

**STUDENTS FOR ARIZONA
BIOINDUSTRY DEVELOPMENT**

**BIOINDUSTRY IN ARIZONA
RECOMMENDATIONS FOR ECONOMIC
DEVELOPMENT**

Submitted by

**Students for Arizona Bioindustry Development
Arizona State University**

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I. Executive Summary

A. Statement of Intent

The Students for Arizona Bioindustry Development submit this document to Arizona lawmakers, bioindustry, and educational institutions with the objective of outlining a pragmatic, highly strategic working plan that will enable Arizona to participate competitively in the field of biotechnology in the near future. The Students for Arizona Bioindustry Development also hope this document will initiate dialog between Arizona's most capable bioindustry leadership, educators and lawmakers that focuses on targeting Arizona's resources towards bioindustry development and provide a platform for these groups to work together in a pragmatic, time-sensitive manner.

B. Background

The Students for Arizona Bioindustry Development consist of students attending Arizona State University's College of Law, MBA Program, and Microbiology and Molecular Biology Graduate Program. The Students organized an Advisory Board to assist in the production of this document. The Advisory Board is comprised of Arizona's strongest talent in science, law and business. The Students, concerned with the stagnation of bioindustry development in Arizona, became involved in identifying reasons behind the lack of bioindustry in Arizona and researched the best course of action to rectify the situation. This document represents the culmination of those efforts.

C. Methodology

The initial stage of research involved identifying what, if any, infrastructure and resources exist in Arizona to support bioindustry development in Arizona. Second, case studies were conducted to explore how other geographical areas became successful centers of bioindustry, including determining how they fostered start-up growth and continued to build the industry. Finally, these results were compared with Arizona's current infrastructure and resources in order to evaluate Arizona's bioindustry potential and craft a course of action most likely to enable Arizona to actualize its potential in bioindustry in a time-sensitive manner.

C. Conclusions

The biotechnology and biomedical industries (collectively, “bioindustry”) are empirically one of the fastest growing economic and manufacturing sectors of the United States economy. Bioindustry is growing into facets of industry never before imagined and promises to revolutionize each industry it impacts. While several geographical areas have already successfully capitalized on this growth, room still exists in this market for future growth. Arizona has the resources necessary to become competitive in bioindustry, but thus far has not succeeded in meaningfully developing the sector. Moreover, relative to states similarly situated, Arizona has not attained the same success in bioindustry.

D. Proposals

- Establish an effective BIO affiliate in Arizona that provides a legislative and public policy forum for the Arizona bioindustry and has a complimentary, mutually beneficial relationship with the Arizona Bioindustry Cluster
- Make a financial commitment to bioindustry economic development
- Reap a more meaningful economic return from public investment in state universities
- Transition Arizona’s existing high technology base into bioindustry
- Develop a California-Arizona bioindustry corridor
- Position Arizona to expand its bioindustry internationally

II. The Life Science Economy

Bioindustry represents one of the fastest growing economic and fiscal sectors of the United States, more than doubling between 1993 and 1999.¹ The chart below demonstrates the significant financial contributions that bioindustry has made to the economy in 1999 alone.²

U.S. Jobs	437,400
Revenues ³	\$47 billion
R&D Spending	\$11 billion
Tax Revenue	\$10 billion

For the purpose of this report, “bioindustry” describes any industry utilizing life science research and technology, also referred to as the “life science industry.” Bioindustry is often divided into two health care sectors, biotechnology and medical devices. While these sectors are often treated separately, they are rapidly converging into a unified industry.⁴ In order to develop a strong bioindustry economy, both components are important. However, bioindustry seeks to pervade nearly every facet of the economy. Currently, the bioindustry encompasses other industries including chemicals, pharmaceuticals, agriculture, food processing, mutual funds, and law firms. Other industries such as environmental mining, energy, cosmetics, supermarkets, pharmacies, military, and computer hardware and software are becoming involved. Additionally, industries such as robotics, household appliances, internet communications, information services, and media are on the verge of becoming involved in the life science industry. “[A]dvances in genetic engineering will not only have dramatic implications for people and society, they will reshape vast sectors of the world economy. The boundaries between many once-distinct businesses, from agribusiness and chemicals to health care and pharmaceuticals to energy and computing, will blur, and out of their convergence will emerge what promises to be the largest industry in the world: the life science industry.”⁵

The success of bioindustry is underscored by both the 10,000 patents issued in 1998 (a ten-fold increase from 1985) and the numbers of drugs and medical devices approved by the FDA. Over half the drugs approved in 1998 were biotechnology-based, and since 1996, the FDA has approved over 100 biotechnology-based drugs. Over 700 currently fill the clinical pipeline, including drugs for fighting cancer, Alzheimer’s and Parkinson’s disease, heart disease, diabetes, multiple sclerosis, and AIDS. Agricultural bioindustry also promises to revolutionize food production by increasing production and decreasing both economic and environmental costs.

¹ Based on annual industry revenues of \$8 billion in 1993 increasing to \$20 billion in 1999.

