



OFFICE OF THE GOVERNOR
ECONOMIC DEVELOPMENT & TOURISM



TEXAS BIOTECHNOLOGY INDUSTRY REPORT

MARCH 2007



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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 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 since approximately 7000 B.C., 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 current biotechnology products and research include the Human Genome Project, bioethanol, 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 541710	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: ⁱ

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 2005, the global biotechnology marketplace grew 12.2 percent to an estimated \$126.3 billion and is forecast to reach \$226.1 billion by 2010. Between 2001 and 2005, there was a compound annual growth rate (CAGR) of 12.8 percent. Revenues generated from the development and sales of medical sector products accounted for \$77.7 billion or 61.5 percent of the 2005 global market’s value. The agriculture and food segments were also significant with 2005 revenues of \$15.4 billion. Because of the industry’s costly and research-intensive nature, biotechnology 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 10.5

percent in 2005 to an estimated \$34 billion, with 26.9 percent of the global market share. Although the U.S. continues to dominate the global biotechnology marketplace, it is diversifying. A small number of multinational companies, mostly U.S.-based, dominate the marketplace. The global biotechnology industry has experienced strong growth in the recent years, spurred by fresh investments and new products.

The global pharmaceuticals industry is the largest part of the global biotechnology marketplace according to most authorities 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 reference biotechnology. In 2006, global pharmaceuticals grew by 4.9 percent to an estimated \$555 billion while global OTC pharmaceuticals grew by 5.6 percent to an estimated \$88.7 billion, for a combined total of \$643.7 billion. Cardiovascular drugs were the most profitable pharmaceuticals segment, accounting for \$106.2 billion or 19.1 percent market share, closely followed by central nervous system drugs estimated at \$100.7 billion or 18.1 percent market share. Traditional medicines dominated the 2006 global OTC pharmaceuticals market, generating revenues of \$22.6 billion or 25.5 percent market share, followed by vitamins and minerals sales which generated \$15.2 billion or 17.2 percent market share. Mergers and multinational companies dominate the global pharmaceuticals and OTC pharmaceuticals marketplaces. While the U.S. is the largest global pharmaceuticals marketplace at 47 percent market share, Asia-Pacific leads in the global OTC pharmaceuticals marketplace with 44.1 percent market share. Both pharmaceuticals breakouts have seen steady growth in recent years; however, the global pharmaceuticals market is forecast to decelerate.

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

**TOP GLOBAL BIOTECHNOLOGY COMPANIES
(ARRANGED BY INDUSTRY AREA THEN BY COMPANY SALES IN MILLIONS)**

Company	Country / State	Sales	Industry Area
GE Healthcare * (Ultimate Parent = GE)	England (U.S. / CT)	\$15,153	Biotechnology
Amgen *	U.S. / CA	\$12,430	Biotechnology
Novo Nordisk A/S *	Denmark	\$6,857	Biotechnology
Genentech *	U.S. / CA	\$6,633	Biotechnology
Genzyme *	U.S. / MA	\$2,735	Biotechnology
Thermo Fisher Scientific *	U.S. / MA	\$2,663	Biotechnology
Merck Serono S.A. (formerly Serono)	Switzerland	\$2,586	Biotechnology
Biogen Idec	U.S. / MA	\$2,423	Biotechnology
Quintiles Transnational *	U.S. / NC	\$2,399	Biotechnology
CSL Limited *	Australia	\$2,079	Biotechnology
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Pfizer *	U.S. / NY	\$51,298	Pharmaceutical
Johnson & Johnson *	U.S. / NJ	\$50,514	Pharmaceutical
GlaxoSmithKline *	U.K.	\$42,414	Pharmaceutical
Novartis AG *	Switzerland	\$36,749	Pharmaceutical
Sanofi-Aventis *	France	\$33,771	Pharmaceutical
Bayer AG *	Germany	\$32,432	Pharmaceutical
AstraZeneca PLC *	U.K.	\$27,253	Pharmaceutical
Roche *	Switzerland	\$26,985	Pharmaceutical
Abbott Laboratories *	U.S. / IL	\$22,338	Pharmaceutical
Merck & Co. *	U.S. / NJ	\$22,012	Pharmaceutical

