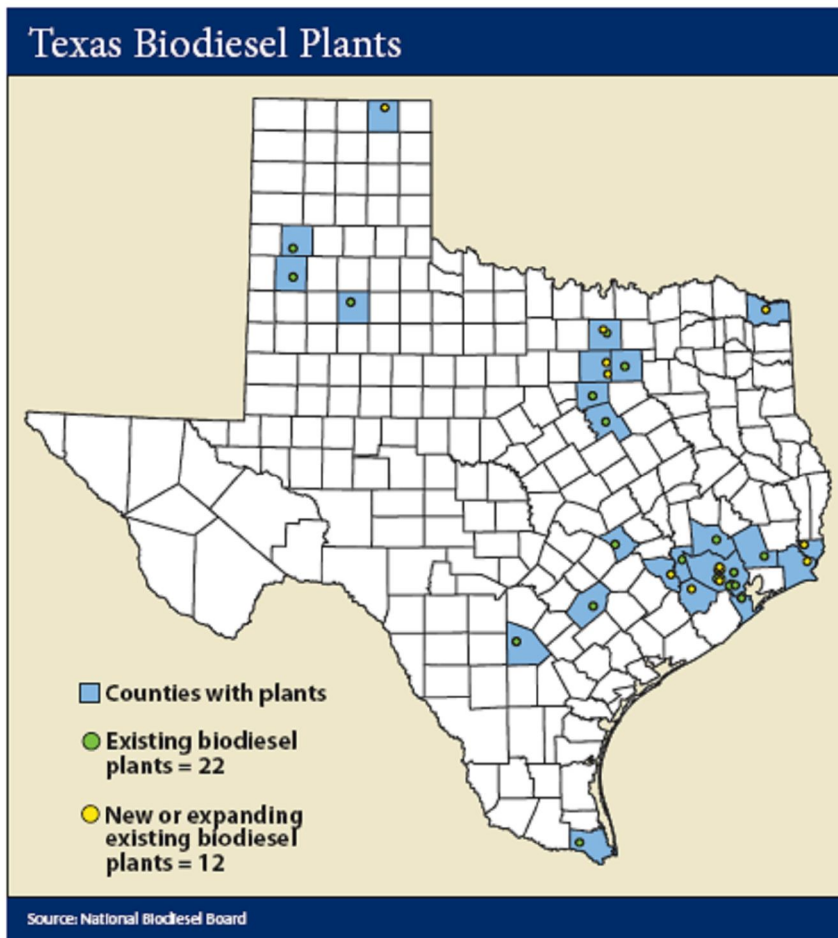


Chart source: *The Energy Report 2008*, Texas Comptroller of Public Accounts, May 2008

- In April 2008, there were 147 ethanol refineries in the U.S., according to the Renewable Fuels Association (RFA). The RFA indicates that Texas has four ethanol refineries, while the Texas State Energy Conservation Office (SECO) lists more – including some not yet operational. When operational, the Texas ethanol biorefineries should produce 729 million gallons per year, as the following chart indicates.

TEXAS ETHANOL BIOREFINERIES * (ARRANGED BY NAME)			
Company	Location	Feedstock	Capacity (MGY)
BioFuels Energy Corporation	Raymondville, TX	TBD	4
Blackland Ethanol Corporation	Temple	Corn/Milo	50
Levelland/Hockley County Ethanol, LLC	Levelland, TX	Corn/Milo	40
Panda Ethanol	Hereford, TX	Corn/Milo	115
Panda Ethanol	Muleshoe, TX	Corn/Milo	115
Panda Hereford Ethanol LP	Hereford, TX	Corn/Milo	115
Texas BioEnergy Marketing Associates	5 Central Texas Locations – TBD	Sweet Sorghum	12 each (60 total)
Panhandle Energies	Dumas	Corn/Milo	30
White Energy	Hereford, TX	Corn/Milo	100
White Energy	Plainview, TX	Corn/Milo	100
TOTAL	---	---	729 MGY

* Most aren't yet operational

MGY = Million Gallons per Year

Sources: Renewable Fuels Assn. at http://www.seco.cpa.state.tx.us/re_ethanol_plants.htm and the Texas State Energy Conservation Office at <http://www.ethanolrfa.org/industry/locations/>, accessed May 2008