² Table adapted from ERNST & YOUNG ECONOMICS CONSULTING AND QUANTITATIVE ANALYSIS, THE ECONOMIC CONTRIBUTIONS OF THE BIOTECHNOLOGY INDUSTRY TO THE U.S. ECONOMY (May 2000).

³ This includes both the industry itself and companies supplying inputs or selling goods and services to bioindustry employees.

⁴ Areas such as vascular implants, artificial organs, tissue engineering, and medical instrumentation represent current examples of merging technologies.

⁵ Juan Enriquez and Ray A. Goldberg, *Transforming Life, Transforming Business: The Life Science Revolution*, HARVARD BUS. REV. 96, (Mar.-Apr. 2000).

With the advent of scientific accomplishments, such the completion of the human genome, bioindustry has been thrust into the forefront of global industry. The knowledge gained promises to provide greater opportunity for bioindustry growth. In addition, the need to efficiently deal with the exponential amounts of data gathered is integrating the bioindustry with the high-tech industry in the field of bioinformatics, high-throughput screening, and BioChips.

Bioindustry development has directly benefited the economies of other states including those profiled in our case study compilation attached as Appendix A. About one-third of all taxes generated by bioindustry in 1999 went to state and local governments, constituting over three billion dollars. Several states have successfully developed a strong bioindustry to take advantage of these economic benefits. California and Massachusetts represent the industry leaders. The main reason these and other states have been successful is because of definite industry leadership in the form of strong industry organization, i.e. a BIO affiliate.

III. Arizona's Place in the Life Science Economy

Currently bioindustry in Arizona is in its infant stage. Even using our broad definition of bioindustry, Arizona is only home to about 138 firms. Of these, 83 are medical device companies, 24 are biotechnology companies, and the remainder are pharmaceutical companies, laboratories, and other product and support services. However, bioindustry growth in Arizona has been stagnate. Twenty percent of Arizona's biotechnology firms were started before 1980, forty percent in the 1980's and only forty percent in the 1990's. Furthermore, the biotechnology companies employ, on average, fewer than ten people. While Arizona's strongest bioindustry sector is currently medical devices, based on the number of companies located in Arizona, Arizona's medical device companies represent only one percent of all medical device companies in the United States. These statistics demonstrate Arizona's inability to grow its bioindustry.

The lack of bioindustry development has occurred because Arizona lacks the ability to draw outside investment interests. Specifically, the lack of venture capital firms interested in investing in Arizona has slowed small business proliferation. In 1997, venture capital firms invested over \$13 billion dollars in the United States. Arizona captured less than one percent of that, partially due to the lack of an established bioindustry. Venture capital firms will only invest in an area after an industry has been established and some success has been demonstrated. This makes opportunities elsewhere more attractive because of organized industry and management team availability, thereby creating a synergy.

Arizona's educational and research institutions provide numerous programs and opportunities in diverse facets of biotechnology and bioengineering.⁶ Bioindustry in Arizona includes five private research institutions.⁷ Arizona also houses three state

⁶ See Appendix B outlining the numerous bioindustry-related programs provided by Arizona state universities, research institutions, private colleges and universities, and community colleges.

⁷ Barrow Neurological Institute, Sun Health Research Institute, the Mayo Clinic -Arizona, Harrington Arthritis Institute, and Good Samaritan Regional Medical Center.

universities that conduct extensive research important to bioindustry.⁸ Both ASU and UA are Level I research institutions with strong graduate and undergraduate programs in the life sciences and related fields. The Arizona Biomedical Institute (ABI) at ASU is one outstanding example of how universities and private research can fuel bioindustry in Arizona.⁹ ABI provides a collaborative research effort bringing together ASU researchers with both allied faculty from member clinical institutions in the Phoenix area, as well as existing and new bioindustry in Arizona.

Arizona has allocated substantial funding for research and development, has a good availability of scientists, and a strong industrial and manufacturing base. Additionally, Arizona has a positive record of accomplishment for retaining big business. Industry giants such as Motorola, Intel, Gore, Raytheon and Hughes Missile Systems demonstrate the economic stability Arizona offers. Motorola, Intel and Gore are currently transitioning some resources into bioindustry in the areas of bioinformatics, BioChip technology, high-throughput screening, and population genetic profiling. Arizona also provides a favorable climate for small businesses and start-ups. The Arizona Department of Commerce has implemented programs that reflect the state's attitude toward encouraging start-ups. Some of these include job training grants, state corporate income tax credit, research and development tax credit, and 5-year property tax reclassification for manufacturing businesses.

Arizona can also experience advantages from being a "late-comer" to the global bioindustry. The top reasons cited for bioindustry locating in Arizona include the high tech industry that has developed here, other industry growth and spin-off activity, physical geography and resort-like atmosphere, and proximity to research institutions. The industry developments, especially in the high-tech sector, that have preceded bioindustry make Arizona's expansion into bioindustry more attractive. Additionally, as discussed in Section II, bioindustry is still rapidly expanding. Federal programs still offer support to bioindustry start-ups and expansion.

Arizona has all the pieces necessary to establish a thriving and robust bioindustry, but Arizona must take the required steps to put the puzzle together. However, as a late-comer to bioindustry, if Arizona fails to put the necessary pieces together in the immediate future, the gap may widen and Arizona may be left behind.

