

MOVING TO THE NEXT LEVEL:  
ACCELERATING ST. LOUIS' PLANT  
AND LIFE SCIENCE ECONOMY



## ST. LOUIS PLANT AND LIFE SCIENCE STRATEGY UPDATE AND ACTION PLAN



PREPARED FOR:  
St. Louis Coalition for Plant and Life Sciences  
St. Louis Regional Chamber and Growth Association  
Technology Gateway Council

PREPARED BY:  
Technology Partnership Practice  
Battelle

January 2005

A Joint Project of the  
St. Louis Regional Chamber and Growth Association  
Technology Gateway Council  
and the Coalition for Plant and Life Sciences  
with additional financial contributions from Monsanto Company

Battelle Memorial Institute (Battelle) does not endorse or recommend particular companies, products, services, technologies nor does it endorse or recommend financial investments and/or the purchase or sale of securities. Battelle makes no warranty or guarantee, express or implied, including without limitation, warranties of fitness for a particular purpose or merchantability, for any report, service, data or other information provided herein.

**Moving to the Next Level:  
Accelerating St. Louis' Plant and Life Science Economy**

**ST. LOUIS PLANT AND LIFE SCIENCE STRATEGY  
UPDATE AND ACTION PLAN**

**Prepared by:**

**Battelle Technology Partnership Practice**

**Prepared for:**

**St. Louis Coalition for Plant and Life Sciences  
St. Louis Regional Chamber and Growth Association  
Technology Gateway Council**

**January, 2005**



# Table of Contents

	<u>Page</u>
<b>Executive Summary .....</b>	<b>v</b>
<b>Introduction .....</b>	<b>1</b>
Progress to Date .....	2
<b>St. Louis' Plant and Life Sciences Industry Base .....</b>	<b>9</b>
Definition .....	10
Data and Methodology.....	11
The St. Louis Bioscience Industry Sector.....	11
St. Louis Plant and Life Sciences Subsectors .....	14
Comparative Ranking of St. Louis Plant and Life Sciences Sector.....	18
Summary.....	22
<b>Competitive Assessment .....</b>	<b>23</b>
Bioscience R&D Funding.....	23
Venture Capital .....	26
Workforce .....	29
Summary.....	31
Bioscience Initiatives.....	31
Overall Activity .....	32
Focal Areas .....	35
Research Capacity Building.....	37
Industry Partnerships .....	40
Technology Transfer/Commercialization .....	42
Seed-Stage Venture Capital .....	44
Research Parks/Incubators.....	47
Talent Pool.....	51
Business Environment .....	54
Summary and Conclusions .....	55
<b>Moving Forward: Continuing Implementation and Addressing Gaps.....</b>	<b>57</b>
Venture Capital .....	58
Facilities and Research Infrastructure.....	60
Talent .....	62
Technology Transfer and Commercialization .....	63
Plant and Life Science Business Base .....	65
<b>Requirements for Success.....</b>	<b>69</b>
<b>Appendix A: Benchmarking Profiles .....</b>	<b>A-1</b>



# Executive Summary

## INTRODUCTION

Four years ago, the St. Louis region committed to investing aggressively to grow the region's technology economy by becoming the premier location in the world for plant sciences and a major center in the life sciences.<sup>1</sup> A strategic plan was adopted that proposed the following five strategies to grow St. Louis' plant and life sciences sector:

1. Establish a national and international image for St. Louis as the leading center in plant sciences and a major center in life sciences.
2. Build an entrepreneurial culture that supports and nurtures new, young firms in plant and life sciences.
3. Take advantage of the region's intellectual capital resources to capture its commercial potential and applications locally.
4. Insure a progressive business climate to foster and sustain the growth of the region's plant and life science industries.
5. Build, attract and retain a quality workforce drawing on all parts of the St. Louis community.

Under the leadership of the St. Louis Regional Chamber and Growth Association (RCGA), Civic Progress, and its Technology Gateway, numerous organizations and institutions came together to develop the strategy. At the strategy's completion, the St. Louis Plant and Life Sciences Coalition (Coalition), chaired by Chancellor Emeritus of Washington University, William Danforth and comprised of 37 business, academic, economic development and community leaders, was formed to lead and coordinate implementation of the strategy. This report assesses the progress that has been achieved to date, updates and compares the region's economic base with other metropolitan areas in the U.S., benchmarks the region's competition, and assesses and identifies areas that should be addressed in the future.

## KEY ACCOMPLISHMENTS

Significant accomplishments achieved to date include the following.

1. The region's citizenry has embraced and recognized the importance of plant and life sciences as part of a diversified economic future.
2. The St. Louis region is gaining recognition as a center of plant and life sciences.
3. The capital market for plant and life science companies has greatly expanded, enabling St. Louis to finance syndicate and attract outside funds, and serve as an origination center for bioscience investments.
4. Increased resources have been made available to encourage, facilitate and support the commercialization of new products and processes in St. Louis.

---

<sup>1</sup> *Plant and Life Sciences Strategies for St. Louis: The Technology Gateway for the 21<sup>st</sup> Century*, September 2000, p. 14.

5. There is increased collaboration among the region's research universities, as exemplified by CORTEX, the Biogenerator, and the Research Alliance of Missouri.
6. Investments have been made in new facilities to support the plant and life science research and business enterprise.
7. St. Louis has succeeded in increasing the number of start-up plant and life sciences companies, some of which are on the verge of becoming key players in the biosciences.
8. St. Louis is the only major U.S. metropolitan area with two exemplary plant and life science incubators, the Center for Emerging Technologies (CET), and the NIDUS Center for Scientific Enterprise (NIDUS Center), both filled to capacity.
9. The region has continued to strengthen its plant and life science research base.
10. St. Louis has been able to retain operations of several major life science corporations despite corporate consolidations and downsizing.

It is clear that much has been accomplished in building an infrastructure to support the continued growth of St. Louis' plant and life science sector. The strategy adopted in 2000 proposed 20 specific actions. To date, our review indicates that partial to total progress has been made on 18 of 20 recommendations, or nearly 90 percent in four years. The status of implementation is as follows:

- Goal Achieved– 2
- Substantial Progress – 7
- Progress – 9
- Not Yet Implemented – 2

Table ES-1 summarizes the progress made on each of the actions to date.

**Table ES-1: St. Louis Plant and Life Science Strategies: Implementation Progress, 2004**

Action	Priority	Current Status	Implementation as of Dec. 2004
Establish a St. Louis plant and life science campaign	Immediate	<ul style="list-style-type: none"> <li>• Bio-Belt Marketing Campaign</li> <li>• Launched Bio-Belt website</li> <li>• Increased presence at BIO 2004</li> <li>• Bio Mid-America Venture Forum 2004 in St. Louis</li> </ul>	Substantial Progress
Develop an active alliance marketing effort to attract plant and life science business and investors	Immediate	<ul style="list-style-type: none"> <li>• Marketing mission to Japan, 3<sup>rd</sup> Q of 2004</li> <li>• Retained Pfizer, Centocor and Tyco operations in the region</li> </ul>	Substantial progress

**Table ES-1: St. Louis Plant and Life Science Strategies: Implementation Progress, 2004, cont.**

Action	Priority	Current Status	Implementation as of Nov. 2004
Form a statewide plant and life science coalition	Short-term	<ul style="list-style-type: none"> <li>• The Plant and Life Sciences Coalition is fully operations</li> <li>• MO Bio has been established</li> </ul>	Goal Achieved
Encourage federal support to establish a national institute or center in plant and life sciences in St. Louis	Long-term	<ul style="list-style-type: none"> <li>• Bill filed in U.S. Congress to establish National Institute for Plant and Agricultural Sciences within NSF to make peer-reviewed awards for plant science research</li> </ul>	Progress
Educate bi-state Congressional delegation to maximize federal discretionary spending in plant and life sciences	Long-term	<ul style="list-style-type: none"> <li>• Corn to Ethanol Plant at SIU funded</li> <li>• EDA funding for multi-tenant buildings</li> <li>• Congressional earmarks for UM projects</li> </ul>	Progress
Establish a Dedicated Commercialization Fund Pre-seed/Seed Fund Technology Business formation and Commercialization Center	Immediate	<ul style="list-style-type: none"> <li>• Biogenerator – operating, 3 investments made totaling more than \$1 million</li> <li>• Pre-seed fund under development</li> <li>• Arch Angel Investor Network under development</li> </ul>	Substantial progress
Establish locally managed, dedicated life sciences venture funds	Immediate	<ul style="list-style-type: none"> <li>• Prolog and RiverVest Partners</li> <li>• Vectis Life Sciences Fund I</li> <li>• Since 2001, more than \$400 million invested in VC locally</li> </ul>	Goal Achieved
Increase the efficiency and scale of plant and life sciences net2working	Short-term	<ul style="list-style-type: none"> <li>• MoBio, full-time staff and 250 members</li> <li>• RCGA Technology Gateway Life Sciences Network and Bioinformatics Network</li> <li>• RCGA Plant and Life Science Working Group</li> <li>• Center for Emerging Technologies CEO Series</li> </ul>	Substantial Progress
Expand experience and knowledge base of business service providers	Long-term	<ul style="list-style-type: none"> <li>• Increased participation in networking (see above) and increased knowledge and understanding of biosciences industry but not completed as critical mass has not yet been achieved.</li> </ul>	Progress

**Table ES-1: St. Louis Plant and Life Science Strategies: Implementation Progress, 2004, cont.**

Action	Priority	Current Status	Implementation as of Nov. 2004
Establish an R&D Voucher Tax Credit Program	Short-term	<ul style="list-style-type: none"> <li>• Currently, no funding for the state's R&amp;D tax credit</li> </ul>	Not yet implemented
Encourage higher education institutions to review their IP/technology transfer policies	Long-term	<ul style="list-style-type: none"> <li>• Missouri Research Alliance</li> <li>• Developing common industry contract</li> <li>• New commitment to tech transfer and entrepreneurship at Wash U</li> <li>• Bear Cub Fund</li> <li>• SLU dedicated funds for commercialization assistance</li> </ul>	Substantial progress
Nurture and expand Danforth Plant Science Center	Long-term	<ul style="list-style-type: none"> <li>• Has grown to 160 employees</li> <li>• \$5.5 million external grants in 2004</li> <li>• \$50 million challenge grant just awarded by Danforth Foundation</li> </ul>	Substantial progress
Undertake a comprehensive review of the state and local tax structure in MO and IL	Short-term	<ul style="list-style-type: none"> <li>• No review has been undertaken</li> </ul>	Not yet implemented
Providing financing, through a state technology financing authority, for specialized technology facilities, tenant improvements, and research parks	Short-term	<ul style="list-style-type: none"> <li>• CORTEX and St. Louis County post-incubator, multi-tenant buildings</li> <li>• Wash U's BioBed21</li> </ul>	Progress
Develop research parks to leverage strengths in plant and life sciences	Short-term	<ul style="list-style-type: none"> <li>• Cortex</li> </ul>	Progress
Establish one-stop/fast track regulatory approaches in St. Louis region	Long-term	<ul style="list-style-type: none"> <li>• St. Louis County in association with municipalities around Creve Coeur developed streamlined permitting processes for bioscience facilities to insure more predictability and less delays</li> </ul>	Substantial Progress
Pursue key quality of life investments, such as rejuvenating downtown and upgrading airport services	Long-term	<ul style="list-style-type: none"> <li>• Airport expansion/renovation underway</li> <li>• Downtown redevelopment projects, such as Old Post Office project, underway</li> <li>• No international flights out of Lambert Field</li> </ul>	Progress

**Table ES-1: St. Louis Plant and Life Science Strategies: Implementation Progress, 2004, cont.**

Action	Priority	Current Status	Implementation as of Nov. 2004
Expand and scale up co-op and intern programs	Short-term	<ul style="list-style-type: none"> <li>• SIUE offers 90 internship/coop opportunities in plant and life sciences</li> </ul>	Progress
Encourage high education institutions to review and revise curricula	Immediate	<ul style="list-style-type: none"> <li>• SLU's new bioinformatics program for existing workforce</li> </ul>	Progress
Develop and expand career opportunities with community college and vocational partnerships, with special outreach to inner-city minority youth		<ul style="list-style-type: none"> <li>• St. Louis Community College offers Associate of Applied Science in Biotechnology degree</li> <li>• Clyde Miller Career Academy</li> <li>• Metropolitan Vocational School District Life Science Academy</li> </ul>	Progress

## ECONOMIC ANALYSIS

*St. Louis' plant and life science sector, which has a significant employment base, grew substantially between 2001 and 2002.* In 2002, the plant and life sciences in the St. Louis Metropolitan Area employed 10,166 across 187 establishments. This sizable employment base represents the core plant and life sciences industry and accounts for 0.89 percent of private sector employment, mirroring the national trend. *Between 2001 and 2002, the growth of the region's plant and life sciences sector exceeded the average growth rate of the state of Missouri and the nation.* Between 2001 and 2002, employment in the plant and life sciences in St. Louis grew 56.6 percent. This rate of growth signifies that the regional economy added 3,676 new jobs over the course of one year. *St. Louis is regionally concentrated in the plant and life sciences with a location quotient of 1.08.* Though not yet at a level of specialization, the plant and life sciences industry is 8.0 percent more concentrated within the St. Louis region than the national concentration average. The average wage of St. Louis' plant and life science sector is \$26,500 more than the average private sector wage.

Each of the four core subsectors is present in St. Louis. In fact, the plant and life science base is more evenly distributed across the St. Louis region than it is across the US. The diversity of St. Louis's subsector base indicates that the region is well positioned to benefit from the advancements made in all the subsectors of the plant and life sciences and may be well suited to be a center of excellence for converging and intergrating technology across subsectors.

Agricultural Feedstock and Chemicals is the fastest growing subsector in the St. Louis region and is the most regionally specialized. Drugs and pharmaceuticals is the largest subsector of the plant and life sciences and is the second fastest growing subsector within the region. Research and testing is a highly specialized and growing subsector in the St. Louis region. Medical devices and equipment, is the second largest plant and life sciences subsector and well out pacing national growth.

## COMPARATIVE RANKING OF ST. LOUIS PLANT AND LIFE SCIENCES SECTOR

The St. Louis plant and life sciences sector was ranked against all metropolitan areas of the U.S. in terms of employment in order to gauge regional performance and identify areas requiring additional understanding and attention.

**Table ES-2: Metro-Regional Rank of St. Louis Plant and Life Sciences Strengths**

	Metropolitan Statistical Area (MSA) 2003 Definition	Total Plant & Life Sciences		
		Employment 2002	Rank	LQ
Top Ten Metros	New York-Northern New Jersey-Long Island, NY-NJ-PA	81,842	1	1.46
	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	44,148	2	2.33
	Chicago-Naperville-Joliet, IL-IN-WI	39,472	3	1.28
	Los Angeles-Long Beach-Santa Ana, CA	38,561	4	0.99
	Boston-Cambridge-Quincy, MA-NH	34,064	5	1.98
	San Francisco-Oakland-Fremont, CA	22,777	6	1.58
	Minneapolis-St. Paul-Bloomington, MN-WI	21,626	7	1.78
	Indianapolis, IN	21,183	8	3.63
	San Jose-Sunnyvale-Santa Clara, CA	18,917	9	2.77
	San Diego-Carlsbad-San Marcos, CA	16,489	10	1.95
	<b>St. Louis, MO-IL</b>	<b>10,166</b>	<b>17</b>	<b>1.08</b>
Benchmark Metros	Indianapolis, IN	21,183	8	3.63
	San Diego-Carlsbad-San Marcos, CA	16,489	10	1.95
	Seattle-Tacoma-Bellevue, WA	11,956	14	1.10
	Baltimore-Towson, MD	5,717	32	0.70
	Pittsburgh, PA	5,634	33	0.70
	Phoenix-Mesa-Scottsdale, AZ	3,551	48	0.31

Source: Battelle calculation based on ES-202 data provided by Minnesota Implan Group, Inc.

*St. Louis is a leading center for the plant and life sciences ranking 17th among US metro areas<sup>2</sup> in total plant and life science employment.* St. Louis' plant and life sector is diversified with three strong subsectors: agricultural feedstock and chemicals, drugs and pharmaceuticals and research and testing. Leveraging the region's diverse industrial subsector strengths presents the opportunity for the St. Louis area to further position itself as a leading center of plant and life science innovation.

## COMPETITIVE POSITIONING OF ST. LOUIS

In 2000, Battelle benchmarked St. Louis against nine communities that then seemed current leaders of the bioscience race, or which had developed active plan to become leaders. Special focus was given to those regions with strong plant science economies. The original benchmark regions included Baltimore/Washington, Boston, Philadelphia/Princeton, Raleigh-Durham, San Diego, San Francisco, Seattle, Saskatoon, and Israel.

<sup>2</sup> There are 360 metro areas in the U.S.

To update the benchmark, it was important to preserve some stability in the set but also to drop those that did not seem strategically relevant to the challenges faced by St. Louis, substituting others that have emerged in recent years as serious competitors. The set agreed to after discussions with RCGA and the Coalition was as follows.

- **Maintained and updated** – Baltimore, San Diego, Saskatoon, and Seattle
- **Dropped** – Boston, Philadelphia/Princeton, Raleigh-Durham, San Francisco, and Israel
- **Added** – Indianapolis, Phoenix, and Pittsburgh

Battelle benchmarked St. Louis against these regions in terms of bioscience R&D funding, venture capital, bioscience workforce, and bioscience initiatives.

This review of quantitative data to measure St. Louis' competitive position reveals that

- St. Louis has a very strong plant and life science research base but other regions are growing their bioscience R&D base at a faster rate. St. Louis must continue to invest in the research infrastructure needed to maintain its position of leadership in plant and life science R&D.
- St. Louis has greatly improved its position in getting the private venture capital market to invest in its bioscience companies. The addition of \$400 million in venture funds places the region in a very competitive position.
- The region's educational institutions are producing significant numbers of people with bioscience degrees. This is a competitive advantage in terms of attracting and retaining plant and life science companies. The region will need to work however to retain these graduates, to have ample employment opportunities for them and to continue to build the bioscience workforce.

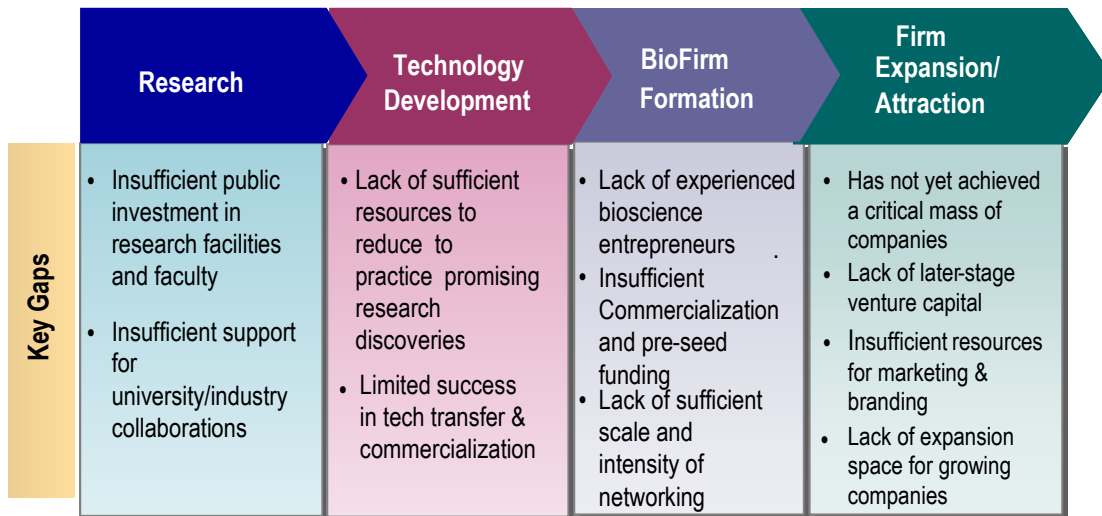
With regards to the specific benchmark communities, we found that:

- In plant sciences, St. Louis is gaining on benchmarks like San Diego and Saskatoon, which both suffered from consolidation in the sector.
- However, new or existing players (Indianapolis, Research Triangle) bear watching, and Saskatoon is branching into food, fiber, and fuel applications of bioprocess technology.
- Many regions with broad bioscience strategies are targeting subsectors at a finer level of detail than St. Louis.
- Many regions with interest in other sectors based on the existing industrial base are placing stronger emphasis on convergent fields such as bioinformatics, bio-engineering, and bioprocessing.
- While St. Louis's investments in R&D capacity are impressive on the philanthropic side, they seem to involve a lesser commitment from state government than in many other jurisdictions; at least until tobacco settlement funds are available in 2007.
- St. Louis's success in building early-stage venture capital funds should not obscure competitive threats posed by other regions with strong programs for industry partnership, technology commercialization, and formation of later-stage capital.

## MOVING FORWARD: CONTINUING IMPLEMENTATION AND ADDRESSING GAPS

In the process of assessing the progress that has been made in implementing St. Louis' plant and life science strategy, individuals interviewed were also asked to identify gaps that remain in St. Louis infrastructure to support the development of the region's plant and life science economy. As shown in Figure 11, a number of areas were identified as still needing attention. These include continuing funding gaps at the commercialization and seed capital stage as well as at the later stage for growing firms, difficulty in finding experienced managers and CEOs for start-up companies, need to create a more entrepreneurial culture at Wash U and lack of expansion space for growing companies.

**Figure ES-1: Gaps in St. Louis Infrastructure**



The gaps identified suggest that there are six areas that need additional, ongoing attention. These include:

1. Venture capital
2. Facilities and research infrastructure
3. Talent
4. Technology transfer and commercialization
5. Plant and life science business base
6. Business climate and quality of life issues.

Table ES-3 identifies actions that should be taken to address each of these areas.

**Table ES-3: Proposed Actions**

Identified Need	Proposed Actions
Commercialization funding at the level of \$50,000 - \$150,000	<ul style="list-style-type: none"> <li>▲ Organize angel investors</li> <li>▲ Expand Bear Cub Fund and SLU’s discretionary funds for commercialization</li> <li>▲ Restructure Biogenerator to enable it to undertake proof of concept/due diligence/scouting function that cannot have an ROI expectation</li> <li>▲ Address pre-seed/seed stage capital financing gaps</li> </ul>
Later-stage venture capital	<ul style="list-style-type: none"> <li>▲ Convince Missouri’s public pension funds and other institutional investors to invest in regional venture funds as well as national funds that agree to open an office in the state or consider Missouri investments</li> <li>▲ Continue and expand Midwest Venture Group and establish ground rules for participation</li> </ul>
Facilities for both firms and research institutions	<ul style="list-style-type: none"> <li>▲ Implement CORTEX</li> <li>▲ Proceed with construction of multi-tenant buildings near CET and NIDUS</li> <li>▲ Continue to invest in life science research facilities <ul style="list-style-type: none"> <li>Tobacco settlement dollars</li> <li>Increased state research support and funding (research, faculty, facilities)</li> </ul> </li> <li>▲ Develop long-term plan for ongoing support of the Danforth Center</li> </ul>
Talent, both experienced technology entrepreneurs and bioscience workers	<ul style="list-style-type: none"> <li>▲ Create an expanded Entrepreneur in Residence Program</li> <li>▲ Explore ways to expand biotechnology offerings of SLCC, including providing space in the new multi-tenant buildings for educational purposes</li> </ul>
Greater technology transfer and commercialization of university research findings	<ul style="list-style-type: none"> <li>▲ Create a technology liaison position within the Biogenerator</li> <li>▲ Establish a business development function at Wash U</li> <li>▲ Facilitate dialogue between academic and industry researchers</li> <li>▲ Create a university/industry matching grant program</li> </ul>

**Table ES-3: Proposed Actions, cont.**

Identified Need	Proposed Actions
Create an environment to attract and retain a critical mass of plant and life science companies	<ul style="list-style-type: none"> <li>▲ Undertake a targeted business recruitment effort tied to the core competencies of the region’s research institutions and industries</li> <li>▲ Significantly increase funding for marketing to a level to impact Biobelt brand (several million)</li> <li>▲ Provide additional opportunities for intensive networking</li> <li>▲ Address quality of life issues including downtown redevelopment, air access, and highways</li> <li>▲ Better coordination of plant and life sciences community by a newsletter and expanded networking</li> </ul>

## REQUIREMENTS FOR SUCCESS

St. Louis has made a great deal of progress in marketing itself as a center of plant and life sciences, growing its venture capital market, and nurturing and supporting a significant number of start-up plant and life science companies, a few of which are on the verge of success. But there are also several critical issues that must be addressed if St. Louis is to succeed in achieving its vision for plant and life sciences. These include

***Sustained state support for the development of Missouri’s plant and life science sector.*** In 2002, the Danforth Foundation and the Ewing Marion Kauffman Foundation, at the request of the State, funded the development of statewide life science strategy.<sup>3</sup> The strategy proposed a number of actions by which the state would provide support for the development of the life science sector. ***To date, very few of these initiatives have been implemented. St. Louis is at a disadvantage vis a vis other regions located in states that are making significant investments in the biosciences.*** It will not only make it difficult to attract companies to expand in St. Louis but it is likely that other states will offer incentives to try to attract successful start-up St. Louis companies to relocate to their state. St. Louis needs to work with the Governor and legislature to create an economic development toolkit targeted to the plant and life sciences, and to ensure that state government makes the investments in research infrastructure and education that will be needed to support the development of a dynamic plant and life science sector.

***Addressing the issue of stem cell research with the legislature.*** The debate on stem cell research is hurting the region’s efforts to build its plant and life science sector in many ways. First, the possibility of a ban on stem cell research could discourage researchers and businesses from locating in St. Louis. This issue has already been raised as universities seek to attract the best researchers to St. Louis. Second, it hurts the region’s image as a leading center of plant and life sciences. Third, the threat of having to fight an amendment to criminalize stem cell research kept bills dealing with “life sciences”, “biotechnology”, research or any related topic from coming to the floor. Addressing this issue should be a top priority.

<sup>3</sup> Battelle Technology Partnership Practice. *Life Sciences & Missouri’s Economic Future: An Opportunity to Build “One Missouri”*, May 2002.

***Building support within the larger business community.*** While the business community and the general public are supportive of the efforts to build the region’s plant and life science sector, they have not embraced the initiative and are not investing dollars in it. Steps must be taken to increase the business community’s understanding of the potential direct and indirect benefits that will accrue from developing this sector and to obtain their “buy-in” and full-fledged support.

***Continuing to educate, inform and encourage the broader citizenry to understand and support biosciences for both its health benefits as well as economic benefits.*** St. Louis and Kansas City joined with other groups throughout the state to encourage passage of a cigarette tax, a portion of the proceeds of which would have been used to support increased state funding of bioscience research. While this effort failed by a slim margin statewide, the \$4 million spent in securing its passage did serve as an educational campaign for biosciences. In the future, both the regional and statewide efforts will need to continue to be undertaken to explain and educate the citizenry on the benefits of the biosciences in terms of individual health and economic competitiveness. Expanded financial support for marketing as well as celebrating the success and promoting the roles of entrepreneurs in the region will also be important.

***Greater collaboration is needed both within the region and between St. Louis and other regions of the state.*** The region would benefit if there were greater collaboration between large and small companies within the region and between industry and academia. In addition, ways need to be found to better link the region with the resources and expertise found at the University of Missouri in Columbia as well as with efforts to grow the life sciences that are underway in Kansas City.

***A more cohesive approach is needed.*** There are many organizations involved in promoting and growing the region’s plant and life science sectors: the RCGA Technology Gateway, the Coalition, CET, the NIDUS Center, Wash U, SLU, UMSL, and the Biogenerator, among others. And there is a strong interest and desire by the region’s citizens, whether they are industry, academe, business service providers, or civic leaders, in wanting to become more involved. The RCGA Technology Gateway Alliance needs to take on a greater role as the initial catalyst and facilitator to link at the operating level firms, academe, and service providers, working closely with the Coalition. In addition, there is a need to broaden their efforts to involve and keep the community’s business, civic, governmental and philanthropic leadership more informed of developments, issues and opportunities affecting St. Louis’s biosciences future.

## **CONCLUSION**

***St. Louis has made more progress in its implementation of the plant and life sciences strategy as any region of the country and is well on the road to becoming the leading center for the plant sciences and a major center for the life sciences.*** Addressing the issues identified above and implementing the actions proposed in this report will help move the region to the next level of development in growing its plant and life science economy.



## Introduction

Four years ago, the St. Louis region committed to investing aggressively to grow the region's technology economy by becoming the premier location in the world for plant sciences and a major center in the life sciences.<sup>4</sup> A strategic plan was adopted that proposed the following five strategies to grow St. Louis' plant and life sciences sector:

1. Establish a national and International image for St. Louis as the leading center in plant sciences and a major center in life sciences.
2. Build an entrepreneurial culture that supports and nurtures new, young firms in plant and life sciences.
3. Take advantage of the region's intellectual capital resources to capture its commercial potential and applications locally.
4. Insure a progressive business climate to foster and sustain the growth of the region's plant and life science industries.
5. Build, attract and retain a quality workforce drawing on all parts of the St. Louis community.

Under the leadership of Civic Progress, the St. Louis Regional Chamber and Growth Association (RCGA) and its Technology Gateway, numerous organizations and institutions came together to develop the strategy. The St. Louis Plant and Life Sciences Coalition (Coalition), chaired by Chancellor Emeritus of Washington University, William Danforth and comprised of 37 business, academic, economic development and community leaders, was formed to lead and coordinate implementation of the strategy.

During the last four years significant progress has been made in putting in place the infrastructure to achieve St. Louis' plant and life sciences vision. At the same time, much has changed. Many more states and regions have become aggressive in trying to develop their bioscience economies with initiatives underway in all 50 states to support the development of the bioscience sector.<sup>5</sup> Florida, for example committed more than \$500 million to recruit the Scripps Florida Biotechnology Research Institute, around which the state plans to build a bioscience cluster. Arizona is investing \$440 million to construct R&D facilities at its universities, most of which will be in the biosciences. Universities and other research institutions are experimenting with ways to accelerate the flow of technology into the marketplace. Changes also have occurred within the plant and life science industries resulting in businesses being acquired and consolidated.

In light of this changing landscape and given that four years have passed since the St. Louis Plant and Life Sciences Strategy was adopted, RCGA and the Coalition decided that this is an opportune time to assess progress that has been made in building the infrastructure to support the development of the region's plant and life science economy, revisit the actions proposed in the original strategy, and make adjustments in the strategies and actions being pursued in light of the region's competitive position. RCGA and the Coalition (with financial support also provided by

---

<sup>4</sup> *Plant and Life Sciences Strategies for St. Louis: The Technology Gateway for the 21<sup>st</sup> Century*, September 2000, p. 14.

<sup>5</sup> *Laboratories of Innovation: State Bioscience Initiatives 2004*. Columbus: Battelle, June 2004.

Monsanto) engaged Battelle's Technology Partnership Practice—which served as the original lead consultant for development of the plant and life sciences strategy—to assist in gauging progress and updating St. Louis's strategy for competitive positioning based on identified progress, remaining gaps, and the changing global industry and research landscape for biosciences. To this end, this report catalogs progress that has been made, benchmarks St. Louis against key competitor and peer regions, identifies gaps that remain, and suggests actions to be taken to move St. Louis to the next level in terms of achieving the region's vision of being the leading plant science center and a leading life science center.

## **PROGRESS TO DATE**

The Battelle project team interviewed approximately 45 individuals including CEOs of plant and life science companies, venture capitalists, university officials and representatives of the region's economic and business development organizations in October and November 2004. The interviewees were asked to 1) assess the progress that has been made in positioning St. Louis in the plant and life sciences, 2) comment on the current environment, including the availability of venture capital, for start-up plant and life sciences companies in the region, and 3) identify any unfinished agenda items that should be focused on further. In addition, Battelle reviewed progress reports prepared by the Coalition and RCGA and other studies and reports, to supplement these interviews. Information from these materials has been incorporated into this updated strategy.

The interviewees, in general, feel that great progress has been made in the past four years in positioning St. Louis in the plant and life sciences and building a reputation for the region, particularly in the plant sciences.

### **Ten Key Accomplishments**

The following ten key accomplishments were cited by the interviewees.

- 1. The Region's citizenry has embraced and recognized the importance of plant and life sciences as part of a diversified economic future.** In four short years, the region's citizenry, leadership in civic, private and public sectors, and its institutions have enthusiastically adopted and supported the efforts to position St. Louis in the plant and life sciences. As one key strategy in the original design—educating the citizenry—much has been accomplished with limited marketing dollars. The "BioBelt" brand has become recognized not only in the region but far outside the region. And we did not meet or interview any opinion leader who felt that this is a pathway St. Louis should not continue to pursue.
- 2. The St. Louis region is gaining recognition as a center of plant and life sciences.** There is general recognition within the plant and life science business and venture community that St. Louis' plant and life science sector is strong and growing. East and West Coast-based venture firms are paying greater attention to the St. Louis region as a result. St. Louis has been chosen as a site for a number of major plant and life science conferences, such as hosting the Mid-America BIO Investors Forum in 2004 and the World Agricultural Forum's Regional Congress. The Congress, scheduled to be held in St. Louis every other year, furthers the region's international stature.
- 3. The capital market for plant and life science companies has greatly expanded, enabling St. Louis to finance, syndicate and attract outside funds, and serve as an origination center for bioscience investments.** In the last four years, more than \$400

million has been invested in locally managed venture capital funds specializing in investing in plant and life sciences. This compares very favorably with Battelle's original recommendation that St. Louis would need to raise at least \$100 million in venture capital to be at the table for venture investments in plant and life sciences and ranks St. Louis among, if not the, nation's leader in venture capital raised for plant and life sciences. Prolog Ventures, an early-stage venture capital firm specializing in life sciences, health care and related IT companies raised its first fund in 2001 and has just closed on \$37 million towards its goal of \$50 million for a Prolog II fund. RiverVest Partners, a national venture capital firm focused on seed, early and later stage life science investments is headquartered in St. Louis and has invested in three St. Louis companies. Triathlon Medical Ventures, based out of Cincinnati, has opened an office at the NIDUS Center. Oakwood Medical Ventures, which invests in mid- late stage companies has raised a 4<sup>th</sup> fund. Lastly, a fund of funds, the Vectis Life Science Fund, has raised \$80 million to invest in venture funds both on the East and West Coast as well as in St. Louis.