- In February 2008, Texas AgriLife Research, part of the Texas A&M University System, and General Atomics, a San Diego-based technology company, received a Texas Emerging Technology Fund (ETF) grant of over \$4 million for biofuel microalgae research. The ETF grant will leverage more than \$4 million of parallel U.S. Department of Defense sponsored research aimed at developing microalgae-derived biodiesel fuels to support U.S. domestic and military needs.
- The Texas Tax Code offers a Biofuel Tax exemption (§162.001 and §162.204). Biodiesel or ethanol blended with taxable diesel, that is identified when sold or used as a biodiesel or ethanol fuel blend, is exempt from the diesel fuel tax.
- In 2006, the Texas Department of Agriculture created the Texas Biofuel Incentive Program to encourage the production of biofuel in Texas. The program allowed Texas biofuel producers to register to become eligible to receive grants, based on the amount of biofuel produced by their facilities, and distributed \$11.5 million in funding. The 2007 Texas Legislature extended the program but appropriated no further funds, so as of September 1, 2007, no new registrations or reports are being accepted. However, there are federal level biodiesel tax credits available through the end of 2008.
- In August 2005, Gov. Perry signed Texas Senate Bill 20 into law. The new law requires more renewable energy to be developed and used in the next 10 years and complements research under way to determine how and where biomass can be used. Researchers have been working with manure as a fertilizer and have studied ways to convert it into energy. This latest push of legislation and research should result in more energy projects becoming a reality.
- In FY2006, Texas institutions of higher education spent \$130.89 million for environmental sciences R&D. ^x

SELECTED RECENT TEXAS BIOTECHNOLOGY INDUSTRY ACTIVITIES

Below is a selection of recent, major Texas biotechnology projects and announcements. They provide a snapshot of the activity in the dynamic Texas marketplace, and are not a complete or authoritative list.

- On March 28, 2008, Gov. Rick Perry participated in a groundbreaking ceremony for the Texas Institute for Preclinical Studies (TIPS) at Texas A&M University in College Station. The TIPS facility will train veterinarians, physicians, scientists, technicians and engineers for the state's growing biomedical industry and further bolster Texas' position as a leader in bioscience.
 - TIPS was first announced in May 2007, followed by a July 2007 announcement that the state would invest \$6 million in the institute through the Texas Emerging Technology Fund (ETF) to help recruit world-class biotechnology researchers to the institute. The ETF investment leveraged an additional \$40 million from the TAMU System and \$2.5 million from the local community's Research Valley Partnership.

- In December 2007, Gov. Rick Perry announced a Texas Enterprise Fund \$7.5 million grant to Scott & White Memorial Hospital and Scott and Sherwood & Brindley Foundation to increase critical research initiatives in Bell County. Scott & White, Bell County's largest private employer, will generate nearly 1,500 jobs during the next decade by expanding its Cancer Research Institute and other healthcare programs.
 - In November 2003, the Temple Health & Bioscience Economic Development District (THBEDD) was created through unique legislation passed by the Texas Legislature and approved by the citizens of Temple. The district was formed to identify and recruit Biotechnology and Life Science related businesses to locate operations in Temple.
 - Scott & White Healthcare System, a non-profit healthcare corporation based in Temple, has assisted with and is very involved in the THBEDD. In December 2004, the THBEDD announced the establishment of the new Cancer Research Institute (CRI) as part of a joint development agreement with the Scott & White Healthcare System. It opened in July 2005.
 - Also in December 2004, a development agreement was announced between the THBEDD and Scott & White to develop up to 220,000 square feet of a former Texas Instruments building as a research complex.
 - In early 2005, Scott & White was able to recruit renowned cancer researcher Dr. Arthur Frankel from the Wake Forest University School of Medicine. Since then, Scott & White's recognition for research has elevated to international status, with working relationships in both Canada and Europe. Under Dr. Frankel's leadership, the Cancer Research Institute has attracted researchers and scientists representing four of the world's continents.




Dr. Arthur Frankel
Photo Source:

http://www.sw.org/web/SW/healthcareProfessionals/templatedata/hr/staff/data/phy_def/phy_frankel_a

- In January 2006, the Texas A&M System Board of Regents approved an expansion of the A&M Health Science Center College of Medicine, a plan that brought a full, four-year medical school to Temple and Scott & White Memorial Hospital. Classes began in 2007.