Sources: Hoover's Pro Premium, Datamonitor

* Texas locations

U.S. BIOTECHNOLOGY MARKETPLACE

The U.S. biotechnology marketplace is the largest in the world. In 2005, it grew 13.3 percent to an estimated \$68.6 billion or 54.3 percent of the global market, according to Datamonitor. The U.S. market is forecast to grow to \$131.8 billion by 2010. Between 2001 and 2005, the U.S. biotechnology market saw a CAGR of 14 percent. Revenues generated from the development and sales of medical sector products accounted for \$45.7 billion or over 66 percent of the 2005 U.S. market's value. The agriculture and food segments were also significant with 2005 revenues of \$3 billion. The U.S. is also the world's largest producer of and market for genetically modified/biotechnology crops with an estimated 54.6 million hectares under production in 2006, 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. 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 2006, the combined U.S. pharmaceuticals/OTC pharmaceuticals segments totaled \$282 billion, according to Datamonitor. U.S. pharmaceuticals grew by 5.2 percent in 2006 to an estimated \$260.8 billion or 47 percent of the global market. Revenues generated from sales of central nervous drugs accounted for \$59.6 billion or 22.9 percent of the 2006 U.S. pharmaceuticals market share, closely followed by cardiovascular drugs at \$50.2 billion or 19.3 percent of the market. The U.S. was the second largest OTC pharmaceuticals market in 2006. U.S. OTC pharmaceuticals grew by 4.3 percent to an estimated \$21.2 billion or 23.9 percent of the 2006 global market. Revenues generated from cough and cold preparations accounted for \$4.7 billion or 22.3 percent of the 2006 U.S. OTC pharmaceuticals market share, followed by vitamins and minerals at \$4 billion or 18.7 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 2005, the U.S. biotechnology marketplace included approximately 1,415 U.S. biotechnology firms, according to data posted by the Biotechnology Industry Organization (BIO). Most of these firms are small, and only about 329 are publicly held. It is the few large firms that account for most of the industry's revenues. From 1995 to 2005, the U.S. biotechnology industry's revenues increased over 250 percent to a total of \$50.7 billion. The economic downturns in the early 2000s negatively impacted the U.S. and global biotechnology industry, and some areas have been slow in recovering.

The following U.S. biotechnology industry chart tracks 11 years of revenue growth for all U.S. publicly-traded companies, as well as other industry statistics. The chart data are published by BIO and are derived from Ernst & Young, whose analysts define biotechnology in the traditional fashion. Note the recent downturns in the number of companies and employment in the chart, reflecting consolidations within the industry.

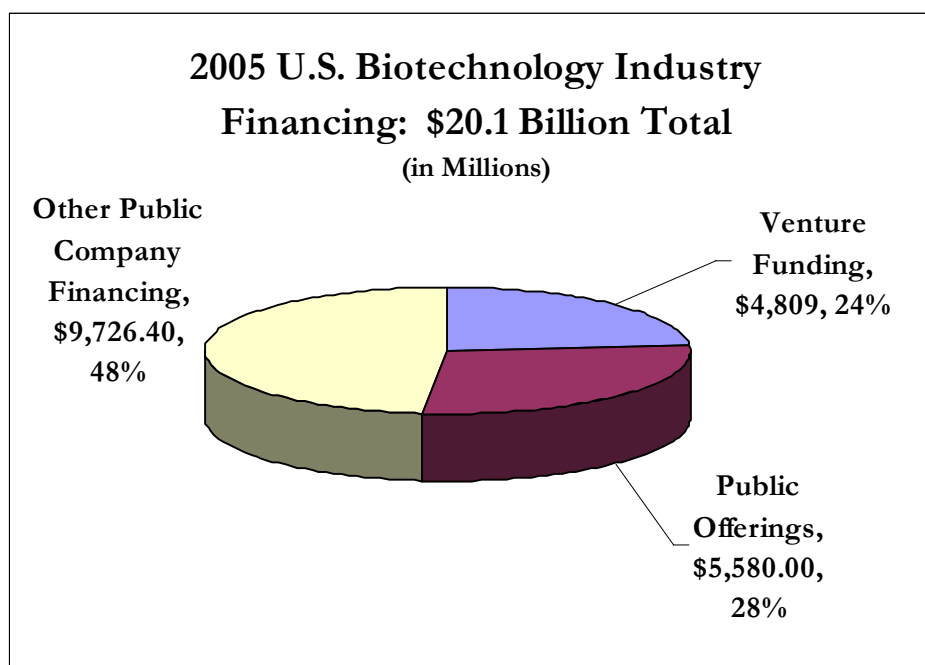
U.S. BIOTECHNOLOGY INDUSTRY STATISTICS: 1995–2005 (U.S. DOLLARS IN BILLIONS)											
Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Sales	9.3	10.8	13	14.5	16.1	19.3	21.4	24.3	28.4	28.1	32.1
Revenues	12.7	14.6	17.4	20.2	22.3	26.7	29.6	29.6	39.2	43.8	50.7
R&D Expense	7.7	7.9	9.0	10.6	10.7	14.2	15.7	20.5	17.9	19.6	19.8
Net Loss	4.1	4.6	4.5	4.1	4.4	5.6	4.6	9.4	5.4	6.5	4.1
Number of Public Companies	260	294	317	316	300	339	342	318	314	331	329
No. of Companies	1,308	1,287	1,274	1,311	1,273	1,379	1,457	1,466	1,473	1,444	1,415
Employees	108,000	118,000	141,000	155,000	162,000	174,000	191,000	194,600	177,000	187,500	NA