IV. Strategy for Arizona Competitiveness

Arizona's bioindustry development and expansion currently lacks coordination among the industry itself. Additionally, bioindustry in Arizona is experiencing ineffective coordination between the industry and Arizona's Level I research universities even in light of existing technology transfer programs and policies. Primarily though, bioindustry in Arizona lacks a strong, unified entity to voice the needs and problems of bioindustry. This absence results in low visibility and a public policy vacuum inducing repression of vibrant bioindustry development in Arizona. This situation can be rectified by the establishment of a Biotechnology Industry Organization ("BIO") affiliation and applying tried and proven methods of establishing a state bioindustry.

⁸ Arizona State University (ASU), Northern Arizona University (NAU), and University of Arizona (UA).

⁹ See Appendix C describing ABI's collaborative research program.

A. Establish a BIO Affiliate

Arizona's bioindustry has the opportunity to establish a BIO affiliation and in doing so adopt the "best practices" from other states that define an effective BIO affiliate. The need for a formal industry organization to promote bioindustry growth was one of the primary recommendations made in 1997 in the University of Arizona's report, "Designing the Future: The Bioindustry in Arizona."¹⁰ However, four years later, this still has not been accomplished. The establishment of an effective BIO affiliate will create a valuable "commons" for the local bioindustry in two major ways: (1) by providing a forum for voicing concerns prompting resource-sharing, problem-solving, and legislative action, and (2) by enabling Arizona access to national resources and attracting attention and interest to Arizona at the national level. In order to successfully establish a formal industry organization that is effective, the following key elements should form the core of the Arizona's BIO affiliate's development.

(1) Structure and Membership

- Industry representation that is decisive, capable, active, on-going, results-oriented, dynamic, and bioindustry-focused with strong leadership that is efficient, motivated, and prominent within Arizona's bioindustry
- Committee-driven structure that promotes information sharing and problem solving and addresses issues affecting Arizona bioindustry, i.e. Law and Policy Committee, Business Development Committee, Strategic Planning Committee, and so forth
- Utilize all benefits of BIO Affiliation including the Corporate Alliance Program, group purchasing discounts and cash savings for services that can make a crucial financial difference to small and medium-sized companies

(2) Educational and Networking Functions

- Research and develop credible data and reports on Arizona bioindustry for dissemination to political leaders, media, venture capitalists, investment bankers, and the public
- Promote the research and development of Arizona's agricultural and environmental components of bioindustry
- Provide a forum for the academic community and Arizona bioindustry, to advance innovation and especially technology transfer, as well as provide opportunities for networking between affiliate members, potential investors, and parties interested in licensing technology
- Emphasize and promote education and new degree programs in the life sciences throughout Arizona, and seek to develop, in cooperation with the universities and community colleges, internships and programs to allow students to work in the Arizona bioindustry

¹⁰ BARBARA J. MOREHOUSE AND MARISA PAULA WALKER, DESIGNING THE FUTURE: THE BIOINDUSTRY IN ARIZONA (Univ. of Ariz., Apr. 1997).

- Facilitate, through BIO, bioindustry start-ups by providing advice, support and encouragement to entrepreneurs, including helping start-ups access federal program
- Provide continuing education forums to educate members on advances in bioindustry, regulation, economic development, and political advocacy and issues to enable members to better strategize, improve investor relations, and lobby more effectively on the state level
- Offer meaningful events for networking between Arizona bioindustry, academia, venture capitalists, and political leaders
- Create and maintain a comprehensive Arizona bioindustry database
- Send monthly electronic updates including legislative and regulatory information, industry news, and events

(3) Advocacy Functions

- Provide a legislative and public policy forum for issues dealing with the Arizona bioindustry which includes:
 - Being a voice for bioindustry in the legislature and sustaining a favorable business climate by advocating for bioindustry in the legislature
 - Identifying, analyzing, and developing positions on public policy issues that affect Arizona's life science industry development and manufacturing interests;
 - Establishing coordinated tactics to pursue in the legislative arena;
 - Being an asset and valuable resource for the legislature; and
 - Taking legislators, in the interim, around Arizona to visit with the businesses and universities to appreciate the magnitude of the life science industry here and its effects on the state.
- Initiating and fostering a concerted and coordinated campaign of scientists, entrepreneurs, venture capitalists, state legislators, and members of the Arizona BIO that promotes and develops bioindustry

To accomplish these advocacy objectives, the Law and Policy committee of the Arizona BIO affiliate, under the direction of its board of directors, should facilitate and enable the legislative advocacy forum. The primary role for the committee would be to communicate to public officials and the general public the value of Arizona's life science industry and manufacturing interests to the economic well being of Arizona. In fulfilling its role, the Law and Policy committee should provide key legislators with information on bioindustry issues between legislative sessions. During this time, the committee has an opportunity to make the case for Arizona's life science industry. If the committee does its job, it will motivate the legislature and instill in their minds the key issues affecting Arizona's life science industry, thereby laying the groundwork for the next legislative session. For example, Texas Healthcare & Bioscience Institute (THBI), the Texas BIO affiliate, provides key legislative interim information to influence and enlighten Texas's state legislature.