- In November 2007, Texas voters approved Proposition 15, a \$3 billion bond proposal for cancer research and prevention which will use general obligation bonds during a span of 10 years. Texas is among several states taking a larger role in cancer research as federal funding has stagnated in recent years. The Cancer Prevention and Research Institute of Texas will award up to \$300 million a year in grants for 10 years to public and private institutions to investigate cancer causes, cures, and treatment. For every dollar the Institute awards, recipient organizations must put up 50 cents.
 - In June 2007, Gov. Rick Perry signed HB 14 into law, creating the Cancer Prevention and Research Institute of Texas and dedicating \$300 million in general obligation bonds to annually fund scientific research aimed at finding a cure for cancer. HB 14 funding comes from Proposition 15.

- In November 2007, the National Trauma Institute (NTI) in San Antonio received a Texas ETF grant of \$3.8 million for developing new medical devices and technology for trauma victims. The grant will help make Texas a hub for treating trauma-related injuries. The NTI is a non-profit consortium formed by the Brooke Army Medical Center, the U.S. Army Institute of Surgical Research, and the San Antonio Military Medical Center at Fort Sam Houston; the University Health System-University Hospital; The University of Texas Health Science Center at San Antonio; and Wilford Hall USAF Medical Center at Lackland Air Force Base.
 

- In August 2007, the AT&T Foundation donated \$1 million to the Southwest Foundation for Biomedical Research (SFBR), which will allow the institute's AT&T Genomics Computing Center to upgrade and double its processing power and speed. The SFBR has the world's largest cluster of computers linked together for genetic analysis.

- In July 2007, Gov. Rick Perry laid out his plans for a statewide bioenergy initiative. He indicated that Texas will focus on developing alternative fuel from woody grasses and other plants rather than food crops like corn. The Governor announced a \$5 million Texas ETF grant to Texas A&M University (TAMU) to help recruit commercially-focused faculty to conduct research for the next generation of biofuels. He also recognized the newly formed Texas Bioproducts Industry Council, and announced it will be housed at the University of Houston's Center for Industrial Partnerships.
 - The Texas Bioproducts Industry Council will help develop statewide bioenergy policy. It includes partners from Shell, BASF, Bayer CropScience, Chevron, Earth Biofuels, Standard Renewable Energy, and CleanFuel USA.
 - In July 2006, TAMU's two premier research agencies in agriculture and engineering, the Texas Agriculture Experiment Station and the Texas Engineering Experiment Station, joined to form the TAMU Agriculture and Engineering BioEnergy Alliance (TAEBA).
 - In March 2007, Chevron Technology Ventures, a division of Chevron USA Inc., announced a formal four-year partnership with TAEBA to support biofuels research initiatives. Research initiatives will focus on converting non-food crops into renewable fuels.

- In February 2007, the Texas Bioscience Institute (TBI) in Temple, Texas won the prestigious Bellwether Award, which recognizes the nation's best and most innovative community college educational programs. Created to prepare students to enter the rapidly evolving bioscience medical industry, the TBI is a collaboration of partners including Scott & White, Temple College, the Temple Health and Bioscience District, the City of Temple, Temple ISD, and other Central Texas public and private schools.
 - In May 2008, TBI graduated its first nine high school dual credit students with Associate Degrees. Currently, TBI has 108 students registered for the 2007-2008 school year.

