Biotech in Texas

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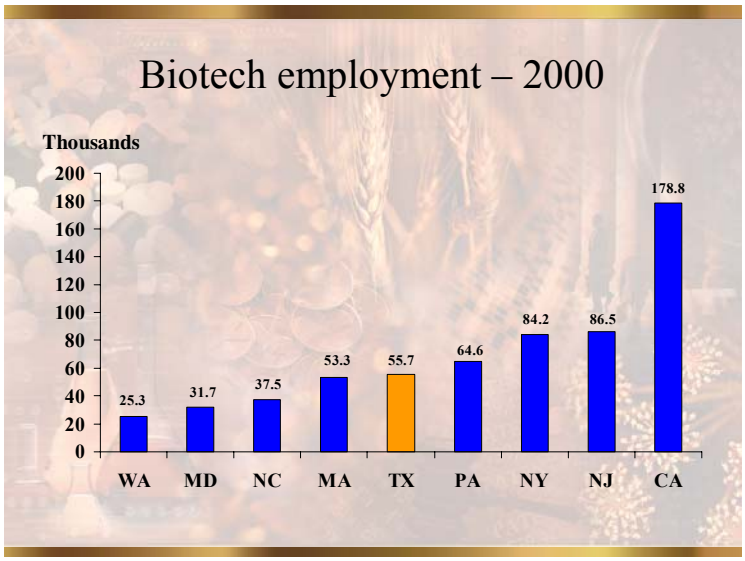
In April 2002 the Dallas Fed had a very successful conference, *Science and Cents, Exploring the Economics of Biotechnology*, that John Duca and I jointly organized. Last month John discussed much of what we've learned about the general economic aspects of biotechnology. Today I am going to speak about the regional issues surrounding the biotech industry in Texas.

Strong research and commercialization are the two necessary elements for a region to become a major biotech center. Some of the key ingredients for becoming a renowned center of biotech research are having top-ranked schools, star scientists and research funding. The strong academic institutions and laboratories draw star scientists to the region, who in turn provide the groundbreaking research.

However, research by itself is not enough for a region to excel as a biotech center. The second important element is the ability to commercialize the knowledge and innovations developed by research institutions. Access to capital is important for commercialization and depends on the interplay between public, private, and venture capital firms.

Where does Texas stand in the biotech arena today compared to the rest of the country? In a recently released study, the Brookings Institution classified regions as major biotech centers if they had both strong track records in research and commercialization. No metro areas in Texas were on this list. This ranking was partly based on Ernst & Young's widely used definition of biotech which includes pharmaceuticals and in life science R&D firms.

Figure 1



Nevertheless, using a broader definition which also includes medical devices and testing laboratories, Texas ranks sixth in the nation in terms of biotech employment as shown in **Figure 1**. Texas has about 56,000 jobs in this industry compared to almost 180,000 in California. There aren't many jobs in these industries in Texas primarily because there is not much of a pharmaceutical presence in the state.

Recognizing the potential of the biotech industry to be the next engine of growth for the region, Texas is pursuing economic initiatives to foster growth in its biotech sector, as are 40 other states.

What determines the location of the biotech industry?

Our conference title hit the nail right on the head when it comes to the local determinants of the biotech industry. For biotech to flourish in the state, we need great science and a lot of cents. As discussed by both Professors Zucker and Stone at the conference, the biotechnology industry is largely dependent upon academia as a source of new technology. Economic research shows that intellectual capital flourishes around the great universities, which draw both good scientists and students. However, the most important factor seems to be the outstanding scientists in the area. The existence of star scientists plays a role over and above the presence of university and government research funding. In science and engineering most breakthroughs are made in the top-rated doctoral programs which generally house the best scientists.

Star scientists are also integral to the successful commercialization of scientific discoveries. Star scientists who collaborate with outside firms provide the intellectual human capital that defines a firm's core technology and largely determines a company's success. The location of top scientists also predicts where new technology firms will locate.

Research by Professors Darby and Zucker (two of our speakers) also shows that local venture capital is very important to the industry's growth. Venture capital increases R&D productivity and fuels company expansion.

Research

Top-ranked schools

The quality of the educational institutions and scientists in a state are critical for a regional biotech presence. **Figure 2** shows the top research medical schools in the U.S., as ranked by *U.S. News and World Report* in 2001. Texas has two universities in the top 20 list, Baylor College of Medicine and UT Southwestern. Baylor is ranked thirteenth and UT Southwestern seventeenth in the nation.