Moreover, the Law and Policy committee should provide Legislative bill tracking and highlights from the current legislative session,¹¹ and also archives of bills from

¹¹ See, e.g., Appendix D outlining the current 2001 Arizona legislation affecting bioindustry.

previous legislative sessions. For example, the 2000 legislative session considered many bills that would have directly affected Arizona's bioindustry. By tracking and archiving bills, the Law and Policy committee will keep the life science industry informed about past and current legislative developments. In addition, this will allow life science industry advocates to see what has been done before, what can be improved, what should be tried again in terms of previous bills, or what legislative approaches other state BIO affiliates have taken on similar issues.

(4) Maintain a complementary, mutually beneficial relationship between the BIO affiliate and the Arizona Bioindustry Cluster

The 1997 “Designing the Future” report also advocated that a formal industry organization should be formed separately from the Arizona Bioindustry Cluster.¹² Following formation of the industry organization, the report then recommended integration of the Bioindustry Cluster. This approach should be adopted because the Bioindustry Cluster cannot operate under the time and pressure constraints that an independent BIO affiliate could. In addition, putting the affiliation in the Bioindustry Cluster would be ineffective because the Cluster has too many competing interests and is too diluted in representation and too bureaucratic to be an effective representative for bioindustry economic development in Arizona.

Moreover, it would be a mistake if Arizona adopted the BIOCOM approach in San Diego, California. Although BIOCOM is not an official BIO affiliate, it is on amicable terms and often partners with BIO. However, BIOCOM prides itself on being autonomous from BIO and on being a grassroots, regional organization. Though the BIOCOM model may be attractive, BIOCOM has been successful because of many conditions absent in Arizona. First, Arizona is in the fledgling stages of commercial bioindustry development, unlike San Diego which had developed a strong commercial bioindustry base when BIOCOM emerged. Second, Arizona does not have an effective technology transfer program and sufficient business collaborations between the bioindustry and the universities. Furthermore, educational programs addressing the needs of the bioindustry are just emerging from their formative stages. Lastly, the Bioindustry Cluster is a failed attempt at instituting the BIOCOM model in Arizona. Thus, the Cluster has been the classic “false start” and has not proven an effective and viable model to launch Arizona into the commercial bioindustry national or regional network.

By remaining united with the Bioindustry Cluster, yet distinct, the Arizona BIO affiliate will provide an invaluable insulator and forum between the bioindustry and the state government, allowing the industry to have an effective and unconstrained voice in petitioning the government. Nevertheless, the Arizona Bioindustry Cluster has a crucial role as well in developing and expanding Arizona life science industry. At times, this role might parallel or overlap with the Arizona BIO Affiliate’s role. For instance, the two organizations can jointly sponsor efforts and events, perhaps with the BIO affiliate eventually raising most of the funding via dues and sponsorships.

If these expansive, but essential elements, are implemented, Arizona’s BIO affiliate can play a crucial role in the development of Arizona’s bioindustry. The Arizona BIO affiliate should be shaped by the Advisory Board of the Students for Arizona

¹² See *supra* note 10.

Bioindustry Development, which is comprised of significant Arizona talent in bioindustry.

B. Make a Financial Commitment to Bioindustry Economic Development

Making a financial commitment to bioindustry entails implementing five different practices: (1) financial incentives, (2) capitalization, (3) commercialization, (4) workforce, and (5) state strategy.¹³

- (1) Financial Incentives
 - Credit on Research and Development expenses
 - Credit on cost of cooperative research with state universities
 - Credit to offset First Tax Liability
 - Income tax credit on cost of facilities construction
 - Sales tax exemption for most purchases of bioindustry-related equipment
 - Carry-forward provision for Net Operating Loss
- (2) Capitalization Practices
 - Seed capital investment program
 - Management assistance and other resources
 - Opportunity for state funds to invest a portion of their funds in venture capital bioindustry investments
 - Capital gains tax cut for qualified stocks held for a requisite number of years
 - Investment tax credit
 - Portion of tobacco settlement to fund bioindustry health-related research
- (3) Commercialization Practices
 - Technology transfer assistance grants
 - Involvement with UCSD Connect
 - State matching funds for university faculty providing research and development work and mentoring services for bioindustry companies
 - Technical assistance and bridge loans for companies participating in the federal SBIR program
 - Manufacturing incentive program to financially assist companies in commercialization
 - Investment in technology incubators and research parks
- (4) Workforce Practices
 - Employee training and technical assistance program grants
 - Tax credit for employee training in bioindustry skills

¹³ Based on a study done by the Texas BIO affiliate (THBI) of the following states: Arkansas, California, Connecticut, Georgia, Maryland, Massachusetts, New Jersey, New York, North Carolina, Pennsylvania, Washington, and Wisconsin.

- K-12 mini- grant program
- (5) State Strategy
- Expand Funding for Technology Incubators

Arizona has developed two successful technology incubators: the Arizona Technology Incubator (ATI) in Phoenix and the Tucson Technology Incubator (TTI) in Tucson. Both ATI and TTI provide examples of working models, however, insufficient funding exists to expand the incubators to support a growing bioindustry economy.