4. **Increased resources have been made available to encourage, facilitate and support the commercialization of new products and processes in St. Louis.** Washington University (Wash U), St. Louis University (SLU), the NIDUS Center and CET, joined together to form the BioGenerator, a new not-for-profit entity, whose mission is to accelerate the commercialization of plant and life science technologies within the St. Louis region by providing funding and management support to pre-seed and seed stage companies. The Biogenerator is designed to bridge the gap between research universities and venture capital funds, thereby assuring the transfer of new technologies to the marketplace. In its first year of operation, the BioGenerator evaluated 47 technologies, initiated due diligence on 30 of them, and approved investments in three companies. Two additional investments are pending Board approval. Its goal is to create 20 companies over four years that are fundable by traditional venture capitalists.
5. Both Wash U. and SLU have made funds available to support commercialization activities. Wash U's Bear Cub Fund, which was created in 2002, provides small grants of \$20,000–\$50,000 that can be used by faculty and students to move promising ideas from the drawing board to the marketplace. In 2003, five grants were awarded. SLU has created a similar small proof of concept fund that makes grants of \$15,000–\$20,000. Approximately \$100,000–\$200,000 has been allocated for this effort annually.
6. **There is increased collaboration among the region's research universities, as exemplified by CORTEX, the Biogenerator and the Research Alliance of Missouri.** The Center of Research, Technology and Entrepreneurial Expertise or CORTEX is a joint undertaking of Wash U., University of Missouri—St. Louis (UMSL), the Missouri Botanical Garden, Barnes-Jewish Hospital, and SLU to develop a biotechnology corridor in St. Louis' central core. CORTEX was created to fill a gap in the region for scientific research space to house academic/medical center and new and emerging plant and life science companies. The founding research institutions have pledged \$29 million over five years toward CORTEX. In addition, the Missouri Development Finance Board approved \$12 million in tax credits for CORTEX. To date, CORTEX has purchased several properties and in December 2004 broke ground on the construction of a multi-tenant building for which it has received \$2.9 million from the US Economic Development Administration.
7. The Research Alliance of Missouri (RAM) was created by Governor Holden in 2003 to coordinate the activities of the state's research universities and to provide more access to

- technology for Missouri businesses. The Alliance, which includes academic officials and technology transfer officers from the 13 universities statewide that have an annual R&D budget of \$15 million or more, seeks to promote collaboration among the universities and serves as a resource for state industries. Examples of initial projects of the Alliance include development of a model licensing agreement that was developed collaboratively by SLU, Wash U and UM, and the construction of a research matrix to identify areas of interest of researchers in the various schools.
8. **Investments have been made in new facilities to support the plant and life science research and business enterprise.** St. Louis University is building an \$80 million research building to house its health sciences center, their first new research building in 30 years. The building will include SLU's Center for Vaccine Development, one of six NIH biodefense vaccine testing centers in the nation. UMSL, which is committed to doubling its research budget, has plans to increase the size of their science labs by one-third in the next five years. The university is currently renovating the building that houses its science complex and has plans to construct three new buildings. The first is an IT incubator, for which they have received \$1 million from the SBA. The second planned facility is a clinical building to provide space for their nursing and optometry programs. The third is an academic building to house biology, chemistry and psychology programs.
  9. As part of BioMed 21, Wash U is planning a new \$150 million, 250,000 sq. ft. research facility to be located in proximity to Barnes Jewish Hospital, St. Louis Children's Hospital, and the Center for Advanced Medicine and Siteman Cancer Center. In the summer of 2004, the University of Missouri-Columbia (UM) opened its new \$60 million Life Science Center. The Center is equipped with state-of-the-art lab equipment and is designed to encourage collaborations across disciplines. The building, which includes approximately 67,000 sq. ft. of lab space, houses the Proteomics Center, the Molecular Cytology Core, and the DNA Core.
  10. As mentioned above, CORTEX is constructing a multi-tenant, post incubator facility. Planning also is underway to construct a multi-tenant facility in proximity to the NIDUS Center. The US EDA has awarded funding to both project.
  11. **St. Louis has succeeded in increasing the number of start-up plant and life sciences companies, some of which are on the verge of becoming key players in the biosciences.** Stereotaxis, which designs, manufactures and markets an advanced cardiology instrument control system, issued its Initial Public Offering (IPO) in 2004, and Metaphore Pharmaceuticals, a company that is developing drugs for the treatment of pain, autoimmune disorders, and inflammation, is expected to issue an IPO in the near future. On the plant science side, two NIDUS companies, Chlorogen and Divergence are ready to move out of the incubator and expand their operations. Chlorogen produces proteins and antibodies in plant cells for use in human therapy while Divergence is a world leader in the application of genomics to agriculture and infectious diseases.
  12. **St. Louis is the only major U.S. metropolitan area with two exemplary plant and life science incubators, the Center for Emerging Technologies (CET), and the NIDUS Center for Scientific Enterprise (NiDUS Center), both filled to capacity.** Both CET and NIDUS have companies that are ready to graduate. CET is considering expanding to a third building that would include a pilot manufacturing capability. These incubator and accelerator facilities, along with efforts to address talent and capital, help position the region to build a critical mass of bioscience firms in the future.

13. **The region has continued to strengthen its plant and life science research base.** The Donald Danforth Plant Science Center (Danforth Center), which opened in 1998, has continued to increase its extramural research budget and add researchers. The Center had approximately 160 employees in 2004 and received \$5.5 million in outside R&D grants. It expects to increase its external R&D budget to \$10 million by 2010. NIH funding flowing to the St. Louis region increased 78 percent between 1998 and 2003, growing from \$239.0 million to \$424.1 million. Washington University ranked second in the nation in NIH awards made to medical schools in 2003.
14. In 2003, Wash U. and its School of Medicine announced a \$300 million strategic research initiative, BioMed 21, which is designed to apply new knowledge of human genetics to change how illnesses are understood, diagnosed and treated. BioMed 21 will bring together basic scientists and clinical researchers across a range of disciplines and with varying expertise. As many as 50 new faculty positions are anticipated as part of this initiative.
15. **St. Louis has been able to retain operations of several major life science corporations despite corporate consolidations and downsizing.** Pfizer Pharmaceuticals chose to keep its R&D operations in St. Louis after they acquired Pharmacia given the high quality of the research conducted at the site, the investment in facilities, and the presence of Wash U. The presence of Pfizer provides a strong anchor for the region's biopharmaceutical sector. Other indicators that St. Louis is viewed as a strong location for major plant and life science companies include the decision by Centocor – a subsidiary of Johnson and Johnson - to purchase Wyeth Pharmaceuticals' St. Louis biopharmaceutical facility; Sigma Aldrich's decision to open its research center that now has 120 scientists; and the decision of Tyco Healthcare to maintain its pharmaceuticals operation in St. Louis.

It is clear that much has been accomplished in building an infrastructure to support the continued growth of St. Louis' plant and life science sector. The strategy adopted in 2000 proposed 20 specific actions. To date, our review indicates that partial to total progress has been made on 18 of 20 recommendations, or nearly 90 percent in four years. The status of implementation is as follows:

- Goal Achieved– 2
- Substantial Progress – 7
- Progress – 9
- Not Yet Implemented – 2

Table 1 summarizes the progress made on each of the actions to date.

**Table 1: St. Louis Plant and Life Science Strategies: Implementation Progress, 2004**

Action	Priority	Current Status	Implementation as of Dec. 2004
Establish a St. Louis plant and life science campaign	Immediate	<ul style="list-style-type: none"> <li>Bio-Belt Marketing Campaign</li> <li>Launched Bio-Belt website</li> <li>Increased presence at BIO 2004</li> <li>Bio Mid-America Venture Forum 2004 in St. Louis</li> </ul>	Substantial Progress
Develop an active alliance marketing effort to attract plant and life science business and investors	Immediate	<ul style="list-style-type: none"> <li>Marketing mission to Japan, 3<sup>rd</sup> Q of 2004</li> <li>Retained Pfizer, Centocor and Tyco operations in the region</li> </ul>	Substantial progress
Form a statewide plant and life science coalition	Short-term	<ul style="list-style-type: none"> <li>The Plant and Life Sciences Coalition is fully operations</li> <li>MO Bio has been established</li> </ul>	Goal Achieved
Encourage federal support to establish a national institute or center in plant and life sciences in St. Louis	Long-term	<ul style="list-style-type: none"> <li>Bill filed in U.S. Congress to establish National Institute for Plant and Agricultural Sciences within NSF to make peer-reviewed awards for plant science research</li> </ul>	Progress
Educate bi-state Congressional delegation to maximize federal discretionary spending in plant and life sciences	Long-term	<ul style="list-style-type: none"> <li>Corn to Ethanol Plant at SIU funded</li> <li>EDA funding for multi-tenant buildings</li> <li>Congressional earmarks for UM projects</li> </ul>	Progress
Establish a Dedicated Commercialization Fund Pre-seed/Seed Fund Technology Business formation and Commercialization Center	Immediate	<ul style="list-style-type: none"> <li>Biogenerator – operating, 3 investments made totaling more than \$1 million</li> <li>Pre-seed fund under development</li> <li>Arch Angel Investor Network under development</li> </ul>	Substantial progress
Establish locally managed, dedicated life sciences venture funds	Immediate	<ul style="list-style-type: none"> <li>Prolog and RiverVest Partners</li> <li>Vectis Life Sciences Fund I</li> <li>Since 2001, more than \$400 million invested in VC locally</li> </ul>	Goal Achieved

Action	Priority	Current Status	Implementation as of Nov. 2004
Increase the efficiency and scale of plant and life sciences net2working	Short-term	<ul style="list-style-type: none"> <li>• MoBio, full-time staff and 250 members</li> <li>• RCGA Technology Gateway Life Sciences Network and Bioinformatics Network</li> <li>• RCGA Plant and Life Science Working Group</li> <li>• Center for Emerging Technologies CEO Series</li> </ul>	Substantial Progress
Expand experience and knowledge base of business service providers	Long-term	<ul style="list-style-type: none"> <li>• Increased participation in networking (see above) and increased knowledge and understanding of biosciences industry but not completed as critical mass has not yet been achieved.</li> </ul>	Progress
Establish an R&D Voucher Tax Credit Program	Short-term	<ul style="list-style-type: none"> <li>• Currently, no funding for the state's R&amp;D tax credit</li> </ul>	Not yet implemented
Encourage higher education institutions to review their IP/technology transfer policies	Long-term	<ul style="list-style-type: none"> <li>• Missouri Research Alliance</li> <li>• Developing common industry contract</li> <li>• New commitment to tech transfer and entrepreneurship at Wash U</li> <li>• Bear Cub Fund</li> <li>• SLU dedicated funds for commercialization assistance</li> </ul>	Substantial progress
Nurture and expand Danforth Plant Science Center	Long-term	<ul style="list-style-type: none"> <li>• Has grown to 160 employees</li> <li>• \$5.5 million external grants in 2004</li> <li>• \$50 million challenge grant just awarded by Danforth Foundation</li> </ul>	Substantial progress
Undertake a comprehensive review of the state and local tax structure in MO and IL	Short-term	<ul style="list-style-type: none"> <li>• No review has been undertaken</li> </ul>	Not yet implemented
Providing financing, through a state technology financing authority, for specialized technology facilities, tenant improvements, and research parks	Short-term	<ul style="list-style-type: none"> <li>• CORTEX and St. Louis County post-incubator, multi-tenant buildings</li> <li>• Wash U's BioBed21</li> </ul>	Progress
Develop research parks to leverage strengths in plant and life sciences	Short-term	<ul style="list-style-type: none"> <li>• Cortex</li> </ul>	Progress

Action	Priority	Current Status	Implementation as of Nov. 2004
Establish one-stop/fast track regulatory approaches in St. Louis region	Long-term	<ul style="list-style-type: none"> <li>St. Louis County in association with municipalities around Creve Coeur developed streamlined permitting processes for bioscience facilities to insure more predictability and less delays</li> </ul>	Substantial Progress
Pursue key quality of life investments, such as rejuvenating downtown and upgrading airport services	Long-term	<ul style="list-style-type: none"> <li>Airport expansion/renovation underway</li> <li>Downtown redevelopment projects, such as Old Post Office project, underway</li> <li>No international flights out of Lambert Field</li> </ul>	Progress
Expand and scale up co-op and intern programs	Short-term	<ul style="list-style-type: none"> <li>SIUE offers 90 internship/coop opportunities in plant and life sciences</li> </ul>	Progress
Encourage high education institutions to review and revise curricula	Immediate	<ul style="list-style-type: none"> <li>SLU's new bioinformatics program for existing workforce</li> </ul>	Progress
Develop and expand career opportunities with community college and vocational partnerships, with special outreach to inner-city minority youth		<ul style="list-style-type: none"> <li>St. Louis Community College offers Associate of Applied Science in Biotechnology degree</li> <li>Clyde Miller Career Academy</li> <li>Metropolitan Vocational School District Life Science Academy</li> </ul>	Progress

At the same time that much has been accomplished, more work is needed for the region to continue to progress and care must be taken to continue to address gaps in the infrastructure needed to support the development of the plant and life science sectors. The next section of this report considers St. Louis' competitive position vis-à-vis peer and competitor regions that are seeking to develop their plant and life science economies. It is followed by a discussion of gaps identified in the interviews and ways to address them in moving forward with implementation of the region's plant and life science strategy.

## St. Louis' Plant and Life Sciences Industry Base

The plant and life sciences is a set of knowledge-based industry segments that together form an industry cluster of established and emerging opportunities. It is a cluster that is constantly altered and reinvented as scientists, engineers, and researchers gain new insights into the ways living organisms function. It is a set of industries with roots in academic and clinical discovery as well as engineering and ecological advancements. These technological breakthroughs take shape in new and innovative products used in everyday life. This explains in part the reason that public officials, private investors, and academic scholars have watched developments in the plant and life sciences with intense interest.

The industry's ability to continually reinvent itself is an indicator of the potential that the plant and life sciences have to spur new economic activity. The implication of new life altering discoveries is the reason the sector has become such a high value adding industry segment. Countless new commercial prospects emerge with every new breakthrough and discovery.

The inherent diversity of the plant and life sciences sector is a strong factor contributing to the growing focus on this innovative sector.

New cross-cutting technologies have contributed to company formation geared towards a variety of new market opportunities ranging from bio-engineered foods and fuels to advanced new botanical medicines, from breeding healthier animals to mapping the human genome. The development of each market segment is contributing to the advancement of life sciences, whether related to plant, animal or human health discovery.

The innovative nature of the plant and life sciences has positioned the sector as a high value adding share of the economy. The industry has given rise to establishments that pay their employees an average annual wage of \$62,317,

more than \$25,000 above the private sector average annual wage. In 2002, the plant and life sciences employed almost 892,000 nationally, across 17,158 establishments.<sup>6</sup> This presents a growing share of total private sector employment, an increase of 1.5 percent since 2001.

The United States is a world leader in the plant and life sciences—clinical research and discovery, genetically enhanced agricultural and food commodities, surgical and medicinal healthcare. Interaction between researchers and practitioners has been a vital factor in the continual

**Table 2: US Plant and Life Science Wages**

<b>United States Average Annual Wages per Employee 2002*</b>	
<b>Drugs &amp; Pharmaceuticals</b>	<b>\$73,162</b>
<b>Research &amp; Testing</b>	<b>\$71,118</b>
Finance & Insurance	\$62,762
<b>BIOSCIENCES</b>	<b>\$62,317</b>
Information	\$56,103
<b>Agricultural Feedstock &amp; Chemicals</b>	<b>\$55,919</b>
<b>Medical Devices &amp; Equipment</b>	<b>\$53,939</b>
Manufacturing	\$44,097
Construction	\$39,027
Transportation & Warehousing	\$36,823
<b>US Total Private Sector</b>	<b>\$36,539</b>
Real Estate	\$33,924
<b>* Wages are based on 2002 ES-202 annual average wage from the Department of Labor, Bureau of Labor Statistics.</b>	

<sup>6</sup> Based on U.S. Department of Labor, Bureau of Labor Statistics Census of Employment and Wages data. An establishment is an economic unit which produces goods or provides services. Multiple locations of a single firm would each be counted as a separate establishment.

advancement and progress for the sector. It is not surprising that based on this the plant and life sciences have tended to concentrate in certain regional economies in the nation where such relationships are prevalent. Nevertheless, many other areas are supporting centers of research and development activity and engaging in efforts to promulgate, support, and enhance the promise of the plant and life sciences.

The St. Louis region has continued to build its existing base in the plant and life sciences. This analysis examines the current structure and trends in the region's overall plant and life science sector and in its major subsectors.

## DEFINITION

Varying industrial classifications could be used to define the plant and life sciences or the "bioscience" sector of the economy. At present there is no universally accepted definition of the industry. Categorization is difficult due to the diversity of bioscience activity. The industry is dynamic and encompasses a wide variety of industrial applications. Technological innovation further complicates attempts to define the industry.

Biological and bioengineering advancements are continually being applied in new and different ways, creating new industry segments such as genetically improved health foods or alternate energy sources such as agriculturally based fuels.

Accurately representing the plant and life sciences industry requires an analytical approach that accounts for the diversity of industrial applications. Examining the industry sector according to four major subsectors of economic activity provides the means to observe the varying unique market applications of biotechnology. Each subsector specializes in distinct aspects of the plant and life sciences and contains its own value chain and set of supply relationships. In an effort to address this diversity, the four major subsectors were identified:

**"New plant biotech firms and research facilities are being created throughout the United States. The number of agricultural and food scientists are increasing as workers are attracted to the biotech sector's above-average wages, and a large number of individual states are reaping the benefits of this investment and job-related activity. While 41 of 50 states had some type of biotech initiative by 2001, those that have aggressively adopted and invested in biotechnology are reaping the greatest rewards."**

**– Dr. C. Ford Runge, director of the Center for International Food and Agricultural Policy and Distinguished McKnight University Professor of Applied Economics and Law.**

1. **Agricultural Feedstock & Chemicals:** includes firms that seek industrial applications geared toward production agriculture, energy, industrial commodities, and specialty health products.
2. **Drugs & Pharmaceuticals:** includes firms that develop and produce medicinal and diagnostic substances.
3. **Medical Devices & Equipment:** includes firms that develop and produce physical products for diagnostics, therapeutics, surgical applications, and supplies and equipment for health care delivery.
4. **Research & Testing:** includes firms that are highly research-oriented, cutting-edge companies seeking to commercially advance the latest breakthrough technologies in drug discovery and delivery systems as well as more services-oriented firms engaged in research and testing services.

The four subsectors encompass a wide variety of economic activity with varying levels of biotechnology sophistication. As a result, while these sectors include firms that are leaders in applying biotechnology, not all of the firms in these subsectors are currently using biotechnology. The rate and level to which individual establishments within each of these sectors implement biotechnologies can vary affecting the depth, scale, and scope of plant and life sciences related activity found in a state.<sup>7</sup>

## **DATA AND METHODOLOGY**

The Bureau of Labor Statistics Current Employment and Wage (CEW) data, commonly referred to as ES-202, was the data series used for this analysis.<sup>8</sup> The data set provides information on establishments, employment, and wages. Unsuppressed ES-202 data by NAICS codes was available from the Minnesota Implan Group, Inc. for the years of 2001 and 2002.

The initial assessment of the St. Louis plant and life sciences, as well as the analysis of Missouri's life science sector, was based on Dun & Bradstreet MarketPlace data. This data set is based on the former and now out of date Standard Industrial Code (SIC) system. Since the initial study the federal government and each of the state labor market information offices have ceased collecting employment data according to the SIC system.

Unfortunately, D&B has not fully transitioned to the new classification system. Desiring to be current, Battelle decided to use ES-202 data. In addition, using this data allowed us to better define the agricultural bioscience sector. As a result, the data are not comparable to the data used in the 2000 report or the data reported in the State of Missouri strategy, so historical data can only be reported for the 2001–2002 time period. Utilizing ES-202 data, however, will make it easier to periodically update and track the St. Louis region's performance in the plant and life sciences with publicly available data.

## **THE ST. LOUIS BIOSCIENCE INDUSTRY SECTOR**

Since 2000, when the initial assessment of the St. Louis plant and life sciences sector was conducted by Battelle, significant progress has been made in identifying the specific detailed industry classification codes that make up the biosciences sector. The agricultural feedstock and chemicals subsector is one example of an emerging segment of the plant and life sciences that has been better defined.

---

<sup>7</sup> It must be understood that when attempting to define an industrial sector no one data source can fully account for all economic activity related to a particular industry. It is indicative of industries that are constantly converging with other economic segments that certain pieces may be absent. This analysis selected the best data system based on the North American Industrial Classification System in which to characterize the bioscience industry and capture the largest portions of industry activity.

<sup>8</sup> The ES-202 data series is a cooperative program involving the Bureau of Labor Statistics (BLS) of the U.S. Department of Labor and State Employment Security Agencies (SESA). The QCEW program produces a comprehensive tabulation of employment and wage information for workers covered by State unemployment insurance (UI) laws and Federal workers covered by the Unemployment Compensation for Federal Employees (UCFE) program. Publicly available files include data on the number of establishments, monthly employment, and quarterly wages, by NAICS industry, by county, by ownership sector, for the entire United States. These data are aggregated to annual levels, to higher industry levels (NAICS industry groups, sectors, and super-sectors), and to higher geographic levels (national, State, and Metropolitan Statistical Area (MSA)).

Economic changes have also altered the context of the plant and life sciences. In 2001, the national economy experienced the end of one of the nation's longest periods of economic growth. The National Bureau of Economic Research made a determination that the economic expansion that had lasted for a period of 10 years concluded in March of 2001 as a recession began.<sup>9</sup>

Since that time, the national economy has begun to recover. According to the Bureau of Economic Analysis, the Gross Domestic Product has consistently shown quarterly annual average increases. The latest BEA data illustrates that in the 3<sup>rd</sup> quarter of 2004 the national economy grew at an annual average rate of 3.7 percent.<sup>10</sup> Many analysts believe that high-technology oriented industry sectors are key for economic growth, including sectors like the plant and life sciences.

The combination of new economic data and scientific discovery make it prudent to reassess the region's plant and life sciences industry sector. Reexamining the sector in light of these changes will better position St. Louis as it continues to advance its plant and life sciences sector.

### **Basic Trends**

***St. Louis' plant and life science sector, which has a significant employment base, grew substantially between 2001 and 2002.*** In 2002, the plant and life sciences in the St. Louis Metropolitan Area employed 10,166 across 187 establishments.<sup>11</sup> See Table 3. This sizable employment base represents the core plant and life sciences industry and accounts for 0.89 percent of private sector employment, mirroring the national trend. The previous assessment of the region's plant and life sciences included core industry subsectors as well as ancillary industrial segments and other business services. For purposes of strategic planning and focus, this current analysis seeks to emphasize the core industry subsectors that benefit most from direct investments in the plant and life sciences sector.

---

<sup>9</sup> The National Bureau's Business Cycle Dating Committee maintains a chronology of the U.S. business cycle. The chronology identifies the dates of peaks and troughs that frame economic recession or expansion. The period from a peak to a trough is a recession and the period from a trough to a peak is an expansion. According to the chronology, the most recent peak occurred in March 2001, ending a record-long expansion that began in 1991. The most recent trough occurred in November 2001, inaugurating an expansion. <http://www.nber.org/cycles/november2001/recessnov.html>

<sup>10</sup> <http://www.bea.doc.gov/beahome.html>

<sup>11</sup> The St. Louis metro region is comprised of counties from the states of Missouri and Illinois; Missouri Counties include: Crawford, Franklin, Jefferson, Lincoln, St. Charles, St. Louis, Warren, and Washington

Illinois Counties include: Bond, Calhoun, Clinton, Jersey, Macoupin, Madison, Monroe, and St. Clair

**Table 3: Plant and Life Sciences Sector, 2001-2002**

Region	Plant & Life Sciences	Total Private Sector
<b>St. Louis MSA</b>		
<b>Establishments, 2002</b>	<b>187</b>	<b>69,885</b>
Establishments Change, 01-02	35	8,534
'01-'02 %Change	22.8%	13.9%
<b>Employment, 2002</b>	<b>10,166</b>	<b>1,136,344</b>
Employment Change, 01-02	3,676	189,832
'01-'02 %Change	56.6%	20.1%
Share of Private Sector	0.89%	n.a..
Location Quotient	1.08	n.a..
<b>Average Wage</b>	<b>\$63,154</b>	<b>\$36,607</b>
<b>State of Missouri</b>		
<b>Establishments, 2002</b>	<b>385</b>	<b>155,968</b>
'01-'02 %Change	-4.8%	1.4%
<b>Employment, 2002</b>	<b>15,114</b>	<b>2,215,966</b>
'01-'02 %Change	-1.3%	-1.2%
Share of Private Sector	0.68%	n.a..
<b>Average Wage</b>	<b>\$59,090</b>	<b>\$33,260</b>
<b>U.S. Totals</b>		
<b>Establishments, 2002</b>	<b>17,158</b>	<b>7,839,903</b>
'01-'02 %Change	2.0%	1.4%
<b>Employment, 2002</b>	<b>892,872</b>	<b>107,577,300</b>
'01-'02 %Change	-1.6%	-1.6%
Share of Private Sector	0.83%	n.a..
<b>Average Wage</b>	<b>\$62,317</b>	<b>\$36,539</b>

Source: Battelle calculations based on ES-202 data provided by Minnesota Implan Group, Inc.

*Between 2001 and 2002, the growth of the region's plant and life sciences sector exceeded the average growth rate of the state of Missouri and the nation.* Between 2001 and 2002, employment in the plant and life sciences in St. Louis grew 56.6 percent.<sup>12</sup> This rate of growth signifies that the regional economy added 3,676 new jobs over the course of one year. This is quite significant in light of the employment decline that occurred within the state of Missouri and across the US. Missouri witnessed an employment loss of 1.3 percent in the plant and life sciences. The rate of employment loss was even greater at the national level. The US exhibited a 1.6 percent rate of decline across the plant and life sciences.

In fact, the strong rate of growth demonstrated by St. Louis helped

to offset the loss of employment experienced in the state of Missouri. The St. Louis MSA represents the majority of Missouri's plant and life sciences employment, accounting for 67.3 percent of state employment. Although the region includes counties found within the state of Illinois, the majority of economic activity in the St. Louis MSA occurs in the state of Missouri. Therefore the strong growth of the St. Louis region can be credited in part for securing that the state kept pace with the national trend.

The concentration of the region's employment base can also be analyzed relative to the nation. The location quotient is a way to measure an industry's level of concentration within an economic region.<sup>13</sup> The fact that plant and life sciences employment in St. Louis accounts for a larger share of private sector employment than the industry does at the national level results in an above

<sup>12</sup> While it is useful to examine the rate of change for comparison purposes, without a longer trend than one year it is difficult to say with any degree of certainty if the resulting change is an actual economic trend or merely just an anomaly or statewide.

<sup>13</sup> Location quotients are a common measure of the concentration of particular industry in a region relative to the nation (reference area). The LQ consists of the ratio of the share of total regional employment that is in the particular industry and the share of total employment in the nation (reference area) that is in the particular industry. A LQ greater than 1.0 for a particular industry indicates that the region is relatively concentrated, whereas an LQ less than 1.0 signifies a relative under-representation. A location quotient of above 1.20 denotes employment concentration well above the national average. Throughout this report, LQs are used to report regional industry concentrations relative to the United States as a whole. The minimum concentration threshold for declaring a regional specialization is a matter of judgment and varies somewhat in the relevant literature. In this analysis, regional specializations are defined by LQs of 1.2 or greater.

average location quotient for the region. When the location is significantly above average (e.g., a location quotient above 1.20), the region is said to possess a specialization in the industry.

***St. Louis is regionally concentrated in the plant and life sciences with a location quotient of 1.08.*** Though not yet at a level of specialization, the plant and life sciences industry is 8.0 percent more concentrated within the St. Louis region than the national concentration average.

***The average wage of St. Louis' plant and life science sector is \$26,500 more than the average private sector wage.*** Examining the average annual wage is another important indicator of the strength and importance of the plant and life sciences within St. Louis. The average annual wage for a worker in the plant and life sciences is \$63,154. This wage stands well above the average annual wage for the entire private sector within the regional economy. The high regional wage is also above both the state and national average wage for the plant and life sciences. Though marginally above the national average wage of \$62,317, the St. Louis plant and life sciences wage is well above the state average annual wage of \$59,090.

## **ST. LOUIS PLANT AND LIFE SCIENCES SUBSECTORS**

Approximately 50 percent of Missouri's plant and life sciences establishments are located in the St. Louis metro area. The distribution of plant and life sciences employment across regional subsectors illustrates that St. Louis possesses a highly diversified plant and life sciences sector. This distribution also demonstrates the dominate role St. Louis plays in the state. Aside from agricultural feedstock and chemicals, St. Louis accounts for more than 50 percent of state employment within each subsector.

Each of the four core subsectors is present in St. Louis. In fact, the plant and life science base is more evenly distributed across the St. Louis region than it is across the US. The diversity of St. Louis's subsector base indicates that the region is well positioned to benefit from the advancements made in all the subsectors of the plant and life sciences and may be well suited to be a center of excellence for converging and intergrating technology across subsectors.

**Table 4: St. Louis Plant and Life Sciences Subsector Performance, 2001-2002**

Region	Agricultural Feedstock & Chemicals	Drugs & Pharmaceuticals	Medical Devices & Equipment	Research & Testing	Total, Plant & Life Sciences
<b>St. Louis MSA</b>					
<b>Establishments, 2002</b>	<b>23</b>	<b>49</b>	<b>67</b>	<b>48</b>	<b>187</b>
Establishments Change, 01-02	6	13	6	10	35
'01-'02 %Change	36.4%	34.3%	9.9%	26.3%	22.8%
<b>Employment, 2002</b>	<b>2,275</b>	<b>3,301</b>	<b>2,976</b>	<b>1,614</b>	<b>10,166</b>
Employment Change, 01-02	1,783	1,198	524	171	3,676
'01-'02 %Change	362.1%	57.0%	21.4%	11.9%	56.6%
Share of Regional Plant/Life Sciences	22.4%	32.5%	29.3%	15.9%	100%
Share of Statewide Subsector Emp	48.0%	66.6%	91.2%	75.1%	67%
Location Quotient	1.37	1.07	0.86	1.31	1.08
<b>Average Wage</b>	<b>\$78,175</b>	<b>\$60,244</b>	<b>\$48,775</b>	<b>\$74,445</b>	<b>\$63,154</b>
<b>State of Missouri</b>					
<b>Establishments, 2002</b>	<b>120</b>	<b>80</b>	<b>104</b>	<b>81</b>	<b>385</b>
'01-'02 %Change	-3.6%	-4.8%	-7.1%	-3.5%	-4.8%
<b>Employment, 2002</b>	<b>4,741</b>	<b>4,958</b>	<b>3,265</b>	<b>2,151</b>	<b>15,114</b>
'01-'02 %Change	6.0%	-5.7%	-3.7%	-2.0%	-1.3%
Share of Statewide Plant/Life Sciences	31.4%	32.8%	21.6%	14.2%	100%
<b>Average Wage</b>	<b>\$66,044</b>	<b>\$59,512</b>	<b>\$42,817</b>	<b>\$67,493</b>	<b>\$59,090</b>
<b>U.S. Totals</b>					
<b>Establishments, 2002</b>	<b>3,353</b>	<b>2,536</b>	<b>6,120</b>	<b>5,149</b>	<b>17,158</b>
'01-'02 %Change	0.5%	-0.8%	0.7%	-0.1%	2.0%
<b>Employment, 2002</b>	<b>156,759</b>	<b>293,179</b>	<b>326,201</b>	<b>116,733</b>	<b>892,872</b>
'01-'02 %Change	-5.6%	4.5%	-1.3%	0.1%	-1.6%
Share of US Plant/Life Sciences	17.6%	32.8%	36.5%	13.1%	100%
<b>Average Wage</b>	<b>\$55,919</b>	<b>\$73,162</b>	<b>\$53,939</b>	<b>\$71,118</b>	<b>\$62,317</b>

Source: Battelle calculations based on ES-202 data provided by Minnesota Implan Group, Inc.

*Agricultural Feedstock and Chemicals is the fastest growing subsector in the St. Louis region and is the most regionally specialized.* The subsector had an employment base of 2,275 in 2002 across 6 establishments. The average firm size is 297 employees. Nationally, the average firm size is 47 employees. This indicates that the region's agricultural feedstock and chemicals subsector is comprised of large employers. Additionally, the subsector accounts for a larger share of regional plant and life sciences employment than it does at the national level.

Between 2001 and 2002, the subsector more than doubled in size, adding more than 1,700 jobs. This employment increase is substantial considering that at the national level employment in this subsector declined by 5.6 percent. The phenomenal growth in St. Louis has positioned the subsector well above the national employment concentration level. The region's employment concentration in agricultural feedstock and chemicals is 37 percent greater than the national average. This level of employment makes the subsector in St. Louis significantly specialized.

*Drugs and pharmaceuticals is the largest subsector of the plant and life sciences and is the second fastest growing subsector within the region.* The subsector employs just over 3,300 individuals across 49 establishments, representing 32.5 percent of all plant and life sciences employment in the St. Louis metro region. Nationally, the drug and pharmaceutical subsector accounts for 32.8 percent of plant and life sciences employment.

In the course of the 12 month period analyzed, the subsector added nearly 1,200 jobs. This healthy rate of growth surpassed the national rate of increase, which grew at a rate of 4.5 percent. The rate of growth demonstrated within St. Louis has contributed to an above average level of employment concentration within the region.<sup>14</sup>

In 2002, the St. Louis region's employment concentration within the drugs and pharmaceutical subsector was 7 percent more concentrated than the national average. Given the strong rate of employment growth across the entire St. Louis private sector and the growing employment base of this subsector, it is possible that the region will continue to increase its concentration in this subsector.

***Research and testing is a highly specialized and growing subsector in the St. Louis region.*** In 2002 the subsector employed 1,614 across 48 establishments. This represents 15.9 percent of total plant and life sciences employment compared to 13.1 percent at the national level

Though not demonstrating the high growth of the other subsectors, the research and testing subsector exceeded the national growth rate. Research and testing employment grew at a rate of 11.9 percent in the St. Louis region compared to 0.1 percent nationally. Once again, a strong growth rate significantly above the national average has led to an increasing employment concentration.

The St. Louis region possesses a location quotient of 1.31 in the research and testing subsector. This level of employment concentration signifies that the region is strongly specialized—31 percent above the national average.

Though not as large as pharmaceuticals or as specialized as ag-feedstocks, research and testing represents a critical aspect of the plant and life sciences. Typically the smallest of the four plant and life sciences subsectors, research and testing is often the most critical in terms of new technological development and business formation. Generally, entrepreneurial establishments in the early stages of firm formation are classified within this subsector. The subsector encompasses establishments seeking to commercially advance the latest break-through in plant and life sciences technologies. When research and development comes to a point where products are commercially viable, the fledging firm is often reclassified, usually into the drug and pharmaceutical subsector but increasingly into the ag-feedstock subsector as well.

***Medical devices and equipment, is the second largest plant and life sciences subsector and well out pacing national growth.*** In 2002 the St. Louis medical devices subsector possessed an employment base of 2,976 across 67 establishments. Compared to the US average, the St. Louis medical device subsector is not as large in relative terms. The average firm has an employment size of 44 workers in St. Louis compared to 53 per firm at the national level. Additionally, medical devices in St. Louis make up 29.3 percent of total plant and life sciences employment. Across the US, the subsector accounts for 36.5 percent of total plant and life sciences employment.

Although smaller in a regional sense when compared to the nation, medical devices and equipment is a growing subsector in St. Louis even as it is declining across the US. In the St. Louis metro area, employment grew at a rate of 21.4 percent. Nationally, the subsector experienced an employment decline of 1.3 percent.

---

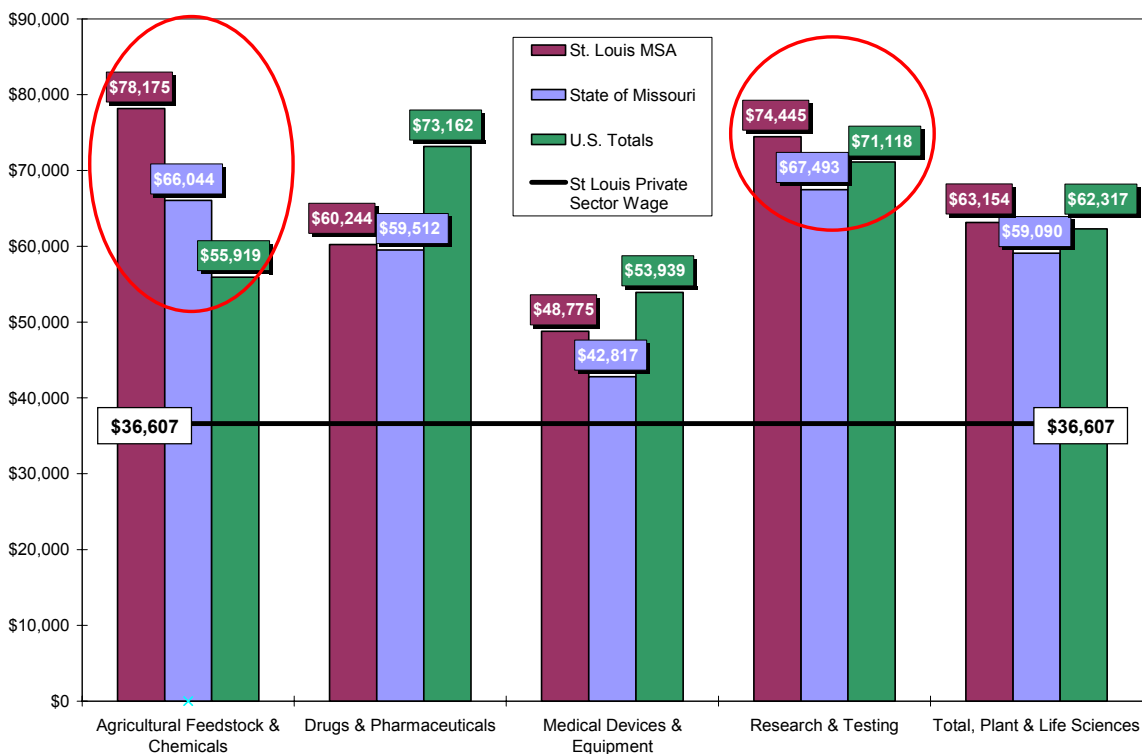
<sup>14</sup> The one year growth rate of this subsector was 57.0%. Battelle analysts have some concerns that this rate is a statistical artifact of an establishment reclassification in the drugs and pharmaceutical subsector.