Source: BIO's Guide to Biotechnology 2007 report at <http://www.bio.org/speeches/pubs/er/BiotechGuide2007.pdf>

Using the broader definition of biotechnology, U.S. Bureau of Labor Statistics data indicate that in 2005 the U.S. biotechnology industry directly employed over 1,729,000 at 52,694 establishments with an average annual salary of over \$69,562. In 2004, BIO data indicate that there were an additional 5.8 million indirect jobs related to biotechnology.

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 2000 to over \$28.5 billion in 2007. In 2005, U.S. biotechnology industry financing totaled \$20.1 billion according to BIO. The largest source of industry funding, public funding, totaled \$9.7 billion or about 48 percent of U.S. biotechnology financing. Many state governments, including Texas, are providing substantial amounts of funding for the biotechnology industry. The second largest source of funding was public offerings, which totaled \$5.58 billion in 2005. Venture funding was third and last source of industry funding at \$4.8 billion. This funding is vital, since the U.S. biotechnology industry spent \$19.8 billion on research and development alone in 2005.

The following chart provides details on 2005 U.S. biotechnology industry financing. ⁱⁱⁱ



Source: BIO's Guide to Biotechnology 2007 report at <http://www.bio.org/speeches/pubs/er/BiotechGuide2007.pdf>

TEXAS BIOTECHNOLOGY INDUSTRY MARKETPLACE

Texas has a vibrant and growing 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 914 traditional biotechnology, biomedical research, business and government consortia, medical manufacturing companies, and world-class universities and research facilities employing approximately 28,913 at an average annual salary of \$83,772. With the inclusion of the expanded and more broadly defined biotechnology areas, the Texas marketplace includes approximately 3,097 establishments employing approximately 78,986 at an average annual salary of almost \$68,293. 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 Advanced Research Program (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. The TEF fund was renewed in 2005 with an additional \$180 million. 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's announced the \$200 million Texas Emerging Technology Fund (ETF) to promote and finance technological innovations across multiple industries, including biotechnology. The ETF has created eight Regional Centers of Innovation and Commercialization (RCIC), including the Texas Life RCIC, which acts as the gateway for biotechnology ETF projects. To date, \$18.8 million from the ETF have been awarded for biotechnology-related projects, as a chart below indicates. 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 March 2007, the ETF has awarded \$18.8 million for biotechnology-related projects. \$8.4 million were awarded to commercialize eight biotechnology start-up companies and \$10.4 million were awarded to recruit biotechnology-related, high caliber faculty to four Texas universities.
- According to 2006 Ernst & Young data, Texas ranked ninth nationally for the number of traditional biotechnology companies located in-state.
- In 2005, one of 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 2003, 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.

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

Company/ Entity	City	Industry Segment	Project Description	Funding (in Millions)
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
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
PLx Pharma	Houston	Pharmaceuticals	Non-steroidal anti-inflammatory drugs (NSAIDs)	\$2
Texas Tech University	Lubbock	Agriculture	Agricultural Genomics R&D	\$1.9
University of North Texas Health Science Center	Fort Worth	Health Sciences	Center for Commercialization of Fluorescence Technology	\$2.27
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	---	---	---	\$18.8

Source: Texas Office of the Gov., Economic Development & Tourism, Emerging Technology Fund Office

The following chart provides a snapshot of the 2006Q3 Texas biotechnology manufacturing industry, using the traditional and expanded industry codes (NAICS).