ATI is the older of the two technology incubators, having been founded in 1992. ATI is not for profit organization whose is to serve as a public/private partnership to assist start-up companies. ATI draws upon the resources of Arizona State University and a number of private companies to accomplish this task. As of 1999, its facility occupies a 23,000 square ft. facility in Scottsdale and has graduated companies that have generated more than \$15 million in revenues and employ over 200 people. ATI is home to nine associate firms, six affiliate firms and one adjunct firm. ATI has raised over \$2.5 million in funds to support technology development. One of its key resources is the Arizona Technology Venture Fund (ATVF), which was formed to provide seed money for start-up companies. ATI is involved in developing bioindustry companies. In particular, it has had great success with Regenesys, a tissue engineering company that has developed new treatments for tissue regeneration. ATI is working to develop the Arizona economy. A City of Scottsdale feasibility study showed that for every dollar invested in the incubator, twenty-nine dollars were returned in economic activity in the area of the incubator.

ATI's continued importance was underscored recently when the Maricopa County Board of Supervisors and the Greater Phoenix Economic Council (GPEC) partnered to provide ATI with \$250,000 in funding to enable the incubator to hire a new chief executive officer and to fund a study to examine expansion possibilities into other parts of the Phoenix metropolitan area. GPEC and the Maricopa County Board of Supervisors provided this funding to insure that their organizations were doing all they could to support the funding of New Economy start-ups locally. Under this new program, the County Supervisors will appoint one member to ATI's board of directors while GPEC will manage the incubators finances and operations and help it expand regionally; GPEC will also help promote ATI in its recruiting and marketing efforts nationally and internationally. This new management structure will allow ATI's CEO to focus on developing new ventures and managing existing start-ups. These new policies will give ATI a greater degree of competitiveness and will further strengthen the cluster organizations in Arizona. This Board of Supervisors/GPEC-ATI partnership took several years to develop, and an organization such as a local BIO Affiliate would have greatly accelerated the process through its negotiating and organizational mechanisms.

The Tucson Technology Incubator located at the University of Arizona Science and Technology Park. TTI recently opened in October 1999 in an 8,000 square foot facility. TTI has two hundred and fifty partners, including the University of Arizona, Arizona Public Service, Well Fargo Bank and Diamond Ventures. Sponsors contribute \$25,000 each. The TTI has an annual budget of \$450,000 and is designed specifically to assist in the development of biotechnology. One of TTI's first client companies is Protein Therapeutics, Inc. (PT) a company focused on developing non-toxic therapies to treat

chronic diseases. PT's first drug is currently undergoing FDA approval. PT expects to have its drug approved and on the market by 2003. Once approved, PT will manufacture the drug in Tucson.

These high-tech incubators can already claim several success stories in attracting the attention of national venture capitalists and other investors to their companies. However, resource limitations hinder the effectiveness of the incubators in establishing a bioindustry in Arizona. For example, only thirty companies have been admitted to ATI out of hundreds that have applied. Lack of funding has caused numerous lost opportunities in failing to admit companies to the incubator. Arizona could also accelerate development of the companies admitted to the incubators by expanding the start-up services offered. If the incubators could help cut down on start-up companies overhead costs, such as rent, this would likely free up the companies' working capital, accelerating their development, and enabling them to operate independent of the incubator, thereby, opening up a place for another start-up company to take advantage of the incubators' services.

- Attract venture capital to Arizona

Although both ATI and TTI provide needed support for bioindustry development, the lack of venture capital is one of Arizona's biggest obstacles. The ATVF can only provide limited support to new bioindustry companies because it is not a fund dedicated to bioindustry. As a result, a bioindustry company must compete with a host of other, focused technology companies to secure ATVF funding. Also, state funding like ATVF cannot match the funding that should be coming in from the investment community.

Unlike California, Arizona has not developed the necessary depth of venture capital support for bioindustry. In order to attract venture capital, the technology transfer policies must be changed so that university-based technology becomes attractive for venture-capitalist investment. Research and technology is not attractive to investors if it is not easily accessible. Additionally, attracting venture capital requires management teams connected enough to the broader industry to be capable of quick development, problem-solving and effective strategizing, and securing venture capital opportunities.

- Pass legislation to provide needed funding

To continue developing the state's bioindustry, Arizona must make a greater effort to fund the needs of bioindustry. Several bills have been proposed in the current 2001, 45th Arizona Legislature that have the potential to further bioindustry development in Arizona.¹⁴ However, HB 2147 would impede new bioindustry development. This bill proposes to repeal economic development tax credits for "increases in employment in enterprise zones" and "increases in research and development spending." As long as Arizona lawmakers pursue this type of legislative agenda, bioindustry economic growth will be stifled.

The bills that failed to pass during the last 44th Arizona Legislature were also examples of legislation required for biotechnology expansion and development.

¹⁴ See Appendix D outlining the current 2001 Arizona legislation affecting bioindustry.