Though the growth is contributing to an increasing employment concentration in the region, the fact that the subsector is smaller in size than the US average results in a below average location quotient. St. Louis possesses a location quotient that is 14 percent below the national average. However, if the growth trend in the medical devices and equipment subsector remains consistently strong over time, the St. Louis region possesses the potential to become regionally concentrated.

### Subsector Wages

Analyzing the average annual wage per employee is another way of identifying critically important plant and life sciences subsectors. Pinpointing subsectors which provide relative high wages is an indication that the subsector is a high value-adding segment. Targeting economic development initiatives and job creation efforts at high paying plant and life sciences subsectors, the St. Louis region will be concentrating on the highest value-adding segments and potentially raise the overall industry annual average wage per employee. Figure 1 illustrates the average annual wage per employee for each subsector in 2002.

**Figure 1: Bioscience Subsector Average Annual Wage per Employee, 2002**



The graph clearly illustrates that all four subsectors pay significantly above (at least \$12,000 greater) the St. Louis average private sector wages of \$36,607. Agricultural feedstock and chemicals along with research and testing are especially important subsectors. In addition to being regionally specialized, the St. Louis agricultural feedstock and chemicals subsector typically pays on average more per year than the national average. The average annual wage per employee for agricultural feedstock and chemicals is more than \$22,000 above the national average wage.

Research and testing is also a growing, regionally specialized subsector with an above average annual wage per employee. The research and testing subsector in St. Louis pays on average \$74,445 per year. This is above the \$71,118 wage received at the national level.

These two subsectors are major sources of current high paying jobs in the plant and life sciences in the St. Louis region. Both are well above the state and national average annual wage per employee. The subsectors are also above the regional plant and life sciences average annual wage which stands at \$63,154.

## COMPARATIVE RANKING OF ST. LOUIS PLANT AND LIFE SCIENCES SECTOR

The St. Louis plant and life sciences sector was ranked against all metropolitan areas of the U.S. in terms of employment in order to gauge regional performance and identify areas requiring additional understanding and attention.

**Table 5: Metro-Regional Rank of St. Louis Plant and Life Sciences Strengths**

	Metropolitan Statistical Area (MSA) 2003 Definition	Total Plant & Life Sciences		
		Employment 2002	Rank	LQ
Top Ten Metros	New York-Northern New Jersey-Long Island, NY-NJ-PA	81,842	1	1.46
	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	44,148	2	2.33
	Chicago-Naperville-Joliet, IL-IN-WI	39,472	3	1.28
	Los Angeles-Long Beach-Santa Ana, CA	38,561	4	0.99
	Boston-Cambridge-Quincy, MA-NH	34,064	5	1.98
	San Francisco-Oakland-Fremont, CA	22,777	6	1.58
	Minneapolis-St. Paul-Bloomington, MN-WI	21,626	7	1.78
	Indianapolis, IN	21,183	8	3.63
	San Jose-Sunnyvale-Santa Clara, CA	18,917	9	2.77
	San Diego-Carlsbad-San Marcos, CA	16,489	10	1.95
	<b>St. Louis, MO-IL</b>	<b>10,166</b>	<b>17</b>	<b>1.08</b>
Benchmark Metros	Indianapolis, IN	21,183	8	3.63
	San Diego-Carlsbad-San Marcos, CA	16,489	10	1.95
	Seattle-Tacoma-Bellevue, WA	11,956	14	1.10
	Baltimore-Towson, MD	5,717	32	0.70
	Pittsburgh, PA	5,634	33	0.70
	Phoenix-Mesa-Scottsdale, AZ	3,551	48	0.31

Source: Battelle calculation based on ES-202 data provided by Minnesota Implan Group, Inc.

### Key Findings

*St. Louis is a leading center for the plant and life sciences ranking 17th among US metro areas<sup>15</sup> in total plant and life science employment.* St. Louis is 8 percent more concentrated in plant and life science employment than is the nation. Among the benchmark regions, St. Louis is centrally positioned; however, St. Louis is not as specialized as the top performing regions. See Table 5.

St. Louis is on the verge of being among the top ten performing regions in the nation in agricultural feedstock and chemicals employment (less than 200 employees from being ranked 10th in the nation). Currently, St. Louis is ranked 13<sup>th</sup> in the nation, ahead of all the benchmark

<sup>15</sup> There are 360 metro areas in the U.S.

regions. Even more telling is the fact that St. Louis is more specialized than some of the top performing regions in the nation.

St. Louis has an employment base in the agricultural feedstock and chemicals subsector that is more concentrated than major metropolitan areas such as Chicago, Philadelphia, and New York City. Although this may not be too surprising given that these metros are heavily urbanized, it is interesting that the St. Louis region is among a select group of major metropolitan areas with a significant employment base and is regionally specialized.

**Table 6: Metro-Regional Rank of St. Louis Agricultural Feedstock & Chemical Subsector Strengths**

	Metropolitan Statistical Area (MSA) 2003 Definition	Agricultural Feedstock & Chemicals		
		Employment 2002	Rank	LQ
Top Ten Metros	Houston-Baytown-Sugar Land, TX	8,209	1	2.95
	New York-Northern New Jersey-Long Island, NY-NJ-PA	5,951	2	0.61
	Richmond, VA	5,332	3	7.94
	Decatur, IL	4,781	4	71.44
	Baton Rouge, LA	4,342	5	11.45
	Charleston, WV	3,181	6	19.38
	Chicago-Naperville-Joliet, IL-IN-WI	3,166	7	0.58
	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	2,790	8	0.84
	Lakeland, FL	2,597	9	11.15
	Cleveland-Elyria-Mentor, OH	2,448	10	1.84
	<b>St. Louis, MO-IL</b>	<b>2,275</b>	<b>13</b>	<b>1.37</b>
Benchmark Metros	Indianapolis, IN	1,442	23	1.41
	Baltimore-Towson, MD	308	75	0.21
	San Diego-Carlsbad-San Marcos, CA	269	78	0.18
	Phoenix-Mesa-Scottsdale, AZ	198	97	0.10
	Seattle-Tacoma-Bellevue, WA	192	99	0.10
	Pittsburgh, PA	133	118	0.09

Source: Battelle calculation based on ES-202 data provided by Minnesota Implan Group, Inc.

St. Louis has a significant position among metro areas in the research and testing subsector, ranking 15th in employment. In addition to its high rank, the St. Louis region is regionally specialized with an employment concentration that is 31 percent above the national average. However, research and testing employment tends to be even more heavily specialized among top performing regions. Even still, St. Louis holds the potential of leveraging its existing research and testing capabilities and strengths and emerging as an important center for commercial technology development. See Table 7.

**Table 7: Metro-Regional Rank of St. Louis Research & Testing Subsector Strengths**

	Metropolitan Statistical Area (MSA) 2003 Definition	Research & Testing		
		Employment 2002	Rank	LQ
Top Ten Metros	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	8,961	1	3.62
	New York-Northern New Jersey-Long Island, NY-NJ-PA	7,935	2	1.09
	Boston-Cambridge-Quincy, MA-NH	7,017	3	3.12
	Chicago-Naperville-Joliet, IL-IN-WI	6,533	4	1.62
	San Diego-Carlsbad-San Marcos, CA	6,342	5	5.73
	Washington-Arlington-Alexandria, DC-VA-MD-WV	6,324	6	2.80
	San Francisco-Oakland-Fremont, CA	5,488	7	2.92
	Seattle-Tacoma-Bellevue, WA	4,688	8	3.30
	Detroit-Warren-Livonia, MI	3,947	9	2.05
	Los Angeles-Long Beach-Santa Ana, CA	3,826	10	0.75
	<b>St. Louis, MO-IL</b>	<b>1,614</b>	<b>15</b>	<b>1.31</b>
Benchmark Metros	San Diego-Carlsbad-San Marcos, CA	6,342	5	5.73
	Seattle-Tacoma-Bellevue, WA	4,688	8	3.30
	Baltimore-Towson, MD	1,089	20	1.02
	Pittsburgh, PA	620	27	0.59
	Indianapolis, IN	446	38	0.58
	Phoenix-Mesa-Scottsdale, AZ	242	58	0.16

Source: Battelle calculation based on ES-202 data provided by Minnesota Implan Group, Inc.

St. Louis is less specialized in drugs and pharmaceuticals and medical devices, ranking 19th and 25th respectively. The region possesses a relatively sizable employment base in drugs and pharmaceuticals but the location quotient indicates that the region is substantially less specialized than leading metro regions across the country. See Table 8

**Table 8: Metro-Regional Rank of St. Louis Drugs & Pharmaceutical Subsector Strengths**

	Metropolitan Statistical Area (MSA) 2003 Definition	Drugs & Pharmaceuticals		
		Employment 2002	Rank	LQ
Top Ten Metros	New York-Northern New Jersey-Long Island, NY-NJ-PA	51,967	1	2.83
	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	24,124	2	3.88
	Chicago-Naperville-Joliet, IL-IN-WI	18,455	3	1.82
	Indianapolis, IN	15,207	4	7.93
	Los Angeles-Long Beach-Santa Ana, CA	12,418	5	0.97
	Norwich-New London, CT	12,212	6	50.61
	San Francisco-Oakland-Fremont, CA	8,381	7	1.77
	Boston-Cambridge-Quincy, MA-NH	7,870	8	1.39
	New Haven-Milford, CT	7,564	9	8.86
	Kalamazoo-Portage, MI	7,205	10	22.27
	<b>St. Louis, MO-IL</b>	<b>3,301</b>	<b>19</b>	<b>1.07</b>
Benchmark Metros	Indianapolis, IN	15,207	4	7.93
	San Diego-Carlsbad-San Marcos, CA	4,844	13	1.74
	Baltimore-Towson, MD	3,587	16	1.34
	Seattle-Tacoma-Bellevue, WA	1,769	26	0.50
	Phoenix-Mesa-Scottsdale, AZ	884	57	0.24
	Pittsburgh, PA	480	76	0.18

Source: Battelle calculation based on ES-202 data provided by Minnesota Implan Group, Inc.

Despite being the second largest subsector in the St. Louis plant and life sciences, the region's position in terms of its medical devices and equipment employment base places St. Louis 25<sup>th</sup> in the nation. This ranking places St. Louis behind all but two of the benchmark regions. See Table 9.

**Table 9: Metro-Regional Rank of St. Louis Medical Devices & Equipment Subsector Strengths**

	Metropolitan Statistical Area (MSA) 2003 Definition	Medical Devices & Equipment		
		Employment 2002	Rank	LQ
Top Ten Metros	Los Angeles-Long Beach-Santa Ana, CA	21,409	1	1.50
	Boston-Cambridge-Quincy, MA-NH	18,571	2	2.96
	Minneapolis-St. Paul-Bloomington, MN-WI	17,549	3	3.95
	New York-Northern New Jersey-Long Island, NY-NJ-PA	15,989	4	0.78
	San Jose-Sunnyvale-Santa Clara, CA	13,063	5	5.23
	Chicago-Naperville-Joliet, IL-IN-WI	11,318	6	1.00
	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	8,273	7	1.20
	San Francisco-Oakland-Fremont, CA	8,108	8	1.54
	Salt Lake City, UT	6,547	9	4.64
	New Haven-Milford, CT	6,364	10	6.70
	<b>St. Louis, MO-IL</b>	<b>2,976</b>	<b>25</b>	<b>0.86</b>
Benchmark Metros	Seattle-Tacoma-Bellevue, WA	5,307	13	1.34
	San Diego-Carlsbad-San Marcos, CA	5,035	14	1.63
	Pittsburgh, PA	4,401	16	1.50
	Indianapolis, IN	4,088	20	1.92
	Phoenix-Mesa-Scottsdale, AZ	2,228	35	0.54
	Baltimore-Towson, MD	733	73	0.25

Source: Battelle calculation based on ES-202 data provided by Minnesota Implan Group, Inc.

## SUMMARY

The plant and life sciences sector is a sizable and concentrated portion of the St. Louis regional economy. The industry has demonstrated successes and shown encouraging industrial potential. During the 12 month period analyzed, the industry sector has outpaced the US, despite the overall national economic downturn during this period. St. Louis' plant and life sector is diversified with three strong subsectors: agricultural feedstock and chemicals, drugs and pharmaceuticals and research and testing. Leveraging the region's diverse industrial subsector strengths presents the opportunity for the St. Louis area to further position itself as a leading center of plant and life science innovation.

## Competitive Assessment

In 2000, Battelle benchmarked St. Louis against nine communities that then seemed current leaders of the bioscience race, or which had developed active plan to become leaders. Special focus was given to those regions with strong plant science economies. The original benchmark regions included Baltimore/Washington, Boston, Philadelphia/Princeton, Raleigh-Durham, San Diego, San Francisco, Seattle, Saskatoon and Israel.

To update the benchmark, it was important to preserve some stability in the set but also to drop those that did not seem strategically relevant to the challenges faced by St. Louis, substituting others that have emerged in recent years as serious competitors. In assembling the updated set, Battelle gave special attention to emerging competition in the Midwest and elsewhere, characterized by strong involvement from state government, regional business partnerships, and philanthropic foundations. The set agreed to after discussions with RCGA and the Coalition was as follows.

- **Maintained and updated** – Baltimore, San Diego, Saskatoon, and Seattle
- **Dropped** – Boston, Philadelphia/Princeton; Raleigh-Durham; San Francisco, Israel
- **Added** – Indianapolis, Phoenix, and Pittsburgh

Battelle benchmarked St. Louis against these regions in terms of bioscience R&D funding, venture capital, bioscience workforce and bioscience initiatives.

### BIOSCIENCE R&D FUNDING

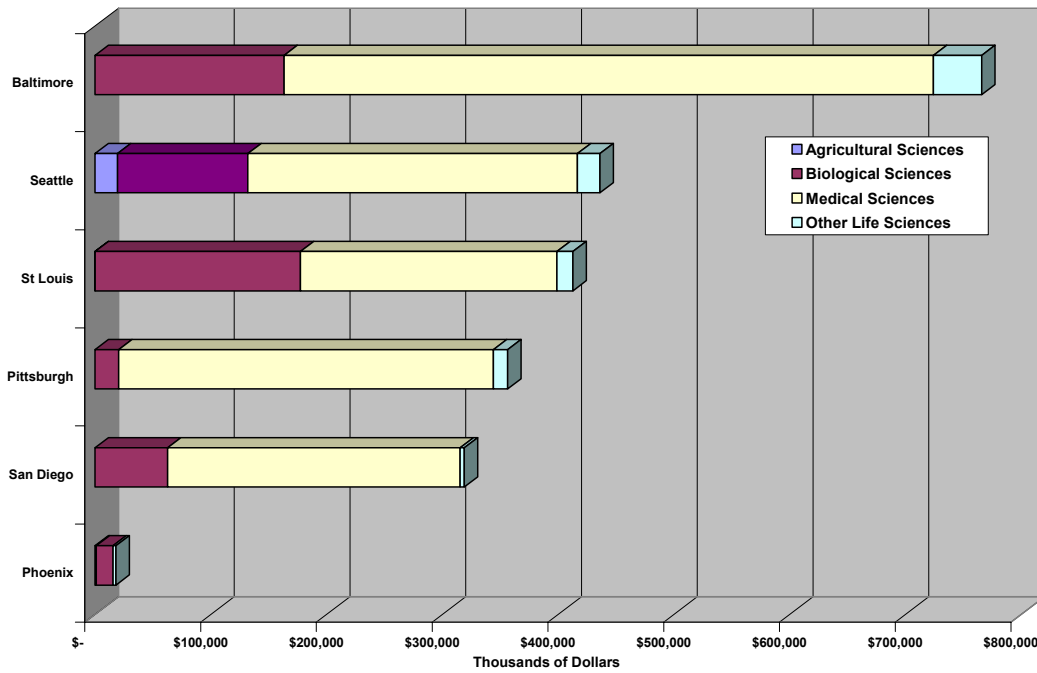
St. Louis maintained its position as one of the leading regions for academic bioscience R&D between 1998 and 2002. Total academic life science R&D reached \$413 million in St. Louis in FY 2002, up 57.1 percent from its FY 1998 level of \$262.8 million. See Figure 2. While St. Louis maintained its position among the benchmarks, Baltimore and Pittsburgh experienced greater growth in total life science academic R&D, with Pittsburgh experiencing an 80.5 percent increase in academic bioscience R&D during this time period.

Medical sciences and biological sciences account for 97 percent of St. Louis' academic life science R&D. Medical sciences, which accounts for 54 percent of the total grew by 50 percent between 1998 and 2002. Medical sciences R&D grew even more rapidly, however, in Pittsburgh (86.6 percent), Baltimore (63.5 percent) and Seattle (54.2 percent). St. Louis performed most strongly in terms of biological R&D, which increased by 65.8 percent between 1998 and 2002. Only San Diego and Pittsburgh experienced higher rates of growth in biological science R&D during this time period, with growth rates of 100.6 percent and 73 percent respectively. Biological science R&D accounts for 43 percent of total academic R&D in St. Louis. Agricultural R&D accounts for less than one-half of one percent of total academic life science R&D in St. Louis. Among the benchmarks, Seattle is the only one that receives any significant agricultural science R&D funding and it only accounts for 4.5 percent of total academic life science R&D. See Figure 3.

Overall, while St. Louis continues to do well in increasing its share of federal R & D funds in the biosciences, other regions are doing even better which suggests that (1) competition for federal

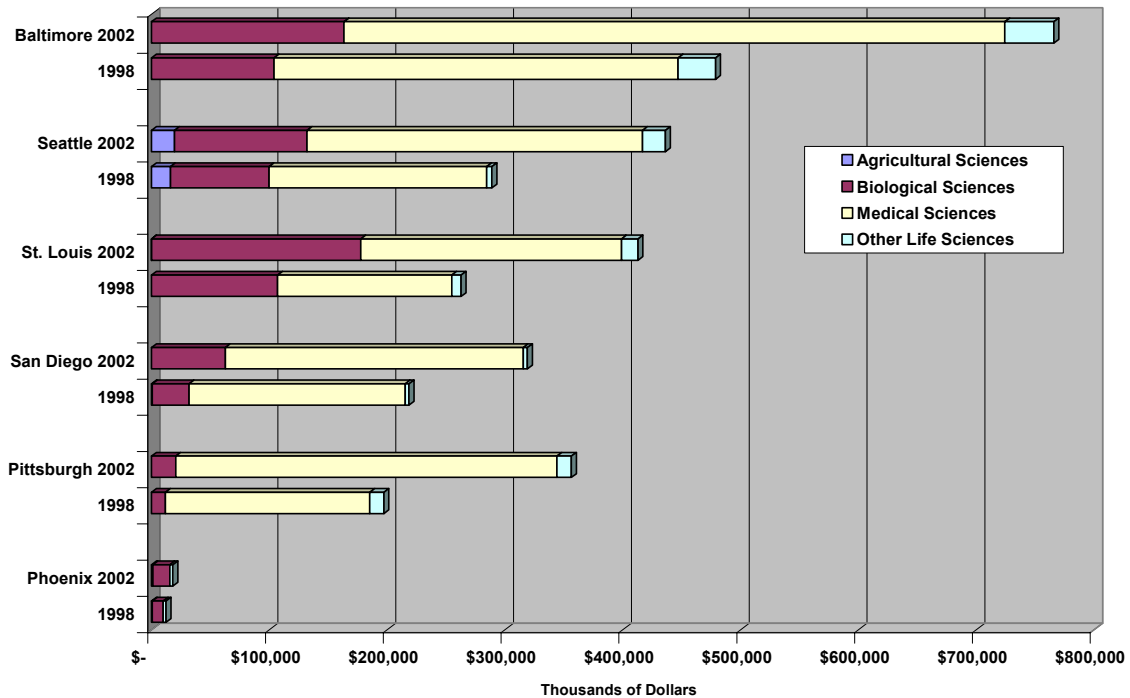
dollars is increasing and (2) St. Louis's comparative advantage in research cannot be taken for granted. Adequate funds for both public and private universities to build facilities and labs and attract faculty are absolutely critical to being able to seek and secure federal dollars.

**Figure 2: Academic Life Science R&D by Discipline and Metro Area, FY 2002**



Source: National Science Foundation. *Science and Engineering Indicators*, 2004.

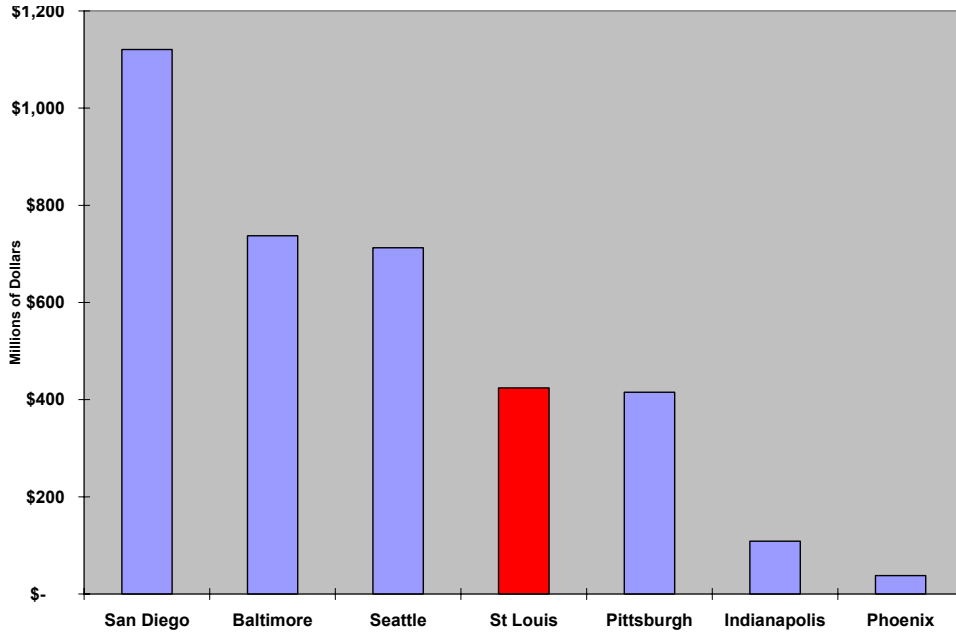
**Figure 3: Academic Life Science R&D by Discipline and Metro Area, FY 2002 and FY 1998**



Source: National Science Foundation, *Science and Engineering Indicators*, 2004.

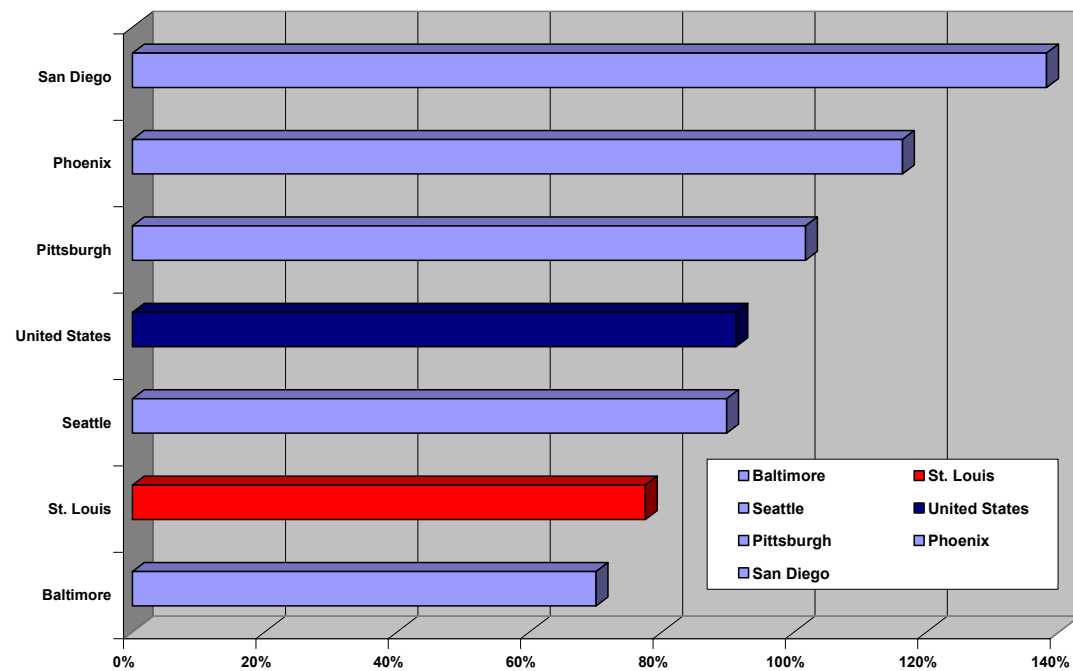
NIH dollars flowing to the St. Louis region increased by 78 percent between FY 1998 and 2003, totaling \$424.1 million in FY 2003. Wash U's Medical School ranks second in the nation in NIH awards to medical schools, receiving \$341.7 million in FY 2003. Despite the success of Wash U, St. Louis ranks fourth among the benchmarks in total NIH funding after San Diego, Baltimore and Seattle, with Pittsburgh having an almost equivalent level of NIH funding as St. Louis. See Figure 4. Of particular concern, all but one of the benchmarks, Baltimore, experienced higher percentage increases in NIH funding between FY 1998 and 2003 than did St. Louis. See Figure 5.

**Figure 4: Total NIH Awards by Metro Area, FY 2003**



Source: National Institutes of Health.

**Figure 5: Total percentage change in NIH Awards by Metro Area between FY 1998 and 2003**

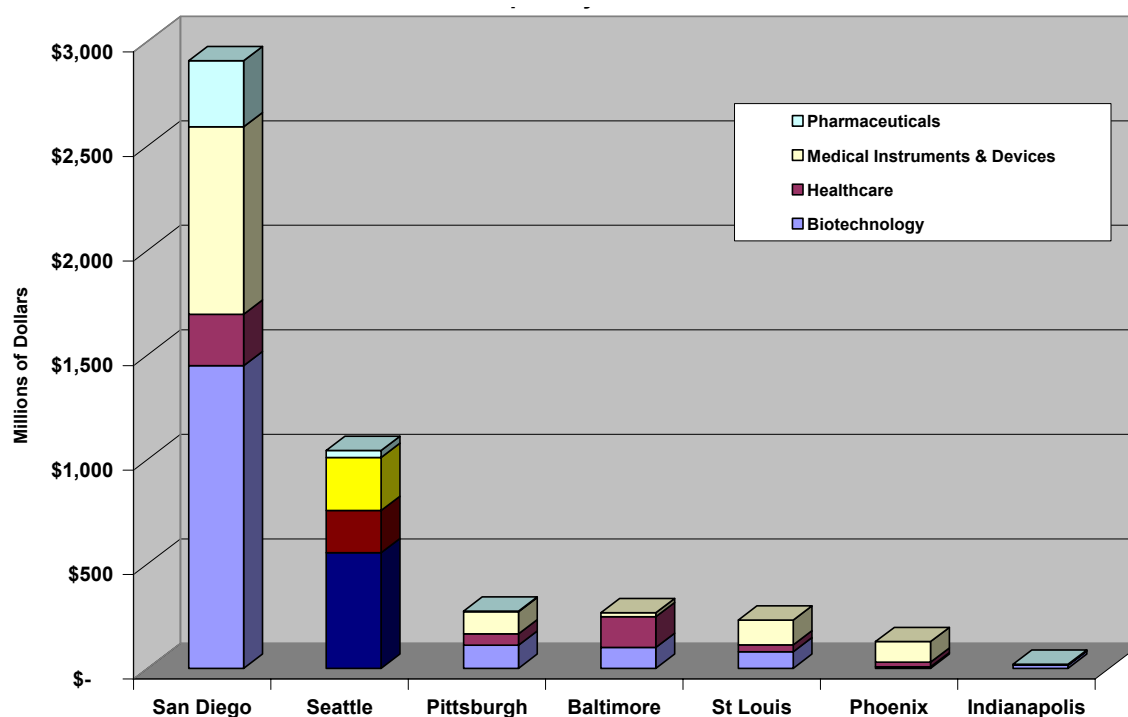


Source: National Institutes of Health.

## VENTURE CAPITAL

Approximately \$231 million in venture capital was invested in St. Louis bioscience companies between 1996 and 2003. See Figure 6. Of the benchmarks, San Diego and Seattle stand out as capturing a significant amount of bioscience venture investment although Seattle experienced a major drop in venture financing between the 1996–2000 time period and the 2001–2003 time period. St. Louis, on the other hand experienced an increase in venture funding in the 2001–2003 time period. The data in Table 10 show that venture capital investments in St. Louis bioscience companies increased by almost 56 percent between the 1996–2000 time period and the 2001–2002 time period. This growth was exceeded only by Indianapolis, which had a very high growth rate because it was starting at such a small base. Three of the benchmarks—Baltimore, Phoenix and Seattle—experienced significant declines in venture capital investments between these two time periods. It is extremely impressive that St. Louis was able to experience this increase during a downturn in the economy.

**Figure 6: Bioscience Venture Capital by Metro Area, FY 1996–2003**



Source: PwC Moneytree Data, Battelle Calculations

During the 1996–2000 time period, St. Louis bioscience investments were heavily concentrated in start-up and early stage companies, accounting for 88 percent of total investments. A similar pattern can be seen in regions with emerging bioscience sectors, such as Pittsburgh and Indianapolis. Investments in companies in regions with more established bioscience sectors tended to cover the full range of stages. See Table 11. St. Louis stands out as the one region in which start-up and early early-stage investments continued to be made in the 2001–2003 time period. See table 12. But at the same time, the investments made between 2001 and 2003 included investments at all stages from seed and early stage to mezzanine and later stage. This may reflect the fact that St. Louis bioscience companies are starting to mature. It may also reflect the region’s success in building a stronger St. Louis-based venture capital base although most of

the investments of the newly established venture funds are yet to be made and will not have shown up in the 2003 data. St. Louis is well positioned as the \$400 million in venture funding that has been raised is invested in the coming five years.

**Table 10: Biotechnology Venture Capital Investments in Tech Boom Years (1996–2000) and Tech Bust Years (2001–2002) in Millions of Dollars**

	1996-2000	2001-2002	% Change 96-00 to 01-02
Baltimore	193.2	73.1	(62.1)
Indianapolis	4.0	15.8	295
Phoenix	68.2	59.7	(12.5)
Pittsburgh	119.5	154.7	29.5
San Diego	1426.5	1480.7	3.8
Seattle	645.5	397.5	(38.4)
St. Louis	90.3	140.6	55.7

Source: PwC Moneytree Data, Battelle Calculations

**Table 11: Biotechnology Venture Capital Investments by Stage of Financing in Tech Boom Years (1996–2000) in Millions of Dollars**

	Start-up/Seed		Early Stage		Mezzanine		Later Stage		Other	
	\$	%	\$	%	\$	%	\$	%	\$	%
Baltimore	61.4	23%	34.7	37%	67.7	20%	0.0	0%	29.5	20%
Indianapolis	3.1	75%	0.85	25%	0.0	0%	0.0	0%	0.0	0%
Phoenix	1.0	6%	46.4	35%	18.8	47%	0.0	0%	2.0	12%
Pittsburgh	10.6	42%	27.1	26%	43.8	21%	33.0	5%	5.0	5%
San Diego	150.0	23%	517.0	28%	409.5	30%	308.4	11%	41.7	8%
Seattle	101.0	35%	126.6	22%	302.5	27%	115.3	14%	0.10	1%
St. Louis	31.9	38%	32.9	50%	0.0	0%	25.5	13%	0.0	0%

Source: PwC Moneytree Data, Battelle Calculations

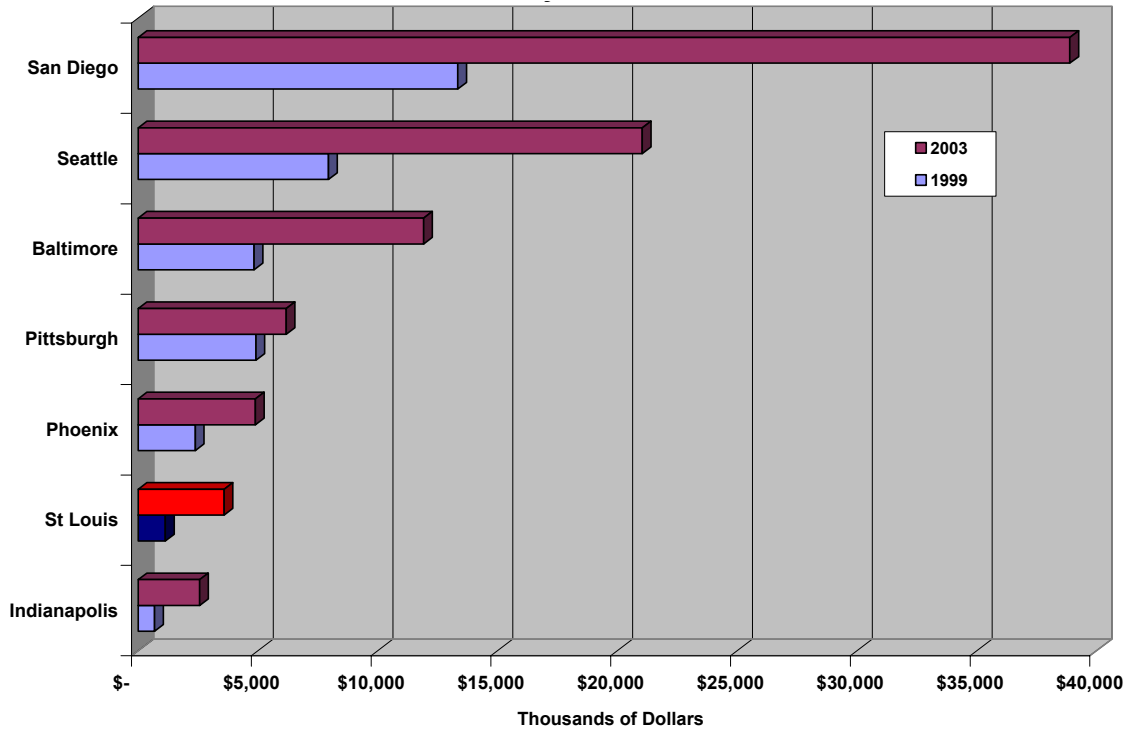
**Table 12: Biotechnology Venture Capital Investments by Stage of Financing in Tech Bust Years (2001–2002) in Millions of Dollars and Percent of Total**

	Start-up/Seed		Early Stage		Mezzanine		Later Stage	
	\$	%	\$	%	\$	%	\$	%
Baltimore	0.10	7%	21.8	29%	45.7	50%	5.5	14%
Indianapolis	0.0	0%	0.0	0%	7.7	67%	8.2	33%
Phoenix	0.0	0%	10.8	30%	47.9	60%	1.0	10%
Pittsburgh	0.6	8%	12.8	21%	108.1	58%	33.3	13%
San Diego	32.5	6%	539.1	33%	736.1	47%	1723.0	14%
Seattle	4.0	4%	91.3	24%	270.6	65%	25.6	7%
St. Louis	19.5	48%	17.7	32%	40.9	13%	62.5	6%

Source: PwC Moneytree Data, Battelle Calculations

Another important source of early stage capital is the federal SBIR/STTR program. In the past, St. Louis has not performed well in terms of competing for these awards. In FY 1999, St. Louis received \$1.14 million in NIH SBIR awards. This amount increased to \$3.6 million in FY 2003 but this still ranks St. Louis behind five of the six benchmarks. See Figure 7.