2006Q3 TEXAS BIOTECHNOLOGY INDUSTRY INFORMATION					
NAICS	Description	Employees	Establishments	Ave. Weekly Wage	Ave. Annual Pay
541710	Physical, Engineering & Life Sciences R&D	19,391	779	\$1,345	\$69,940
3254	Pharmaceutical & Medicine Manufacturing	9,522	135	\$1,877	\$97,604
TRADITIONAL SUBTOTALS / AVERAGES*	---	28,913	914	\$1,611*	\$83,772*
3391	Medical Equipment & Supplies Manufacturing	12,664	715	\$774	\$40,248
3345	Electrical Instrument Manufacturing	21,588	485	\$1,322	\$68,744
6215	Medical & Diagnostic Labs	15,821	983	\$951	\$49,452
EXPANDED SUBTOTALS / AVERAGES*	---	50,073	2,183	\$1,015.6*	\$52,814.6*
OVERALL TOTALS / AVERAGES*	---	78,986	3,097	\$1313.3*	\$68,293*

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

* Averages

The following chart lists some of the leading Texas-based biotechnology companies. Most are small companies; however, Houston-based US Oncology was ranked number 684 on the 2006 Fortune 1000 list. Half of the companies listed below have international locations or distributors.

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

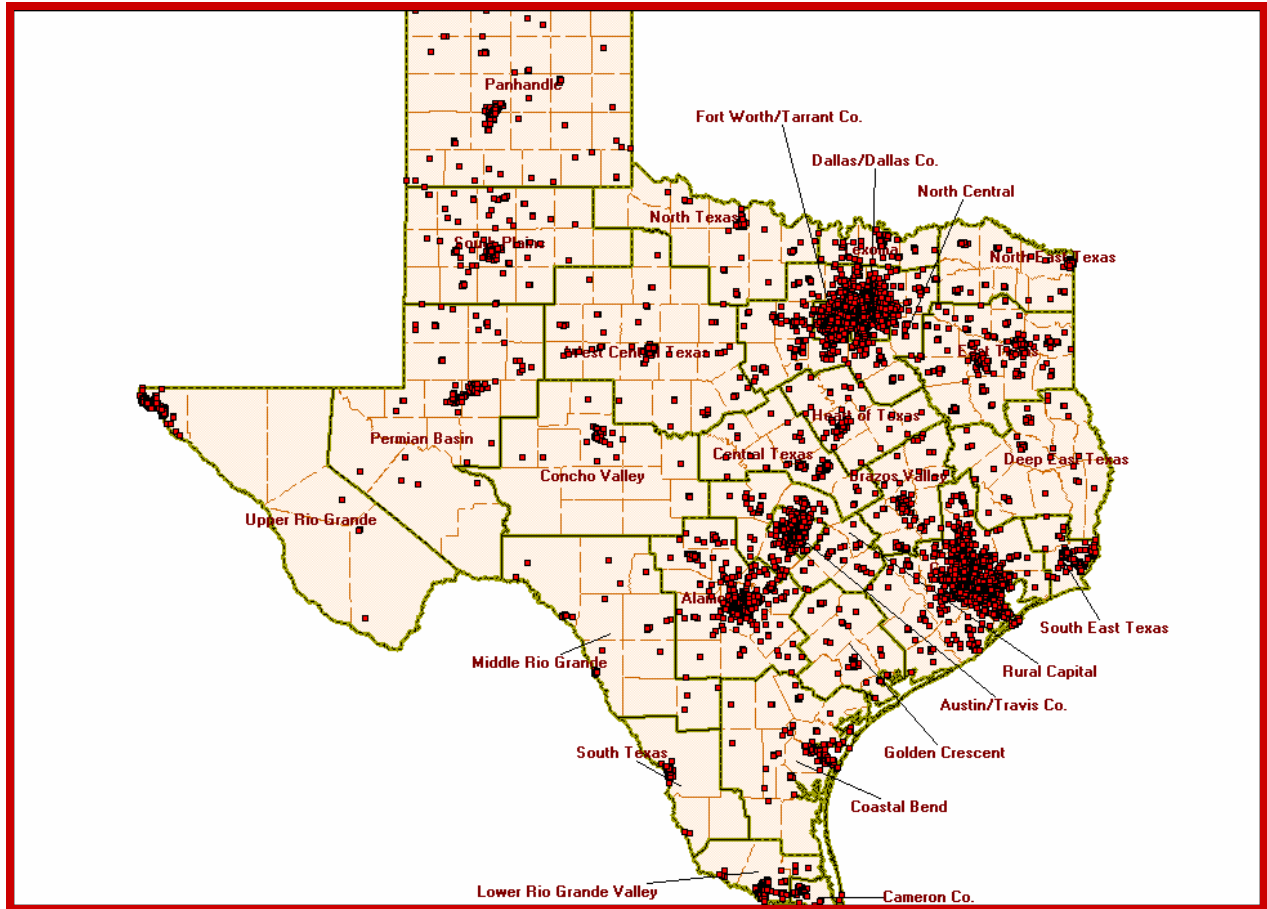
Company	City	Sales	Business Description/NAICS *
Alcon Laboratories *	Fort Worth	\$3,913.6	This private, Nestle S.A. subsidiary manufactures eye care pharmaceuticals and surgical equipment and devices, conducts ophthalmic research (3391)
US Oncology	Houston	\$2,518.6	This private, Fortune 1000 company specializes in cancer treatment and research (6215)
Kinetic Concepts *	San Antonio	\$1,371.6	Manufactures medical equipment and devices (3391)
Mannatech *	Coppell	\$389.4	Manufactures nutritional supplements and personal care products (3254)