- The TBI Middle College Program has also been recognized on the national level as one of the “Best Practice” STEM (Science, Technology, Engineering, and Math) Educational Programs and has received a grant from the Texas High School Project T-STEM Initiative as an “Early Innovator” and model state program. STEM is a national focus on strengthening K-12 STEM education.
 - The first class of about 40 TBI Middle College Program students was admitted in the fall of 2006. The students came from many Central Texas public and private high schools.
 - In January 2007, a new 27,000 square foot, state-of-the-art TBI classroom and laboratory facility located on Scott & White’s campus opened. Construction was funded by a \$2.5 million commitment from the Temple Tax Increment Financing Reinvestment Zone Board along with an \$800,000 commitment from Scott & White, the property owner. The Reinvestment Zone approved an additional \$420,000. The idea of a bioscience institute was spurred by a nearly \$1 million grant in 2005 from the U.S. Department of Labor.
- In April 2006, The University of Texas Health Science Center (UTHSC) at Houston hired Dr. Mauro Ferrari, one of the founders of the biomedical nanotechnology field and with a strong record in commercialization. An award from the ETF played a key role in Dr. Ferrari’s recruitment package. Dr. Ferrari joined the Brown Foundation Institute of Molecular Medicine for the Prevention of Human Diseases at UTHSC at Houston as a professor of nanotechnology. Ferrari is founder and editor of the journal *Biomedical Microdevices*, the oldest journal dedicated to this relatively new area of medicine.
 - Dr. Ferrari currently serves as the President of the Alliance for NanoHealth (ANH), a consortium formed in 2005 to mainstream the use of nanotechnology in medicine and healthcare. The ANH is comprised of eight world-class research institutions, scientists and clinicians located within the Texas Medical Center and the greater Houston region.



Dr. Mauro Ferrari

Photo Source: <http://gsbs.uth.tmc.edu/tutorial/ferrari.html>



Alliance for NanoHealth Logo

Source: <http://www.nanohealthalliance.org/about-us>

- In February 2006, Gov. Perry announced the awarding of a \$1.9 million ETF grant to Texas Tech University to help support its new International Center of Excellence in Agriculture Genomics and

Biotechnology. This was the first ETF grant to be awarded. It has enhanced Texas Tech's agriculture research and ability to develop products for commercialization.

- In February 2006, Texas Tech University (TTU) hired Dr. Thea Wilkins, one of the world's premier cotton geneticists as part of TTU's efforts to become an international leader in agriculture genomics R&D and to help make West Texas the fiber capital of the world. The ETF award to TTU played a key role in Dr. Wilkins' recruitment. Dr. Wilkins serves as Director of the International Center of Excellence in Agricultural Genomics and Biotechnology in Texas Tech's Department of Plant and Soil Science. She has generated millions of dollars in competitive research funding from the National Science Foundation, the U.S. Department of Energy, and the U.S. Department of Agriculture over the years. Dr. Wilkins was recruited from the University of California at Davis.



Dr. Thea Wilkins and Gov. Rick Perry

Photo Source: <http://www.texas-tech.edu/stories/emerging-technology-fund.php>

- In January 2007, Texas Tech University's (TTU) Dr. Thea Wilkins won the 2006 Cotton Biotechnology Award. Dr. Wilkins was the first to discover the signal for vacuolar sorting and this effort has remained a research standard for more than 15 years. Her other efforts include the development of the standard method for RNA isolation in cotton and identification of candidate genes with critical roles in fiber elongation. Dr. Wilkins' pioneering work with cotton transformation, where specific genes are placed into cotton, has resulted in two issued and two pending patents.
- In February 2006, The University of Texas at San Antonio (UTSA) opened its new \$84 million Biotechnology Sciences and Engineering building. The facility is the largest at UTSA and one of the largest research-related educational centers in Texas. UTSA has recruited faculty for the new facility, which joins the UT Health Science Center in developing the area's biomedical industry. Health care is one of San Antonio's leading industries and pumps an estimated \$13 billion into the local economy annually.
- In July 2005, Gov. Perry announced a \$50 million Texas Enterprise Fund grant to help create the Texas Institute for Genomic Medicine (TIGM), a pioneering research institution that will help make Texas an international focal point for medical research and foster job growth in the life science industry. The funds were awarded to Lexicon Genetics (now called Lexicon Pharmaceuticals) and the Texas A&M University System, which formed the non-profit TIGM. Lexicon used \$35 million of grant money to create two copies of its mouse cell line library and provided them to TIGM. The Texas A&M System is using the remaining \$15 million to build new facilities in College Station, remodel facilities, and manage the daily operations at TIGM.
- In May 2004, Gov. Perry announced a \$25 million grant from the Texas Enterprise Fund for the creation of a new Center for Advanced Diagnostic Imaging at the University of Texas Research Park in Houston. Another \$25 million was committed by the University of Texas M.D. Anderson Cancer Center and the University of Texas Health Science Center at Houston. GE Healthcare committed \$30 million in equipment and personnel to the project. The imaging center will create more than 2,200 highly skilled jobs and will speed the development of new commercially marketable biomedical imaging technologies.