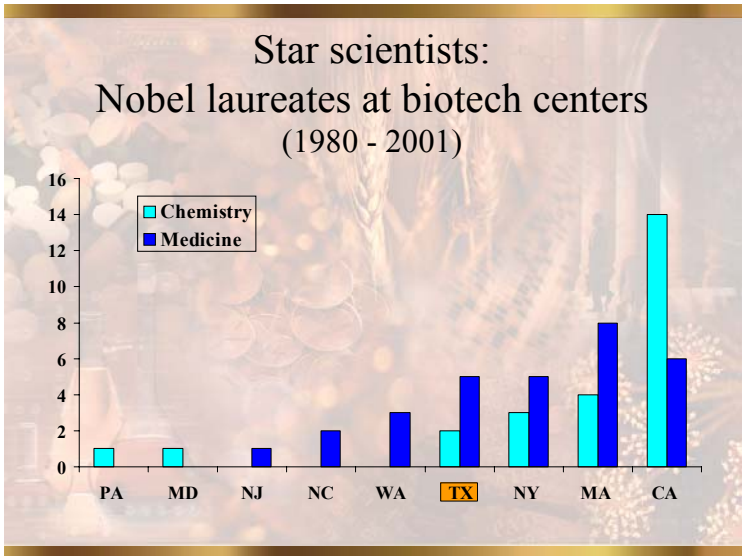
Figure 2

Star scientists

The growth and location of intellectual human capital is very important for the development of the regional biotech industry. According to Professors Darby and Zucker, star scientists are important because, unlike other sciences, innovations in biotech can give rise to excludable knowledge; i.e., knowledge that does not disseminate quickly. This may be because of the complexity or tacit nature (i.e., learning by doing) of the information necessary to apply the innovation.

Moreover, even when the knowledge of new techniques becomes disseminated, "...the knowledge is far more productive when embodied in the scientist with the genius and the vision to innovate, to define the research frontier and apply the research techniques in the most promising areas."[1] Firms working with star scientists are more likely to be successful. According to Zucker et al. (1998) five articles coauthored by academic stars and the firm's scientists imply 5 more products in development, 3.5 more products on the market, and 860 more employees.

Figure 3



How does Texas rank with respect to star scientists? One measure of star scientists is the number of Nobel laureates at the state's research institutions. **Figure 3** shows the number of Nobel laureates in medicine and chemistry since 1980 (chemistry is included because many of the chemistry Nobelists were working in biotech-related fields). As can be seen, Texas has a good number of star scientists: UT Southwestern has four Nobel laureates (Alfred Gilman, Johann Deisenhofer, Michael Brown and Joseph Goldstein), Rice University has two (Richard Smalley, Robert Curl), and the UT Medical School in Houston has one (Ferid Murad).

Funding

Another measure of biotech research capacity and activity is research funding. The majority of public funds for biomedical research flows through the National Institutes of Health (NIH), whose budget in 2001 was $18.8 billion. The better universities and medical schools get the lion's share of funding.

Figure 4

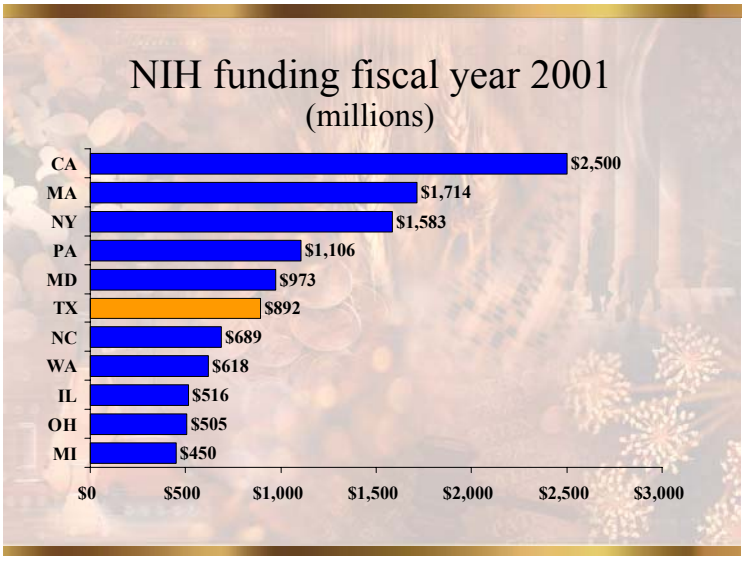
NIH research grant recipients, 2001
(millions)

1	Johns Hopkins	$458
2	U Penn	$376
3	U Washington	$356
15	Baylor College of Med.	$222
26	UT Southwestern	$145
39	M.D. Anderson	$102
50	UT Houston	$ 84

Figure 4 lists research funding in biology granted by the NIH in 2001. Johns Hopkins University ranks first in the nation with half a billion dollars in funding, followed by the University of Pennsylvania and the University of Washington. The Baylor College of Medicine in Houston leads Texas with nearly 500 grants and $221 million dollars in research dollars. Baylor is ranked fifteenth in the nation, UT Southwestern twenty-sixth, M.D. Anderson thirty-ninth, and UT Houston fiftieth.