HB 2300	Arizona Technology Assistance Service	Provided funding to allow university professors, technology and facilities to be provided at no cost
HB 2301	Cooperative Technology Program	Provided a \$500,000 per year state investment in technology development projects already receiving private sector or government funding
HB 2302	Arizona Small Business Enterprise and Research Program	Provided funding to small businesses to bridge the gap between the award of SBIR/STTR Phase I and Phase II funding
HB 2303	Technology Incubators	Provided \$250,000 to ATI and TTI to fund start-up companies at their facilities

All four bills died in Arizona’s House of Representatives. These bills were modeled after similar successful programs in states such as Georgia, California, and Massachusetts. But they are only a start. To match the accomplishments of states such as Georgia, Texas and California, the bills proposed in the 2001 session supporting bioindustry development must be passed. This legislation can then serve as a starting point for greater technology development and strong state support.

C. Reap a More Meaningful Economic Return from Public Investment in State Universities

Technology transfer is the means to translate research and invention at the university level into technologies and income-generating products of industry. Benefits of successful technology transfer extend both to the university and to the industry. Direct financial benefits to universities include:

- Financial contributions made to the universities by industry
- Financial support that can fund entire department or research institutions
- Contributions targeted to a specific area of study that an industry values
- Specific contributions to a critical project
- Overhead expenses paid to the institution by industry-financed research
- Royalties earned through licensing patented technologies

Indirect enriching benefits to the universities include:

- Motivation to students recognizing the commercial value of their research
- Possibilities of employment to students
- Tailored degree programs to supply industry with specialized, skilled professionals
- Expanded internship and externship opportunities
- Drawing talented faculty to enrich the university

- Retaining gifted faculty
- Obtaining access to industry tools for university research

Although the Arizona Board of Regents technology transfer and intellectual property policies were revised in 1999,¹⁵ modifications can still be made to maximize technology transfer benefits. For example, Arizona's policies should also include low transaction costs and provisions that allow more effective negotiations of mutually beneficial agreements. Arizona's policy should also include a provision that allows for a faculty researcher to take a one-year leave of absence to participate in a start-up venture without affecting his faculty standing.

Model technology transfer policies and programs, such as those found at the Massachusetts Institute of Technology,¹⁶ Stanford,¹⁷ and the University of Kansas,¹⁸ allow these universities to maximize the benefits listed above. Although Arizona's technology transfer and intellectual property policies may be similar on paper, these policies need to be implemented through an active and effective technology transfer program and office like those found at these universities. ASU researchers, in particular, are inexperienced with technology transfer as ASU is a relatively young Level I research institution. Therefore, ASU can benefit immensely from adopting the practices of these most successful technology transfer programs.

Infrastructure development is critical factor for an efficient, knowledgeable technology transfer from Arizona universities to Arizona bioindustry. The primary part of the infrastructure is housed at a university's Office of Technology Licensing. Directors of a university's Office of Technology Licensing must be savvy about both technology and business, able to understand the industrial partner's needs and to craft reasonable intellectual property terms that meet those needs while preserving the rights, policies and freedom of action of the university. These professionals should be able to accommodate the needs of industry while helping to preserve the special policies, objectives and long-range views that are characteristic of the academic world. While the members of this creative profession at major research institutions in other states have gone a long way in promoting technology transfer to industry, their counterparts in Arizona universities must play a more active role in promoting a broader entrepreneurial spirit among academic researchers.

Specifically, Arizona universities' Offices of Technology Licensing must become more aggressive. Such aggressive and dynamic technology transfer offices can bring about major improvements in technology transfer at Arizona's academic institutions in the following ways:

- Conducting workshops and seminars to educate students and faculty in technology transfer, to create awareness of the rewards of technology transfer, to explain a researcher's responsibilities to ensure successful patenting, and to educate students and faculty about small business program opportunities;
- Aid researchers in identification of inventions;
- Conduct market research to decide whether a patent should be filed for;
- Become a liaison with industry and create an Industry Liaison program, which

¹⁵ Available at http://www.abor.asu.edu/1_the_regents/policymanual/index.html (ch. 4.I. 6-908 & 6-909).

¹⁶ Available at <http://web.mit.edu/afs/athena.mit.edu/org/tlo/www/>.

¹⁷ Available at <http://www.stanford.edu/dept/DoR/rph/index.html>.

¹⁸ Available at http://www.kumc.edu/research/kumc_ri/RegentsPolicy.html.

- introduces industry to researchers with relevant interests;
- Provide industry start-ups with access to university research facilities, such as establishing core facilities for DNA and protein sequencing and synthesis, bio-imaging and cell sorting that are also accessible to researchers in start-up companies;
- Establish clear policies and guidelines that support consulting and sponsored research, and help resolve conflict of commitment and interest issues, like publication rights, that can lead to industry academia tie-ups;
- Lend experience to the negotiation process with industry;
- Understand the possible licensing strategies and guide researchers in their application;
- Licensing of new inventions to industry; and
- Supporting further research by providing revenue generated by licenses.