**Figure 7: NIH, SBIR and STTR Awards by Metro Area, FY2003 and FY1999**



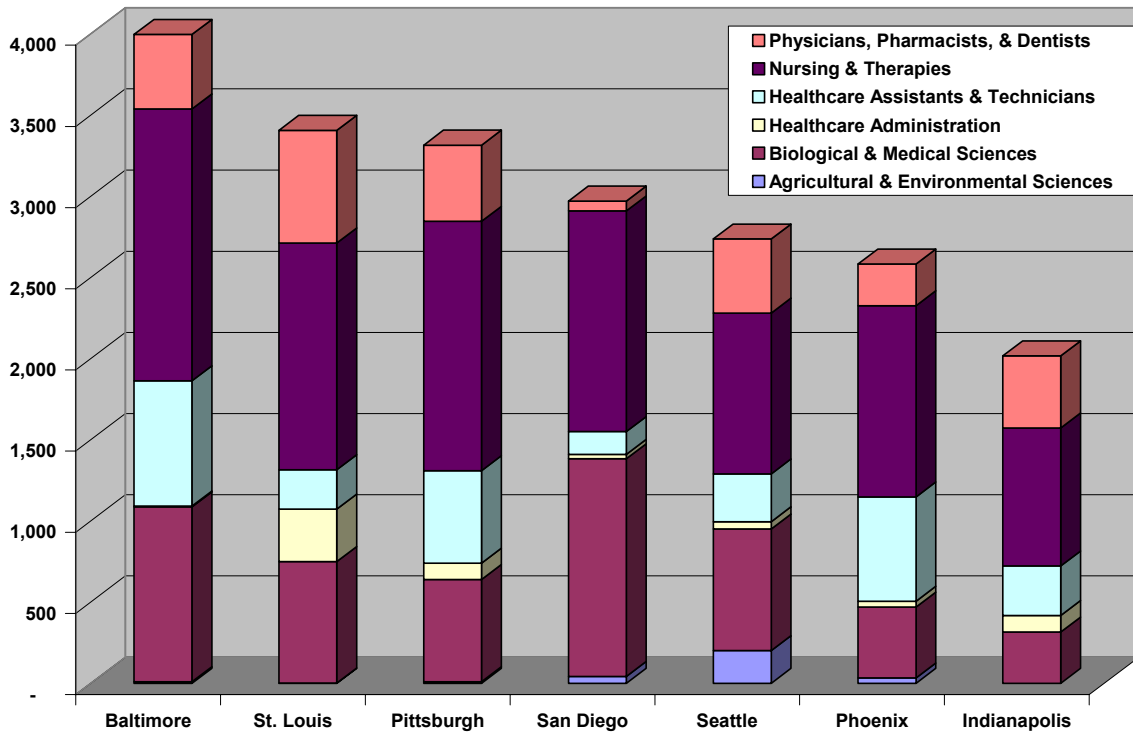
Source: National Institutes of Health.

However, this may be improving. In 2002, the State of Missouri received a grant from the National Science Foundation’s Federal and State Technology Partnership (FAST) Program to provide assistance to companies applying for SBIR/STTR awards. The Missouri FAST program supports a staff person in St. Louis to work with companies in the region. The program has been in place since early 2003. As of June 2004, NIH had awarded 15 grants to Missouri companies, 13 of which are located in St. Louis. NSF awarded five grants to Missouri companies, three of which are in St. Louis, during the same time period. Clearly the region is becoming more competitive in terms of award rates. This will provide companies in the region with access to a critical source of very early stage funding—the largest single source of pre-seed capital in the US.

## WORKFORCE

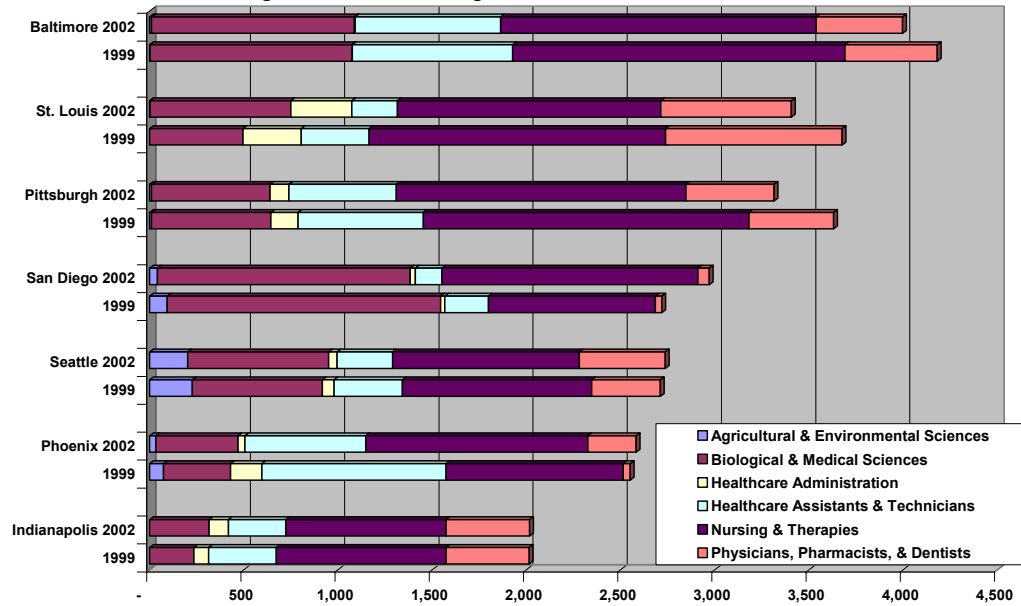
In 2002, higher education institutions in the St. Louis region awarded 3,407 bioscience degrees. The region thus ranked second behind Baltimore in the number of bioscience degrees awarded. See Figure 8. This suggests that the St. Louis region is producing the talent needed by growing bioscience companies and has a competitive advantage in terms of encouraging bioscience companies to locate and expand in the region. This number was down from 4,915 degrees awarded in 1999; however, the majority of the benchmarks experienced similar declines in the number of degrees awarded during this time period as shown in Figure 9.

**Figure 8: Bioscience Degrees Awarded, FY2002**



Source: National Center for Educational Statistics, IPED Survey and Battelle calculations, FY 2002.

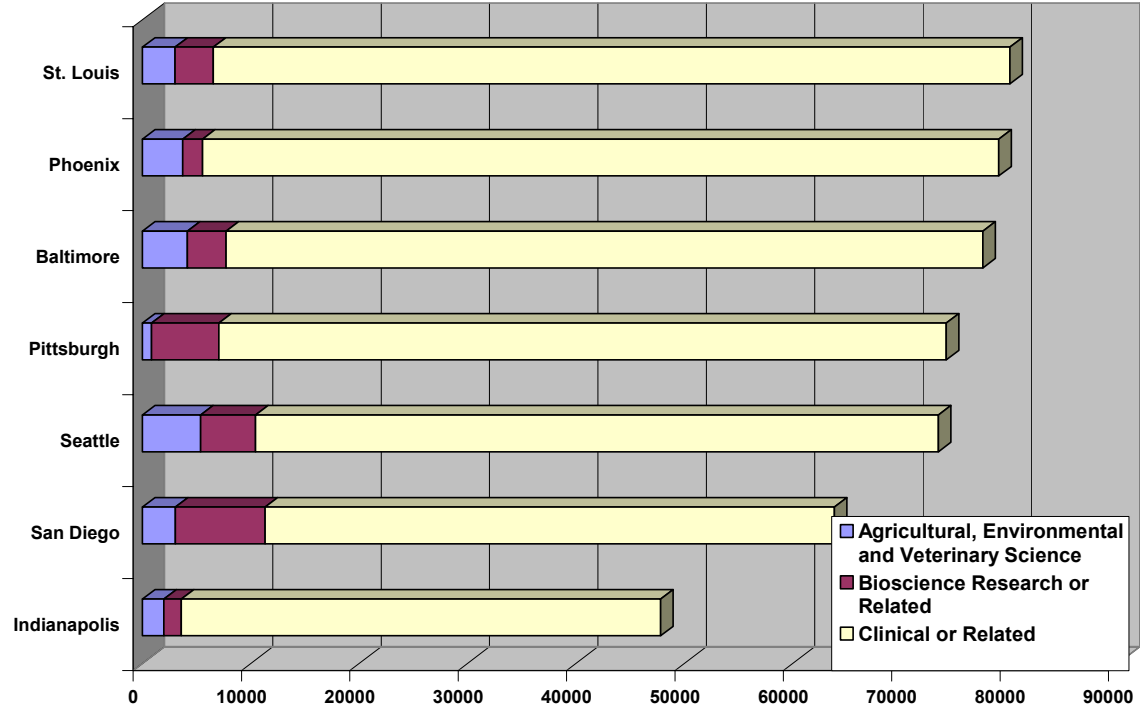
**Figure 9: Change in Bioscience Degrees Awarded, FY 2002 and FY 1999**



Source: National Center for Educational Statistics, IPED Survey and Battelle calculations, FY 1999 - 2002

St. Louis has the largest bioscience workforce of all the benchmarks with more than 80,000 people employed in bioscience occupations. The vast majority, 92 percent, are employed in clinical fields. See Figure 10.

**Figure 10: Occupational Employment in Bioscience Fields by Metro Area, FY 2003**



Source: Occupational Employment Statistics, Bureau of Labor Statistics, 2003.

St. Louis has the smallest percentage of its total bioscience workforce employed in bioscience research and related fields of the benchmarks. Only 2.3 percent of St. Louis' bioscience workers are in bioscience research occupations compared with 13 percent in San Diego, 8 percent in Pittsburgh and 7 percent in Seattle. Having a smaller bioscience research workforce puts St. Louis at a disadvantage in attracting talent to the region if they perceive that there are not enough opportunities for employment across a range of companies and institutions.

## **SUMMARY**

This review of quantitative data to measure St. Louis' competitive position reveals that

- St. Louis has a very strong plant and life science research base but other regions are growing their bioscience R&D base at a faster rate. St. Louis must continue to invest in the research infrastructure needed to maintain its position of leadership in plant and life science R&D.
- St. Louis has greatly improved its position in getting the private venture capital market to invest in its bioscience companies. The addition of \$400 million in venture funds places the region in a very competitive position.
- The region's educational institutions are producing significant numbers of people with bioscience degrees. This is a competitive advantage in terms of attracting and retaining plant and life science companies. The region will need to work however to retain these graduates, to have ample employment opportunities for them and to continue to build the bioscience workforce.

The next section looks at the initiatives that have been put in place in each of the benchmarks to facilitate the growth of the bioscience sector, compares efforts in St. Louis to the benchmarks, and draws conclusions of the implications for the competitive position of St. Louis.

## **BIOSCIENCE INITIATIVES**

The remainder of this section includes a summary of the bioscience initiatives that are being undertaken in the benchmarked communities. Profiles of each of the benchmark regions can be found in Appendix A. The summary and profiles describe activities in the following areas:

- Research capacity building
- Industry partnerships
- Technology transfer/commercialization
- Seed-stage venture capital
- Research parks/incubators
- Talent Pool
- Business Environment

Each summary is followed by an assessment of implications for St. Louis and its plant and life science strategies.

## Overall Activity

The overall competition for bioscience-based economic development has heated up considerably since the last benchmarking exercise in 2000. There are now 21 states applying tobacco-settlement funding to bioscience R&D, according to the Kaiser Family Foundation, and of these about half a dozen have explicit economic-development goals attached to their research program. This is a set that Missouri will not join until 2007, providing enabling legislation is not changed prior to its triggering. Counting programs financed both through settlement funds and other means, there have been at least six very significant initiatives announced since the last benchmark, three of them in benchmark communities:

- **Florida** committed a total of more than \$510 million in state and county resources to attract the Scripps Research Institute of San Diego to open a new research facility in Palm Beach County. In so doing, the state has explicitly targeted the kind of clustering effects observed in San Diego, and officials intend the Scripps facility to anchor a very large research and technology park. Although the package faces environmental challenge, the fiscal commitment is real and significant.
- **Pennsylvania** created three regional “Life Science Greenhouses” to build R&D capacity, promote industry partnerships, and stimulate technology transfer through start-up formation. The state committed \$100 million from tobacco settlement funds (to be matched in each local community) to the startup costs of these nonprofit intermediaries. The state also allocated \$60 million annually to bioscience R&D, of which a considerable fraction will be strategically targeted to fields addressed by the Greenhouses. Finally, the tobacco settlement board will invest \$60 million of its corpus in three regionally targeted venture-capital funds.
- **Arizona** assembled a \$90 million recruitment package for the Translational Genomics Research Institute (T-Gen), allocated \$440 million for its first new investment in years in university-based research capacity (across several fields) and dedicated an increase in tobacco tax rates to fund a \$12 million annual research program through the state’s Disease Control Commission.
- **Indiana** securitized tobacco-settlement funds to fund \$75 million in university R&D facilities (multi-field), allocated \$40 million for new university-related technology parks, re-upped its commitment to a multi-field research and commercialization fund to \$72 million per biennium, and agreed to place \$100 million in pension fund investments with initiatives such as the Indiana Future Fund (a fund of venture capital funds targeting early-stage, in-state, bioscience investment opportunities).
- In November 2004, **California** voters approved a proposition authorizing the state to sell up to \$3 billion in General Obligation bonds to fund stem cell research and facilities. An Institute for Regenerative Medicine will be established to award grants and loans and manage stem cell research activities.
- In November 2004, Governor Doyle of **Wisconsin** announced a \$750 million initiative, partly in response to California’s stem cell initiative, that will fund bioscience research and facilities including a \$375 million Wisconsin Institute for Discovery at University of Wisconsin-Madison, a \$134 million HealthStar Interdisciplinary Research Complex at University of Wisconsin Hospital and Clinics, and a \$132 million research facility at the Medical College of Wisconsin and Children’s Hospital. An additional \$105 million will be available to fund research education and public health efforts over the next five years.

The table on the following page summarizes the “story” of bioscience development in each of the benchmark regions, highlights recent changes, and assesses whether progress has been up, down or sideways. In Battelle’s view, the only benchmark to have lost ground is San Diego, and aggressive gains have been registered in Pittsburgh (especially) and Indianapolis and Phoenix (both earlier stage). Baltimore/Washington has held its strong position, and Saskatoon and Seattle seem to have held their moderate advantages, with certain changes under way as highlighted in the following sections. St. Louis continues to hold a leadership position on plant sciences and appears to have gained ground on San Diego and Saskatoon; however, new players, Indianapolis and Research Triangle have entered the competition and just as the St. Louis region is becoming active in the biofuels arena, Saskatoon also is branching into food, fiber and fuel applications of bioprocessing technology.

Region	The overall regional story or major developments since last benchmark	Vector of Change	Highlights of new activity
Baltimore/- Washington	Genealogy of most bioscience startups traces to federal labs & contractors (NIH, NIST, FDA, Walter Reed Army Institute of Research), with heavy emphasis on sequencing, bioinformatics and applied genomics	↔	Heavy new research park development in Baltimore City near Hopkins and UM, B. Montgomery County holding steady.
Indianapolis	Sector dominated by Lilly, Guidant, Cook and Roche Diagnostics; just starting to get entrepreneurial; ag biotech benefited from consolidation of Dow AgroScience	↑	First wet-lab incubator opened in Indianapolis, housing spin-offs from IU, joint ventures with Lilly/Dow/Roche and several new VC initiatives
Phoenix	Still at early stages, but recruitment of new anchor (T-Gen) unlocked foundation and state support for R&D capacity building and links between UA and ASU	↑	ASU adding Biodesign to its engineering strengths and linking with Tucson-based UA in new downtown Phoenix clinical research center
Pittsburgh	Major state commitment of tobacco funds to Life Science Greenhouse, matched by local foundations, has stimulated close collaboration between Pitt and CMU	↑	Greenhouse opened first wet-lab incubator and stimulating new faculty recruitments; spin-offs in tissue-engineering are stable
San Diego	Genealogy of bioscience startups traces to UCSD and Hybritech, but consolidation has hit hard (including IDEC, Syngenta, Dow & Epicyte) and Scripps expanding in Florida.	↓	Definite loss of momentum in ag biotech, and new state investments in R&D do not recognize bioscience sector; impact of stem cell initiative remains to be seen.
Saskatoon	Heavy clustering of large and small firms interested in hybrid oil-seed research at federal laboratory housed on campus, hit hard by consolidation of ag biotech majors but major victory in recruitment of Pyxis animal genomics startup	↔	Shifting veterinary research into broader virology focus, and leveraging bioprocessing expertise to focus on food, fiber and energy applications
Seattle	Burst of spin-offs from Hutch and Institute for Systems Biology (L. Hood) were acquired, giving out-of-state pharmaceuticals a presence but lowering entrepreneurial energy	↔	Heavy new development of commercial wet-lab space and de facto research park in South Lake Union, near the Hutch.
St. Louis	Region has attracted and grown new start-up companies, in part, as a result of CET and the NIDUS Center and has succeeded in attracting significant investment in local, life science venture funds. St. Louis has gained national recognition as a center for plant sciences.	↑	More than \$400 million invested in life science venture capital funds, and creation of Biogenerator. Efforts designed to increase number of new start-up companies and accelerate their growth.

## Focal Areas

Every one of the seven benchmark regions is targeting bioscience as one of *several* technology sectors (see table on following page). The most common additionally targeted sector is information technology or advanced communications technology. Other sectors that these regions are targeting include advanced manufacturing (including robotics), environmental technology, and homeland-security/defense applications. Three regions—Indianapolis, Phoenix and Pittsburgh—are targeting bioscience pursuant to explicit strategies or commissioned roadmaps. In the balance of the benchmark regions, the targeted sectors can be deduced from the way resources are allocated, but are not the subject of explicit plans.

Within the biosciences, each benchmark is targeting multiple subsectors, either explicitly through a roadmap or implicitly. As in St. Louis, the tendency is to emphasize subsectors where there are existing strengths in either the academic or industrial sectors. The broadest scope of subsector targeting is Seattle, where the Governor has articulated interest in the convergence between bioscience and information technology (levering the presence of Microsoft). The narrowest targeting is in Indianapolis, where the BioCrossroads partnership has identified eight sub-sectors, some related to disease and others to enabling competencies. Two regions (Indianapolis and Saskatoon) explicitly target ag biotech, although there are some additional strengths in San Diego.

**Implications for St. Louis:** *St. Louis should consider whether it needs to undertake an updated and more comprehensive core competency/technology platform analysis as other states and regions have recently done to not only identify their focus areas, such as plant and life sciences, but the specific niches within these areas. The original strategy identified core competencies but it may now be time to further refine and update these areas as well as to examine “convergent” targets given the region’s simultaneous interest in information technology and advanced manufacturing as well as plant and life sciences.*

Region	Overall S&T sectors targeted by the region	Comment	Sub-sectors targeted by the region within bioscience	Comment
Baltimore/- Washington	Bioscience, IT, defense/ homeland security	Implicit – Maryland has no overall strategy	Sequencing, bioinformatics, applied genomics	Implicit, recognized by Montgomery County. No consensus in Baltimore.
Indianapolis	Bioscience, IT, advanced manufacturing identified as “pillar” industries	Explicit targeting by Central Indiana Corporate Partnership/ BioCrossroads	Sports medicine; neuroscience; cardiovascular; protein analysis; Bio-MEMS; cancer; evidence-based medicine; ag biotech	Explicit, in roadmap commissioned by CICIP
Phoenix	Bioscience, AC/IT, Sustainable Systems	Explicit roadmaps commissioned by state Commerce Dept.	Bioengineering; neurological sciences; cancer identified as near term platforms and asthma, infectious diseases, as long term platforms	Explicit, in roadmap commissioned by Flinn Foundation
Pittsburgh	Bioscience, IT, robotics, environmental	Explicitly targeted by Pittsburgh Regional Alliance along with other non-tech sectors	Drug discovery tools and targets; tissue/organ engineering; medical devices/diagnostics and systems biology	Explicit, in roadmap commissioned by Life Science Greenhouse
San Diego	Bioscience, Wireless Telecom	Implicit – region has no explicit strategy	Biomanufacturing targeted as logical follow-on to multi-sector bioscience strength	No other targeting, not even “convergent” bio/IT sectors
Saskatoon	Bioscience, IT, energy	Implicit in provincial policy	Ag biotech, virology, bio-processing, structural biology leveraging light source	Implicit in provincial policy and funded Ag-West Bio intermediary
Seattle	Bioscience, IT	Implicit – no statewide strategy – Washington Technology Alliance recently released a Prospectus for Bio21 to use future tobacco settlement dollars to support the bio/IT convergence and other areas	Convergent bio/IT sectors that lever existing talent and capital	Targeted by governor’s Bio21 initiative
St. Louis	Bioscience, IT, Advanced Manufacturing	Explicit targeting by Coalition and RCGA through plant and life sciences strategy	Plant and life sciences and core competencies in genomics and gene sequencing, plant science, neuroscience, cardiology, virology/microbiology/immunology, tropical botany, and biomedical engineering	Have not further explicitly targeted niches within plant and life sciences

## Research Capacity Building

All the benchmark regions have made directed investments of public or philanthropic funds in building capacity to attract federal R&D funding (see table on following page). In some cases—San Diego, Saskatoon and Seattle—targeting seems to have been relatively weak, and investment has been opportunistic based on availability of funds rather than driven by top-down strategy. In the balance of the benchmarks, investments have been made pursuant to specific strategies or initiatives that enjoy broad support among civic leadership.

The most common form of investment in bioscience R&D capacity has been in “bricks and mortar” or construction of specialized or interdisciplinary research laboratories. The largest such initiatives are in central Indiana and Phoenix. In the Indianapolis region, IU is building major capacity in both downtown Indianapolis and at Bloomington, pursuant to its Indiana Genomics Initiative (INGEN), and Purdue is building a major bioengineering component into its four-building Discovery Park complex in West Lafayette. In Arizona, ASU has embarked on a major multi-building Biodesign Institute at its Tempe campus at the same time as it participates aggressively in an emerging research district in downtown Phoenix.

Three of the regions also have funding available to support the recruitment of “star” faculty who bring with them large portfolios of federally sponsored research, and to retain promising young faculty. The largest directed faculty-recruitment program is in Indiana, where the Lilly Endowment has set aside \$100 million for an Initiative to Recruit and Retain Intellectual Capital. Faculty recruitment is also a main focus of the Pittsburgh Life Science Greenhouse collaborative, and has been supported in Saskatoon through federal/provincial collaboration.

Institutions in Indianapolis and Phoenix are also able to lever state grant programs for bioscience research. The largest targeted bioscience grant program is in Pennsylvania, although part of it is distributed pursuant to formula. The largest competitive program is in Indiana, although bioscience is only one of several fields supported. Arizona is launching a modest-sized, competitive program that is completely targeted to the biosciences. In general, these grant programs attempt to act as strategic investors in programs that have the capacity to build excellence and return many times their cost in enhanced federal R&D support.

In three of the benchmark communities, regional philanthropies have made strong commitments that helped catalyze or release major new commitments from state government. For example, in Indiana, the Lilly Endowment’s \$155 million commitment to INGEN and \$100 million for its faculty recruitment programs helped gain political support for the state’s \$1.2 billion umbrella “Energize Indiana” initiative, which included support for bricks and mortar, research, and associated commercialization activities. In Pittsburgh, several regional foundations (Heinz, Mellon and others) matched the state’s \$33 million commitment to the Life Science Greenhouse 3:1 over 5 years. In Phoenix, the Flinn Foundation commissioned the bioscience roadmap on behalf of state government, in a manner analogous to the roles played by the Danforth and Kauffman foundations in Missouri.

**Implications for St. Louis:** *Washington University’s BioMed 21 initiative compares favorably in scope to most of the capacity-building initiatives in the benchmark set, albeit - a significantly important factor—the absence of strong participation from state government. In addition, both SLU and UMSL are investing in major new bioscience facilities and UM—Columbia has just completed a new life sciences building.*

Region	Bricks and mortar—public or philanthropic	Faculty recruitment	Research Support	Note
Baltimore/- Washington	140,000 sq.ft., \$50m expansion of UMBI CARB II at Shady Grove 138,500 sq.ft., \$55.8m UMCP Bioscience Building \$1 million renovation of Bioprocessing Scale-up Facility at UM- CP			Hopkins raised funds for new cancer center and bioengineering buildings
Indianapolis	IU Genomics Initiative: 140,000 sq.ft., \$55.7m Multidisciplinary Science Building at Bloomington Biomedical Research and Training Complex at IUPUI Bioscience/Engineering building 1 of 4 at \$100m Purdue Discovery Park	\$100m from Lilly Endowment for Initiative to Recruit and Retain Intellectual Capital (multi-field)	21 <sup>st</sup> Century Research and Technology Fund recapitalized at \$72m per biennium for next decade (multi-field)	Major funding sources for IU Genomics Initiative include \$155m from Lilly Endowment and \$75m from the state in securitized tobacco settlement (also for other projects)
Phoenix	Combined state, city, foundation, tribal support for 250,000 sq.ft., \$72.8m home for TGen/IGC, part of \$90m package 250,000 sq.ft., \$72.8m ASU Biodesign Institute Phase I (20% state supported) 170,000 sq.ft., \$65.7m Institute for Biomedical Science and Biotech in Tucson	Proposition 301 funds from a portion of the state sales tax are providing \$20 m. a year for university bioscience initiatives including facilities, faculty and equipment.	Arizona Disease Control Research Commission will apply \$10-12m/year in incremented tobacco tax to translational research ASU/UA/NAU jointly committing \$27m to a Bioscience Collaborative to be housed downtown adjacent to TGen building	State legislature approved \$440m in new capital funding to diversity of Regents-approved projects (multi-field)
Pittsburgh	Facilities Fund part of Life Science Greenhouse and \$90 m. of Pitt's capital campaign is funding a 330,000 sq. ft., \$211m Biomedical Science Tower	Opportunity Fund part of Life Sciences Greenhouse	State will spend \$60m annually from tobacco settlement in biomedical research, some formula, some competitively targeted to priorities of Greenhouses	State committed \$60m in one-time startup funds to Greenhouse, matched 3:1 by local foundations over 5 years.

Region	Bricks and mortar— public or philanthropic	Faculty recruitment	Research Support	Note
San Diego	New interdisciplinary biomedical engineering building (Whitaker and others)			State commitment to Cal Institute in San Diego is focused on wireless/telecom, with no significant convergent thrust
Saskatoon	160,000 sq.ft. of new space for International Vaccine Center at VIDO (Veterinary Infectious Disease Organization) C\$173.5m Canadian Light Source (synchrotron) to open on campus with beam-line stations dedicated to bioscience	Federal/state collaboration filled 17 chairs of strategic importance (multi-field)	Provincial government maintains its own applied-R&D company (multi-field) housed at the research park Light Source projected to capture incremental C\$35m in industrially sponsored research	Federal government maintains two major laboratories on campus
St. Louis	\$60 million Life Science Center at UM-Columbia \$80 million research building at SLU BioMed 21, a \$150 million, 250,000 sq. ft. of research space planned at Wash U UMSL renovating science building and plans to construct clinical building and academic science building		State to spend portion of tobacco settlement dollars on life science R&D starting in 2007	

## Industry Partnerships

In each of the benchmark regions, university faculty can access funding intended to create an incentive for collaboration between university laboratories and industrial R&D operations (see table on the following page).

In the majority of cases, these programs are run external to the university, either by a publicly funded nonprofit or by a government agency itself. The largest government program is Indiana's 21<sup>st</sup> Century Research and Technology Fund. Budgeted at \$72 million per biennium (for research, partnership, and commercialization programs), the 21<sup>st</sup> Century Fund has the capacity to underwrite significantly large-scale collaborations. For example, the Fund has helped create a proteomics center that is a collaboration of the major universities and bio-pharmaceutical firms in central Indiana. Another aggressive program is run by the nonprofit Pittsburgh Life Science Greenhouse, where public funds are melded with philanthropic support to offer generous Collaborative Research Grants.

Investigators at Maryland's College Park campus can lever an internally operated partnership program, and those at San Diego can access a system-wide University of California Discovery Grant. Most of these programs operate at the level of mid-six figure grants, and may be budgeted in total at a few million a year. These are not very large sums in the context of most bioscience research (in either academic or industrial labs). The one region that provides significant funding for university-industry research is Saskatoon where federal funding was applied at the level of *millions* of dollars to underwrite a collaboration at a deep enough subsidy that it helped attract Illinois-based Pyxis to the Innovation Place research park (other factors were Canadian R&D tax credits).

**Implications for St. Louis:** *Absent state action, St. Louis does not have at its disposal partnership mechanisms equivalent to even the most modestly funded of the benchmarks, and falls competitively quite far behind the most generous. Again, lack of state funding as proposed in the State of Missouri Life Sciences Strategy are adversely affecting St. Louis's competitive position.*

Region	External	Institutional
Baltimore/ Washington	<p>TEDCO Federal Lab Partnership pays 90% up to \$20k between in-state companies and federal labs (multi-field)</p> <p>TEDCO Maryland Tech Transfer Fund offers repayable grants up to half cost of collaborations with universities (\$1.5m total budget, multi-field))</p>	University of Maryland Industrial Partnerships Program funds collaborations \$70k-\$100k over one or two years (\$1.35m total budget, with focus on bioprocess)
Indianapolis	21st Century Fund will make grants or loans to academic/industrial collaborations (allocation for such projects is currently 10% but will rise to 50% within the decade)	
Phoenix	Arizona Disease Control Research Corporation can award competitive grants to industry in partnerships with the university although they rarely do so.	
Pittsburgh	Greenhouse offers repayable Collaborative Research grants for partnerships \$150k-\$250k, matched 2:1 by company or .5:1 by startups	
San Diego		<p>UCSD faculty may lever UC Discovery Grant, ranging \$50k-\$250k for up to four years, matched 1:1 by California company (\$20m total program budget, multi-field)</p> <p>UCSD CONNECT cosponsors Translational Medicine program that grants up to \$200k to “establish connections” between companies and investigators at SOM</p>
<b>Saskatoon</b>	<p>Federally, Plant Biotechnology Institute may house industry partnerships in 74,000 sq.ft. wing and they are eligible for federal Industrial Research Assistance Program and University/Industry Challenge Grants (up to C\$100k per year for five years)</p> <p>Ag West Bio has made C\$9m in grants to early-stage industry collaborations (almost pre-seed investments)</p> <p>Saskatoon has three bioprocess facilities open to partnership, one government owned, one nonprofit, and one bought by the research park out of bankruptcy from a private tenant</p> <p>Now completed federal/provincial program located C\$91m to 300 applied R&amp;D projects conducted in partnership with industry</p>	
Seattle	Washington Tech Center R&T Development Grants offer up to \$100k/year for two years matched 1:1 by Washington company, lower ratio for startups (multi-field)	
St. Louis		

## Technology Transfer/Commercialization

Another function recognized in one way or another by all the benchmark regions (see table on the following page) is providing funding to advance the commercialization of technology owned by universities. In order to commercialize institutionally owned IP at the highest value—and sometimes in order to license it at all—it is commonly necessary to perform additional “proof of concept” studies, sometimes involving animal trials or in the case of engineering discoveries a working prototype. Often it is also necessary to “surround” the original discovery with additional patents and protections. This kind of work is usually conducted by faculty members (although sometimes by outside consultants) but at the direction of the professional staff in the university licensing office. It is almost never fundable through conventional, peer-reviewed federal programs, and if it is to take place at all, it must be separately funded under a different set of criteria focused mainly on economic development. This was the original vision for the St. Louis BioGenerator.

In Baltimore/Washington and Pittsburgh, a government-funded nonprofit makes commercialization funds available. In the other regions, the institutions themselves have set aside appropriated funds or endowment to pay for these projects. The size of commercialization awards usually ranges from \$50,000 to \$300,000, and most programs are budgeted at a level that can support only a few such projects per year. Some programs claim to support “commercialization” activity by companies (either of technologies developed in partnership with universities or of the internally generated variety). However, in practice these funds are difficult to distinguish from pre-seed venture funding.

**Implications for St. Louis:** *Wash U through its Bear Cub Fund and SLU using discretionary funding have begun to make funds available for various proof of concept and commercialization activities and the BioGenerator was designed to address this funding gap. St. Louis needs to determine, however, whether the requirement placed on the BioGenerator by its funders of achieving self-sufficiency during a specific time period is preventing it from meeting the identified need for very early-stage, exploratory commercialization funding. Consideration should also be given to whether the resources available for commercialization funding are at a level commensurate with the size of the community’s research enterprise.*

Region	External	Institutional
Baltimore/- Washington	TEDCO University Technology Development Fund pays 50% costs up to \$50k	The region's major research universities jointly market themselves through a Maryland Technology Partnership for Innovation
Indianapolis		Purdue Research Foundation operates Trask Venture Fund \$100k Technology Innovation Awards for pre-commercialization research \$250k pre-seed awards to help launch startup (almost a pre-seed equity fund)
Phoenix		ASU has placed its tech transfer activities with a for-profit commercialization company owned by the research foundation It manages an Innovation Fund which offers grants \$25k-\$50k for proof-of-concept (program budget \$300,000)
Pittsburgh	Greenhouse's Technology Development Fund awards grants up to \$100k for pre-commercialization research Idea Foundry provides \$100,000 to help develop ideas into start-up companies	
San Diego		UCSD branch of Cal tech transfer office states it has higher proclivity than other campuses to accept equity in startups
Saskatoon	Ag West's programs are part industry partnership, part commercialization research, part pre-seed funding	U of S separately incorporated tech transfer agent was integrated into the university as an industrial liaison office
Seattle		Hutchinson Cancer Center has own internal fund for technology development UW's systems are in transition
St. Louis	Biogenerator	Bear Cub Fund SLU discretionary investments

## Seed-Stage Venture Capital

About half the benchmark regions have in place explicit programming to increase the supply of seed-stage capital available to assist in the launch of startups that emerge from university-owned technology and/or university/industry collaborations (see table following page).

The most direct approach to the lack of seed-stage capital is to offer it, using government funding, through a government agency (e.g., the Maryland Department of Business and Economic Development) or through a nonprofit with a special relationship with government (e.g., the regional Ben Franklin Partners Centers of Pennsylvania, including Innovation Works in Pittsburgh). Small injections of capital may be made by repayable grant, while larger investments (nearing \$500,000) are often made through near-equity investments. The investing entity, whether government or nonprofit, is usually allowed to revolve its gains.

Communities that prefer the market discipline of investment through privately managed venture funds may prefer programs that increase the supply of locally managed venture-capital partnerships with a stage and sector orientation appropriate to the region's needs. These programs all operate on the theory that investors with local partners will base locally and source most of their deals locally, and that by providing early or large capital contributions, investors from the public or quasi-public sector can influence investing philosophy in a way that coordinates well with regional strategy. Some regions like Pittsburgh have approached the problem like St. Louis, through loosely coordinated investment decisions by individual institutions. Others have found that they need a formally structured "fund of funds" mechanism, and preferably one that is sufficiently attractive in its risk/return profile to induce participation by larger investors like public pension funds.

One of the older and best known such initiatives is the Maryland Venture Capital Trust (est. 1990), which should be thought of as a publicly chartered fund of funds. Similar in philosophy is the legislatively mandated program under which the Pennsylvania Tobacco Settlement Board has invested \$60 million of its endowment in an internally managed fund of three venture funds, all of which are active in the mid-Atlantic region. In both cases, the investment of the public agency is likely to be levered many times over, counting investments that flow to in-state deals from these VC funds' other institutional investors and from their syndicate partners on individual deals. In a related structure, the Maryland Department of Business and Economic Development was authorized to reinvest returns it made from its direct IT investments into an internally managed fund of funds. Because this kind of vehicle has no fiduciary responsibility to any pension funds, it has been able to insist more clearly on participating only in early-stage venture partnerships.

In Indiana a new model has emerged of a kind that was discussed in St. Louis by certain public pension fund managers: namely a fund of funds privately managed by a well recognized Registered Investment Advisor, in this case the CS First Boston Customized Funds Group. Although the BioCrossroads fund will have pension fund investment, the transparency of an outside professional manager has given its investors confidence to endorse an investment strategy that focuses heavily on in-state venture funds, with a heavy orientation to early-stage deals in sectors targeted by the regional strategy, and with a commitment that a majority of the funds' investments will ultimately be made in Indiana companies.