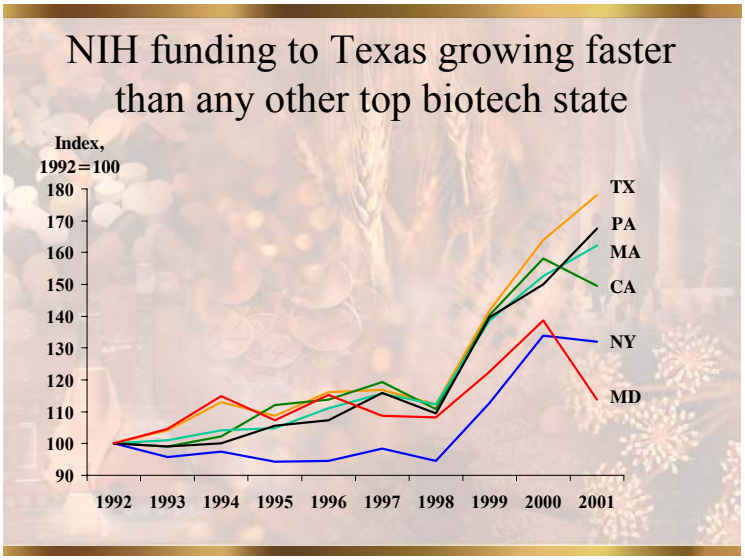
Aggregating by state (see **Figure 5**), Texas is sixth in the nation with nearly $900 million in grants, while California receives nearly three times as much with $2.5 billion in funding. Ranked by cities, Houston is eighth after Boston, New York, San Diego, Philadelphia, Baltimore, Seattle, and Los Angeles.

Figure 5



An encouraging sign is that NIH funding to Texas has grown relatively faster in the 1990s than in any other state. NIH funding to Texas nearly doubled since 1992, and, as can be seen in **Figure 6**, it has really taken off since 1998.

Figure 6



Patents and licenses

A fourth gauge of biotech capacity and research activity is the number of patents granted. Growth in the life science industry is tied to the rate of intellectual property generation and commercialization. The Texas Health and Bioscience Institute (THBI) reports that life science patents issued to Texas residents increased 54 percent from 1997 to 1999, reaching a record 577 in 1999. **Figure 7** shows that the University of Texas system is fifth in the nation in terms of patents issued and Baylor College of Medicine ranks twenty-fifth.

Figure 7

Biotech patents
granted to universities

	Rank	#Patents
U. Cal. System	1	460
MIT	2	121
Stanford	3	111
CalTech	4	107
U. Texas System	5	101
Baylor Col. of Med.	25	31

Texas researchers are beginning to bring biotechnology-related ideas to market. According to THBI, income from Texas intellectual property increased from $4.2 million to $25.6 million between 1993 and 1999. Although still small in magnitude, the latest figure represents more than a 500-percent increase. **Figure 8** shows license income from biotech products generated at universities in 2000. The universities which are top-ranked have had licensing blockbusters or 'big hits'. For example, almost all of the $57 million that Florida State University receives comes from a patent on a method to produce a tumor-fighting chemical which Bristol-Myers Squibb now markets as Taxol–a breast cancer drug.

Figure 8

Tech transfer riches
(millions)