- In May 2004, The University of Texas Medical Branch (UTMB) at Galveston announced the creation of a Center for Technology Development, a new university entity charged with developing and accelerating the translation of UTMB research into medical goods and technologies. One aspect of the center is a “business incubator,” which will provide office space and basic business resources to start-up companies, assisting them in the first few years of their existence. Another key element of the center is the planned Office of Research Translation. The Center for Technology Development and the Office of Research Translation are working with UTMB researchers in the NIH-funded WRCE (the Western Regional Center of Excellence for Biodefense and Emerging Infectious Diseases Research), a coalition of academic and business entities expected to receive about \$48 million in federal support over the next five years for research into new diagnostic techniques, vaccines and therapies for biodefense and emerging infectious diseases.
- In October 2003, UTMB at Galveston was awarded a \$110 million NIH grant to establish one of only two national high-level biocontainment laboratories. UTMB was also awarded \$48 million to establish one of eight federal Regional Center of Excellence for Biodefense and Emerging Infectious Diseases Research. ^{xi}



APPENDICES

TABLE 1
TOP GLOBAL BIOTECHNOLOGY & PHARMACEUTICAL COMPANIES
(ARRANGED BY INDUSTRY AREA THEN BY COMPANY SALES IN MILLIONS)

Company	Country / State	Sales	Industry Area
GE Healthcare * <i>(Ultimate Parent = General Electric)</i>	U.K. <i>(U.S. / CT)</i>	\$16,562	Biotechnology
Amgen *	U.S. / CA	\$14,771	Biotechnology
Genentech *	U.S. / CA	\$11,724	Biotechnology
Baxter International *	U.S. / IL	\$11,263	Biotechnology
Thermo Fisher Scientific *	U.S. / MA	\$9,746.4	Biotechnology
Monsanto	U.S. / MO	\$8,453	Biotechnology
Novo Nordisk A/S	Denmark	\$8,261.6	Biotechnology
TopoTarget A/S	Denmark	\$8,089.6	Biotechnology
Becton, Dickinson & Co. *	U.S. / NJ	\$6,359.7	Biotechnology
Gilead Sciences	U.S. / CA	\$4,230	Biotechnology
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Johnson & Johnson *	U.S. / NJ	\$61,095	Pharmaceutical
Pfizer *	U.S. / NY	\$48,418	Pharmaceutical
GlaxoSmithKline *	U.K.	\$45,479.2	Pharmaceutical
Novartis AG *	Switzerland	\$38,947	Pharmaceutical
Sanofi-Aventis *	France	\$38,934.9	Pharmaceutical
Bayer AG *	Germany	\$38,230.6	Pharmaceutical
Roche *	Switzerland	\$34,465.2	Pharmaceutical
Abbott Laboratories *	U.S. / IL	\$25,914.2	Pharmaceutical
Merck & Co. *	U.S. / NJ	\$24,197.7	Pharmaceutical
Wyeth *	U.S. / NJ	\$22,399.8	Pharmaceutical