**Implications for St. Louis:** *St. Louis has been somewhat unusual in being able to catalyze formation of new venture funds by informal coordination of several large institutional investors. In addition, it has created a fund of funds, Vectis, which has made investments in both local and East and West Coast venture firms. It remains to be seen in terms of the level of investment that these firms will make in St. Louis companies. In the future, St. Louis may need to adopt a more formal structure in order to attract broader and deeper pools of later-stage capital sufficient to give local deals visibility on the national scene as well as to address continuing gaps in the pre-seed to seed stage of financing, gaps also found in benchmark regions.*

Region	Pre-seed programs directly state operated	State chartered fund of funds	Other initiatives
Baltimore/- Washington	<ul style="list-style-type: none"> <li>➤ Maryland Challenge Investment Program makes royalty-payback investments up to \$150k, matched 1:1 by outside co-investment</li> <li>➤ Maryland Investment Fund (MIF) makes equity investments from \$150k to \$500k, matched 3:1 by outside co-investment</li> </ul>	<ul style="list-style-type: none"> <li>➤ Now winding down is 1990 Maryland Venture Capital Trust which combined pension investments and appropriations to invest in 8 VC partnerships that agreed to open local offices and consider in-state deals</li> </ul>	<ul style="list-style-type: none"> <li>➤ MIF gains on IT investments were reinvested through an internally managed fund of funds in five venture capital firms under similar terms to the Trust, including a bioscience-oriented SBIC</li> </ul>
Indianapolis			<ul style="list-style-type: none"> <li>➤ BioCrossroads assembled \$72m in commitments to a privately managed fund of funds to target 60% to in-state VC funds, 70% in early-stage deals, 60% ultimately flowing to Indiana companies; and 60% to bioscience</li> <li>➤ Six investees in first round were one local fund, two joint ventures with out-of-state VCs, and two nationally known firms based elsewhere opening local offices</li> <li>➤ Several other indigenous early-stage funds may compete for allocations from subsequent rounds</li> </ul>

Region	Pre-seed programs directly state operated	State chartered fund of funds	Other initiatives
Phoenix		Legislature considering a tax-credit backed fund of funds as an alternative to CAPCOs. Private sector is forming Fund of Funds with state and local pension funds as a targeted source of funding.	Legislature considering a tax credit for investment in early-stage venture funds
Pittsburgh	<ul style="list-style-type: none"> <li>➤ Ben Franklin Technology Development Authority may make direct investments (multi-field)</li> <li>➤ Innovation Works, the regional Ben Franklin Center, uses appropriations to make several tiers of near-equity and equity investment: up to \$100k, up to \$250k, and up to \$500k or \$1.1 m total (multi-field)</li> <li>➤ Greenhouse has placed \$15m in seed funds with PA Early Stage, one of the funds selected by the Tobacco Settlement Board (see right)</li> </ul>	Tobacco Settlement Board was required to invest \$60m in three venture funds which will be active in state in areas targeted by the three Greenhouses	Pittsburgh foundations have made their own “patriotic” investments in new wave of VCs with local offices (Draper-Triangle, Birchmere, etc.)
San Diego			In recent years many Silicon Valley VC firms have opened San Diego offices
Saskatoon			Regional investors formed Foragen, an early-stage venture firm specializing in commercialization of ag-biotech
Seattle			Institute for Systems Biology partnered with 3 VC firms and Alexandria REIT to form captive seed fund, Accelerator Corporation.

Region	Pre-seed programs directly state operated	State chartered fund of funds	Other initiatives
St. Louis			Vectis Life Science fund, \$100 million fund of funds Prolog Capital RiverVest Venture Partners Oakwood Medical Investors Biogenerator Fund

### Research Parks/Incubators

Of the benchmark regions only San Diego lacks a well developed initiative for university-related bioscience research parks and that is because the private market in the county has served that region so well.

In sheer scope the most active player is Maryland. Its best advanced research park—Montgomery County’s Shady Grove Life Science Center—is not strictly university related, though it has university tenants. Meanwhile, each research branch of the University of Maryland system (Baltimore, Baltimore City, and Baltimore County) is slated for its own research park. Even more significantly, Baltimore City government is embracing large-scale research parks both at the UMD campus near the Inner Harbor and in East Baltimore, adjacent to Johns Hopkins Medicine. The largest-single well established university-related park in the set continues to be Innovation Place in Saskatoon, which is tightly integrated with the University of Saskatchewan and has maintained a strong focus on bioscience including ag biotech.

Other downtown research parks that are currently in development but have the potential to grow much larger and more significant include the Copper Square district in Phoenix, the Canal District in Indianapolis, and the tentative Hazelwood Works in Pittsburgh. In Phoenix, ASU is also re-orienting a substantial share of its existing university research park to bioscience use (as is the University of Arizona in Tucson).

In most cases, a region’s wet-lab incubators are associated with these research parks. The largest incubator complexes are in central Indiana (at least 200,000 square feet of wet-lab space split between Indianapolis and West Lafayette) and Baltimore/Washington (150,000 square feet among Baltimore City, Baltimore County, Montgomery County and Prince George’s County). Incubator space in Pittsburgh remains scarce, and neither San Diego nor Saskatoon has a conventional university-related bioscience incubator at all.

**Implications for St. Louis:** *The original strategy discussed four research park nodes. CORTEX/BioMed21 begin the process of addressing the Washington U biomedical node; NIDUS/Danforth Plant Sciences Center represents the second node; SIU-Edwardsville the third; and the fourth was the already completed Missouri Technology Park in exurban St. Louis. St. Louis’ efforts with CORTEX; development of post-incubator, multi-tenant facilities; and progress at Edwardsville show that appropriate progress is being made to address facilities’ needs in the region.*

Region	Research park	Build out target	Current status	Note	Wet-lab incubators open
Baltimore/- Washington	Shady Grove Life Sciences Center in Montgomery County	300 acres, 200 tenants, surrounded by many more acres in private hands	Complete	County-developed – presence by UMD and Hopkins	Technology Development Center (50,000 sq.ft.) within the park.
	University of Maryland College Park	130 acres	Planning stage only		Technology Advancement Program (20,000 sq.ft.)
	bwtech@University of Maryland Baltimore County	5 buildings, 350,000 sq.ft.	Largely complete		Techcenter (49,200 sq.ft. of lab space – more offices) across the road
	BioPark at University of Maryland, Baltimore	8 acres, 800,000 sq.ft.	1 building		UM,B operates a small (<2,000 sq.ft.) incubator already
	Life Science and Technology Park in East Baltimore	2m sq.ft.	Planning stage only	Adjacent to Johns Hopkins Medicine	
Indianapolis	Unnamed research park	4 buildings to start	1 building (see incubator column)	Incubator/ multi-tenant facility is core of planned downtown research park	Indiana University Emerging Technology Center (62,500 sq.ft. with 28,000 sq.ft. of wet lab space)
	Purdue Research Park	150 acres	100 acres	West Lafayette	Several incubator/multi-tenant buildings now totaling more than 220,000 sq.ft., much of it lab equipped

Region	Research park	Build out target	Current status	Note	Wet-lab incubators open
Phoenix	University Research Park	320 acre, 1.6m sq.ft.	Largely built	16 acres being dedicated to bioscience (similar to re-orientation at UA in Tucson)	None at present
	Unnamed development district at Copper Square (downtown)				Among institutional uses, one entrepreneur will dedicate part of a 300,000 sq.ft. building to incubating other companies
Pittsburgh	Pittsburgh Technology Center	48 acres	Largely built	Presence by both Pitt and CMU as well as non technology tenants	Building custom-built for Cellomics subleased in part to Life Science Greenhouse incubator (15,000 sq.ft.)
	U-PARC	Multiple buildings	Fully built	Adaptive reuse of old Gulf Oil R&D campus including institutional uses for Pitt and multi-tenant labs	No formal incubator, but has served as one de facto
	South Side Works	130 acres	First phase built	Home to Pitt McGowan Institute	None to date
	Panther Hollow	1 building	Built	Dedicated to research partnerships with CMU, but not bioscience	
	Hazelwood Works	138 acres	Planning stage	Acquired by joint venture controlled by area foundations	Unclear
San Diego	San Diego Regional Technology Park	1,000 acres	Discussion stage only	Proposed as hub of network of parks aimed at biomanufacturing	Region's only university-affiliated incubator is not bioscience oriented (SDCC's Center for Applied Competitive Technologies)

Region	Research park	Build out target	Current status	Note	Wet-lab incubators open
<b>Saskatoon</b>	Innovation Place at University of Saskatchewan	80 acres, 18 buildings, >1m sq.ft.	Largely built		No formal incubator, but 75,000 multi-tenant greenhouse  Major federal lab in tenancy (federal PBI) offers space for firms in partnership
<b>Seattle</b>	South Lake Union district	50 acres under control of Vulcan Ventures, 10m sq.ft. of mixed use planned	Emerging	Private development serving as de facto research park for UW, Hutch, ISB  Also emerging private sector interest in Bothell, Renton and Seattle Port Terminal 91	Only formal incubator (WTC) is not wet lab oriented
<b>St. Louis</b>	CORTEX & BioMed21, planned biotechnology corridor in St. Louis central core  Also NIDUS/Danforth Plant Sciences Center/ NIDUS/Monsanto location for plant sciences and SIU/Edwardsville for ag and energy oriented park		Early stage of development	Supported by a partnership of the region's major research institutions	CET  NIDUS Center

## Talent Pool

Efforts to address the talent pool in the benchmark communities include technician training; efforts to interest undergraduates in biosciences; graduate or professional tracks aimed at bioscience employment; and attempts to develop a cadre of skilled entrepreneurial management (see table following page)

Nearly every benchmark region offers technician training through either the community college system (Phoenix or Pittsburgh) or some specially created nonprofit (Baltimore). In Indianapolis, the major biopharmaceutical employers received government funding to work on course development with the joint IU/Purdue campus in Indianapolis and Ivy Tech, the Indiana analogue to a community college network. Also in Indiana, the state's colleges and universities can compete for \$40 million in funding held out by the Lilly Endowment for programs that increase the likelihood that undergraduates will take their first jobs in the region and remain there.

At the graduate and professional level, there is evidence of new M.S. programs (San Diego) and bioscience-tracked MBA programs (Indianapolis). However, the most important new initiatives seem to be aimed at training both faculty and external parties in entrepreneurial skills. Examples include Pitt's Limbach Center, ASU's Technopolis Program, the Executive Corps within the Pittsburgh Life Science Greenhouse, and campus entrepreneurial centers in Seattle and Saskatoon (the latter specifically in agricultural entrepreneurship).

**Implications for St. Louis:** *St. Louis Community College offers an Associate of Applied Science in Biotechnology degree but the program is limited by space. The lab can only accommodate 16 students at one time. As the region's start-up companies expand, there is likely to be greater demand for technicians than can be produced currently. Both NIDUS and CET provide entrepreneurial training and NIDUS has had success with its Executive In Residence program but these efforts may need to be expanded to meet the need for entrepreneurial managers, who do not necessarily emerge from the corporate community or conventional business education programs. Enough energy is needed that personnel being recruited or retained feel they will have other options if their current venture falters. Overall, more attention should be paid to the talent issue than has in the past four years, as it will impact St. Louis's competitive position.*

Region	Technician Level	Undergrad	Grad/Professional	Managers/Entrepreneurs
Baltimore/Washington	BioTechnical Training Institute			
Indianapolis	New biotech associate's degree IUPUI/Ivy Tech	Lilly Endowment offers \$40m in competitive grants for retention programs	IU has new Health Care Life Sciences Academy within Kelly School of Business, co-chaired by incubator CEO	Independent Indiana Venture Center charged to work with all university entrepreneurial centers
Phoenix	Community Colleges led by Maricopa County College commissioned a comprehensive bioscience strategy			ASU created Technopolis, a mentoring/coaching program for both ASU affiliates and others, outsourced to private investment management firm
Pittsburgh	Allegheny Community College a participant in workforce planning efforts by regional leadership	State offers science scholarships to undergrads (\$3k) and community college students (\$1k)		Life Science Greenhouse operates Executive Corps to develop cadre of seasoned interim CEOs  Pitt Medical Center operates Limbach Entrepreneurial center to train faculty/postdocs. A recently created Office of New Enterprise Development also provides support for entrepreneurs.
San Diego	Miramar College hosts a consortial Southern California Biotechnology Center that coordinates training		New UCSD School of Pharmacy and Pharmaceutical Sciences  SDSU has developed specialized masters in regulatory affairs as part of CSUPERB	CONNECT coordinates VentureForth program for UCSD students
Saskatoon		Four divisions of U of S collaborate on a Virtual College of Biotechnology		CIBC granted \$1m to U of S to create a Center for Agricultural Entrepreneurship

Region	Technician Level	Undergrad	Grad/Professional	Managers/Entrepreneurs
Seattle	Shoreline Community College offers lab tech curricula			UW Business School has created a Center for Technology Entrepreneurship
St. Louis	St. Louis Community Colleges offers Associate of Applied Science in Biotechnology		SLU offering Bioinformatics program for existing workforce	CEO in Residence Biogenerator Kauffman Campuses Initiative for Entrepreneurial Education at Wash U

## Business Environment

Three of the communities are in states that have made changes to business tax credits designed to incentivize R&D-based companies, and a fourth is considering this action. Moreover, in contrast to the situation that might have been expected a decade ago, the mayors of five of these communities have aligned themselves strongly with bioscience strategies, and especially research park development (see table below). In San Diego and Seattle this has been accompanied by efforts to provide limited regulatory relief and in Phoenix by a call for a major new incentive program to attract technology-based “anchors” to the city.

**Implications for St. Louis:** *In contrast to the benchmarks, Missouri’s R&D tax credit is no longer funded and no new tax incentives have been put in place to benefit the bioscience or technology sectors. The County and the City of St. Louis have been supportive of CORTEX and efforts to construct multi-tenant space to house bioscience companies. A critical issue in Missouri, that is not an issue in the benchmarks, is opposition to stem cell research, which has resulted in blocking legislation to improve the climate for plant and life sciences companies in the state. The region will want to continue to work with municipal policy-makers, and should continue to try to build support, especially at the state level, to improve the environment for the region’s plant and life science companies, including resolving the dispute over stem cell research.*

Region	Most important initiatives	Municipal support
Baltimore/Washington	Pappas Report recommended enhancements to state R&D credits and pension fund investing – no action to date.	Strong support by mayor for two research parks – one at UMD, one at Hopkins.
Indianapolis	Energize Indiana umbrella economic development initiative included enhancements to state Venture Capital Investment and R&D tax credits	Entire central Indiana initiative has had strong support including financial (for trade associations and incubator construction) from two successive mayoral administrations
Phoenix	State Legislature considering enhancements to R&D tax credit.	City participated in T-Gen/IGC recruitment, and helped force ASU/UA collaboration downtown. Mayor has called for \$100m Knowledge Capital Economy Fund
Pittsburgh	State recently expanded R&D tax credit and made it tradable	Difficult relations between life science initiative and city administration
San Diego	City added San Diego Science & Technology Council and a technology loan fund	Increasingly strong coordination with municipal and county government
Saskatoon		
Seattle	State expanded exemption of research based companies from business and occupation tax	Two successive mayors have expressed strong support for bioscience development as an economic driver, with current mayor’s focus on South Lake Union
St. Louis	Missouri Development Finance Board is providing \$12 million in tax credits to purchase land for CORTEX	The City of St. Louis has committed \$10 million in infrastructure support for the development of CORTEX

## SUMMARY AND CONCLUSIONS

The St. Louis region has made progress in building its infrastructure to support the plant and life sciences and is currently among the top metro areas in terms of bioscience employment. By and large, the region has maintained its position among its peer and competitor regions. But it is also clear that a number of the benchmarks are working aggressively, with significant, sustained support from state and local governments, to build their bioscience economies. The investments being made could threaten St. Louis' position.

Table 13 summarizes the activities underway in the benchmark communities, compares St. Louis to them, and suggests implications for St. Louis' competitiveness in the biosciences.

**Table 13: Implications of Benchmarking Analysis for St. Louis**

Area	Benchmark Findings	Implications for St. Louis
Overall	Significant investment ranging from \$75 million to \$510 million Targeting subsectors and areas of convergence	May want to re-examine core competencies/technology platforms to identify niche areas for focus Examine opportunities for technology convergence
Research Capacity Building	Investing in "bricks and mortar", bioscience research and recruitment of "star" faculty	Wash BioMed21 and other investments in research facilities compare favorably but lack of state support is a problem
Industry Partnerships	All provide funding to university-industry research collaborations	St. Louis does not have mechanisms equivalent to even the most modestly funded of the benchmarks. Lack of state funding puts St. Louis at a competitive disadvantage
Tech Transfer Commercialization	Most provide grants for commercialization projects; however, most programs are budgeted at a level that can support only a few projects per year.	Bear Cub Fund and SLU addressing issue on an institutional level. Business model of Biogenerator may need to be revisited to ensure that it can provide funding for very early-stage, exploratory work. Level of resources for commercialization may not be commensurate with the size of the community's research enterprise
Seed-Stage Venture Capital	About half of the benchmarks have in place explicit programming to increase the supply of seed-stage capital	St. Louis has been unique in being able to catalyze formation of new venture funds. Broader and deeper pools of later-stage capital as well as capital to address gaps in the pre-seed to seed stage will be needed in the future
Research Parks and Incubators	Have well developed initiatives for university-related bioscience research parks and wet lab incubators	St. Louis has made progress in developing its research park infrastructure: CORTEX/ Biomed21 under development; 1 multi-tenant building under construction and another in planning stage; and construction of Corn to Ethanol plant at SIU-Edwardsville

Area	Benchmark Findings	Implications for St. Louis
Human Resources	Offer technician training, are introducing new graduate bioscience programs, and providing training for faculty and others in entrepreneurial skills.	St. Louis Community College offers an Associate of Applied Science in Biotechnology. SLU offers a bioinformatics program. Both NIDUS and CET provide entrepreneurial training and NIDUS has had success with its Executive In Residence program but these efforts may need to be expanded to meet the need for entrepreneurial managers. Talent issue needs to receive more attention than it has in the past four years
Business Environment	Have made changes to business tax credits designed to provide an incentive for R&D companies. Initiatives receiving strong support from local political leaders.	Missouri's R&D tax credit is no longer funded and no new tax incentives have been put in place. The County and the City of St. Louis have been supportive of CORTEX and efforts to construct multi-tenant space to house bioscience companies. Need to continue to work with municipal policy-makers, and try to build support, especially at the state level, to improve the environment for the region's plant and life science companies.

With regards to the specific benchmark communities, we found that:

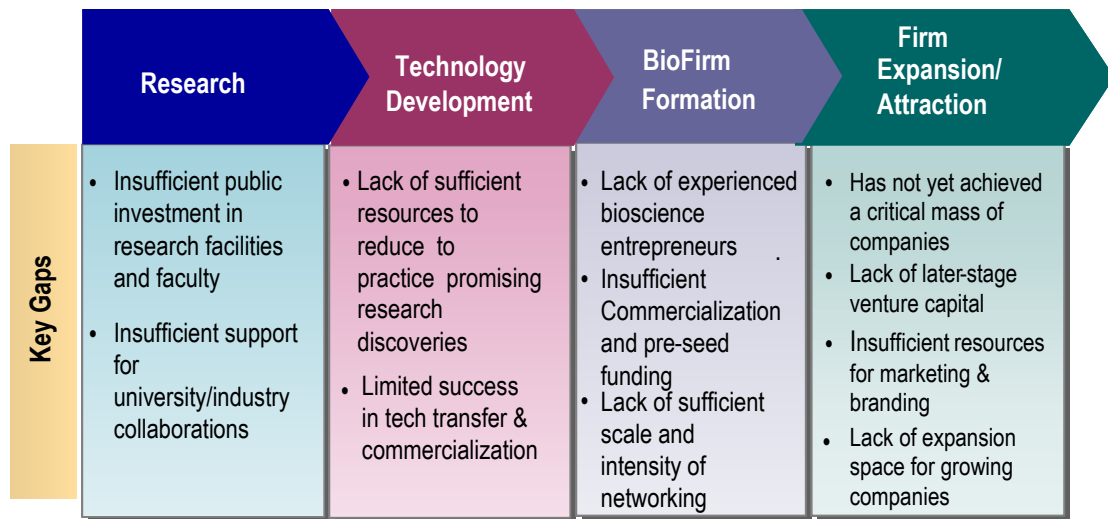
- In plant sciences, St. Louis is gaining on benchmarks like San Diego and Saskatoon, which both suffered from consolidation in the sector.
- However, new or existing players (Indianapolis, Research Triangle) bear watching, and Saskatoon is branching into food, fiber and fuel applications of bioprocess technology.
- Many regions with broad bioscience strategies are targeting subsectors at a finer level of detail than St. Louis.
- Many regions with interest in other sectors based on the existing industrial base are placing stronger emphasis on convergent fields such as bioinformatics, bio-engineering, and bioprocessing.
- While St. Louis's investments in R&D capacity are impressive on the philanthropic side, they seem to involve a lesser commitment from state government than in many other jurisdictions; at least until tobacco settlement funds are available in 2007.
- St. Louis's success in building early-stage venture capital funds should not obscure competitive threats posed by other regions with strong programs for industry partnership, technology commercialization, and formation of later-stage capital.

The next section of the report discusses continuing gaps identified by members of the plant and life science community in St. Louis.

## Moving Forward: Continuing Implementation and Addressing Gaps

In the process of assessing the progress that has been made in implementing St. Louis' plant and life science strategy, individuals interviewed were also asked to identify gaps that remain in St. Louis infrastructure to support the development of the region's plant and life science economy. As shown in Figure 11, a number of areas were identified as still needing attention. These include continuing funding gaps at the commercialization and seed capital stage as well as at the later stage for growing firms, difficulty in finding experienced managers and CEOs for start-up companies, need to create a more entrepreneurial culture at Wash U and lack of expansion space for growing companies. It should be noted that while all of these are areas that are currently being addressed, implementation of planned initiatives must move forward and in some cases the level of activity and/or funding must be increased to fully address the need.

**Figure 11: Gaps in St. Louis Infrastructure**



The gaps identified suggest that there are six areas that need additional, ongoing attention. These include:

1. Venture capital
2. Facilities and research infrastructure
3. Talent
4. Technology transfer and commercialization
5. Plant and life science business base
6. Business climate and quality of life issues.

The nature of the need in each of these areas is discussed below along with suggested actions that could be undertaken to address the gap.

## VENTURE CAPITAL

Two stages of capital investment that continue to be in short supply in the St. Louis region are commercialization and pre-seed funding and later stage venture capital in the range of \$5 - \$15 million investments (A, B and C Rounds).

Part of the rationale for addressing commercialization and pre-seed funding has been the lack of a critical mass of bioscience firms. In 2000, there were few role models and a culture that discouraged risk. While that culture still exists, in four short years there has been evidence of an emerging change in that culture as demonstrated by the emergence of successful role models such as Stereotaxis to fully occupied incubators at CET and NIDUS to success in building a \$400 million set of venture funds located in St. Louis. And entrepreneurs have moved to St. Louis from Saskatchewan, Alabama and Florida because of the region's focus on plant and life sciences.

### Commercialization and Pre-seed Funding

There is general agreement that St. Louis continues to have a need for more funding at the commercialization and pre-seed stage if it is to build both sufficient deal flow and achieve a critical mass of bioscience firms. Funding at the level of \$50,000 - \$150,000 is needed to conduct proof of concept/reduction to practice/ pre-prototype activities and further develop technology coming from university labs to the point at which it has been determined that the technology has commercial potential. This was initially the stage at which the BioGenerator was expected to invest but because the BioGenerator was structured to become self-supporting after eight years, there has been pressure to make larger, more downstream investments that are more likely to generate positive returns. Options for addressing this gap include:

- **Organizing angel investors.** The Tech Gateway Council commissioned a survey in 2004 to determine if there were a sufficient number of potential angel investors in St. Louis to warrant creating a formal angel investor network. The respondents to the survey reported that 32 percent had made angel investments in the 1998–2003 time period and 20 percent planned to make an angel investment in 2004 suggesting that there are indeed individuals in the region that are or could become angel investors. Two-thirds of the respondents said that they had not made an investment because they had not been approached to do so. RCGA is currently working to organize the Arch Angels Investor Network, modeled on a successful angel investor network, Tech Coast Angels in San Diego that would invest at the level of \$200,000 to \$1 million. *Once this angel investor network is launched, efforts should continue to organize additional angel networks, including one focused exclusively on the plant and life sciences.*
- **Expanding Wash U's Bear Cub Fund and SLU's discretionary funds for commercialization.** Both Wash U and SLU have taken important first steps in addressing the need for funding to move technology to the point at which its commercial potential has been demonstrated. These initiatives should be continued and additional funds sought to expand these efforts as demand dictates. The Bear Cub Fund is currently funded at approximately \$250,000 annually, which will enable it to support about 8 projects a year. SLU currently has

between \$100,000 and \$200,000 in discretionary funds that can be used for this purpose. ***Funds need to be doubled or tripled for doing proof of practice/ due diligence of basic research.***

- **Restructuring the Biogenerator to enable it to undertake the proof of concept/ due diligence/ scouting functions in its original design that cannot have a Return on Investment expectation.** Philanthropic or public funds will need to be found to enable the Biogenerator to provide support for proof of concept activities as well as enable it to “bundle technologies” at the earliest stages across research institutions and anchors.
- **Addressing Pre-Seed/Seed Stage Capital Financing Gaps.** In part, this need will be met by the creation of a Pre-seed Fund that is currently under development. Within Prolog II, \$7.5 million is earmarked for funding Biogenerator companies at the pre-seed stage. Ultimately, however, the region will need several sources of seed and pre-seed stage financing to build its critical mass of firms

The most critical priorities in addressing capital gaps for St. Louis are to concurrently address deal flow through increased ability to identify and form firms (proof of concept/ due diligence/ Bear Cub funding), pre-seed and seed financing, as well as, later stage venture funding. The first priorities are the funding for proof of concept and pre-seed and seed financing.

### **Later Stage Venture Capital**

During the last four years, the St. Louis region has been very successful in creating local venture funds that are investing in early stage companies. The region has not yet grown or attracted larger funds able to make the level of investment that will be required as the region’s start-up companies grow. Presently, St. Louis’ venture capital funds are insufficiently capitalized to be capable of leading follow-on financings. A concern expressed quite often in the interviews is that the companies that the region has been able to successfully incubate and nurture may leave the region if they are unable to obtain the venture capital they need for expansion. There has thus far been one instance of a firm, currently in the CET, which is relocating to Wisconsin because its venture investor is located there. Longer-term, St. Louis needs local venture capital funds that are adequately capitalized (at least \$150 – 250 million) to be full-scale participants in the market. The current St. Louis VC funds must establish strong track records in order to raise this amount of capital on the national markets.

In addition to the local funds that are investing at the seed stage, later stage venture funds that can be lead investors and can put together a national syndicate are needed. A major hurdle to be overcome in terms of building the region’s capital market is getting support from the institutional investment community. To date, the region’s insurance companies, financial institutions and pension funds have been unwilling to invest in this arena.

**One way to address this need for later stage venture capital is to convince Missouri’s public pension funds and other institutional investors to invest in regional venture funds as well as national funds that agree to open an office in Missouri or consider Missouri investments.**

Under a similar effort in Oregon, the Governor signed a bill reorienting the obligation so the Oregon Investment Council, which manages the state public pension plans, to “look at Oregon opportunities for diversification unless, under the circumstances, it is not prudent to do so.” In response to this change in its investment mandate, the Council contracted with CS First Boston to operate a \$100 million fund of funds that will invest in four or five venture-capital partnerships

that agree to significant exposure to Oregon deals, including in the biosciences. In Idaho, the state pension fund committed to investing in venture funds that agreed to open an office in the state. Vectis offered the opportunity for the State pension funds to invest in a similar fund but they have so far refused to do so.

**Continue participation in and expand the Midwest Venture Group but also establish clearly stated agreed upon “ground rules”.** Recently, a member of the Midwest Venture Group invested in a St. Louis start-up company. Due to the source of the funds, which included an investment by the Wisconsin Investment Board, the company has to agree to relocate to Wisconsin. While this firm may or may not have been able to obtain financing and still remain in St. Louis, this suggests the need for the Midwest Venture Group to propose ground rules for the future that would preclude out of state venture firms with sufficient second round financing to “raid” other Midwest regions for deal flow. While ground rules could permit relocation, there should be a series of tests required before such an event happens, including requiring each region to invest commensurately in startups. With Wisconsin’s continued efforts to further build a critical mass of venture funds along with other regions in the Midwest, this one example might otherwise be repeated. Wisconsin venture investors should be encouraged to co-invest in St. Louis deals just as St. Louis venture investors should be encouraged to invest in Wisconsin deals but in ways that do not necessitate the company relocating.

## **FACILITIES AND RESEARCH INFRASTRUCTURE**

The second key area that must be addressed if St. Louis is to continue to grow the plant and life science sector and capitalize on its success in nurturing new companies is facilities and research infrastructure. Facilities and space needs are of two types: (1) research space, labs, facilities and equipment in the region’s universities and other research organizations to attract the federal research funds and the commercial and health care benefits there from; and (2) adequate space for start-up firms in multi-tenant space that includes wet labs.

The very success of CET and NIDUS has led to a demand for multi-tenant space that is not currently being met although plans are underway to construct two new multi-tenant buildings. Both incubators have firms ready to graduate and expand who do not have a place, multi-tenant or accelerator space, to which to move. In addition, lab-equipped space will be needed if the region wants to attract expansions of companies that could serve as anchors for the region’s plant and life science sector.

Priority actions to address the need for lab space and facilities include:

- **Implement CORTEX.** A comprehensive, strategic business plan should be developed laying out a multi-year strategy for developing the area into a biotechnology corridor. Tax credits have been provided to enable CORTEX to purchase land and ground has been broken for a multi-tenant building in proximity to CET. Issues, such as marketing, financing for building development and fit out, and creation of a collaborative life science community in the region, among others, need to be addressed. CORTEX offers a significant opportunity to attract large as well as small and medium-sized firms to St. Louis to work in shared use facilities in close proximity to Washington University’s Medical School and complex.

- **Proceed with construction of the two multi-tenant buildings being developed by St. Louis County and CORTEX, and located near CET and NIDUS.** The US Economic Development Administration has awarded funds to cover the construction of two multi-tenant buildings. Plans must be developed and implemented that will allow these facilities to be leased at rates that will be affordable to the region’s emerging plant and life science companies. A clear need in the region, cited by many interviewed, is for more multi-tenant, post incubator space as both CET and NIDUS facilities are full and have firms ready to graduate if such facilities were available. In addition, the region may need to find other credit enhancement mechanisms that can be used to assist these post-incubator firms in obtaining private space.
- **Continue to invest in life science research and facilities but around technology platforms of comparative advantage.** In 2003, the Missouri General Assembly enacted legislation allocating a significant portion of the tobacco settlement revenues for life science research, commercialization, and technology transfer activities. The legislation places 25 percent of the overall tobacco settlement funds (approximately \$36 million per year beginning in 2007 through 2025) into a Life Sciences Trust Fund. Eighty percent of these funds will be invested in building research capacity. The remaining 20 percent will go to life science technology transfer and commercialization activities. **Every effort must be made to ensure that these funds are not diverted for other uses.**

In 2004 legislation was defeated that would have created a capital bonding program to fund medical school and other research and teaching facilities on the four University of Missouri campuses. The University of Missouri – St. Louis would have received the largest allocation of funds from the bond issue, which would have enabled the University to renovate the building that houses its science programs. Funding for these facilities should be pursued. In addition, the implementation of Wash U’s BioMed21 initiative and the funds to accomplish this will be critical to meeting the need for additional research facilities.

Because the region is beginning to lag other regions in attracting NIH funds, attention should be given to insuring the region’s private and public universities have sufficient capital and operating support to construct research facilities and have the funds to attract the best and brightest faculty. These facilities and faculty should be able to leverage significant federal funds. Other states increasingly are financially supporting private as well as public universities needs for financing of bioscience research facilities. Ways to enable the state to support the region’s private universities should be examined. Georgia, Maryland, and Pennsylvania are examples of states that are doing this.

As part of its further building of the region’s research base consideration should be given to undertaking a “core competency” and “technology platform” analysis of the region’s current and emerging bioscience strengths. While this was done in a general fashion in 2000, it has not been subject to further quantitative and qualitative analysis. Such a core competency review can enable the region to better see its R & D strengths across institutions to form a basis for collaboration; identify emerging opportunities around which to give future focus; and better align the region’s research strengths with its existing firm needs and interests. This analysis can also identify further ways to link the region’s strengths in information and communications technologies – the tools for biosciences – with the region’s academic and research strengths. Finally, this analysis can also help identify the areas of future focus for

the region – whether they are in molecular imaging, biopharma or biologics manufacturing including clinical trials, bioterrorism, food nutrition, industrial processing/ag biotech, bioenergy – all areas identified in our interviews as candidates for consideration.

- **Develop a long-term plan for the ongoing support of the Donald Danforth Plant Science Center.** Since it was established in 1998, the Danforth Center has succeeded in attracting a world-class team of interdisciplinary researchers and building its extramural research budget. But for the Center to be successful over the long-term, a stable source of funding must be found. Plans should be developed and implemented to create an endowment for the Center. The recent announcement that the Danforth Foundation will provide a \$50 million challenge grant during the next 5 years to leverage support for the Center is a very significant step in providing for the its long-term financial viability.

## **TALENT**

Interviewees identified two areas of need in terms of talent. First, St. Louis needs to attract and develop more entrepreneurial managers. Second, the region needs to educate and train the future plant and life science workforce.

### **Experienced Technology Entrepreneurs**

St. Louis has a critical need for experienced technology entrepreneurs. A concern expressed by many of the individuals interviewed was that it is very difficult to find experienced CEOs to head start-up plant and life science companies in the region. As a result, a number of the firms located in both CET and NIDUS have had to bring in CEOs from outside the region. This is of concern not only because it is difficult to recruit such CEOs but because it raises the prospect of firms relocating out of state if the CEO has no ties to St. Louis. This is particularly true in those cases in which the CEO is commuting from another region of the country.

The perception that St. Louis does not have a ready supply of entrepreneurs is supported by a study prepared by Joel Kotkin for RCGA and the Greater St. Louis Economic Development Council,<sup>16</sup> which concluded that a primary challenge for the region is attracting and retaining technology and entrepreneurial talent. The corporate culture that has long dominated the region is that of large corporations rather than lots of small, high-tech companies. Interviews and focus groups revealed that the region is “inhospitable to new entrepreneurial ventures and risk-taking. The authors also concluded, however, that talented, more entrepreneurial people are being attracted to the region, in part as a result of the growing “bio-belt” industries. Yet more needs to be done to attract and retain such talent. The designation of Washington University as recipient of a \$3 million Kaufman Campuses Initiative for Entrepreneurial Education grant provides an opportunity to encourage and build a stronger set of future technology entrepreneurs in the region.

Options for addressing the need for technology entrepreneurs include:

- **Create an expanded Entrepreneur in Residence program.** One tool that has been used in St. Louis to attract management talent with experience in the plant and life sciences is the

---

<sup>16</sup> Joel Kotkin, “The Corps of Rediscovery: St. Louis in the 21<sup>st</sup> Century”, Regional Talent Project Report, Spring 2004.

Entrepreneur in Residence program, which has been put in place at the NIDUS Center. The program supports an experienced executive who in turn provides mentoring and coaching for start-up companies in the expectation that the person will, in 6-12 months, become the CEO of one of the companies in the incubator. This approach has been successful at NIDUS whose CEO in Residence, a former Monsanto manager, is now the CEO of Chlorogen, which has raised \$6 million and is expected to graduate from the incubator shortly. In the future, the Entrepreneur in Residence program will be housed in the Biogenerator. It is proposed that this program be expanded into an Entrepreneurial Corps whose services could be made available not only to tenants of CET and NIDUS but to other plant and life science entrepreneurs. Funding on the level of \$500,000 to \$1 million per year will need to be identified to support this initiative. Some of these costs can be covered through reimbursements for services rendered.