Thus, Arizona, with two large Level I research universities, should modify technology transfer policies and programs to encourage bioindustry company start-ups and introduce related policies and programs to educate life science students about technology transfer and small business opportunities. Universities should also make sure that they are taking full advantage of all federal and state programs. Additionally, the universities' technology transfer offices must be observant and knowledgeable regarding: programs at competing institutions, the business community, national and international science, business, and even regulatory trends. Finally, industry leadership must also take responsibility to ensure that state university technology transfer is functioning as effectively as possible.

D. Transition Arizona's High-Technology Base into Biotechnology

Arizona has long been known as the "Silicon Desert" because of the presence of many semiconductor manufacturers such as Motorola and Intel. Arizona has become a center of excellence for the production of semiconductors and related high technology products. In addition to these semiconductor companies, Arizona has attracted such high technology business as Boeing, Honeywell, and Raytheon. The state has also developed numerous software companies and high technology companies such as MicroAge and Pinacor. The state has developed a synergistic high-technology industry where the products of companies such as Intel and Motorola become integral parts of products produced by other companies such as Boeing, Honeywell, and Raytheon. As these industries have developed, a supporting infrastructure of suppliers and services has developed as well. These high-technology industries have also led to the development of engineering centers of excellence at Arizona State University and the University of Arizona and numerous community colleges and private technical colleges to supply graduates to work in these industries.

The last few years have seen a great change in these high-technology industries as Arizona has become less dependent upon the defense and aerospace industries to buy these companies' products and more dependent upon the internet economy to buy these products. Motorola helped usher in the age of cell phones and pagers with its facilities in

the Arizona, as well as helping to supply major components to Apple's ground-breaking personal computers. Intel has been instrumental in helping usher in the success of the Wintel platform personal computer. Both companies were instrumental in developing the current booming internet economy. However, as with all revolutions, there will be an end. These companies know that the internet economy will not continue to offer the rapid growth of business as it has in the past. As a result both companies are looking at new ways to exploit their technological expertise.

Motorola, in particular, has embraced the promise of the BioChip as a source of new business growth. With this new technology we will see a melding of biology and semiconductor technology. Finally, the recent announcement of a Motorola-Intel alliance in forming an "informatics powerhouse," should complement the development of creative, entrepreneurial smaller or start-up companies that can fuel competitiveness outside of Arizona.

E. Develop a California-Arizona Corridor

The fundamental differences between Arizona's and California's bioindustries suggest that both states could reap collective benefits through collaboration, especially given national competitiveness and the regional production and development approach that is now developing among Pennsylvania, New Jersey and Delaware. A regional approach to bioindustry development would benefit Arizona given its late-comer status to the industry. An alliance among the bioindustry companies in San Diego and those in Arizona would seem to provide such a regional approach. San Diego's constraints on growth make Arizona an attractive option for partnership.

Arizona can offer the maturing California sector a close geographical location, and a cost-effective opportunity for manufacturing, both of products and biomaterials used in research. Arizona could also provide a range of CRO services. Arizona has developed strong capabilities in sectors such as medical device manufacturing, pharmaceuticals preparations and commercial physical and biological research. Intellectual know-how, namely manufacturing processes and patents, are easily transportable, especially in this day of internet connectivity. San Diego's biotechnology companies could easily export this intangible property to companies in Arizona that could convert it into tangible products.

San Diego has the nation's third largest cluster of bioindustry companies. The region also produces 9% of all sales and drug revenues in the United States, and the region's medical device sector is the fastest growing in the United States. Despite San Diego's rapid biotechnology sector growth, it must contend with the problem of limited resources and a restrictive geography. A lack of water had inhibited continued growth of industry in the region. It was a drought in the early nineties that led to the formation of BIOCUM San Diego, the region's biotechnology trade organization. San Diego still faces the possibility of future droughts.

Additionally, San Diego's experience with power shortages in the Fall of 2000, makes Arizona an attractive partner. San Diego's utility company, San Diego Gas & Electric is already importing large amounts of electrical power from Arizona. San Diego was the first major metropolitan area to experience the affects of power deregulation in California. This experiment brought severe power shortages and a four hundred per cent

increase in utility costs. A recent meeting of the Bay Area Bioscience Center (BABC) in San Francisco identified reliable and affordable power as the most 'time-critical issue' facing the biotechnology industry. In a 1997, study, BABC identified electricity as the predominant bioscience utility cost, and it stated that the need for electricity increases as people are replaced by more high through put mechanisms.

Currently, Arizona is a net exporter of power, and in the next two to three years, Arizona will add 16,875 megawatts of power generating capacity with 20 new power plants.¹⁹ Arizona has deregulated its utility industry, resulting in a 2.4% to a 7% drop in rate reductions with stable rates for customers of Arizona Public Service and Salt River Project until 2004 and for customers of Tucson electric until 2008.²⁰ Unlike California, Arizona utilities still own their generating facilities through subsidiary companies. The majority of the new power plants are being built either west of the Phoenix metropolitan area or between Phoenix and Tucson. This means that the power plants are located much closer to users, and this close proximity to any future biotechnology facilities will result in more efficient and cost effective power transmission. Arizona can offer San Diego's biotech companies access to affordable and reliable power if they develop manufacturing facilities in the state.