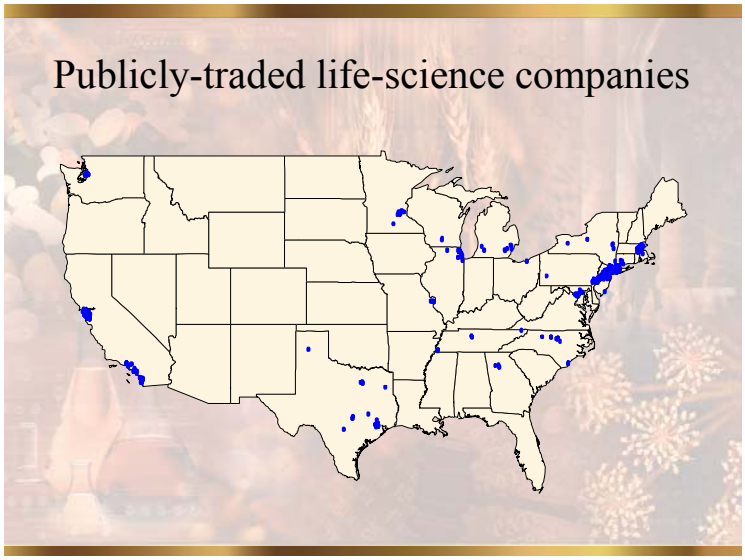
	Rank	License Income
Columbia	1	$89
U. Cal. System	2	$74
Florida State	3	$57
Baylor Col. of Med.	13	$12
TX A&M	24	$ 5
UTSW	25	$ 5

Commercialization

Public companies

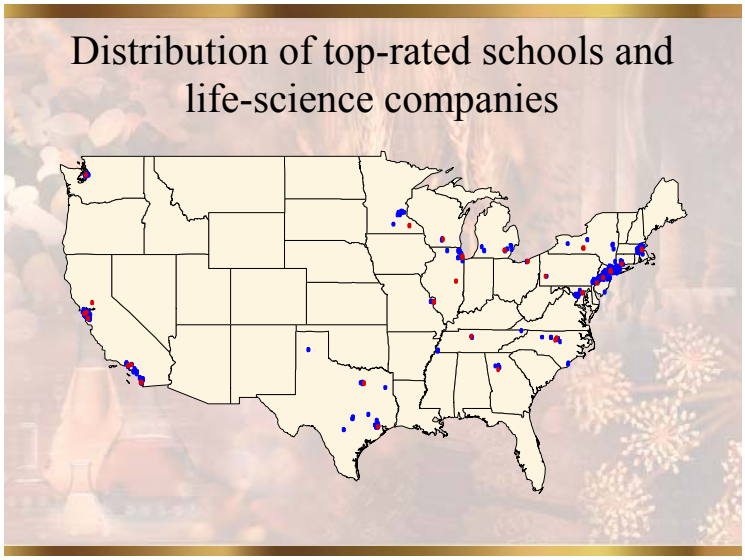
Texas' research base in the biological sciences is very respectable and is growing rapidly. However, the story is not quite the same on the commercialization side. As shown in **Figure 9**, publicly-traded pharmaceutical and biotech firms are concentrated in New York, Boston and San Francisco. Seven of the ten largest pharmaceutical companies in the nation are in New York. Large biotech companies (with more than 100 employees) are concentrated in San Francisco (16 percent), New York (13 percent), and Boston (12 percent).

Figure 9



As shown in **Figure 10** the distribution of top-rated medical and biological sciences schools is similar. Large concentrations of biotech firms are where the top-rated schools are located.

Figure 10

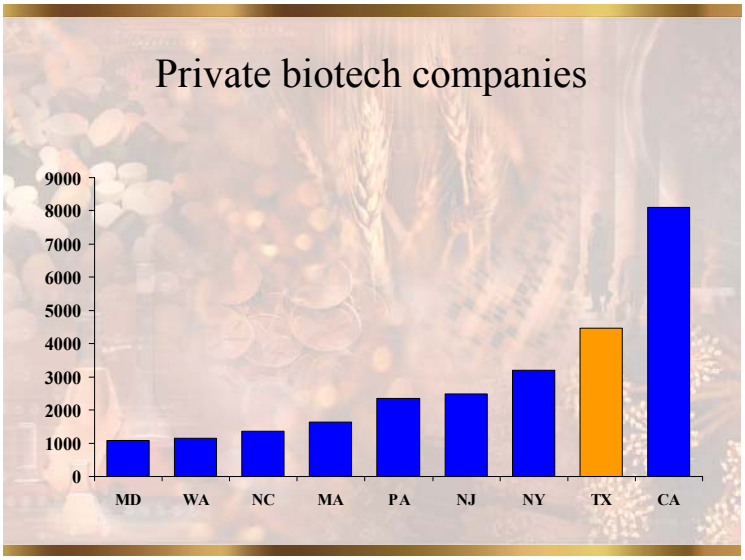


There is a symbiotic relationship between universities, start-up firms, and large pharmaceutical companies. The industrial structure of the biotech industry is such that small start-up companies exist side by side with large established pharmaceutical firms, often in proximity to universities. The academic research done in universities spawns small start-up companies, but these R&D firms, though innovation-rich, are poor in capital and resources necessary to commercialize their products. For this reason, start-ups need the distribution and production processes of larger firms to take their products to market. Conversely, established firms find it difficult to keep abreast of all the technological advances in the industry. By purchasing some of a start-up's equity, they gain access to R&D and have shareholder influence to better monitor the R&D firm, thereby reducing some of the uncertainty of the investment.