### Future Bioscience Workforce Needs

As the St. Louis plant and life science sector expands, there will be a need for a larger number of workers, particularly at the technician level. Yet presently only one institution, St. Louis Community College at its Florissant Valley campus offers training for biotechnology technicians. The program, which is in its fifth year, has been very successful in placing its students with area businesses. In addition, a mobile van, financed with two NSF grants, has enabled 25,000 students in K-12 to be reached to educate and inform them on science, careers, and the biosciences.

The biotechnology technician program is limited, however, by space as its lab can only accommodate 16 students at one time. Furthermore, in order to provide opportunities for minority youth, this program needs to be expanded to locations within St. Louis City. **An option that might be considered to enable SLCC to expand their biotechnology offerings would be to provide lab space for the college in the new multi-tenant building being constructed by CORTEX or in the planned building to be located near the NIDUS Center.** A majority of jobs in the biosciences are expected to be technician jobs so these types of programs are important to both building a critical mass of firms and a critical mass of research to the region. And the State and region's research universities need to support the College's efforts to establish articulation agreements for the biotechnology technician program in order for students to pursue lifelong learning opportunities.

An action proposed in the 2000 strategy that has not been addressed specifically is to **align university curricula with industry needs**, although new curricula have been introduced at individual institutions. SLU, for example, recently announced the establishment of a new bioinformatics program for existing workers.

## TECHNOLOGY TRANSFER AND COMMERCIALIZATION

It is generally acknowledged that the number of companies being created around technologies developed at the regions' research universities is low given the level of research conducted. Data on number of disclosures, licenses and start-up companies at SLU and Wash U collected by the Association of University Technology Managers for 2000–2002 show that both SLU and Wash U significantly outperform the top quartile of universities in terms of licenses per \$10 million of R&D. See Table 14. In terms of the number of start-up companies formed based on university

developed technologies, SLU also outperforms the top quartile of universities. Wash U does not perform as well as the top quartile in terms of start-ups per \$10 million of R&D.

**Table 14: Technology Transfer Activity at SLU and Wash U, 2000–2002**

	SLU	Wash U	Top Quartile
Total R&D (Millions \$)	109.3	1,188.1	<b>123.1</b>
Disclosures	40	241	<b>45</b>
Licenses Executed	21	241	<b>10</b>
Start-ups	2	2	<b>1</b>
Licenses per \$10 million R&D	5.92	6.33	<b>.95</b>
<b>Start-ups per \$10 million R&amp;D</b>	<b>.52</b>	<b>.05</b>	<b>.10</b>

Source: AUTM Survey, 2002.

Interestingly, few of the firms located in either the CET or NIDUS Center are spin outs from the region’s universities. Three of the region and state’s research universities, however, have made considerable progress in technology transfer over the past four years – Washington University, St. Louis University, and the University of Missouri System including UM-St. Louis. Increased patent protection funding, increased licensing revenues, and more startups are showing from the intellectual property portfolios of these institutions.

But more needs to be done to create a more entrepreneurial culture within the universities, including support for technology transfer and commercialization and incentives for faculty and staff to engage in commercial development of technology. Successful faculty entrepreneurs should be recognized and celebrated. Greater collaboration between regional businesses and university researchers is also needed.

Actions that could be taken to increase the flow of technology from the universities into the marketplace are:

- **Create a Technology Liaison position within the Biogenerator.** The Biogenerator has proposed hiring a technology liaison who would seek out faculty whose technology may have potential for commercialization. This was in the original design for the BioGenerator and was termed scouting the faculty and universities for ideas to be followed by the proof of concept or due diligence support to determine value. This would appear to be a good way to supplement the resources available to the universities’ technology transfer offices. The Technology Liaison would identify faculty conducting research with potential for commercial applications, inform them about the resources and services available from the Biogenerator, refer them to resources within the university or local community, and assist them in applying for support from the BioGenerator. The Technology Liaison would work with Wash U, SLU and UMSL.
- **Establish a business development function at Wash U.** It is becoming increasingly common for research universities to create an office of enterprise development or a commercialization office that is separate from the technology transfer and licensing office whose mission is to assist researchers in commercializing their intellectual property. Such

offices provide a range of services including business plan development, test marketing, and financial and technical advice. They often help clients identify a clear pathway for development, provide links to early stage gap financing, and assist with the formation of a management team. Some also make investments in start-up companies. This office could also be charged with building stronger ties between regional businesses and university researchers.

- **Facilitate dialogue between academic and industry researchers.** Interviewees indicated a need for greater interaction between industry and the academic community. Encouraging faculty and administrators to increase their participation in the various bioscience networking functions is one way to address this.
- **Create a university/industry matching grant program.** The most common, and thought by many in the field to be the most effective, means of fostering greater university and industry interaction is to provide matching grants for research partnerships. The State of Missouri Life Science Strategy proposed an R&D Partnership program that would provide matching grants for industry research projects conducted by Missouri research institutions. It was proposed that the industry partner would match the state funds on a 3:1 basis. The development of such a program should be pursued.

Options to meet the need for additional funding for commercialization activities are discussed above under Venture Capital.

## PLANT AND LIFE SCIENCE BUSINESS BASE

Two issues were raised in terms of St. Louis' plant and life science industry base. The first is the need to achieve a critical mass of firms. Second, is the need to increase the scale and level of intensity of networking in the region.

### Reaching Critical Mass

There was consensus among those interviewed that St. Louis does not yet have a critical mass of plant and life science companies nor does it have a sufficient number of anchor companies to support development of the sector despite its success at attracting and creating start-up companies. It was suggested that the region needs to attract mid-size research and industry anchors and additional pharmaceutical companies. Actions that could be taken to build the region's plant and life science business base include:

- **Undertake a targeted business recruitment effort tied to the core competencies of the region's research institutions and industries.** St. Louis has a critical mass of world-class plant and life science research and development organizations including Wash U, SLU, the Danforth Center, and corporate research programs of Monsanto, Pfizer, and Sigma Aldrich, among others. The region should identify firms that would benefit from access to the resources of these organizations and market these assets to them. Such firms could be attracted by the availability of lab space, access to developable sites in Cortex, etc. Additional incentives may be required, however, to attract larger anchor companies.
- **Significantly increase funding for marketing.** St. Louis has created an identity for the region through the BioBelt campaign but additional funding is needed to market the region as

a location for both plant and life science companies and insure a balance of attention to both areas. Other states and regions are increasing their support for marketing their “core technology” assets and the region has been unable to significantly take advantage of its BioBelt brand to do extensive marketing in and outside the region. Funding of up to four million of RCGA’s overall total \$20 million campaign to secure funds might be used in this effort, if fundraising is successful. Other states and regions are also changing their marketing focus to attracting not just larger firms but smaller, entrepreneurial firms, as well as non-profit research anchors. The most successful efforts align recruitment with the region’s strategic technology platforms. Funding is also needed to develop and implement a marketing plan that recognizes CORTEX as an exciting business opportunity. Currently there is a perceived lack of visibility for CORTEX.

## **Networking**

RCGA’s Tech Gateway Alliance has been a successful vehicle for bringing together the region’s technology community and representatives of the plant and life sciences sector have been actively involved in the Alliance. RCGA’s plant and life sciences network meets on a monthly basis and usually attracts 50 –60 participants. A larger Biosciences Work Group that was originally convened by RCGA when the plant and life science strategy was being developed in 2000 continues to meet on an irregular basis. In addition, CET has recently formed a Life Sciences CEO group. Despite these initiatives, there was consensus among the individuals interviewed that more opportunities for intensive networking are needed. There also needs to be more clarity on the roles of the various networking groups and more coordination among them.

Business service providers are becoming more knowledgeable of the needs of the bioscience industry and becoming important matchmakers, accessing sources of capital, and serving as informal advisors to many entrepreneurs and more established firms. Service providers help “capture value” for these entrepreneurs and are important players in networking as well as in developing solutions to issues facing the region in the biosciences. As noted later, service providers generally feel that they have more to contribute than they are being asked to provide and welcome ways to open themselves to the biosciences industry.

Restructuring of MOBIO to support the region’s existing networks and helping to provide linkages to Kansas City and St. Joseph and other regions of the state is needed. RCGA’s Technology Gateway Alliance needs to become the initial or one-stop place where entrepreneurs and businesses go to match their needs with resources and the Gateway can serve as the catalyst to other groups and organizations such as the universities, technology intermediaries, and firms. MOBIO can play a similar role at the state level.

## **Business Climate and Quality of Life Issues**

A challenge for St. Louis that will impact the region’s ability to attract and retain talent as well as businesses is to improve the region’s image and enhance its quality of life. Individuals interviewed pointed to the need to improve the downtown area, invest in highways and improve air service. Focus groups and interviews conducted as part of the Regional Talent Project confirmed that the downtown hurts the region’s economic vitality in a number of ways.

Downtown's continuing dysfunctionality was seen as hurting in several ways. For one thing, it was part of an oft-repeated sense of a "disconnected" metropolis, that the city had nothing of a signature nature to offer. In the suburban areas, this disappointment with downtown, and the urban core, has led to a kind of disengagement from the city. For many St. Louisans, there is little sense of shared destiny.<sup>17</sup>

Continued investment in the downtown will be needed to grow the region's technology economy.

A second area of concern was the lack of air service. It was pointed out, for example, that there are no longer any direct flights to Europe from Lambert-St. Louis International Airport and to travel to most cities requires taking regional jets and flying through another city, often Chicago. Individuals interviewed questioned whether St. Louis could project an image as a major life science center to venture capitalists or CEOs of life science companies if they have to travel in on a small plane. Priority must be placed on improving air service at Lambert – St. Louis International Airport.

A final area requiring investment is the region's highway infrastructure.

---

<sup>17</sup> Joel Kotkin (2004), p. 40–41.



## Requirements for Success

St. Louis has made a great deal of progress in marketing itself as a center of plant and life sciences, growing its venture capital market, and nurturing and supporting a significant number of start-up plant and life science companies, a few of which are on the verge of success. Yet, there are still areas that need attention and investment in order for the region to succeed in generating a solid plant and life science sector that will become a key driver of the region's economy. These include investment in facilities, commercialization support, and attracting and retaining talent, among other. But there are also several critical issues that must be addressed if St. Louis is to succeed in achieving its vision for plant and life sciences. These include

### *Sustained state support for the development of Missouri's plant and life science sector.*

In 2002, the Danforth Foundation and the Ewing Marion Kauffman Foundation, at the request of the State, funded the development of statewide life science strategy.<sup>18</sup> The strategy proposed a number of actions by which the state would provide support for the development of the life science sector. ***To date, very few of these initiatives have been implemented. St. Louis is at a disadvantage vis a vis other regions located in states that are making significant investments in the biosciences.*** It will not only make it difficult to attract companies to expand in St. Louis but it is likely that other states will offer incentives to try to attract successful start-up St. Louis companies to relocate to their state. St. Louis needs to work with the Governor and legislature to create an economic development toolkit targeted to the plant and life sciences, and to ensure that state government makes the investments in research infrastructure and education that will be needed to support the development of a dynamic plant and life science sector. The State role is significant in many ways, from how it treats the reimbursement of bioscience products in its Medicaid program, its policies on drug importation, its support for the region to attract and growth biopharmaceutical firms, to its financing of researchers, their programs and facilities. Missouri has lagged other states considerably in addressing these issues. Yet the State government in recent years has acted contrary to the opportunities the biosciences offers – holding a \$350 million bond issue hostage for university research facilities; stopping a local reinvestment act from passage; failing to enact a cigarette tax increase for health research; and the list could go on.

***Addressing the issue of stem cell research with the legislature.*** The debate on stem cell research is hurting the region's efforts to build its plant and life science sector in many ways. First, the possibility of a ban on stem cell research could discourage researchers and businesses from locating in St. Louis. This issue has already been raised as universities seek to attract the best researchers to St. Louis. Second, it hurts the region's image as a leading center of plant and life sciences. Third, the threat of having to fight an amendment to criminalize stem cell research kept bills dealing with "life sciences", "biotechnology", research or any related topic from coming to the floor. Legislation that was not enacted in 2004 due to the threat of a stem cell ban include

---

<sup>18</sup> Battelle Technology Partnership Practice. *Life Sciences & Missouri's Economic Future: An Opportunity to Build "One Missouri"*, May 2002.

- Life Sciences Reinvestment Act, which would have provided funding for regional research and commercialization efforts.
- R&D tax credits
- Support for endowed chairs at state universities
- Capital Bonding Program for University of Missouri Campuses that would have been used to build medical school and other research and teaching facilities on all four UM campuses.

The State's economic future should not be held hostage to attempts to attach other agendas to any proposed state bioscience research initiatives. This has happened in Missouri more than in any other state and as initiatives such as California's \$3 billion investment in stem cell research take effect St. Louis's research institutions are going to have more and more difficulty attracting and retaining research talent if the state government climate continues to hold the state's economic development agenda hostage to other issues. If this issue isn't addressed, even private institutions, such as Washington University, will suffer in reputation and research and the region in economic benefit in terms of not only lost research expenditures but from the losses of their long term impact on the regional economy. Resolving this issue should be a top priority.

***Building support within the larger business community.*** While the business community and the general public are supportive of the efforts to build the region's plant and life science sector, they have not embraced the initiative and are not investing dollars in it. Steps must be taken to increase the business community's understanding of the potential direct and indirect benefits that will accrue from developing this sector and to obtain their "buy-in" and full-fledged support.

***Continuing to educate, inform and encourage the broader citizenry to understand and support biosciences for both its health benefits as well as economic benefits.*** St. Louis and Kansas City joined with other groups throughout the state to encourage passage of a cigarette tax, a portion of the proceeds of which would have been used to support increased state funding of bioscience research. While this effort failed by a slim margin statewide, the \$4 million spent in securing its passage did serve as an educational campaign for biosciences. In the future both in the region and statewide efforts will need to continue to be undertaken to explain and educate the citizenry on the benefits of the biosciences in terms of individual health and economic competitiveness. And part of this effort can include celebrating the success and promoting the roles of entrepreneurs in the region.

***Greater collaboration is needed both within the region and between St. Louis and other regions of the state.*** The region would benefit if there were greater collaboration between large and small companies within the region and between industry and academia. In addition, ways need to be found to better link the region with the resources and expertise found at the University of Missouri in Columbia as well as with efforts to grow the life sciences that are underway in Kansas City.

***A more cohesive approach is needed.*** There are many organizations involved in promoting and growing the region's plant and life science sectors: the RCGA Technology Gateway, the Coalition, CET, the NIDUS Center, Wash U, SLU, UMSL, and the Biogenerator, among others. And there is a strong interest and desire by the region's citizens whether they are industry, academe, business service providers, or civic leaders in wanting to become more involved. The

Coalition has done an excellent job of bringing all the players to the table but there are still a variety of organizations, each acting independently. The RCGA Technology Gateway Alliance needs to take on a greater role as the initial catalyst and facilitator to link at the operating level firms, academe, and service providers, working closely with the Coalition. In addition, there is a need to broaden their efforts to involve and keep the community's business, civic, governmental and philanthropic leadership more informed of developments, issues and opportunities affecting St. Louis's biosciences future. A quarterly newsletter on progress and developments put out by both organizations might help take advantage of this widespread interest. So would a more active catalyst role played by the Alliance. There is a need to better coordinate efforts and present a united front to the business community.

***St. Louis has made more progress in its implementation of the plant and life sciences strategy as any region of the country and is well on the road to becoming the leading center for the plant sciences and a major center for the life sciences.*** Addressing the issues identified above and implementing the actions proposed in this report will help move the region to the next level of development in growing its plant and life science economy.



## **Appendix A: Benchmarking Profiles**

# Baltimore/Washington

## RECAP OF THE REGIONAL STORY

The “Baltimore” bioscience community really refers to two or three distinct clusters of development in Maryland’s Baltimore/Washington corridor. Baltimore City and its environs are strong in academic research but relatively weak in spin-off generation. A much more vibrant cluster has emerged over the past two decades in suburbs radiating from the District of Columbia Capital Beltway – especially the I-270 corridor connecting Bethesda, Gaithersburg, and Rockville in Montgomery County. There is also a smaller cluster of activity surrounding the University of Maryland flagship campus at College Park, in Prince George’s County.

The “genealogy” of Maryland’s bioscience companies has been studied in depth by a policy center at Johns Hopkins University (along with five other sectors).<sup>19</sup> Researchers traced a number of the region’s “founding bio-entrepreneurs” to Invitrogen’s **BioReliance** analytical unit, founded in 1947 as Microbiological Associates, and a few other federal contractors of similar vintage. The study also concluded that most of the region’s modern bioscience startups were not recruits to the region but rather were founded by non-native Marylanders who had started their careers in federal agencies, university laboratories, small contract consultancies, or larger companies. Montgomery County specifically recognizes the role of Microbiological Associates as one of the founding tenants of its Shady Grove Life Sciences Center (see below under research parks).

Once the federal government ramped up the Human Genome Project in the late 1980s and early 1990s, federal agencies became a particularly important source. The Hopkins researchers singled out the National Institutes of Health (the source of the founding entrepreneurs for **Human Genome Sciences** and **Celera Genomics**) and Walter Reed Army Institute of Medical Research (**EntreMed** and **MedImmune**). They also cited the Uniformed Service University of the Health Sciences, USDA, FDA and other federal laboratories in the capital region.

## DEVELOPMENTS SINCE THE LAST BENCHMARK

Since the last benchmarking exercise, news has been generally good for the region, which seems to be holding its assets even in the face of mergers and consolidations in the bioscience sectors. Here are some recent events:

- The existing startup **Guilford Pharmaceuticals** licensed a key technology from the Johns Hopkins University, raised new funding and immediately became the pre-eminent, high-profile bioscience startup situated in Baltimore City.
- The state Department of Business and Economic Development recognized gains on information technology investments its Enterprise Investment Fund had made during the 1990s and recycled them the **Maryland Venture Capital Fund**, a pool of limited

---

<sup>19</sup> M. Schachtel and S. Heacock. *Founders of Maryland Bioscience and Medical Instrument Companies*. Baltimore: Johns Hopkins Institute for Policy Studies, August 2002. Available on-line at: [http://www.marylandtedco.org/resources/publication\\_pdfs/BioGenealogyStudy.pdf](http://www.marylandtedco.org/resources/publication_pdfs/BioGenealogyStudy.pdf).

partnership interests in six different firms that opened offices in the region and agreed to look at bioscience and IT deals (see below under venture capital).

- Two different science park projects were launched in Baltimore City, one at the University of Maryland Baltimore campus, and the other at the medical campus of Johns Hopkins University (see below). In addition, Hopkins created an Enterprise Development Office within the provost's office, staffed by the venture capitalist who formerly ran the "internal venture fund" at the Abell Foundation (which as an early investor in Guilford Pharmaceuticals).<sup>20</sup>
- Gov. Ehrlich's Commission on the Development of Advanced Technology Businesses issued what became known as the **Pappas Report**,<sup>21</sup> after the venture capitalist who chaired it. While the report has not yet had a great deal of practical impact, it strongly confirmed the importance of Maryland's existing strategies and recommended that the state's public pension funds be encouraged to invest in locally focused venture capital partnerships.

Maryland's only significant disappointment came when the Bethesda-based **Howard Hughes Medical Institute**, which supports Howard Hughes Investigators at biomedical institutions around the nation, decided to locate a major new campus for its *intramural* research programs (especially in convergent technologies) not in Maryland but in Loudoun County in northern Virginia.<sup>22</sup>

## FOCAL AREAS AND STRATEGY ENVIRONMENT

The **Maryland Technology Development Corporation**,<sup>23</sup> the state-funded nonprofit recognized as the lead entity for technology-based economic development, recognizes six major technology clusters that it is interested in developing: bioscience/medical instruments; information technology equipment and services (including information security); "private research and development"; energy/chemicals/materials; defense/aerospace; and high-tech machinery and instruments. Montgomery County categorizes its strengths in the biosciences in three subsectors: sequencing (**The Institute for Genomics Research**, a nonprofit founded at the same time as HGS); bioinformatics (Celera and **GeneLogic**); and applied genomics (**Digene**, and **HGS**).

Focal areas can also be assessed by reviewing the major components of the **University of Maryland Biotechnology Institute**,<sup>24</sup> a quasi-independent unit of the University of Maryland System with branches in several of the bioscience centers:

- The **Center for Advanced Research in Biotechnology (CARB)**,<sup>25</sup> a cooperative venture with NIST to apply physical science expertise to the study of molecular structure, based at the Shady Grove Life Sciences Center in Rockville.

---

<sup>20</sup> See <http://www.abell.org/abellinvestments/index.html>.

<sup>21</sup> "Report of the Commission on Development of advanced Technology businesses." January 2004. Available on-line at: [http://mgr.choosemaryland.org/assets/document/Pappas\\_Report.pdf](http://mgr.choosemaryland.org/assets/document/Pappas_Report.pdf).

<sup>22</sup> See <http://www.hhmi.org/janelia/>.

<sup>23</sup> See <http://www.marylandtedco.org>.

<sup>24</sup> See <http://www.umbi.umd.edu>.

<sup>25</sup> See <http://www.carb.nist.gov/>

- The **Center for Biosystems Research (CBR)**,<sup>26</sup> a core laboratory facility for sequencing, micro-array production and other analytical techniques located in the plant science complex at University of Maryland College Park.
- The **Center for Marine Biotechnology (COMB)**,<sup>27</sup> a facility equipped for transgenic aquaculture studies, situated at the Baltimore inner harbor adjacent to the National Aquarium.
- The **Medical Biotechnology Center**,<sup>28</sup> a molecular medicine program at the University of Maryland, Baltimore.
- The **Institute of Human Virology**,<sup>29</sup> carved out of the MBC in 1996 as a vehicle for recruitment of virologist Robert Gallo.

UMBI still receives nearly \$50 million a year in operating budgets. However, pursuant to the Commercial Biotechnology Strategy adopted by the state in 1991, UMBI has been encouraged for more than a decade to place increasing emphasis on externally sponsored research and particularly partnerships with bioscience companies.

## RESEARCH-CAPACITY BUILDING

Capacity-building programs in the University of Maryland system must be spread over several campuses with significant bioscience research competency – Baltimore, College Park, Baltimore County, and Shady Grove. The two major projects for physical expansion are:

- a 140,000 square-foot, \$50 million “**CARB II**” at Shady Grove. The new facility will include Level 3 containment laboratories and a GMP-certified plant for production of small molecules and proteins.<sup>30</sup>
- A 138,500 square-foot, \$55.8 million **Bioscience Building** at the College of Life Sciences at College Park, scheduled to house 35 PI teams.<sup>31</sup> At the same time, UCMB’s existing **Bio-Process Scale-up Facility**<sup>32</sup> will undergo a \$1 million renovation.

At Hopkins, a recent, extended cycle of capacity additions has included a new home for research operations of the **Kimmel Cancer Center**, and Clark Hall, a new home for the joint Department of Biomedical Engineering and the associated Whitaker Biomedical Engineering Institute.

## INDUSTRY PARTNERSHIPS

TEDCO offers two programs<sup>33</sup> that promote partnerships between industry and either federal laboratories or universities:

<sup>26</sup> See <http://www.umbi.umd.edu/~cbr/>.

<sup>27</sup> See <http://www.umbi.umd.edu/~comb/>.

<sup>28</sup> See <http://www.umbi.umd.edu/~mbc/pages/about.htm>

<sup>29</sup> See <http://www.ihv.org/>.

<sup>30</sup> See <http://www.umbi.umd.edu/~cbr/carbii/carbii.htm>.

<sup>31</sup> See <http://www.life.umd.edu/biosciencebuilding/genfacts.html>.

<sup>32</sup> See <http://www.biotech.umd.edu/BSF.html>.

<sup>33</sup> See <http://www.marylandtedco.org/programs/index.html>.

- The **Federal Laboratory Partnership Program** makes grants for up to 90 percent of the cost of collaborative projects up to \$20,000 between small Maryland companies and Maryland federal laboratories (a lower subsidy prevails for larger companies).
- The **Maryland Technology Transfer Fund** provides repayable grants for up to half the cost of research collaborations between Maryland companies and Maryland universities. This program is budgeted at \$1.5 million in total.

At the University of Maryland, the **Maryland Industrial Partnerships Program**<sup>34</sup> provides matching funds for university/industry collaborations focused on new-product development, with particular focus on biological engineering and use of the **Bioprocessing Scale-up Facility** at UMCP. The program is budgeted at \$1.35 million and projects range from \$70,000 to \$100,000 over one or two years. The participating company is required to commit cash or in-kind matching funds, with requirements scaled to the size of the company.

## TECHNOLOGY TRANSFER/COMMERCIALIZATION

TEDCO makes available a **University Technology Development Fund** that pays 50 percent of the cost up to \$50,000 of feasibility studies or demonstration projects conducted on early-stage university technologies. The Maryland High Tech Council also sponsors a Clinical Development Initiative to help connect member bioscience companies with clinical trial opportunities at regional institutions. Finally, the region's major research universities jointly market themselves and licensing opportunities through a **Maryland Technology Partnership for Innovation**.<sup>35</sup>

## VENTURE CAPITAL

Maryland has experience creating “funds of funds” through its creation in 1990 of the **Maryland Venture Capital Trust**,<sup>36</sup> which channeled \$20 million in appropriations and investments from state and city pension funds into a series of eight venture partnerships that agreed to open local offices. The funds placed by the trust levered three times that amount in other institutional investment in these partnerships, and so the amount that came back to Maryland companies exceeded the state's contributions by a large margin – at least 17:1 if one includes investments by these funds' syndicate partners. From a return on investment perspective, the Trust preserved its principal and provided a moderate return (there are a few remaining investments to be closed out, most considered not of material value). The continued lack of enthusiasm by public pension funds for locally targeted investing led to the recommendation by the Pappas Commission that they explore other ways to participate in the sector.

However, a new “fund of funds” experiment has been launched in the last several years. It stems from the state's experience in the 1990s with two seed-stage investment funds internally managed by the Maryland Department of Business and Economic Development:<sup>37</sup>

<sup>34</sup> See <http://www.mips.umd.edu/>.

<sup>35</sup> See <http://www.marylandtedco.org/programs/MPTI.html>.

<sup>36</sup> See <http://www.mdarchives.state.md.us/msa/mdmanual/25ind/html/76vent.html>.

<sup>37</sup> See <http://www.choosemaryland.org/datacenter/taxesincentives/investment.asp>.

- **Challenge Investment Program** is a royalty-payback fund that makes investments up to \$150,000 in small, high-risk startups for use in feasibility studies, testing and market development. There is a requirement for 1:1 co-investment by outside parties.
- **Enterprise Investment Fund** makes equity investments from \$150,000 to \$500,000. For this program, the co-investment requirement is 3:1.

The Enterprise Fund made significant profits by disposing of equity holdings in Maryland IT companies during the Internet boom, and DBED has since reinvested \$16.5 million of these gains in an internally managed “fund of funds,” that it calls the **Maryland Venture Fund**. The investees of this fund are five venture partnerships of varying size and orientation, all of which have offices in the general region and will consider both IT and bioscience investments. The state believes it has levered more than \$420 million in third-party institutional investment in these funds, a significant fraction of which will come back to Maryland companies. Following are the investee partnerships:

- **Toucan Capital**,<sup>38</sup> an SBIC 60 percent invested in the biosciences, based in Bethesda near the NIH headquarters. Of the company’s first eight investments, half were in Maryland
- **New Markets Growth Fund**,<sup>39</sup> a fund headquartered at the Smith School of Business at the University of Maryland College Park. This professionally managed fund is recognized by the federal New Markets Venture Capital Program and has a number of banks and bank-holding companies as investors.
- **Anthem Capital**, a Baltimore-based firm with additional offices in Pennsylvania, focusing on “early stage” deals in the mid-Atlantic region;
- **Boulder Ventures**, a Colorado-headquartered firm that has opened mid-Atlantic offices in the Baltimore suburb of Owings Mills.
- **CIP Capital**, a later-stage firm associated with Safeguard Scientifics in the Philadelphia suburb of Wayne, Pa.

There are several other miscellaneous sources of seed funding:

- **MdBio** – a nonprofit funded by rent payments on a bioprocessing facility constructed with state funds but leased to a private operator – has provided more than \$4 million since 1998 in “project accelerator” awards<sup>40</sup> (grants repayable from royalties) to 32 Maryland companies.
- Montgomery County itself has a **Technology Growth Program** that offers grants that convert to loans only if within five years the applicant has achieved pre-negotiated milestones for equity financing or revenue.

---

<sup>38</sup> See <http://www.toucancapital.com/about.htm>.

<sup>39</sup> See <http://www.rhsmith.umd.edu/pr/news-nmgf04.htm>.

<sup>40</sup> See <http://www.mdbio.org/newsite/programs/index.html>.

## RESEARCH PARKS/INCUBATORS

Maryland has a wide range of research parks and wet-lab incubators. The I-270 corridor is anchored by the **Shady Grove Life Sciences Center**, a 300-acre site originally owned by Montgomery County and developed incrementally by sale or land-lease since 1983. The Shady Grove Park was anchored by a local hospital and its first commercial tenants included Microbiological Associates and a Japanese inward investment. It now houses many of the county's most visible bioscience companies among its 200 tenants. Institutional anchors CARB, an extension campus serving University of Maryland,<sup>41</sup> and a similar facility for Johns Hopkins University.<sup>42</sup> It is also directly across the street from Montgomery County's **Technology Development Center**,<sup>43</sup> a 50,000 square-foot incubator facility housing 12 firms using 24 laboratory suites.

Around the Beltway in Prince George's County, the University of Maryland at College Park has proposed its own research park on 130 acres close to the location of major FDA and USDA laboratories, seeking to replicate the federal laboratory synergies experienced in Bethesda, Gaithersburg, and Rockville. Land assembly by the university has been blocked, although private developers continue to build on surrounding lots on the same theory. On the campus itself, UMCP operates an incubator/business accelerator that it calls the **Technology Advancement Program**,<sup>44</sup> which offers 20,000 square-feet of wet lab space.

In Baltimore County, a few minutes south of Baltimore City and near the BWI Airport, the University of Maryland Baltimore County is developing **bwtech@UMBC**,<sup>45</sup> a five-building, 350,000 square-foot, multi-sector research park. UMBC already operates **Techcenter**,<sup>46</sup> a former Lockheed Martin laboratory converted into a fairly large technology-business incubator that includes 49,200 square feet of wet lab space.

In downtown Baltimore, near the inner harbor, the University of Maryland at Baltimore is developing an 8-acre, 800,000 square-foot **BioPark**<sup>47</sup> across the street from its medical school. The anchor tenant for the first building will be a team from the **Jerome Holland Laboratories**, which was recently divested by the American Red Cross. The team was recruited by senior university leadership, who offered faculty slots for its 23 senior investigators and will make them the core of a planned focal area on vascular and inflammatory disease.

Farther east, near the medical center of Johns Hopkins University, East Baltimore Development Corporation is developing a **Life Science and Technology Park**.<sup>48</sup> UMB maintains a small amount (less than 2,000 square feet) of wet-lab space at MBC for use by bioscience companies, but Hopkins does not at present. However, an existing wet-lab incubator currently located at the **Bard Building** of Baltimore City Community College and sponsored by the Baltimore Development Corporation<sup>49</sup> may relocate and/or expand to one or the other park.

---

<sup>41</sup> See <http://shadygrove.umd.edu/>.

<sup>42</sup> See <http://www.jhu.edu/washingtonarea/mcc/>.

<sup>43</sup> See <http://www.montgomerycountymd.gov/bustmpl.asp?url=/Content/DED/incub/mtdc/index.asp>.

<sup>44</sup> See <http://www.tap.umd.edu/experience.html>.

<sup>45</sup> See <http://www.bwtechumbc.com/files/home.htm>.

<sup>46</sup> See <http://www.umbc.edu/Business/Research/>.

<sup>47</sup> See <http://www.umbbiopark.com/>

<sup>48</sup> See [http://www.ebdi.org/life\\_sciences.html](http://www.ebdi.org/life_sciences.html).

<sup>49</sup> See [http://www.baltimoredevelopment.com/venture\\_etc.shtml](http://www.baltimoredevelopment.com/venture_etc.shtml).

## HUMAN RESOURCES

Baltimore hosts a unique nonprofit, the **BioTechnical Training Institute of Maryland**.<sup>50</sup> BTI trains post-high-school grads for entry level lab-tech positions in biotechnology.

Montgomery County has financed a bioscience-oriented training center at the Germantown campus of its Montgomery College.<sup>51</sup>

## BUSINESS ENVIRONMENT

The recommendations Pappas report has not yet resulted in any significant enhancement to the state's R&D tax credit, which includes a base and incremental component. Pappas also recommended regular review of regulatory issues affecting bioscience companies.

At the local level, bioscience has received strong support from Montgomery County government, and in Baltimore City the current administration has been strongly behind the two research park initiatives at UMB and Hopkins.

## SUMMARY OF LESSONS

- Once divided into two distinct poles – commercial activity in Montgomery County, academic research in Baltimore City – the Maryland bioscience community is integrating thanks to a dense network of research parks and wet-lab incubators.
- Although its pension funds have been reticent, the state has been unusually aggressive in pursuing other quasigovernmental mechanisms to build the base of venture capitalists interested in early-stage bioscience deals.
- Agbiotech is less a focus than one might think despite the presence of Agriculture Department federal laboratories and research excellence at UMD.

---

<sup>50</sup> See <http://www.biotechmd.org/>.

<sup>51</sup> See <http://www.montgomerycollege.edu/Departments/biotechnology/>.

# Indianapolis

## RECAP OF THE REGIONAL STORY

Indiana's manufacturing sectors were punished in the economic recessions that have opened each of the last three decades. The current downturn has intensified civic focus on planning for technology-led growth. This effort began in earnest in the early 1990s, once Indianapolis had solidified its reputation as a center of amateur sports and revitalized its downtown as a shopping and entertainment hub. Spurred by a technology task force convened by the then-Mayor, the corporate community turned its attention to creating a new technology identity for the region.

The region's bioscience strategy seeks to lever the presence of major corporations while encouraging its research universities to become more entrepreneurial. Key corporate assets include the headquarters and R&D operations of **Eli Lilly Co.**, the headquarters of **Guidant** (a medical device firm spun off by Lilly more than a generation ago), the headquarters of **Cook** (a privately held device company based in Bloomington), R&D for **Roche Diagnostics**, and the headquarters for **Dow AgroScience** (the surviving entity when Dow Chemical bought out Lilly's interest in their one-time joint venture Dow Elanco). There is a separate cluster of orthopedic device makers in Warsaw, in northeast Indiana.

There is far less division between city and suburb in Indianapolis than in St. Louis because the city and Marion County consolidated in the 1980s, but even the entire nine-county metropolitan region does not technically encompass two of the major research drivers in outlying communities – Indiana University in Bloomington and Purdue University in West Lafayette. The universities do operate a joint campus in downtown Indianapolis that hosts the IU School of Medicine, but it has proved challenging to generate critical mass from three such dispersed centers of excellence.

The principal public-sector vehicle driving development has been the **21<sup>st</sup> Century Research and Technology Fund**,<sup>52</sup> created in 1999 at the intense urging of the Indianapolis business community. This revolving fund, whose budget has fluctuated widely, makes grants or loans of up to \$5 million for up to two years, in support of research excellence, technology commercialization, or matching of major federal awards. In four years of operation, the fund 85 awards totaling more than \$110 million.

Additional energy has been provided by the **Lilly Endowment** – not Lilly's corporate foundation, but an independent foundation capitalized by Lilly stock.<sup>53</sup> Once known for its religious and community-development charity, the Endowment has become seized by the economic implications of the state's historically low retention of its university graduates. Over the last decade, driven by the need to meet statutory distribution requirements from the rising value of its Lilly stock, and constrained to grant only in Indiana, the Endowment has directed enormous grant payouts to university-based research initiatives and associated technology-transfer programs, as ways of creating attractive job opportunities that will hold college graduates in-state.