Falcon Pharmaceuticals *	Fort Worth	\$385	This private, Alcon Laboratories subsidiary manufactures ophthalmic and otic drugs (3254)
Encore Medical *	Austin	\$293.7	Manufactures medical devices used to treat and replace damaged joints and bones (3391)
HealthTronics	Austin	\$267.7	Manufactures urological medical devices and performs urological laboratory test services (3391)
ArthroCare	Austin	\$263	Manufactures specialized electro-surgical equipment incorporating radio frequencies (3391)
Avail Medical Products	Fort Worth	\$244.5	Manufactures medical and surgical equipment, devices, and supplies (3391)
Essilor Laboratory of America *	Dallas	\$192.5	Manufactures ophthalmic products (3391)
D P T Laboratories Ltd.	San Antonio	\$183.8	Manufactures pharmaceutical preparations by contract (3254)
First Aid Products LP	Houston	\$127.4	This private, NutraMax Products subsidiary manufactures pharmaceutical preparations, surgical appliances/supplies, etc. (3254)
Cyberonics	Houston	\$123.4	Manufactures first FDA-approved electro-medical device for treating epilepsy (3345)
HealthPoint Ltd. *	Fort Worth	\$119	Manufactures pharmaceutical products (3391)
Alcon Surgical *	Fort Worth	\$117.8	This private, Alcon Laboratories subsidiary manufactures ophthalmic surgical 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)
AdvoCare International *	Carrollton	\$80	Manufactures and distributes nutritional and skincare products (3254)
Lexicon Genetics	The Woodlands	\$75.7	Conducts pharmaceutical R&D using mice with specific gene functions disrupted or “knocked out” (5417)
Tanox	Houston	\$44.7	This Genentech subsidiary develops and manufactures pharmaceuticals for areas including infectious and autoimmune diseases, allergies, cancer, and inflammation (3254)