Private firms

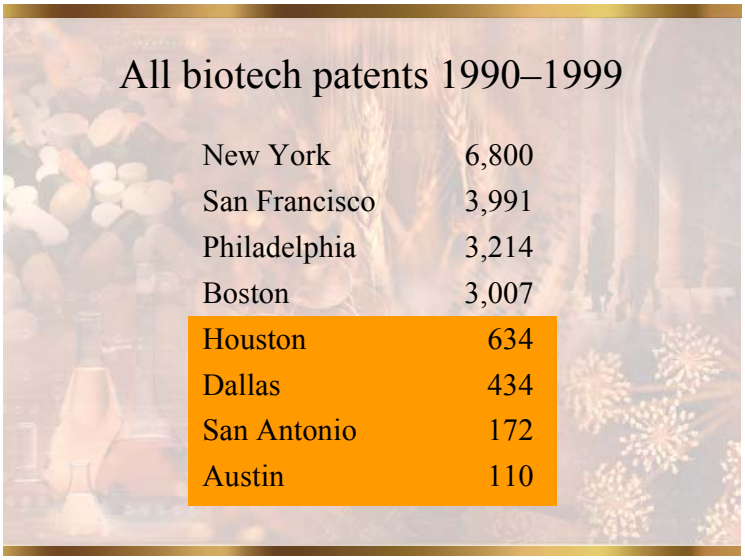
Figure 11 illustrates the number of private biotech firms across states. These firms can be as small as a one-person firm. California has a total of 8,100 firms and Texas has about 4,500 firms. The numbers are very recent and show that even though Texas does not have large pharmaceutical or biotech firms, it has many small firms, indicative of the rapid growth of biotech activity in Texas.

Figure 11



Texas universities fare well with respect to patents. However, most patents are owned by firms and the distribution of patents is very similar to the distribution of pharmaceutical and biotech firms across the country. As can be seen in **Figure 12**, scientists in New York received 6,800 patents between 1990 and 1999, ranking first in the nation, while. San Francisco was second with 3,900 patents. In Texas, the number of patents received between 1990-1999 was 1,350, with 634 in Houston and 434 in Dallas.

Figure 12



Venture capital

Figure 13

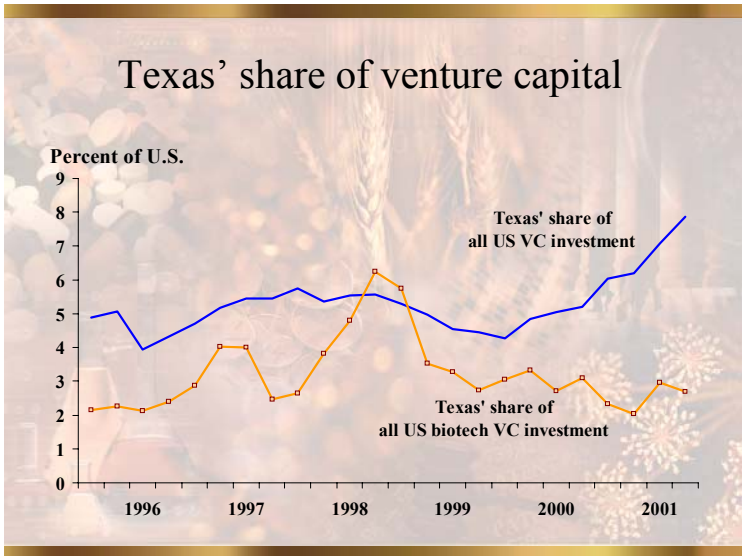


Figure 13 illustrates Texas' share of venture capital (VC) funding. The blue line depicts Texas' share in total venture capital investment and the orange line Texas' share in biotech venture capital investment. Although Texas' share of total VC investment has been going up, the state has not been keeping up in the biotech arena.

Between 1995 and 2001, Boston had 10 highly active venture capital firms and San Francisco had 21. In contrast, no city in Texas had an active venture capital firm specializing in biotech. Economic research in this area strongly suggests that venture capital investment, especially local VC investment, is important for the development of a region's biotech industry. So, Texas still has a long way to go.