---

<sup>52</sup> See <http://www.21fund.org/aboutfund.aspx>.

<sup>53</sup> See <http://lillyendowment.org/theendowment.html>.

## DEVELOPMENTS SINCE THE LAST BENCHMARK

Indianapolis was not one of the prior benchmarks for the St. Louis plant and life science strategy, but since the time of the last benchmarking exercise, it has earned admission to the set as an aggressive competitor for Midwest leadership. Since the time of the last benchmarking the following major developments have occurred:

- The **Central Indiana Corporate Partnership**,<sup>54</sup> a regional CEO leadership network, commissioned a study in 2001 that identified three “pillar industries” for the region’s future – biosciences, information technology, and advanced manufacturing. Subsequently, with financial support from the City of Indianapolis, CICP spun out an affiliated nonprofit called **BioCrossroads**,<sup>55</sup> which is dedicated to developing the bioscience strategy and marketing the name as a regional brand. BioCrossroads is chaired by a retired Lilly executive and run day to day by a loaned executive from Lilly Ventures. It has assembled a major venture-capital initiative described below.
- Under intense lobbying from BioCrossroads member organizations, the Governor and state Legislature agreed in 2003 on a \$1.2 billion umbrella economic development initiative called **Energize Indiana**.<sup>56</sup> This package, financed predominantly by securitizing tobacco settlement proceeds, includes \$75 million in support for university research infrastructure projects; \$72 million per biennium for the next decade for the 21<sup>st</sup> Century Fund; \$40 million in capital funding for a statewide network of “certified technology parks”; and \$100 million in alternative investments by the state’s public pension funds.
- IU relocated the headquarters of its technology-transfer office<sup>57</sup> from Bloomington to Indianapolis, in a wet-lab equipped business incubator called the **Indiana University Emerging Technologies Center**.<sup>58</sup> In addition to providing an outlet near the medical school for spin-outs from IU’s genomics initiative in Bloomington, the IUETC provides a home for the regional bioscience trade association, several venture-capital groups, and other activities.
- Lilly and the two universities collaborated on **InProteo**,<sup>59</sup> a -profit joint venture charged with developing new proteomics-based instrumentation and methodologies for drug and diagnostic development. InProteo has already produced three startup/spinouts based at the IUETC, including the **Indiana Centers for Applied Protein Sciences (INCAPS)**,<sup>60</sup> a contract technology-validation and services center. INCAPS was launched with a \$2 million grant from the 21st Century Fund matched by fees pre-committed by Lilly and many of the corporate and institutional members of BioCrossroads.

---

<sup>54</sup> See <http://www.cincorp.com>.

<sup>55</sup> See [www.biocrossroads.com/](http://www.biocrossroads.com/).

<sup>56</sup> See <http://www.in.gov/gov/energize/>.

<sup>57</sup> The affiliated Advanced Research and Technology Institute. See <http://arti.iu.edu/>.

<sup>58</sup> See [http://iuetc.org/about\\_message.html](http://iuetc.org/about_message.html).

<sup>59</sup> See <http://www.inproteomics.com/abthist.html>.

<sup>60</sup> See <http://www.indianacaps.com/>.

- Both Lilly and Cook made major new commitments to R&D facilities in their respective headquarters towns, although Guidant made location of a new manufacturing facility contingent on provision of incentives by the state.

## FOCAL AREAS AND STRATEGY ENVIRONMENT

In 2002 CICP identified eight niche focal areas within the biosciences:

- Sports-centered life sciences<sup>61</sup>
- Neuroscience
- Cardiovascular care
- Protein analysis
- Bio-MEMS and Sensors
- Cancer
- Evidence-based medicine
- Agbiotech

A series of unified strategy elements cut across all three clusters:

- Leverage sufficient investment capital
- Retain and attract a skilled workforce
- Market the region as a world-class bioscience hub
- Develop successful collaborations including a downtown research community

In executing its tactics, BioCrossroads works closely with the Indiana Health Industry Forum, a trade association representing major healthcare providers, the major pharmaceutical and device companies in-state, and the entrepreneurial community.<sup>62</sup>

## RESEARCH AND CAPACITY BUILDING

Investment in research capacity in the biosciences was jump-started at the turn of the millennium by the Lilly Endowment, which ultimately committed \$155 million in grant support to IU's **Genomics Initiative** (INGEN),<sup>63</sup> mostly for faculty recruitment, salary support for research staff, and improvements to existing laboratories. IU levered this contribution to raise additional private funds for construction of several new buildings relevant to biosciences, including:

- a new building adjacent to the IUETC for a new School of Informatics,<sup>64</sup> which will include a focus on bioinformatics and chemical informatics;

---

<sup>61</sup> This focal area leverages Indianapolis's emergence during the 1980s as a center of amateur sports and its successful recruitment of the American College of Sports Medicine.

<sup>62</sup> See <http://www.ihif.org>.

<sup>63</sup> See <http://www.ingen.iu.edu/faq/backgrounders.html>.

<sup>64</sup> See <http://www.informatics.indiana.edu/>.

- a new Biomedical Research and Training Complex also in Indianapolis, not far from IUETC.<sup>65</sup>
- a new, 140,000 square-foot, \$55.7 million Multidisciplinary Science Building at Bloomington.

At Purdue, Lilly Endowment's support has focused mainly on computing and information technology, but the Endowment did contribute \$26 million toward the Discovery Park,<sup>66</sup> which is not part of Purdue's research park but rather an on-campus, 40-acre, \$100 million complex for interdisciplinary research that includes one building each for bioscience/engineering; nanotechnology; information technology; and campus entrepreneurship programs. At Rose Hulman Institute of Technology in Terre Haute, a resource for the state's biomedical device sector, the Endowment contributed \$29 million for an incubator and associated seed fund.<sup>67</sup> On top of these initiatives, the Endowment has set aside another \$100 million for an Initiative to Recruit and Retain Intellectual Capital for Indiana Higher Education Institutions.<sup>68</sup> Purdue is leveraging this program to recruit faculty for its own biotechnology efforts, including in agriculture. Significant new resources have been directed to capacity building by the **Centers of Excellence** program of the 21<sup>st</sup> Century Fund.

## INDUSTRY PARTNERSHIPS

The 21<sup>st</sup> Century fund also makes awards for **Science and Technology Commercialization**, which may be in the form of grants or loans, to either academic or corporate recipients. The INCAPS center referenced above was one of the programs catalyzed by such a grant. The legislative understanding under which Energize Indiana was approved calls for progressive tilting of the 21<sup>st</sup> Century Fund budget from R&D to commercialization. What is currently a 10:1 ratio will shift by the end of the decade to 50:50.

## TECHNOLOGY TRANSFER/COMMERCIALIZATION

For many years, Purdue has operated within its Research Foundation an unusually aggressive and effective Office of Industry Research and Technology Programs.<sup>69</sup> This industrial liaison office serves as a single point of contact for companies with research needs, and it facilitates negotiation of sponsored research and licensing agreements. The university also makes available commercialization funding from its **Trask Venture Fund**<sup>70</sup>:

- \$100,000 Technology Innovation Awards to help on-campus researchers build the university's patent-position on newly discovered intellectual property;

<sup>65</sup> See [http://medicine.indiana.edu/iu\\_medicine/03\\_summer/articles/researchFrontier.html](http://medicine.indiana.edu/iu_medicine/03_summer/articles/researchFrontier.html).

<sup>66</sup> See <http://discoverypark.e-enterprise.purdue.edu/wps/portal>.

<sup>67</sup> See <http://www.rhventures.org/>.

<sup>68</sup> See <http://www.lillyendowment.org/pdf/IntellectualCapital.pdf>.

<sup>69</sup> See <http://www.purdue.edu/research/vpr/partners/industry.html>.

<sup>70</sup> See <http://www.otc.purdue.edu/inventors.html>.

- \$250,000 Pre-Seed Awards to help move faculty companies through a “Gateways” mentoring process designed to identify promising candidates for spin out into the Research Park.

## VENTURE CAPITAL

BioCrossroads assembled \$72 million in commitments for the **Indiana Future Fund**,<sup>71</sup> a privately managed “fund of funds” along the lines floated but never implemented in St. Louis. The Fund is managed by the customized fund investment group of CS First Boston from an office in the IUETC incubator in downtown Indianapolis. This fund of funds will invest in both regional and national venture capital funds that agree to establish and Indiana presence. Committed investors include the state’s public pension funds, Lilly, Guidant, two insurance companies (Anthem and AUL), both university endowment funds and also Ball State and Indiana State. The agreed-on investment strategy is to place funds:

- 60 percent to be placed through Indiana focused or based funds
- 70 percent to be made in funds that intend to make seed- or early-stage investments
- 60 percent ultimately flowing to Indiana-based investees;
- 60 percent flowing to bioscience investments.

In the initial investing round, IFF committed funds to:

- **Spring Mill Venture Fund**,<sup>72</sup> an early-stage venture fund with offices in Indianapolis and Bloomington;
- **REI Ventures**,<sup>73</sup> a joint venture between EDF Ventures of Ann Arbor (with an Indianapolis office) and the Rose Hulman Ventures seed fund capitalized by Lilly Endowment at Rose Hulman Institute of Technology;
- **Pearl Street Venture Funds**,<sup>74</sup> a joint venture between an Indianapolis investment-advisory firm and Coastview Capital of Los Angeles;
- **A.M. Pappas** of Research Triangle, with offices in Indianapolis;
- **Burrill & Co.**, of San Francisco, with offices in Indianapolis.

Other local bioscience venture activity includes:

- **CID Equity Partners**, founded in the 1980s with state investment, more recently created a \$30 million seed fund,<sup>75</sup> targeting early-stage deals emerging from Midwestern universities.
- **Arboretum Ventures**,<sup>76</sup> a Michigan-based bioscience venture fund, opened an office in the IUETC;

<sup>71</sup> See <http://www.indianafuturefund.com/investmentstrategy.htm>.

<sup>72</sup> See <http://www.springmillvp.com>.

<sup>73</sup> See <http://www.rei-ventures.com/>.

<sup>74</sup> See <http://www.psvf.com/>.

<sup>75</sup> See <http://www.cidequity.com/aboutCID/index.cfm?fuseaction=0204>.

<sup>76</sup> See <http://arboretumvc.com>.

- A group of local investors created **Gazelle TechVentures**,<sup>77</sup> a privately managed partnership that will attempt to identify locally based early-stage deals;
- Lilly's corporate ventures unit founded three separate national funds (including one focused on IT applications) to make investments that advance Lilly's core pharmaceutical strategies.

In its most recent round, the 21<sup>st</sup> Century Fund provided pre-seed capital by making \$75,000 awards to companies receiving Phase I SBIR awards, and \$25,000 to those that successfully submit Phase II proposals.

## RESEARCH PARKS/INCUBATORS

The largest and best-established research park complex in the state is Purdue's Research Park,<sup>78</sup> in West Lafayette, far outside the central Indiana core. This 150-acre park features a rapidly growing set of incubator/multitenant facilities, now totaling more than 220,000 square feet, and three of them wet-lab equipped.

The Indiana University Emerging Technology Center is a 62,500 square-foot, commercial multitenant building in downtown Indianapolis. A two-story building was reclaimed by IU from its former use as a furniture warehouse, rehabilitated for office use, and then equipped with a new, 28,000 square-foot wing of wet-lb space at a total cost of about \$10 million. IUETC is owned and operated by the university's affiliated nonprofit technology transfer corporation, ARTI.

The joint development corporation that is sponsoring the IUETC's status as an Energize Indiana-certified "Technology Park" envisions a complex of four buildings, to provide for post-incubation space for graduates of IUETC. More broadly, the IUETC serves as the planned first step of a major downtown research park. As part of the regular downtown visioning exercise managed by Ball State University, urban planners have estimated that 15.7 million square feet of commercial technology space could ultimately be developed in the Northwest quadrant of downtown.

## HUMAN RESOURCES

Lilly Endowment has always justified its large grants for university R&D and technology-based economic development on the basis of the urgent need to improve the state's abysmal educational attainment rates, in part by retaining college graduates, 36 percent of whom now leave the state after receiving their degrees.<sup>79</sup> The Endowment has offered \$40 million in a competitive program for universities to come up with creative ways to retain graduates in-state. Among the initiatives funded this way was a new biotechnology associate's degree offered jointly by IUPUI (the joint campus) and Ivy Tech, the state's equivalent of a community college network. Both large and small companies are receiving subsidies to put certain employees through this program.

<sup>77</sup> See <http://www.gazellevc.com/overview/overview.htm>.

<sup>78</sup> See <http://www.purdueresearchpark.com/>.

<sup>79</sup> See a study by the Indiana Fiscal Policy Institute, financed partly by Lilly, at <http://www.indianafiscal.org/docs/Report1.pdf>. See also [http://www.lillyendowment.org/pdf/\\$40%20million%20initiative.pdf](http://www.lillyendowment.org/pdf/$40%20million%20initiative.pdf).

IU's Kelly School of Business has launched a new Health Care Life Sciences "Academy" within its MBA program, co-chaired by the CEO of IUETC/ARTI. In addition, every major Indiana university has a well developed entrepreneurial center. Finally, an alumnus of IU recently gave \$3.5 million to endow an independent nonprofit Indiana Venture Center whose mission is to work with these other centers to serve "as a catalyst for the creation and growth of entrepreneurial, high growth businesses in Indiana."<sup>80</sup> The center offers entrepreneurial self-assessments, technical feasibility studies, review of business plans, and advice on strategy.

## **BUSINESS ENVIRONMENT**

In addition to Indiana's R&D tax credit and a parallel credit for investment in facilities construction, Energize Indiana added a 20 percent Venture Capital Investment Tax Credit for investments in qualified Indiana businesses focused on research and development. More broadly, the Central Indiana bioscience initiative has enjoyed strong support, including financial, from two successive mayors of the unified government of Indianapolis/Marion County.

## **SUMMARY OF LESSONS**

- Strong leadership by foundations and regional businesses unlocked state support and gave visibility to the biosciences and other technology sectors in a state with traditionally low educational achievement.
- Indianapolis is still at an early stage of development, but has benefited from agbiotech consolidation and is steadily building momentum in venture capital and research park development.

---

<sup>80</sup> See <http://www.indianaventurecenter.org>.

# Phoenix

## RECAP OF THE REGIONAL STORY

Although Arizona has an active communications/IT sector, its progress in building a bioscience cluster had been impeded until recently by a variety of barriers, including serious divisions between the biomedical communities of Phoenix and Tucson. University of Arizona, the state's premier public university and the only one with a medical school, is based in Tucson, while the vast majority of patients – encompassing the genetic diversity of both aging “snowbirds” and large tribes of Native Americans – can be found in or near Phoenix. The latter is home to Arizona State University, whose research reputation has rested primarily in engineering. Efforts to link researchers at the UA medical school to clinical settings in Phoenix had historically been blocked by private physician groups, which saw their livelihoods threatened by institutionally controlled faculty practices of a kind that did not exist in Phoenix. The state's development strategy rested primarily on recruiting firms dissatisfied with costs or congestion in California, but until recently the state had little to offer bioscience firms.

## DEVELOPMENTS SINCE THE LAST BENCHMARK

Phoenix was therefore not a benchmark for St. Louis at the time of the first exercise. Arizona's bioscience activities were kick-started in 2001/2002 as a direct consequence of an interregional competition mounted by Dr. Jeffrey Trent, then director of the NIH National Human Genome Research Institute. Dr. Trent wished to leave NIH to establish his own nonprofit Translational Genomics Research Institute (now known as **TGen**<sup>81</sup>), and he let it be widely known that he could be recruited. He entertained bids from several regions with leading academic medical centers – including Baltimore, Houston, Atlanta and others – but it was understood that as a doctoral alumnus of the University of Arizona, he would look favorably on a generous proposal from his former home state. Pushed by a Phoenix lawyer/dealmaker who envisioned major health benefits for the region, then-Gov. Hull convened a task force to try and raise the \$75 million it was then estimated it would take to attract Dr. Trent. This task force approached the usual donor community: large corporations, wealthy individuals, and private foundations.

Among the entities approached was the **Flinn Foundation**,<sup>82</sup> which seized the opportunity to radically reinvent itself and has since played a role in bioscience strategy analogous to that pioneered by the Danforth Foundation in St. Louis. Established in 1965 by a successful Phoenix physician and his wife, the Flinn Foundation was known until 2001 for a wide-ranging program to promote broader access to healthcare and social services, with miscellaneous programs in arts, university scholarships, and medical research. In 2001, the Flinn Foundation board took the governor's task force appeal as the opportunity “to commit all the Foundation's healthcare resources over the next decade to propel Arizona to national prominence in the biosciences.” In so doing, the board anticipated both social and economic-development benefits as Arizona

---

<sup>81</sup> See <http://www.tgen.org/about/index.cfm?pageid=40>.

<sup>82</sup> See <http://www.flinn.org>.

progressed toward national leadership. The foundation further understood that this change “meant abandoning the Foundation’s conventional practice of awarding grants among a broad universe of applicants. Instead the Foundation uses its grant dollars to fill strategic gaps.”

The Flinn Foundation played a major role in assembling what became a total package of \$90 million in capital funds and early-year operational support for TGen and the **International Genomics Consortium**,<sup>83</sup> a separate vehicle also led by Dr. Trent but currently focused on understanding the expression of cancer-promoting genes (which was a key issue to the lawyer who spurred the recruitment of Dr. Trent). Flinn provide \$30 million in declining support over TGen’s first five years, matched by \$5 million from another local foundation, \$30 million from the state government, \$21 million in land and construction from the City of Phoenix; and miscellaneous other contributions including from the Salt River Pima-Maricopa Indian Community. The capital portion of the project helped build a 6-story, \$46 million headquarters for TGen and IGC across the street from the Arizona Center office complex, anchoring a rapidly developing bioscience campus in the Copper Square district of downtown Phoenix.<sup>84</sup>

The money from the Flinn Foundation served as “glue” allowing TGen to seek and secure major collaborative grants that for the first time produced significant linkages among investigators at UA, ASU, Northern Arizona University, and the several large research hospitals and institutes that populate the Phoenix area, including a branch of the Mayo Clinic.

Flinn’s complete commitment to bioscience development also catalyzed the following critical events, all of which have unfolded over the last three years:

- With financial support from Flinn, a “**bioscience roadmap**” was commissioned on behalf of the state. It recommended<sup>85</sup> sustained investment in research from both public and private sources; development and patient pursuit of a clear strategy; attraction of risk capital; improvement of mechanisms for translational research; and focus on quality of life attractive the bioscience workforce.
- In response, ASU unveiled several new initiatives that strengthen its life science research base, including a major **Arizona Biodesign Institute**<sup>86</sup> that links its engineering strengths to biomedical applications, and a School of Life Science to be created within the College of Liberal Arts and Sciences,<sup>87</sup> including a new department of biomedical informatics.
- To accommodate this institutional growth at all three universities, and guided by the Flinn-commissioned roadmap, the state legislature embraced bioscience development, allocating \$440 million in new capital funding to a diversity of Regents-approved projects over the next several years, the first such major investment in the public university system in many years.
- The three public universities and TGen have agreed to create an **Arizona Bioscience Collaborative**,<sup>88</sup> which will focus on translational research that links basic science at any of the participating institutions to the patients and hospital beds controlled by the state’s

---

<sup>83</sup> See <http://www.integen.org/funding.html>.

<sup>84</sup> See <http://www.intgen.org/bioaz.html>.

<sup>85</sup> See [http://www.flinn.org/html/ar2002/journey\\_01.html](http://www.flinn.org/html/ar2002/journey_01.html).

<sup>86</sup> See <http://www.biodesign.org/about/index.html>.

<sup>87</sup> See <http://sols.asu.edu/text/aboutsols.php>.

<sup>88</sup> See [http://www.flinn.org/bio/article.cms/itemid=b\\_fn\\_abc\\_expand](http://www.flinn.org/bio/article.cms/itemid=b_fn_abc_expand).

clinical institutions. UA committed \$17 million, ASU \$10 million, and NAU agreed to lease space. The facility will be built adjacent to the TGen building at Copper Square.

## **FOCAL AREAS AND STRATEGY ENVIRONMENT**

Guided by the Flinn-sponsored roadmap, wide consensus has emerged that three “platform” areas in which the state will invest for excellence are: bioengineering; neurological sciences; and cancer therapeutics. Strategy is guided loosely by several academic/industrial/governmental “platform committees” assembled by the Flinn Foundation and by a newly energized Governor’s Council on Innovation and Technology.<sup>89</sup>

## **RESEARCH-CAPACITY BUILDING**

The funds allocated by the Legislature will lever privately raised funds for a wide variety of university, and among the largest of these is the home for the new ASU Biodesign Institute. The first building alone is a \$72.8 million, 250,000 square-foot structure (20 percent state supported), and the ultimate build out plan calls for 1 million square feet over four buildings, or enough space to house 15-20 newly created university research centers. In the same wave, UA is receiving funding for a \$65.7 million, 170,000 square-foot **Institute for Biomedical Science and Biotechnology** housing 30 interdisciplinary faculty members in Tucson.

Even more significantly, the Arizona Bioscience Collaborative will eventually add three new buildings to the TGen/IGC headquarters, creating 1 million square feet of space dedicated to institutional and clinical research, and including an expansion of ASU’s downtown campus. In 2003 state voters approved a referendum incrementing the state’s tobacco tax by \$10-12 million per year, with proceeds dedicated to the Arizona Disease Control Commission,<sup>90</sup> a state agency that is being revitalized to focus on funding translational and clinical research of the very nature in which the Collaborative will specialize.

## **INDUSTRY PARTNERSHIPS**

TGen is vigorously pursuing industry partnerships, but there is currently in Arizona no centralized source of funding open to university investigators that would incentivize creation of industry partnerships.

## **TECHNOLOGY TRANSFER/COMMERCIALIZATION**

TGen was created with the expectation that it would attract partners willing to invest in spin-offs from its research projects. To better match this newly energized environment, ASU placed its existing technology transfer activities **Arizona Technology Enterprise LLC**,<sup>91</sup> a for-profit corporation owned by its research foundation. This entity has resources to manage the ASU

---

<sup>89</sup> See <http://www.gcit.az.gov/about/default.html>.

<sup>90</sup> See <http://www.adcrc.com/description.html>.

<sup>91</sup> See [http://www.azte.com/about\\_mission.html](http://www.azte.com/about_mission.html).

Innovation Fund, which offers grants in the range of \$25,000 to \$50,000 to support proof-of-concept research. The first-year budget was \$300,000.

On this year's November ballot is Proposition 102,<sup>92</sup> an initiative recommended by the Flinn-commissioned strategy that would give unambiguous authority to the public universities and their technology licensing agents to hold equity in startup companies.

## VENTURE CAPITAL

Arizona has not traditionally had a broad or deep venture-capital community, in part because it is so easily reachable from California, and its institutional investors have been highly conservative. However, the Flinn-commissioned strategy advised a strong focus on building sources of "creative" risk capital, and so several initiatives are now under consideration in the state legislature, including a tax credit for investment in venture-stage funds (SB1315) and a publicly sponsored "fund of funds" (SB1328) that is competing for support with a bill to create a traditional CAPCO program (SB1401).

## RESEARCH PARKS/INCUBATORS

Although the University of Arizona's **Science and Technology Park**<sup>93</sup> in Tucson is usually considered more successful, ASU's 320-acre, 1.6 million square-foot **University Research Park**<sup>94</sup> is being reoriented to create closer connections to the campus's research directions. For example, in 2003, the board of the research park approved a 16-acre "Arizona Life Sciences Campus" (similar initiatives are under way at the UA Park). An incubator initiative in Phoenix the 1990s failed, but a local bioscience entrepreneur recently announced that she would dedicate part of a 300,000 square-foot building she is renovating for incubator-like uses, on land close to the Copper Square development.<sup>95</sup>

## HUMAN RESOURCES

In 2003, several community colleges (led by Maricopa, one of the nation's largest), the state, and the Flinn Foundation commissioned a comprehensive, statewide bioscience workforce strategy.<sup>96</sup> The report found a mismatch between supply and demand and recommend establishment of a statewide industry/education council to foster strong industry guidance on skill-standard-driven program offerings and career pathways. The strategy calls for a stronger emphasis on 2+2+2 degree programs.

There is also increasing attention to entrepreneurial education. ASU has created a coaching and mentoring program called Technopolis<sup>97</sup> whose management is outsourced to a team of local business people with startup and early-stage investment experience. Its services are open to all

---

<sup>92</sup> See <http://www.azsos.gov/election/2004/info/PubPamphlet/english/prop102.htm>.

<sup>93</sup> See [http://www.uatechpark.org/Park\\_Overview.pdf](http://www.uatechpark.org/Park_Overview.pdf).

<sup>94</sup> See <http://researchpark.asu.edu/>.

<sup>95</sup> See <http://www.ribomed.com/news.htm>.

<sup>96</sup> See <http://www.maricopa.edu/workforce/bioscience.html>.

<sup>97</sup> See <http://www.asutechnopolis.org>.

entrepreneurs, not just faculty spin-offs. Finally, several other Phoenix institutions (such as the Barrow Neurological Institute<sup>98</sup> and the Arizona Science Center<sup>99</sup>) are becoming more aggressive at K-12 educational programming aimed at enhancing career interest in biosciences and bioengineering.

## **BUSINESS ENVIRONMENT**

Among the initiatives under consideration in the Legislature is an enhanced R&D tax credit (SB1370) that would provide extra incentives for incremental R&D conducted at in-state research institutions.

Phoenix Mayor Phil Gordon has called for a \$100 million “Knowledge Capital Economy Fund,” that he could use for strategic recruitment of technology companies including in the biosciences.

## **SUMMARY OF LESSONS**

- Aggressive institutions following a clear strategy with foundation backing have unlocked state support for research capacity building for the first time ever, with momentum building for follow-on improvements in research park infrastructure and venture capital initiatives.
- In turn, public figures have forced cooperation among the state’s leading research institutions both in clinical biomedicine and convergent opportunities in bioengineering that are now at the top of ASU’s priority list.

---

<sup>98</sup> See [http://www.thebni.com/index.asp?pg=lc\\_rsrch\\_scenrich&supnav=off&catID=lc](http://www.thebni.com/index.asp?pg=lc_rsrch_scenrich&supnav=off&catID=lc).

<sup>99</sup> See <http://www.azscience.org/teachers/abc.htm>.

# Pittsburgh

## RECAP OF THE REGIONAL STORY

Pittsburgh has struggled to convert the bioscience research base at the University of Pittsburgh into business formation for much of the last two decades. However, until recently these efforts were overshadowed by the singular success of Carnegie Mellon University, where the advance of engineering programs to world-class status during the 1980s was followed by a strong burst of software and Internet company formation during the IT wave of the 1990s.<sup>100</sup>

One of Pitt's early steps was to lever its Medical Center's clinical expertise in organ transplantation with a research center that became known as the **McGowan Institute for Regenerative Medicine**,<sup>101</sup> named after the MCI CEO who received a life-saving heart transplant at Pitt's Medical Center in 1987. A lukewarm effort by the region's technology community to exploit these assets led to the Pittsburgh Biomedical Development Corporation and the Pittsburgh Tissue Engineering Initiative, an early step at collaboration between the two institutions. Both have been subsumed by subsequent initiatives.

It was not until this decade that the right conditions emerged for Pittsburgh to position itself as a center of biomedical development in Pennsylvania, competing with the more traditional pharmaceutical and specialty-chemical sectors based around Philadelphia. This story unfolded under the general aegis of a knowledge-based development strategy put in place over decades by the **Allegheny Conference on Community Economic Development**,<sup>102</sup> a CEO leadership group that had led the post-World War II reinvention of Pittsburgh's downtown.

## DEVELOPMENTS SINCE THE LAST BENCHMARK

Since the last benchmarking exercise, Pittsburgh has emerged as a bioscience competitor well worth monitoring, although commercial progress is still at an early stage. What has made the difference was the convergence of state economic-development programming with a growing sense by the Allegheny Conference's "Working Together Consortium" that Pitt could benefit from some of CMU's entrepreneurial energy, and that the two institutions needed to work together in building the region's knowledge-based economy.

The two universities had already begun planning some kind of joint venture in the biosciences in 2000 when as part of its plan for the tobacco settlement Pennsylvania committed \$100 million in one-time funding to establish three regional "**Life Science Greenhouses**." Pittsburgh's share was about one-third, and the region's philanthropic foundations – already very active in the Allegheny Conference and its related, spin-off programming – committed to match the \$33 million 3:1 over a two-decade period. (At the same time, the state committed \$60 million more in tobacco-

---

<sup>100</sup> For example, internet search pioneer Lycos – which wounded the region by relocating to Massachusetts – and FORE Systems, a networking company ultimately acquired by the now-troubled Marconi.

<sup>101</sup> See <http://www.mirm.pitt.edu/aboutus.htm>.

<sup>102</sup> See [http://www.alleghenyconference.org/public/cfm/homepage\\_accd/](http://www.alleghenyconference.org/public/cfm/homepage_accd/).

settlement funds annually to biomedical research projects statewide<sup>103</sup> and agreed to invest \$60 million of the settlement trust's corpus in three newly established venture-capital funds charged to focus heavily on the state and companies emerging the three Greenhouses.)

The result was a comprehensive non-profit intermediary called the **Pittsburgh Life Sciences Greenhouse**,<sup>104</sup> modeled on the region's earlier success with the **Pittsburgh Digital Greenhouse**<sup>105</sup> (established 1999), a 28-member consortium focused on systems on a chip that aggregated state support with company dues to support a program of pre-competitive R&D, training, and business assistance. Likewise, the Life Science Greenhouse targets the biosciences. It has already recruited 11 research "stars" to the two universities, seeded several collaborations in targeted sectors (see below), opened the region's first wet-lab incubator, and created new sources of funding for technology commercialization and pre-seed and seed-stage venture capital.

By Greenhouse definitions, the region now counts 90 active bioscience companies up from 50 in 2001. Success has been somewhat mixed:

- **Cellomics**,<sup>106</sup> a tissue-engineering startup founded in 1996 and which incubated at Pitt's UPARC research park, had a phase of rapid growth followed by shrinkage, which allowed the Greenhouse to sublease some of its custom-developed space as the wet-lab incubator;
- **Tissue Informatics** was acquired by North Carolina-based Paradigm Genetics, now Icoria;<sup>107</sup>
- Although it has had several near-death experiences, **Launchcyte**<sup>108</sup> – a Pittsburgh-based for-profit commercialization company targeting university spin-offs and modeled loosely on the city's for-profit dot-com incubators – seems to have stabilized and has generated several of the firms ultimately attracted to the Greenhouse incubator. However, it also draws intellectual property from research institutions elsewhere and is not above "competing" locational decisions for the companies it has founded.

## FOCAL AREAS AND STRATEGY ENVIRONMENT

The **Pittsburgh Regional Alliance**,<sup>109</sup> a 10-county collaborative that merged the former Chamber of Commerce and several related promotional organizations for southwestern Pennsylvania, targets as emerging technology sectors advanced manufacturing (including robotics), environmental technology, IT and life sciences. Within the biosciences, strategy leadership – once taken by the **InnovationWorks**,<sup>110</sup> the Pittsburgh regional center for the state-sponsored

---

<sup>103</sup> See [http://www.dsf.health.state.pa.us/health/lib/health/Tobacco-CURE/2002-03\\_Annual\\_Report-Section\\_1.pdf](http://www.dsf.health.state.pa.us/health/lib/health/Tobacco-CURE/2002-03_Annual_Report-Section_1.pdf).

<sup>104</sup> See <http://www.pittsburghlifesciences.com/content.aspx?id=aboutplsg>.

<sup>105</sup> See [http://www.digitalgreenhouse.com/default.aspx?id=about\\_pdg](http://www.digitalgreenhouse.com/default.aspx?id=about_pdg).

<sup>106</sup> See [http://www.cellomics.com/content/menu/About\\_Us/](http://www.cellomics.com/content/menu/About_Us/).

<sup>107</sup> See <http://www.icoria.com/about>.

<sup>108</sup> See <http://www.launchcyte.com/pages/about.htm>.

<sup>109</sup> See <http://www.pittsburghregion.org/public/cfm/aboutus/>.

<sup>110</sup> See <http://www.innovationworks.org/about.jsp>.

Ben Franklin Technology Partners Program<sup>111</sup> and/or by the **Pittsburgh Technology Council**<sup>112</sup> – now rests with the Greenhouse itself.

The targets the following four “pillar” areas:

- **Drug discovery tools and targets**, with a particular focus on cancer therapeutics that levers Pitt’s rapidly growing Hillman Cancer Institute.
- **Therapeutic strategies for neurological and psychiatric disorders**, which combines great strengths in clinical medicine at Pitt with imaging and computation at CMU.
- **Tissue/organ engineering and regenerative medicine**, an expression of the growing strength of the McGowan Institute
- **Medical devices and diagnostics**, which also integrates bioscience research with the engineering strengths of CMU.

The elements of the Greenhouse strategy are:

- Maximize incentives to increase linkages between research, technology and commercialization
- Nurture and develop entrepreneurial bioscience enterprises
- Invest in and grow the region’s talent pool from entry-level to senior executive
- Expand specialized capacity within regional economic-development organizations
- Leverage the regions’ research stature in areas that reflect leadership in science and clinical care

## RESEARCH-CAPACITY BUILDING

The Greenhouses are themselves recipients of grants from the statewide “University Research and Economic Development Program” of the **Ben Franklin Technology Development Authority**.<sup>113</sup> Matching this core support with commitments from the region’s major philanthropic foundations, The Greenhouse offers the following capacity building programs:

- **Opportunity Fund**<sup>114</sup> to support faculty recruitment, and the creation of strategic centers and programs tied to priority areas;
- **University Facilities Fund**,<sup>115</sup> which supports laboratory expansion and acquisition of major scientific equipment that promotes multidisciplinary teams, levers federal supports, assists in recruitment of “star” faculty, and provides for sharing with the private sector.

Carnegie Mellon’s capacity-building programs remained focus on software engineering and robotics, but Pitt’s \$1 billion capital campaign includes **Biomedical Science Tower 3**,<sup>116</sup> a \$211 million, 10 story, 330,000 square foot structure with five floors of core labs and links to partner

---

<sup>111</sup> See <http://www.benfranklin.org/about/index.asp>.

<sup>112</sup> See <http://pghtech.org/aboutus/>.

<sup>113</sup> See <http://www.inventpa.com/default.aspx?id=30> and <http://www.inventpa.com/default.aspx?id=31>.

<sup>114</sup> See <http://www.pittsburghlifesciences.com/content.aspx?id=oppfund>.

<sup>115</sup> See <http://www.pittsburghlifesciences.com/content.aspx?id=university>.

<sup>116</sup> See [http://www.health.pitt.edu/pittmed/MAY\\_2003/98\\_6Degree.pdf](http://www.health.pitt.edu/pittmed/MAY_2003/98_6Degree.pdf).

computational laboratories at CMU. The facility is currently funded by state grants and debt that the university intends to partly retire through philanthropic support.

## INDUSTRY PARTNERSHIPS

The Greenhouse also offers **the Industry/University Collaborative Research Program**,<sup>117</sup> which supports research partnerships between university faculty and companies at the level of \$150,000 to \$250,000. Grants may be made to either the company or the university and require a match of 2:1 in cash for large firms and .5:1 in kind for startups. There is payback through royalty sharing, and a clawback in case the company leaves the region.

## TECHNOLOGY TRANSFER/COMMERCIALIZATION

The Greenhouse offers a **Technology Development Fund**<sup>118</sup> that offers grants up to \$100,000 to support pre-commercialization research aimed at placing university-derived intellectual property. Possibly more significant has been **Launcheyte**, an independent, pre-seed stage commercialization company that has positioned itself to work closely with several research institutions in both Pittsburgh and Philadelphia.

## VENTURE CAPITAL

Pittsburgh extraordinary community of private philanthropic foundations have long been active in bringing new venture-capital firms to the region, especially those interested in earlier-stage investing. For example, more than a decade ago the Benedum Foundation took part of its existing asset allocation to alternative assets and made what it called “patriotic investments” in **Draper Triangle Venture Fund**,<sup>119</sup> a Pittsburgh affiliate of the well known Draper Juvetson Fund, and **Birchmere Ventures**,<sup>120</sup> started as a dot-com incubator but operates as a multisector venture capital fund. In such efforts, the foundations have often been joined by one or more of the state’s public pension funds which have a long history of making commitments that help fund managers establish a new presence or a new focus.