Sources: Hoover's Pro Premium, Datamonitor, InfoUSA's ReferenceUSA

* Texas locations

**TABLE 2
BIOTECHNOLOGY-RELATED ETF AWARDS
(ARRANGED BY COMPANY/ENTITY)**

Company/ Entity	City	Industry Segment	Project Description	Funding (in Millions)
Algae Bio Fuels Consortium	Pecos	Biofuels	Bio Energy	\$4.025
Bellicum Pharmaceuticals	Houston	Health Sciences	Cancer Vaccine	\$1.45
CardioSpectra	San Antonio	Medical Devices	Fiber-Optic Cardiac Catheter	\$1.35
CorInnova	College Station	Medical Devices	Heart Therapy Device	\$.5
Endothelix	Houston	Health Sciences	Cardiovascular Test	\$1
Halsa Pharmaceuticals	Houston	Pharmaceuticals	Clinical Obesity – Drug Development	\$.25
Laser Tissue Welding	Humble	Medical Devices	Surgical Therapy	\$.16
MicroTransponder	Dallas	Medical Devices	Neurostimulation Pain Management	\$1.38
Molecular LogiX	The Woodlands	Health Sciences	Genetically Engineered Therapeutic Cancer Treatment	\$.79
Monebo	Austin	Medical Devices	Heart Health Assessment	\$.5
NanoSpectra	Houston	Medical Devices	Oncologic Imaging Detection	\$1.25
National Trauma Institute (NTI)	San Antonio	Health Sciences	Civilian and Military Trauma Research	\$3.8
OrthoAccel	Houston	Medical Devices	Orthodontics	\$.75
PLx Pharma	Houston	Pharmaceuticals	Non-steroidal anti-inflammatory drugs (NSAIDs)	\$2
Resonant Sensors	Arlington	Health Sciences	Optical Bio- and Chemical Sensors	\$.6
Seno Medical	San Antonio	Medical Devices	Laser Optical for Cancer Scanning	\$2
Texas A&M System	College Station	Medical Devices	Medical Devices Research (TIPS)	\$6
Texas A&M System	College Station	Biofuels	Bio Energy	\$5
Texas Tech University	Lubbock	Agriculture	Agricultural Genomics R&D	\$1.9
Thrombo Vision	Houston	Medical Devices	Platelet Measuring Device	\$1.5
University of North Texas Health Science Center	Fort Worth	Health Sciences	Center for Commercialization of Fluorescence Technology	\$2.27
University of Texas at Austin	Austin	Health Sciences	Neuroscience Imaging	\$3.5
University of Texas Health Science Center	Houston	Health Sciences	Biomedical Nanotechnology R&D	\$2.5
University of Texas at Tyler	Tyler	Environmental Health	Texas Allergy, Indoor Environment and Energy (TxAIRE) Institute	\$3.75
Xilas Medical	San Antonio	Medical Devices	Diabetic Foot Products	\$1
TOTAL	---	---	---	\$49.23 M

Source: Texas Office of the Gov., Economic Development & Tourism Division, Emerging Technology Fund Office, http://www.texasone.us/site/PageServer?pagename=tetf_homepage

TABLE 3
TOP TEXAS-BASED BIOTECHNOLOGY COMPANIES (ARRANGED BY COMPANY SALES IN MILLIONS)

Company	City	Sales	Business Description (NAICS)
Kimberly-Clark *	Irving	\$18,266	A global company best known for its consumer products, it has expanded into medical products and is now a leading manufacturer of disposable medical goods (3391)
US Oncology	Houston	\$3,000.8	A private Fortune 1000 company that specializes in cancer treatment and research (6215)
Kinetic Concepts * (AKA KCI)	San Antonio	\$1,609.9	Manufactures medical equipment and devices (3391)
Alcon Holdings *	Fort Worth	\$681.3	A private subsidiary of Swiss-based Nestle S.A. that manufactures pharmaceuticals and surgical/medical instruments (3254 & 3391)
Galderma Laboratories *	Fort Worth	\$430	A private subsidiary of Swiss firm Galderma, a L'Oréal and Nestlé joint venture, that focuses on over-the-counter and prescription dermatology products (3254)
Alcon Laboratories *	Fort Worth	\$379	A private Nestle S.A. subsidiary that manufactures eye care pharmaceuticals, surgical equipment and devices, and conducts ophthalmic research; other Texas-based Alcon Labs. subsidiaries include Alcon Surgical (\$117.8) and Falcon Pharmaceuticals (\$385) (3254 & 3391)
DFB Pharmaceuticals *	San Antonio	\$378	A private, fully integrated specialty pharmaceutical company whose operating companies include Texas-based DPT Laboratories Ltd. (\$221.4) and Healthpoint Ltd. (\$119) (3245)
ArthroCare *	Austin	\$319	Manufactures specialized electro-surgical equipment incorporating radio frequencies (3345)
Avail Medical Products *	Fort Worth	\$244.5	Manufactures medical and surgical equipment, devices, and supplies (3391)
Essilor Laboratory of America *	Dallas	\$192.5	A private subsidiary of France-based Essilor International SA that consists of a wholesale laboratory network, providing services and lens brands to opticians, optometrists, and ophthalmologists (3391)
HealthTronics *	Austin	\$140.4	Manufactures urological medical devices and performs urological laboratory test services (3391)
ReAble Therapeutics (FKA Encore Medical) *	Austin	\$137.4	Manufactures medical devices used to treat and replace damaged joints and bones (3391)
Cyberonics *	Houston	\$131	Manufactures first FDA-approved electro-medical device for treating epilepsy (3345)
First Aid Products LP	Houston	\$127.4	A private NutraMax Products subsidiary that manufactures pharmaceutical preparations, surgical appliances/supplies, etc. (3254)
Mission Pharmacal	San Antonio	\$97.9	A private pharmaceutical firm with a range of products including muscle ointments and treatments for kidney stones, and urinary and vaginal infections (3254)
Atrion Corporation	Allen	\$88.5	Atrion Medical Products subsidiary makes ophthalmic, diagnostic, and cardiovascular equipment while another subsidiary, Quest Medical, makes cardiovascular and intravenous fluid delivery products (3391)
Helena Laboratories *	Beaumont	\$84.1	Manufactures medical and surgical instruments (3391)
Virbac Corporation *	Fort Worth	\$80.8	Manufactures animal pharmaceuticals and health care products (3254)
Luminex *	Austin	\$75	The company's xMAP® technology allows large numbers of biological tests (bioassays) to be effectively conducted and analyzed (3345)
Stoller USA Inc. *	Houston	\$68.9	Conducts research into the genetic potential of plants; develops and distributes Crop Health Products (54171)
Lexicon Pharmaceuticals (FKA Lexicon Genetics)	The Woodlands	\$50.1	Conducts pharmaceutical R&D using mice with specific gene functions disrupted or "knocked out;" the company has five compounds in trials or studies (3254)