Figure 14

Although the amount of venture capital available to industry declined drastically in 2001 and 2002, **Figure 14** shows that the biotech industry was the third largest recipient of venture capital funds in the first quarter of 2002. Of the $752 million invested in this industry, however, Texas received only $14 million in funds, with the money going to three Houston firms: ADVISYS, Inc. ($10 million), Medical Metrics, Inc. ($2.3 million), and MithraGen, Inc. ($1.3 million).

Texas biotech initiatives

Statewide interest in biotech is very high and cooperation among public and private stakeholders is growing, as is state funding. The state government has committed vast resources to the Texas biotechnology cause.

Governor Perry established a Council on Science and Biotechnology Development after he took office to assess the strengths and weaknesses of the state and to propose a road map for fostering biotech in the state. The Council is made up of presidents and CEOs of the major medical schools, hospitals and biotech firms in the state, plus one or two Nobel laureates. The Council will soon publicize its findings.

Also, in 2001, Governor Perry asked for, and the legislature approved, $800 million for science and engineering research, and commercialization activities. This includes funding for the following:

- $385 million for construction, laboratory expansion and equipment acquisition for science and engineering in the State's universities

- $25 million for a Product Development Fund, giving preference to biotech

- $20 million for a Small Business Incubator fund, giving preference to biotech

- $20 million to establish the Southeast Texas Biotech Park in Houston

- Creation of a new San Antonio Life Sciences Institute in the UT System

- Creation of the Texas Tech Diabetes Research Center at the El Paso campus

Various research parks that include facilities for life science companies also stand to benefit from the legislature's commitment to industry. These include BioHouston, the Woodlands Research Forest, the Texas Research Park in San Antonio, and the Harrington Regional Medical Center in Amarillo.

In addition to state programs, there are also many regional and local initiatives in all major cities in Texas. Many are business accelerators that assist emerging companies and entrepreneurs with business plans, management expertise, and acquiring venture capital. Most are working closely with universities and their start-ups. These include:

- **Austin Technology Incubator** was launched in 1989, and is a division of the IC^2 Institute. It has spawned about 60 companies in the high-tech arena and five of these companies have gone public.

- **STARTech Early Ventures** is a high-tech business accelerator in Dallas with a recently established medical division. STARTech has spawned three firms. Eliance, one of the firms, was just bought by Macrogenics in June 2002.

- **Houston Technology Center** is a business accelerator for Houston-based emerging technology industries. The Center has spawned five biotech-related companies.

- **Southwest Bio-Link Center** links seven regional centers across the country to promote biotech education, particularly technician education. The national center is in San Diego and the Southwest region center is located at Austin Community College.

- **Center for Nanoscience and Technology** is working on an interface between nanosciences and bioengineering at Rice University. It is one of six major Nanoscale Science and Engineering Centers funded by the National Science Foundation, and the first to focus on applications of nanoscience to biology and the environment. Their $10.5 million grant will enable educational and industrial outreach activities in addition to research. Other grant recipients include Columbia, Cornell, Harvard, Northwestern and Rensselaer Polytechnic.

- **San Antonio Initiative** is designed to bring public and private sectors together to foster the development of biotech and life science companies.

- **The Panhandle Initiative** is based at The Harrington Regional Medical Center in Amarillo. The Center works with many agencies and facilities across Texas such as Texas Tech, Texas A&M, West Texas A&M and the U.S. Veterans Hospital to carry out research in agritech, biotech, environmental biology and pharmacology.

Conclusion

Does Texas have what it takes to develop a major biotech presence?

On the plus side, Texas has a good research base, with competitive institutions that are benefitting from rapid research funding. The state has several top-ranked institutions, and a good number of star scientists and the state's universities rank highly in terms of patents and research funding.

On the other hand, Texas lags in the commercialization of innovative ideas coming out of the universities and research centers. Texas lacks the venture capital and the large, established pharmaceutical firms which will extend research contracts and equity funding to fledgling biotech companies.

If Texas is to become a major biotech center, it needs to leverage its scientific base and transform itself from a center of innovation to also become a center of commercialization. While there is no guarantee that stimulating the necessary local venture capital and entrepreneurship will assure Texas a prominent place on the biotech map, without commercialization, Texas cannot become a major player.

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[1]Zucker, Lynne, Michael Darby and Jeff Armstrong (1998). "Geographically Localized Knowledge: Spillovers or Markets?", *Economic Inquiry*, Vol XXXVI, pp. 65-86.