Geographical constraints such as mountains to the east, the ocean to the west, the Mexican border to the south and sprawling growth from the Los Angeles metropolitan area to the north limit regional growth of San Diego's manufacturing sector. The only area available is in the Otay Mesa Area south of Chula Vista along the Mexican Border. Further, limited transportation expansion hinders logistics and distribution avenues. The region has limited airport facilities, primarily the San Diego International Airport in the city center and Brown Field to the south. Both sites only offer limited growth for air transportation and air cargo. The region's three interstate highways are near capacity. The Burlington Northern Santa Fe rail line is the only rail service into San Diego. For San Diego's continued viability as a biotechnology center, it must find some way to export manufacturing capabilities.

Arizona does not face the same growth constraints as San Diego. There is an abundance of real estate to support the establishment of manufacturing facilities in Flagstaff, Phoenix, Tucson and smaller areas such as Yuma. Arizona has the capability to export the products easily.²¹ Both Phoenix and Tucson are located along major rail lines and interstate highways.²² Both cities are home to major airports with air cargo services.²³ Effectively, the two cities could create an easy and natural base for nationwide manufacture and distribution of biotechnology products. Phoenix and Tucson are home to university research parks and technology incubators that could provide space

¹⁹ Lukas Velash, *Arizona Becoming Southwest Power Farm*, ARIZ. REP., Feb. 25, 2001 at D11.

²⁰ Max Jarman, *Where Western States Stand: Deregulation in Phases*, ARIZ. REP., Feb. 25, 2001 at A 22.

²¹ Phoenix is served by all of the major motor carriers, air cargo services and two major transcontinental railways. Tucson International Airport is being considered for expansion, opening up the city to greater access by passenger and air cargo carriers. Tucson also sits astride a main transcontinental route of the Union Pacific Railroad.

²² Both Phoenix and Tucson are located along I-10 which is a gateway between Los Angeles and the east. I-8 is equidistant between the two cities and connects directly to San Diego. Phoenix straddles I-17 creating a distribution avenue to the north, while Tucson can access Mexico through I-19.

²³ In Phoenix, both Sky Harbor International Airport and Williams Gateway Airport have expanded air cargo service access.

for these manufacturing facilities. The only limitation faced by Tucson and Phoenix is a continued water supply, but this problem has been alleviated to a large part by the Central Arizona Project canal that brings Colorado River water to the two metropolitan areas. As Arizona's economy grows less dependent upon agriculture, more water is available for use by industry.

While Arizona can provide San Diego with manufacturing capabilities, San Diego can provide Arizona with access to a developed bioindustry infrastructure. San Diego has the access to venture capital that Arizona needs to develop its nascent bioindustry. Arizona can also benefit from the best practices developed by the bioindustry, which will speed up the development the local bioindustry.

A strong Arizona BIO affiliate would be able to bridge the gap between Arizona and San Diego biotechnology companies. The networking opportunities resulting from a regional approach to biotechnology development are numerous. Arizona's BIO affiliate could become a participant in the annual CALBIO Summit. In fact, this annual meeting could become a regional meeting encompassing biotechnology not only in Southern California but also Nevada, Utah, Arizona, Colorado and New Mexico.

Arizona was successful in the past in attracting high technology industries from states such as California and Massachusetts because of the support of the government and the business community for new business development. The lower cost of living, easy access to markets, proximity to major universities and the presence of a skilled work force allowed these companies to choose Arizona as a site for new business development. The same forces that drove high-technology companies to Arizona can drive bioindustry companies to relocate to Arizona as well. Arizona can offer itself to these companies as a site for low cost, high quality production in bioindustry. Both the San Diego area and the Los Angeles/Orange County area are booming with bioindustry companies, but there is a limit to how much they can grow because of constraints on water, power, space, transportation and quality of life. Arizona can meet their needs in the area of bioindustry development and manufacturing.

F. Position Arizona Internationally

Modern businesses, bioindustry included, have been subjected to the expansion of commerce and competition on the global level. From 1991 to 1998, Arizona experienced export growth from \$3100 per employee to \$5100 per employee. Some of Arizona's bioindustry companies have already taken advantage of the world marketplace, with top markets being Europe (71%), Asia (67%), and Canada (8%).²⁴ Arizona's physical geography provides an excellent location for exporting, not only does Arizona border Mexico, but Pacific ports are less than 400 miles away. Since the enactment of NAFTA, Arizona is more poised than ever to expand trade. While transnational partnering arrangements maintained by United States bioindustry firms is, on average, 2.1, the number is sure to grow and Arizona is in position to take advantage of the global market.

²⁴ Based on of a survey of 66 companies, 24 exported. Other destinations include Mexico, Australia, the Middle East, and South America.

V. Appendices

Appendix A – State Case Studies

**Appendix B – Arizona Higher Education Institutions
Bioindustry-Related Programs**

Appendix C – Arizona Biomedical Institute Overview

Appendix D – 2001 Arizona Legislation Affecting Bioindustry

Appendix E – Source List

Appendix F – Students for Arizona Bioindustry Development

**Appendix G – Students for Arizona Bioindustry Development
Advisory Board**