Sources: Hoover's Pro Premium, 2008 Fortune 1000 List published by Fortune Magazine, Company Websites

* International locations or distributors

TABLE 4
TEXAS-BASED BIOTECHNOLOGY-RELATED NOBEL LAUREATES AND NATIONAL AWARD WINNERS
(ARRANGED BY YEAR)

Name	Medal/Year	Field	Institution	Description
Norman E. Borlaug	<i>Nobel Peace Prize/1970</i> <i>Presidential Medal of Freedom/1977</i> National Medal of Technology/2004 National Medal of Science/2006 Congressional Gold Medal/2007	Biological Sciences & Agriculture	<i>International Maize and Wheat Improvement Center (CIMMYT), Mexico City</i> <i>CIMMYT</i> Texas A&M University (TAMU) TAMU TAMU	Dubbed the "Father of the Green Revolution" for his work in successfully breeding semi-dwarf, disease-resistant high-yield wheat, which provided a new high-quality food source for millions of people around the world. Dr. Borlaug has been honored by scores of governments, holds 50 honorary degrees, belongs to academies of science in 12 countries, founded the World Food Prize in 1985, and has served as a TAMU professor since 1984.
Michael DeBakey	National Medal of Science/1987 Congressional Gold Medal/2008	Biological Sciences	Baylor College of Medicine	Pioneered medical innovations in cardiovascular surgery
Joseph L. Goldstein	National Medal of Science/1988 Nobel Prize/1985	Biological Sciences & Medicine	The University of Texas Southwestern Medical Center at Dallas	Discoveries in cholesterol metabolism leading to new treatments of cardiovascular disease
Michael S. Brown	National Medal of Science/1988 Nobel Prize/1985	Biological Sciences & Medicine	The University of Texas Southwestern Medical Center at Dallas	Discoveries in cholesterol metabolism leading to new treatments of cardiovascular disease
Karl Folkers	National Medal of Science/1990	Chemistry	The University of Texas at Austin	Discoveries in chemical research and clinical medicine leading to new disease treatments
Alfred Gilman	Nobel Prize/1994	Medicine	The University of Texas Southwestern Medical Center at Dallas	Discovery of G-proteins and their role in cell signal transduction
Denton A. Cooley	Presidential Medal of Freedom National Medal of Technology/1998	Medicine	Texas Heart Institute at St. Luke's Episcopal Hospital	Accomplishments in cardiovascular surgery, including the first successful human heart transplant in the U.S. and the world's first artificial heart implantation
Ferid Murad	Nobel Prize/1998	Medicine	The University of Texas Health Science Center at Houston	Discovery concerning nitric oxide as a cardiovascular system signaling molecule
Bruce McCarl	Nobel Peace Prize/2007	Agricultural Economics	Texas A&M University	Former Vice President Al Gore and the UN Intergovernmental Panel on Climate Change (IPCC), with which McCarl worked, shared this award for their efforts to document and disseminate greater knowledge about man-made climate change.