Sources: Hoover's Pro Premium, 2006 Fortune 1000, Company Websites

* International locations or distributors

The following Texas Workforce Commission (TWC) map shows that the state's core biotechnology manufacturing facilities, using the expanded biotechnology NAICS codes, 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 Facilities



Source: TWC Clusters Geographic Information System (GIS) at <http://www.texasindustryprofiles.com/apps/gis/clustersgis/>

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 ranks in the top ten nationally in many R&D and educational statistical breakouts. This is important since biotechnology has the highest R&D costs of any major industry. Seven Texas-based biotechnology scientists and researchers are Nobel Laureates and National Medalists. Texas is also home to several significant independent and nonprofit applied R&D institutions engaged in the biotechnology industry.

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

- The following chart shows the seven Texas-based recipients of biotechnology-related Nobel Prizes, National Medals of Science, and National Medals of Technology. 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.

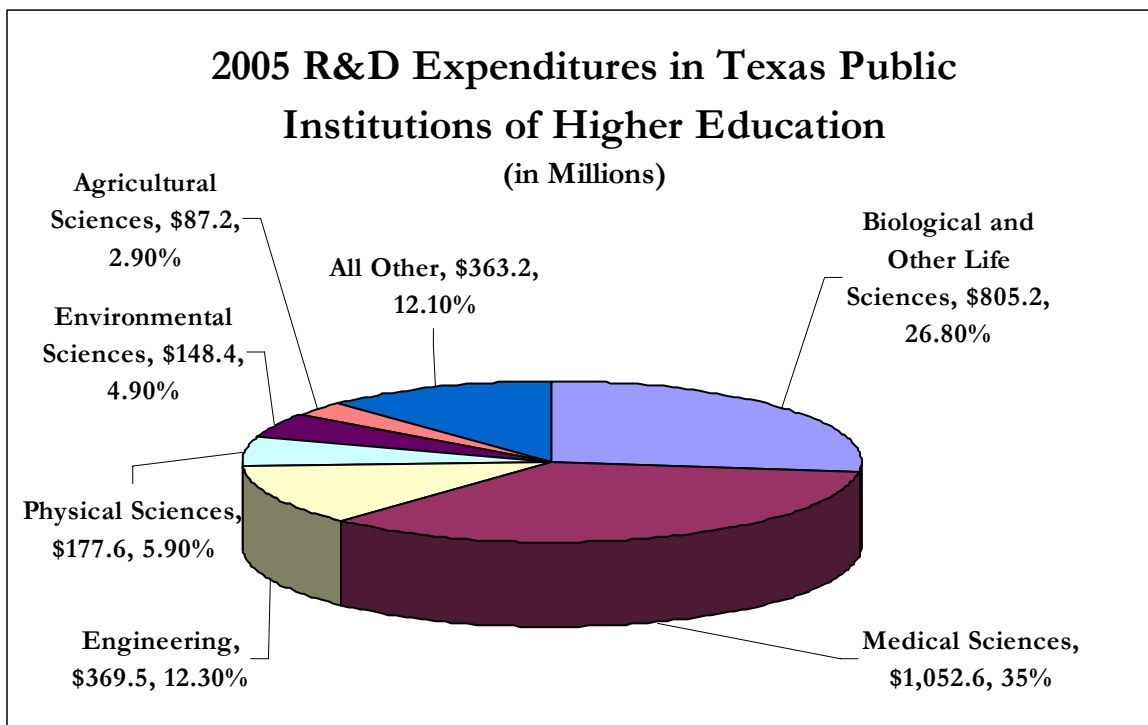
TEXAS-BASED BIOTECHNOLOGY-RELATED NOBEL LAUREATES AND NATIONAL MEDALISTS

Name	Medal/Year	Field	Institution	Description
Michael DeBakey	National Medal of Science/1987	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
Denton A. Cooley	National Medal of Technology/1998	N/A	Texas Heart Institute	Accomplishments in cardiovascular surgery, including the first successful human heart transplant in the U.S. and the world's first artificial heart implantation
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
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

Sources: Texas Nobel Laureates and National Medalists at www.researchintexas.com/Nobels.pdf and Wikipedia

- 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 2006 revenues were \$455 million. During 2006, SwRI provided \$5 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 \$50 million annual budget, employs almost 400, and is located on a 322 acre campus. 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 SBC Genomics Computing Center, which houses the world's largest computer cluster devoted to statistical genetic analysis.
- In 2005, Texas ranked sixth in the nation for NIH awards, which are largely biotechnology funding, with \$1.15 billion in grants to Texas institutions and businesses.
- In 2005, Texas ranked fifth nationally for NIH SBIR (Small Business Innovation Research) awards. NIH granted Texas \$33,599,178 in SBIR awards.
- In 2005, the NIH provided 64 percent of the federal research support for science and engineering at Texas higher education facilities.
- In 2005, over \$97.8 million were spent on specialized biotechnology R&D at Texas public universities. Also in 2005, \$481.5 million were spent on specialized cancer R&D and \$135.7 million were spent on specialized cardiovascular R&D at Texas health-related institutions.
- The following chart shows 2005 R&D expenditure breakouts by disciplines in Texas public institutions of higher education, which totaled over \$3 billion. Medical, biological and agricultural sciences alone accounted for \$1.94 billion or 64.7 percent.



Source: Texas Higher Education Coordinating Board

The following chart shows R&D expenditures at ten top Texas health-related higher education institutions in fiscal year 2005. The ten institutions had combined R&D expenditures of over \$1.6 billion.

**TOP TEXAS HEALTH-RELATED HIGHER EDUCATION INSTITUTIONS BY R&D EXPENDITURES
FISCAL YEAR 2005**

Institutions	Dollars (in Millions)
Baylor College of Medicine	\$442.6
UT M.D. Anderson Cancer	\$341.9
University of Texas (UT) Southwestern Medical Center	\$322.7
UT at Houston Health Science Center	\$156.5
UT Medical Branch at Galveston	\$149.9
UT Health Science Center at San Antonio	\$134.1
Texas A&M Health Science Center	\$70.7
University of North Texas Health Science Center	\$24.8
Texas Tech University Health Science Center	\$18.2
UT Health Center at Tyler	\$11.4
TOTAL	\$1,673

Source: Texas Higher Education Coordinating Board

- Between 2001 and 2005, approximately 1,570 Texas biotechnology-related 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 653 patents or over 41 percent.
- Between 2000 and 2004, the University of Texas (UT) system was the top-ranked university in the nation for biotechnology patents according to the Milken Institute. UT tied the University of California at San Francisco with 219 U.S.-issued biotechnology patents.
- 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. Texas ranked third in the nation in these categories.
- In 2003, the National Science Foundation (NSF) ranked Texas third nationally for all R&D expenditures, third for life sciences R&D expenditures, fourth for total R&D performance, and fifth for industry R&D performance. ^v

TEXAS BIOTECHNOLOGY INDUSTRY AREAS

LIFE SCIENCES

Life science is a broad, catchall term which is broadly defined as the study of living organisms, including all biotechnology areas and other biology-related sciences. Biotechnology is the most dynamic aspect of the life sciences, while biomedicine and pharmaceuticals are the most prominent. 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.