Sources: http://nobelprize.org/nobel_prizes/lists/2007.html, <http://www.nsf.gov/od/nms/recipients.cfm>, Wikipedia

Italicized text = non-Texas awards

INDUSTRY RESOURCES

BioHouston at www.biohouston.org/home/index.asp

A Houston nonprofit association's website with biotechnology business resources.

Bio-Link: Texas Resources at <http://www.bio-link.org/centersTX.htm>

This biotechnology resource provides a list of Texas educational institutions, organizations, and businesses.

Biotechnology Industry Organization (BIO) at www.bio.org

A U.S. biotechnology industry association website with statistics, reports, charts, links, and more. Note the 2007 Guide to Biotechnology posted at <http://www.bio.org/speeches/pubs/er/> and a 2007 report titled *Growing the Nation's Bioscience Sector: A Regional Perspective* posted at <http://www.bio.org/local/battelle2007/BIO2007RegionalPerspective.pdf>.

F-D-C Reports at <http://www.fdcreports.com/>

These electronic reports cover the latest regulatory, legislative, and business news affecting the U.S. drug, biotechnology, medical device, non-prescription drug, nutritionals, and cosmetics industries.

IMS Health at http://www.imshealth.com/ims/portal/front/indexC/0,2773,6599_5264_0,00.html

This global pharmaceutical and healthcare consulting firm provides some free U.S. and world industry data, articles, and reporting.

ISAAA at <http://www.isaaa.org/>

The International Service for the Acquisition of Agri-Biotech Applications (ISAAA) website contains global information on genetically modified (GM)/biotechnology crops.

Medical Devices Manufacturers Assn. (MDMA) at <http://www.medicaldevices.org/public/default.asp>

A U.S. industry association web site with medical devices news, resources, and links.

National Biodiesel Board at <http://www.biodiesel.org/>

A national trade association offering industry news, statistics, papers, links, and much more.

National Institutes of Health (NIH) at www.nih.gov

The U.S. government agency which serves as the steward for medical research, including national grant distribution. Many NIH reports and statistics are posted to the website.

National Institute of Standards and Technology (NIST) at <http://www.cstl.nist.gov/div83/>

A U.S. government website focusing on technical biotechnology information.

National Science Foundation (NSF) at <http://www.nsf.gov/>

This U.S. government agency funds much of the nation's basic research and publishes many reports and statistics on its website.

PEWIFB at <http://pewagbiotech.org/>

The PEW Initiative on Food and Biotechnology's (PEWIFB) website contains global information on genetically modified (GM) crops and biotechnology.

The Pharmaceutical Research & Manufacturers of America (PhRMA) at www.phrma.org

A U.S. pharmaceutical industry association website. PhRMA's *2006-2007 Annual Report* is posted at http://www.phrma.org/files/Annual_Report_2006_2007.pdf.

State Energy Conservation Office (SECO) at <http://www.seco.cpa.state.tx.us/index.htm>

The Texas Comptroller of Public Account's SECO website offers information focused on cost-effective clean energy technologies in Texas, including biodiesel, ethanol, biomass, and much more.

Texas Healthcare & Bioscience Institute (THBI) at www.thbi.org

A Texas biotechnology resource site geared for business and academia with data resources, including an industry directory listing a selection of Texas companies and research institutions. THBI's 2002 report *The 21st Century Life Science Roadmap: Creating a World-Class Life Science Industry in Texas* is posted at www.thbi.org/about/roadmap.pdf.

Texas Industry Cluster website at <http://www.twc.state.tx.us/news/ticluster.html>

This Texas Workforce Commission website contains the 2005 Texas industry cluster reports, including Biotechnology and Life Sciences, and some follow-up reporting. Also note the *Texas Industry Profiles* website at <http://www.texasindustryprofiles.com/>, which has Texas industry cluster information and the Clusters GIS Mapping tool.

USDA's Economic Research Service website at <http://www.ers.usda.gov/Browse/>

This U.S. Department of Agriculture website provides a wealth of data, including some international statistics.

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