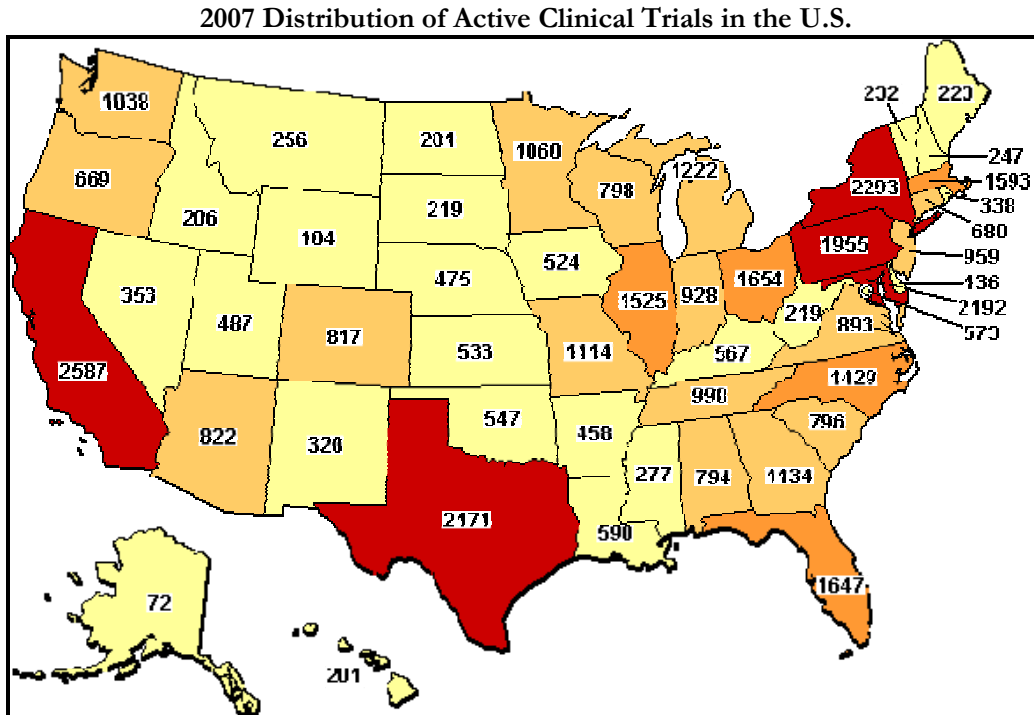
- Between 1996 and 2006, venture capital firms invested roughly \$641 million in Texas life science companies.
- In fiscal year 2006, Texas public health-related institutions awarded 4,515 degrees and Texas independent health-related institutions awarded 647 degrees for a total of 5,162.
- In 2005, Texas public institutions of higher education spent \$805.2 million for biological and other life sciences and \$1,052.6 million for medical sciences for a total of over \$1.8 billion.
- In 2003, 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. 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 135 pharmaceutical manufacturing companies employing 9,522, and 1,762 medical research, development, and testing laboratories employing 35,212.
- The Texas Medical Center in Houston is one of the world's largest, best-known, and finest medical complexes. There are 45 member institutions housed there, 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, and the Houston Community College System.
- In 2005, Texas public institutions of higher education spent \$1.05 billion for medical sciences R&D.
- In 2003, Texas awarded 305 professional pharmacy degrees and 119 professional veterinary degrees.
- In 2003, Texas pharmaceutical and medicine manufacturing's (NAICS 3254) total value of shipments was \$2.79 billion, total capital expenditures were \$40.6 million, and value added was \$2.33 billion, with more than 5,197 employed.

The following chart shows that in early 2007, Texas ranked third nationally with 2,172 active clinical trials. ^{vii}



Source: NIH's ClinicalTrials.gov at <http://www.clinicaltrials.gov/ct>, accessed March 2007

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 715 medical equipment companies employing 12,664 skilled workers.
- In 2006, venture capital firms invested \$82 million in Texas medical devices and equipment companies.
- From 2000 to 2006, venture capital firms have invested roughly \$230 million in Texas medical devices companies - over \$32.8 million per year on average.

- In 2003, Texas medical equipment's (NAICS 3391) total value of shipments was \$2.66 billion, total capital investments were \$130.1 million, and value added was \$1.74 billion, with more than 15,208 employed. ^{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 due to its 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 2005, the receipt value of the state's top five agricultural commodities alone exceeded \$16.3 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 2006, Texas ranked second nationally for agricultural products exports.
- In 2006, agricultural products were Texas' 11th largest export item at \$3.1 billion.
- In 2006, 77 percent of the state's corn crop and 70 percent of the state's cotton crop were genetically modified to resist insects, tolerate herbicides, or both. Texas accounted for a third of the nation's 2006 cotton crop.
- 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 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 2005, 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 2005		
Agricultural Products	State Rank	Value (in Millions)
Cotton and Linters	1	\$1,337.50
Feeds and Fodders	2	\$300.8
Hides and Skins	3	\$282.1
Live Animals and Meat	7	\$281
Wheat and Products	6	\$280.3
Overall State Rank/Value *	3	\$3,526.30 *

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 in 2005.

TEXAS TOP 5 AGRICULTURAL COMMODITIES IN 2005			
Agricultural Products	Value of Receipts (in Thousands)	Percent of State Total Farm Receipts	Percent of U.S. Value
Cattle and Calves	\$7,580,168	46.3	15.4
Cotton	\$1,839,437	11.2	31.7
Broilers	\$1,436,644	8.8	6.9
Greenhouse/Nursery	\$1,323,040	8.1	8.2
Dairy Products	\$981,801	6	3.7
All Commodities	\$16,355,268	---	6.8

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

- In 2005, Texas public institutions of higher education spent \$87.2 million for agricultural sciences R&D.
- In 2004, Texas was ranked first in the nation for acres of genetically modified cotton, with over 3.4 million acres in cultivation.
- In 2003, Texas awarded 50 doctoral degrees and 199 master’s degrees in agriculture. ^{ix}

ENVIRONMENT

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.

- In 2006, the Texas Department of Agriculture created the Texas Biofuel Incentive Program to encourage the production of biofuel in Texas. The program allows Texas biofuel producers to register to become eligible to receive grants based on the amount of biofuel produced by their facilities. Qualified producers will receive 20 cents per gallon of ethanol or biodiesel produced, limited to the first 18 million gallons produced per year for the first 10 years.
- 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 2005, Texas public institutions of higher education spent \$148.4 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 and authoritative list.

- 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.
 - 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 50 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. He also serves as the president of the Alliance for NanoHealth, a collaborative venture of seven Houston-area research institutions dedicated to nano-medicine. Ferrari is founder and editor of the journal *Biomedical Microdevices*, the oldest journal dedicated to this relatively new area of medicine.



Dr. Mauro Ferrari

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

- 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 will enhance 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. An award from the ETF 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. Wilkins 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. She 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 at an estimated \$13 billion 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 and the Texas A&M University System, which formed the non-profit TIGM. Lexicon will use \$35 million of grant money to create two copies of its mouse cell line library and provide them to TIGM. The Texas A&M System will use the remaining \$15 million to build new facilities in College Station, remodel facilities, and manage the daily operations at TIGM.

- In June 2005, Gov. Perry signed a bill creating the \$200 million Texas Emerging Technology Fund (ETF). The ETF will improve Texas university research, increase collaboration between public and private sector entities, help start-up technology firms, assist in speeding technology commercialization, and attract more top-notch companies and researchers. The ETF targets industries including biotechnology.
- In May 2004, Gov. Perry announced a \$25 million grant from the Texas Enterprise Fund (TEF) 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 is committing \$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 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 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 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 will bring a full, four-year medical school to Temple and Scott & White Memorial Hospital. Classes are scheduled to begin in 2007.
- In October 2003, The University of Texas Medical Branch 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}



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 in Texas at <http://agnews.tamu.edu/biotech>

This biotechnology resource produced by Texas A&M University features news stories, Texas A&M biotechnology project information, a biotechnology glossary, and links with an academic focus.

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 is posted at <http://www.bio.org/speeches/pubs/er/BiotechGuide2007.pdf> and a report titled *Growing the Nation's Biotech Sector: State Biosciences Initiatives 2006* is posted at <http://www.bio.org/local/battelle2006/>.

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 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 federal agency funds much of the nation's basic research and publishes many reports and statistics.

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.

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.

ENDNOTES

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