The **Ben Franklin Technology Development Authority** has the legal authority to make equity investments either directly in companies or through venture-capital limited partnerships. Most recently, the state has been active in creating new venture funds through the **Tobacco Settlement Board**. Through a competitive process, it placed about \$20 million each – matched 3:1 by third-party investors – in three Pennsylvania-based funds

- **Quaker BioVentures**,<sup>121</sup> based in Philadelphia and active throughout the Mid-Atlantic region.

---

<sup>117</sup> See <http://www.pittsburghlifesciences.com/content.aspx?id=CRF>.

<sup>118</sup> See <http://www.pittsburghlifesciences.com/content.aspx?id=TDF>.

<sup>119</sup> See <http://www.drapertriangle.com/>

<sup>120</sup> See <http://www.birchmerevc.com/about.html>.

<sup>121</sup> See <http://www.quakerbio.com/index.html>.

- A new fund established by **PA Early Stage Partners**,<sup>122</sup> which was itself founded a decade ago by collaboration between the state's pension funds and Safeguard Scientifics of suburban Philadelphia on IT investments;
- **Birchmere Ventures**, the same firm referenced above.

The Greenhouse took \$15 million of its startup funds and placed them with PA Early Stage as a sub-fund targeted specifically to **seed**-stage opportunities. The Greenhouse also operates its own, internal **pre-seed** fund integrating the capital base of the former Pittsburgh Biomedical Development Corporation.<sup>123</sup>

Also at the early stages of investment, InnovationWorks offers three tiers of venture-like investing subsidized by its annual state grant:

- **Innovation investments** via convertible debt up to \$100,000
- **Commercialization investments** via convertible debt of up to \$250,000, targeted at prototype development
- **Equity co-investments** with third-party angels or venture capitalists up to \$500,000.

Pittsburgh is one of the few areas to have created an angel-capital forum specifically targeting the life sciences, known as Lifespan.<sup>124</sup> The Ben Franklin Partners also recently announced a program under which state funds will guarantee up to 25 percent of the investment of qualifying angel investors in qualifying early-stage companies.<sup>125</sup>

## RESEARCH PARKS/INCUBATORS

Pittsburgh has the elements of a university-related research parks scattered over several separate projects:

- **Pittsburgh Technology Center** is a 48-acre reclaimed brownfield at the riverfront, one of three sites made available by the demise of steel manufacturing in downtown Pittsburgh. Both universities maintain facilities on site, including the Pitt's Center for Biotechnology and Bioengineering. Here a private developer recently custom-built a structure for Cellomics, which subsequently contracted and subleased space to the Greenhouse for its 5,000 square foot wet-lab incubator. Among the 11 tenants are **Renal Solutions**,<sup>126</sup> **Rivivacor** (a PPL Therapeutics spinout),<sup>127</sup> and **Crystalplex**, a Launchcyte startup.<sup>128</sup>
- **U-PARC** is a mature technology park in suburban Hamarville 14 miles upriver. UPARC was originally an R&D campus for Gulf Oil, which donated it to Pitt after Chevron acquired Gulf in 1984. Its extensive wet-lab capacity (available from the university at

<sup>122</sup> See <http://www.paearylstage.com/aboutus.htm>.

<sup>123</sup> For information on both initiatives see <http://www.pittsburghlifesciences.com/content.aspx?id=601bbc5c-d418-439e-b721-aa8b2191e41b>.

<sup>124</sup> See <http://pghlifespan.com/>.

<sup>125</sup> See [http://www.inventpa.com/press\\_release.aspx?prid=599](http://www.inventpa.com/press_release.aspx?prid=599)

<sup>126</sup> See <http://www.renalsolutionsinc.com/press-june2003.html>.

<sup>127</sup> See <http://www.revivicor.com/about.html>.

<sup>128</sup> See <http://crystalplex.com/news.shtml>

\$16-18 per square foot) has made it an attractive de facto technology incubator for companies such as **Cellomics**.

- **South Side Works** is directly across the river from PTC and is the former finishing mill for J&L. A master developer has successfully redeveloped the core of the 130-acre site, although considerable acreage still remains undeveloped. The key bioscience tenant is a brand-new facility for the **McGowan Institute**.
- **Hazelwood Works** is a 138-acre site that fed the two J&L steel mills and is now being redeveloped by Almono LLC, a developer jointly owned by several Pittsburgh foundations and the **Regional Industrial Development Corp**,<sup>129</sup> the operator of the Allegheny Conference's \$70 million Strategic Investment Fund. Almono bought the site in bankruptcy court for under \$10 million and is exploring research park uses.
- At **Panther Hollow**, CMU is developing a 127,000 square foot Collaborative Innovation Center targeted at attracting research partners (though not currently in the biosciences) of Carnegie Mellon faculty.

## HUMAN RESOURCES

The Greenhouse operates its own **Executive Corps**<sup>130</sup> to develop a cadre of seasoned bioscience executives available to serve as interim CEOs of spin-offs that are positioned for formal venture capital investment. It also recently received a \$2.4 million U.S. Department of Labor grant for a National Biotechnology Worker Training initiative.

In addition, UPMC operates internally the **Limbach Entrepreneurial Center**,<sup>131</sup> to help scientists at its Hillman Cancer Institute and the McGowan Institute commercialize their discoveries. This center includes education programs and intramural university funding for proof of concept.

The state offers "SciTech scholarships" of up to \$3,000 a year for students in four-year college and "Technology" scholarships of \$1,000 for community college students.<sup>132</sup> An advertising campaign tagged "Come/Stay Invent the Future" to retain college students evolved into the theme for the entire economic-development presentation on the state's web page" InventPA.

## BUSINESS ENVIRONMENT

The state recently expanded its previously tightly capped R&D tax credit, and made credits tradable by application to the state economic development department.<sup>133</sup>

---

<sup>129</sup> See <http://www.ridc.org/about/index.html>.

<sup>130</sup> See <http://www.pittsburghlifesciences.com/content.aspx?id=execresidence>.

<sup>131</sup> See [http://www.limbach.org/about\\_home.asp](http://www.limbach.org/about_home.asp).

<sup>132</sup> See <http://www.inventpa.com/default.aspx?id=212>.

<sup>133</sup> See <http://www.inventpa.com/default.aspx?id=620>.

## **SUMMARY OF LESSONS**

- Pittsburgh's embrace (at the urging of involved foundations) of inter-university cooperation has allowed it to connect some of CMU's entrepreneurial energy with the bioscience research base at Pitt, enhancing a focus on convergent opportunities.
- These changes are beginning to show in research funding, faculty recruitments and other measures of Pittsburgh's visibility on the national scene.

# San Diego

## RECAP OF THE REGIONAL STORY

The history of San Diego's takeoff as a center of wireless telecom and biotechnology has been studied extensively, most recently by consultants for the Small Business Association and the Council on Competitiveness.<sup>134</sup> There is wide agreement that San Diego's success is linked to its rise in the years following World War II (with the active assistance of the local Navy base) as a center of defense avionics R&D. Defense contractors entered and exited the region in cyclical fashion, leaving occasional openings for entrepreneurs.

Alumni of giant contractors were responsible for the creation of many early startups, not only in telecom but also in bioscience. In this way, General Dynamics begat General Atomics, which begat SAIC (an employee owned technology firm, and now one of the region's major holders of NIH research contracts). Other key sources of spin-offs were the young and vibrant **UCSD** campus,<sup>135</sup> which was built on excellence in the life and physical sciences, and its research partners at Scripps Research Institute,<sup>136</sup> Salk Institute,<sup>137</sup> and the Burnham Cancer Institute.<sup>138</sup> Eventually two critical spin-outs were formed: Linkabit (1968) in telecom and **Hybritech** (1978) in biosciences. Alumni of Hybritech ultimately played a key role in generating 40-50 other bioscience firms, especially after Hybritech was sold to Eli Lilly Co., resulting in wholesale exit of freewheeling scientists who disliked the corporate culture of the pharmaceutical sector.

The trickle of startups became a surge once San Diego confronted the defense downsizing of the early 1990s, under the leadership of then **UCSD** Chancellor Richard Atkinson, who created the campus-based **CONNECT** program described below. Demonstrating the relevance of university research to regional business interests and economic development was a key part of his strategy to create a new engineering school at UCSD (this goal was reached with a founding donation from Irwin Jacobs, the former UCSD faculty member who founded Linkabit and co-founded Qualcomm).

However, from the earliest days of the sector's growth, San Diego bioscience startups have tended to be acquired by larger entities and then spun out again or resold. This has the virtue of giving several large pharmaceutical companies a local presence, and often scatters dissatisfied talent that can be picked up by new startups, but on the downside there is currently no large, locally headquartered firm as significant in the biosciences as Qualcomm is in the wireless sector.

---

<sup>134</sup> Innovation Associates. *Developing High-Technology Communities: San Diego*. Washington: U.S. Small Business Administration, April 2000. Available on-line at <http://www.innovationassoc.com/Executive%20Summary.pdf>. Another good source is: Michael Porter. *San Diego: Clusters of Innovation Initiative*. Washington: Council on Competitiveness. Available on-line at [http://www.compete.org/pdf/sandiego\\_final.pdf](http://www.compete.org/pdf/sandiego_final.pdf).

<sup>135</sup> Founded 1960.

<sup>136</sup> Founded as a clinic in 1924, but basic biomedical research dating to the recruitment of Frank Dixon from the University of Pittsburgh in 1955.

<sup>137</sup> Founded in 1963 with the recruitment of Dr. Salk by the Mayor and civic leaders.

<sup>138</sup> Founded in 1976 by retired Tufts faculty member Bill Fishman.

## DEVELOPMENTS SINCE THE LAST BENCHMARK

Since the last benchmark, the San Diego region has maintained its position as the second-most vigorous bioscience region in California after the greater San Francisco Bay Area, and is still one of the nation's top markets in several important subsectors. However, the region has suffered some significant reversals, and civic leadership continues to fret about the state policy environment, and lack of space and resources to capture the “manufacturing” end of the bioscience product-development cycle.

Among the key recent disappointments in San Diego have been:

- The state-supported California Technology Investment Program – which distributed grants to assist young companies in capturing federal awards – was de-funded in last year's budget crisis, forcing the nonprofit **San Diego Regional Technology Alliance** (one of several like entities supported by the state to manage the CalTIP program) to reinvent itself as a business accelerator and provider of market-research data.<sup>139</sup>
- The **Scripps Research Institute** decided to place its next major expansion not in San Diego but in Florida, which has made available more than \$500 million in state and county incentives to try and duplicate the perceived clustering benefits that Scripps brought to La Jolla<sup>140</sup>
- Consolidation hit San Diego hard, particularly in the agbiotech sector:
  - The planned Novartis Agricultural Discovery Institute was folded into the U.S. operations of **Syngenta** and relocated in 2002 from La Jolla to Research Triangle Park, North Carolina, where it joins the U. S. headquarters of Bayer CropScience;
  - Dow Chemical, whose **Dow AgroSciences** R&D unit<sup>141</sup> was briefly based in San Diego after it bought local startup Mycogen, relocated all agbiotech research to Indianapolis, leaving behind only a process-development center for the Dow Pharma unit;
  - Epicyte Pharmaceutical, a “biofarm” startup company, was sold to North Carolina-based **Biolex** this year, and all San Diego operations were closed.
- San Diego lost a medical biotech headquarters when **IDEC** merged with Biogen. The merged company maintained manufacturing and a center of excellence in San Diego but is now run from Cambridge, Mass., with additional manufacturing in Research Triangle. There is now no locally headquartered biotech nearly as large as Genentech in the Bay Area or Amgen in Thousand Oaks near LA.

On the positive side, San Diego received a boost from a study by the Milken Institute that ranked it top among U.S. metro areas in sustainability of its biotech sector.<sup>142</sup> However, the director of BIOCOM has told Battelle that the study had been commissioned as a way of showcasing San

---

<sup>139</sup> See <http://www.sdrta.org>.

<sup>140</sup> See <http://www.scripps.edu/intro/history.html>.

<sup>141</sup> Created when Dow bought out Eli Lilly's interest in the Dow Elanco joint venture.

<sup>142</sup> See

<http://www.milkeninstitute.org/publications/publications.taf?function=detail&ID=312&cat=ResRep>.

Diego before BIO 2004 in San Francisco. Advocates of the Bay Area have pointed out the study disaggregated their region, resulting in a higher ranking for San Diego. Finally, the report de-emphasizes the fact that under a broader definition of biosciences (including medical devices but not agbiotech), Boston would have ranked first.

## FOCAL AREAS AND STRATEGY ENVIRONMENT

While the wireless sector has received significant recognition and support from the state government, the bioscience sector still depends much on its own ingenuity. State strategy as expressed through the University of California's "**Cal Institutes**" program<sup>143</sup> has chosen to recognize UCSD only for its expertise in wireless communications and networking. Of the four Cal Institutes for which the state is underwriting about \$100 million each in capital costs, UCSD benefits directly only from Cal-(IT)<sup>2</sup> – the California Institute for Telecommunications and Information Technology. This institute has no explicit "convergent" thrust, despite the long-standing interest of the San Diego Supercomputer Center in bioinformatics, and a moderately strong regional presence of gene-chip and biomedical device companies.

Development strategy in San Diego continues to rest primarily on a perceived higher quality of life and lower cost of living than the Bay Area. Regional strategy is shaped largely by a series of technology trade associations – **BIOCOM**<sup>144</sup> for the biosciences – that touch each other only in superficial ways through their mutual participation in UCSD's **CONNECT**<sup>145</sup> program, which is in effect a regional technology council lodged inside the university's extension division. Bioscience entrepreneurs active in the San Diego region have told Battelle that CONNECT now focuses more on helping existing startups survive than generating new ones, and that publicity for both CONNECT and BIOCOM may overshadow the reality of their continued relevance to startup generation.

As noted above, SDRTA has ceased to play a role as policy custodian. However, the La Jolla-based California Healthcare Institute, a statewide public-policy organization affiliated with BIO, issued a Biomedical Industry Report in 2004 that recommends improving the environment for biopharmaceutical manufacturing, through an investment tax credit, among other initiatives.<sup>146</sup> Regional BIO affiliates in San Diego, San Francisco and Los Angeles have largely lined up behind these recommendations.

## RESEARCH CAPACITY-BUILDING

At UCSD the most important new bioscience capacity brought on line in recent years was the interdisciplinary **Whitaker Institute of Biomedical Engineering**, which received major support from the Whitaker Foundation as it moved into a newly constructed engineering complex. (Whitaker has supported several such initiatives nationwide as it spends down its endowment on a pre-planned closeout mission.)

---

<sup>143</sup> See <http://www.ucop.edu/california-institutes/>.

<sup>144</sup> See <http://www.biocom.org/aboutus.asp>.

<sup>145</sup> See <http://www.connect.org/about/index.htm>.

<sup>146</sup> See reports available at <http://www.chi.org>.

## INDUSTRY PARTNERSHIPS

Since it will not have or share in a bioscience-oriented Cal Institute, San Diego must leverage **UC's Discovery Grant**, a far more modest challenge grant to encourage academic/industrial collaboration.<sup>147</sup> The Discovery Grants grew from the Industry/University Cooperative Research Program launched by Richard Atkinson after he moved from the UCSD Chancellorship to the UC Presidency. He modeled the program on MICRO, a long-standing program run at the Berkeley campus, and his experience with similar activities at the National Science Foundation.

The overall Discovery Grant is now funded at more than \$20 million annually, but awards are split over seven disciplines of which only two are relevant to the biosciences: **Biotechnology** (where the program was originally called BioSTAR), and **Information Technology for the Life Sciences**. Discovery Grants, which range from \$50,000 to \$250,000 for up to four years, must be matched 1:1 by a California-based industry partner. At a well developed institution like UCSD, such grants can benefit on the margin but on the whole are not significant relative to the size of the research enterprise, and generally do not pay for facilities or major research equipment.

Locally, CONNECT co-sponsors a **Translational Medicine Program**<sup>148</sup> that makes available on a peer-reviewed basis grant of up to \$200,000 per year to establish connections between regional bioscience companies and investigators at the school of Medicine. Both the Discovery Grants and the TransMed grants are not necessarily aimed at “applied” research; they are better seen as resources for directing basic research projects toward areas of strategic interest to the regional bioscience industry community.

## TECHNOLOGY TRANSFER/COMMERCIALIZATION

UCSD's **Technology Transfer and Intellectual Property Services** Office, the campus satellite of the University of California's centralized Office of Technology Transfer, acknowledges the campus's commitment to assist in regional economic development. The director has told Battelle that he therefore has a “higher proclivity” than licensing directors at the other UC campuses to accept equity in startups in lieu of royalty-license payments. (Data reported by the UC system are not regularly disaggregated in a way that it is possible to verify this claim.)

## VENTURE CAPITAL

One of the early initiatives of CONNECT was a program to introduce regional entrepreneurs to the venture capital community of Silicon Valley. However, as the region has matured, most of these firms have found ways to source their own deals in the San Diego region, and a number of indigenous firms have opened. The venture community in California benefits from several initiatives of the giant **California Public Employees Retirement System**, which runs a “California Initiative” and a “Biotechnology Program” – both \$500 million programs that disproportionately benefit venture managers based in California. However, among the first \$285 million in investment commitments, none were to San Diego-based venture firms.

---

<sup>147</sup> <http://uc-industry.berkeley.edu/welcome.asp>.

<sup>148</sup> See <http://invent.ucsd.edu/TransMed/>.

## RESEARCH PARKS/INCUBATORS

No action has been taken on **San Diego Regional Technology Park**, a 1,000-acre park proposed by San Diego Regional Economic Development Corporation as the anchor of a network of decentralized 200-acre parks. Bioscience and biopharmaceutical manufacturing were among the several targets for this network of parks. The Center for Applied Competitive Technologies at San Diego City College,<sup>149</sup> the only formal university-affiliated business incubator in San Diego, is not primarily bioscience-oriented.

## HUMAN RESOURCES

Since the last benchmark, UCSD graduated its first class of doctoral students from its new **School of Pharmacy and Pharmaceutical Sciences**, approved by the UC regents in 2000. The school will have its own building by 2005.<sup>150</sup> San Diego had been the largest metropolitan area in the U.S. without its own pharmacy school, according to the UC regents. The school represents the national trend toward coupling Ph.D. and advanced research programs to traditional doctor of pharmacy degrees. It is explicitly charged to cooperate with various UCSD units, the Supercomputer Center, and the regional biotechnology sector.

In addition, existing efforts by San Diego State University to serve the educational needs of the bioscience sector have become better integrated into a **CSU Program for Education and Research in Biotechnology**<sup>151</sup> that is now system wide within the California State University System, the state's second system of public higher education comprising former teachers colleges advanced to university status over the last decades. Through this system, degrees are offered at SDSU in a range of relevant disciplines including regulatory affairs and pharmaceutical manufacturing.

In the community college system, Miramar College hosts a Southern California Biotechnology Center<sup>152</sup> that coordinates training and retraining programs offered by six community colleges in the San Diego region.

CONNECT also cosponsors a student-developed **VentureForth**<sup>153</sup> program aimed at encouraging student interest at multiple levels in various technology sectors including the biosciences.

## BUSINESS ENVIRONMENT

In 2000 San Diego added a municipal ordinance that created a **San Diego Science and Technology Council** to advise the Mayor and City Council on issues pertaining to several technology fields including biotech.<sup>154</sup> The City's Department of Community and Economic

---

<sup>149</sup> See <http://www.cact.org/sandiego/>.

<sup>150</sup> See <http://pharmacy.ucsd.edu/about.shtm>.

<sup>151</sup> See <http://www.csuchico.edu/csuperb/>.

<sup>152</sup> See <http://www.miramar.sdccd.net/programs/biol/biotech/>.

<sup>153</sup> See <http://ventureforth.org/about/whatisvf.html>.

<sup>154</sup> See <http://www.sannet.gov/city-clerk/boards-commissions/technology.shtml>.

Development also offers a **Technology Loan Fund**<sup>155</sup> that can provide working-capital loans up to \$250,000, preferably in participation with a non-public source of debt or equity financing.

## **SUMMARY OF LESSONS**

- Considerable effort has gone toward developing UCSD research excellence on the engineering side, with biosciences – and especially agbiotech – suffering from corporate consolidation and living off accumulated entrepreneurial energy.
- The region’s hidden asset is its success in convincing Silicon Valley venture capitalists to open offices in San Diego, substantially increasing the exposure of deals in all fields and at all stages to a variety of investment styles.

---

<sup>155</sup> See <http://www.sannet.gov/economic-development/business-assistance/finance/emtek.shtml>.

# Saskatoon

## RECAP OF THE REGIONAL STORY

The largely agricultural province of Saskatchewan staked out an early position on agbiotech, originally leaving medical biotechnology to the more populous provinces of Quebec, Ontario and British Columbia. The **University of Saskatchewan** already had strong programs in agricultural research and veterinary medicine, and it was relatively easy for political leadership to ensure that the federally sponsored **Plant Biotechnology Institute**<sup>156</sup> came to **Innovation Place**, the university's 80-acre, 18-building affiliated research park (see below).

The PBI is funded by the Canadian National Research Council, which sponsors large-scale research centers intended to promote academic/industrial collaboration. The university campus itself hosts the **Saskatoon Canada Research Centre**,<sup>157</sup> which could be thought of as a rough analogue to an American Agricultural Experiment Station, although it is operated directly by Agriculture and Agri-Food Canada, a federal agency similar to USDA. Finally, Innovation Place hosts the **Saskatchewan Research Council**,<sup>158</sup> an applied R&D company owned by the provincial government, with several technical focuses including agbiotech, IT, and energy technology.

**Ag-West Bio**,<sup>159</sup> a cluster-development organization sponsored by the provincial Agriculture and Food and Rural Revitalization Agency, promotes academic/industrial collaboration and spin-off formation. Ag-West has no research responsibilities itself but has successfully created a strong “brand” for Saskatchewan in agricultural biotechnology. Among the major multinational companies with R&D presence (not headquarters) in Saskatoon are **Bayer CropScience Canada**, **BASF Canada**, **Dow AgroScience**, and DuPont's **Pioneer Hi-Bred** unit. The balance of tenants at Innovation Place are smaller companies and commodity-crop organizations.

Part of the region's appeal to the industry has been strong acceptance of genetically enhanced products by the province's farmers. Within three years of the legal introduction of a transgenic strain of canola, half the province's farmers had adopted it.

## DEVELOPMENTS SINCE THE LAST BENCHMARK

Since the time of the last benchmark exercise, Saskatoon has been buffeted by the waves of consolidation that have affected the multinational agbiotech industry, but it has continued to capture new startups and even expanded somewhat into human biomedicine and bio-based products and alternative energy. In the latter field it will compete directly with Calgary, Alberta, Canada's undisputed center of traditional energy research. Here are some major developments:

---

<sup>156</sup> See <http://pbi-ibp.nrc-cnrc.gc.ca/en/pbi.htm>.

<sup>157</sup> See [http://res2.agr.ca/saskatoon/index\\_e.htm](http://res2.agr.ca/saskatoon/index_e.htm).

<sup>158</sup> See [http://www.src.sk.ca/html/about\\_src/index.cfm](http://www.src.sk.ca/html/about_src/index.cfm).

<sup>159</sup> See <http://www.Ag-West.sk.ca/about/index.php>.

- Consolidation in the agbiotech sector has reduced from about 20 to about half a dozen those major multinational companies that can sustain R&D presence in communities other than their headquarters. Innovation Place still serves several of these organizations (with the exception of Syngenta) but did lose some pharma tenants, including an outpost of Merck-Frosst of Montreal.
- Ag-West Bio was created as the consolidation of three smaller cluster organizations: Ag-West Biotech, Bio-Products Saskatchewan Inc., and the Saskatchewan Nutraceutical Network. This change augurs a new, expanded focus encompassing not just crop development per se but also bio-manufacturing of fibers, foods, and fuels such as biodiesel from oilseeds.
- The university's affiliated **Veterinary Infectious Disease Organization (VIDO)**, founded in 1975, was renamed in 2003 as the *Vaccine* and Infectious Disease Organization<sup>160</sup> and now targets applications of genomics and proteomics to prevention of human diseases such as hepatitis C and SARS. The province's Innovation and Science Fund, which matches major excellence awards from the federal government, is contributing \$C9 million over five years to assist in the transition. VIDO has three startups to its own credit.
- **Pyxis Genomics**, an animal genomics firm started by University of Illinois faculty, was transplanted to Saskatoon at the direction of its investor Burrill and Company, the San Francisco venture capitalist. A partner of Burrill has told Battelle that the main draw was the availability of Canadian federal R&D tax credits<sup>161</sup> and the company's invited participation in joint research with VIDO that would be co-funded by **Genome Canada**,<sup>162</sup> a federally funded project. Pyxis and a Vancouver-based biotech company will together fund \$C13 million in research at VIDO, but they will be matched by Genome Canada for a total \$C27 million in research purchasing power. Two thirds of the total will be spent at VIDO and the balance in B.C.
- The joint federal/provincial **Canada-Saskatchewan Agri-Food Innovation Fund**<sup>163</sup> expired, having allocated \$C91 million to 300 applied R&D projects across several technologies at the university, PBI, the Saskatoon Research Centre, and other entities. The provincial government has assumed responsibility for winding down these projects. At the same time, the federal government has started major new R&D initiatives in Agriculture, AgriFood, and Sustainable Development in which university and PBI investigators are expected to do well.

## FOCAL AREAS AND STRATEGY ENVIRONMENT

Regional bioscience strategy is guided by Ag-West Bio, successor to a not-for-profit founded in 1989 and funded by the province's Department of Agriculture and Food. It promotes the region

<sup>160</sup> See <http://www.vido.org/about/story.php>.

<sup>161</sup> See <http://www.cra-arc.gc.ca/sred/>.

<sup>162</sup> A government-funded agency to develop a national genomics strategy and network of research resources. See <http://www.genomecanada.ca/GCgenomeCanada/enBref/index.asp?l=e>. Interestingly, none of Genome Canada's funded research centers is in Saskatchewan.

<sup>163</sup> See <http://www.agr.gov.sk.ca/afif/Homepage.htm>.

and attempts to articulate with the national biotechnology strategy (last updated half a decade ago)<sup>164</sup> and the national innovation strategy,<sup>165</sup> which has been important in building research capacity and promoting university/industry collaboration. While the university's agriculture school has traditionally emphasized legumes and cereal crops, PBI and the Saskatoon Research Centre both focus tightly on hybrid oil-seed crops, which attract industrial interest because they must be bought by farmers each growing season. The newest focal areas are bioprocessing of foods, fibers and fuels.

## RESEARCH CAPACITY BUILDING

While there are other university-related bioscience research parks in Canada, and even a direct competitor in ag-biotech at the University of Guelph (Ontario),<sup>166</sup> none seems to have been as successful as Innovation Place. Recognizing the benefits that accrue from the vitality of the PBI and Research Centre programs, the university has been aggressive in recruiting and relocating from other regions investigators who can have joint appointments with two or more of the institutions. The university is assisted by a Strategic Research Fund operated by the same provincial agency that funds Ag-West BIO, allowing it to fill 17 chairs in fields of strategic importance,<sup>167</sup> in general coordination with the federal Research Chairs Program.<sup>168</sup>

The university, the city and the province have also invested considerable effort and \$C10 million in matching funds to capture federally sponsored **Canadian Light Source**,<sup>169</sup> a synchrotron similar to the Advanced Photon Source at Argonne National Laboratory or the synchrotron at Brookhaven National Laboratory. Counting local, provincial and federal contributions from various "pots," the project cost totals \$C173.5 million. The explicit intention is to put the light beam to use as a tool for structural biology (and also miscellaneous therapeutic uses). The beam lines are projected to help capture an incremental \$C35 million in industry research sponsorship annually once fully operational later this year.

Considerable effort has also gone into the transition at VIDO, already recognized as a Network Centre of Excellence by the National Science and Engineering Research Council (Canada's analogue to the NSF). The Canadian Foundation for Innovation<sup>170</sup> awarded VIDO \$C19.2 million for the expansion of its existing facility and establishment an **International Vaccine Center** (INTERVAC). The university and VIDO are raising the balance of an estimated total cost of \$C61.8 million for construction of a new 160,000 square-foot building, the province's first Level 3 biocontainment laboratory.

---

<sup>164</sup> See [http://biotech.gc.ca/epic/internet/incbs-scb.nsf/en/h\\_by00152e.html](http://biotech.gc.ca/epic/internet/incbs-scb.nsf/en/h_by00152e.html).

<sup>165</sup> See <http://innovation.gc.ca/gol/innovation/interface.nsf/engdocBasic/3.2.html>.

<sup>166</sup> See [http://www.uoguelph.ca/realestate/projects/respark\\_history.html](http://www.uoguelph.ca/realestate/projects/respark_history.html).

<sup>167</sup> See <http://www.agr.gov.sk.ca/docs/research/ADF/StatResearchProgram04.asp>.

<sup>168</sup> See [http://www.nserc.gc.ca/programs/indus3\\_e.htm](http://www.nserc.gc.ca/programs/indus3_e.htm).

<sup>169</sup> See <http://www.cls.usask.ca/aboutus/about.php>.

<sup>170</sup> A government-funded but privately chartered foundation to modernize research infrastructure. See <http://www.innovation.ca/index.cfm>.

## INDUSTRY PARTNERSHIPS

PBI has opened a new 74,000 square-foot wing that it calls an Industry Partnership Facility,<sup>171</sup> essentially a cross between an incubator and a dedicated space for industrial collaboration. Participation in the facility gives companies access to the Canadian National Research Council's Industrial Research Assistance Program,<sup>172</sup> a federal grant for pre-competitive R&D conducted by small and medium-sized enterprises. Similar grant assistance is available from a separate federal program, Technology Partnerships Canada.<sup>173</sup> University investigators interested in partnerships may also apply for university/industry challenge grants, funded at up to \$100,000 a year for five years by the Natural Sciences and Engineering Research Council, the analogue to the U.S. National Science Foundation.<sup>174</sup>

In 1997 Ag-West Bio merged with a separate arm that funded research collaborations and made pre-seed investments in startups. Together, these two entities have invested \$9 million in 49 commercialization projects involving 35 companies or agencies, and claim the creation of 670 jobs.

Among the facilities in Saskatoon that enable industry partnerships are:

- POS Pilot Plant Corp., a 54,000 square-foot facility with 11 laboratory suites that offers confidential contract services in extraction, fractionation, purification, and modification of biological materials. This organization was founded on campus in 1977.
- A 13,000 square-foot Bio-Processing Centre at Innovation Place that bought by the park itself after its tenant/operator entered bankruptcy.
- A fermentation pilot plant owned by the Saskatchewan Research Council;

## TECHNOLOGY TRANSFER/COMMERCIALIZATION

The university's separately incorporated technology transfer agent, University of Saskatchewan Technologies, was recently reintegrated into the university as an industrial liaison office and is currently in the process of reorganization. Saskatchewan Research Council is responsible for its own spin-offs. The major source of funding for commercialization research has been Ag-West BIO.

## VENTURE CAPITAL

Only limited product development funding (\$20, 000) is available from the province, and aside from the small pre-seed investments made by Ag-West Bio, there is no major provincial initiative in venture capital. However the private market has produced **Foragen**,<sup>175</sup> a venture fund dedicated to commercialization of advanced agricultural technology from Canadian sources.

---

<sup>171</sup> See <http://pbi-ibp.nrc-cnrc.gc.ca/en/bdo/ipf.htm>.

<sup>172</sup> See [http://irap-pari.nrc-cnrc.gc.ca/english/howirapcanhelpyou\\_e.html](http://irap-pari.nrc-cnrc.gc.ca/english/howirapcanhelpyou_e.html).

<sup>173</sup> See <http://tpc.ic.gc.ca/>.

<sup>174</sup> See [http://www.nserc.gc.ca/professors\\_e.asp?nav=profnv&lbi=toc\\_b](http://www.nserc.gc.ca/professors_e.asp?nav=profnv&lbi=toc_b).

<sup>175</sup> See <http://www.foragen.com/html/about.html>

## RESEARCH PARKS/INCUBATORS

Innovation Place was created in 1977 through an agreement between the provincial government and the university, which owned the underlying land. Improvements on this land are now owned and operated by a provincial quasipublic financing agency. More than \$700 million has since been invested in the park and related infrastructure by either public, private or university sources. In the years since its initial founding, Innovation Place has become more closely aligned with the university's own interests, as faculty investigators accrued benefits from the province's early positioning in ag-biotech.

Innovation Place has no formal incubator but does operate a 75,000 square-foot greenhouse complex as a multitenant facility with flexible leases. This facility has a commercial orientation that cannot be matched by the campus-based 145-chamber phytotron. Tenants of the greenhouse include a range of startups and also PBI itself. Innovation Place also operates a multitenant wet-lab building that has well received by biomedical companies.

## HUMAN RESOURCES

**ABIC Foundation**,<sup>176</sup> an independent foundation spun off by Ag-West, offers educational services for members of the biotech community, and Ag-West itself operates a public information center.

With provincial support, the university has created a "Virtual College of Biotechnology"<sup>177</sup> weaving course offerings from four separate divisions to prepare students at all levels for careers in the industry.

The Canadian investment banker CIBC granted \$C1 million to the university to create a new Centre for Agricultural Entrepreneurship.

## LESSONS LEARNED

- The federal/university focus on hybrid oil seeds attracted early interest from agbiotech companies who want to sell hybrid crop seeds annually.
- However, the wave of consolidation has forced the community to think about other applications of its core competencies, such as in biomedicine and energy/environment.
- Access to low-cost, patient debt capital from the province allowed the Innovation Place research park to build innovative structures on spec and emerge as a leader.

---

<sup>176</sup> See <http://www.abic.ca/>.

<sup>177</sup> See <http://biotechnology.usask.ca/Introduction.html>.

## Seattle

### RECAP OF THE REGIONAL STORY

Seattle emerged during the 1990s as a secondary center of bioscience industry development as its two largest biomedical institutions – the University of Washington (UW) and the Fred Hutchinson Cancer Research Center (known informally as the Hutch) – caught the tailwind of a growing NIH budget and simultaneously became increasingly entrepreneurial. A burst of innovation followed the \$12 million gift from Bill Gates in 1992 that allowed UW to recruit gene-sequencing pioneer Leroy Hood from Caltech. Hood, who assisted in at least one Hutch spin-off, stayed on the faculty at UW until 1999 when he resigned to form his own **Institute for Systems Biology**, and kept it in Seattle.

### DEVELOPMENTS SINCE THE LAST BENCHMARK

Since the last benchmarking exercise, the Puget Sound's IT boom – which was fueled by wealth and talent recycled from Microsoft's success – crested and collapsed along with the Internet sector nationwide. In addition, Boeing ran into difficulty and ultimately relocated its headquarters to Chicago, the better to distance itself from what looked like inevitable shrinkage of its huge Seattle-area workforce of engineers and line workers. In the meantime, consolidation in the bioscience sector presented a mixed picture for the region:

- **Immunex**, a 1981 spin-off of the Hutch, was acquired by **Amgen**,<sup>178</sup> and
- **Rosetta Inpharmatics**, a 1996 spin-off from Hutch that also involved Dr. Hood, was acquired by **Merck**.<sup>179</sup>

This gave two large biopharmaceutical companies instant presence in the region, and both decided to keep their new acquisitions local: Amgen at Elliott Bay on Puget Sound north of downtown, and Merck in the South Lake Union district profiled below. However, the loss of control over what had been rapidly growing enterprises focused attention of civic leaders on opportunities that may be missed to consolidate the sector. Within the past two years, three important developments have taken shape:

- A real estate venture in the **South Lake Union** district controlled by Microsoft co-founder Paul Allen reoriented itself heavily to biosciences, attracting support from UW (which is fully built out at its North Lake Union campus) and from Seattle Mayor Greg Nickels, who projects a district with 20,000 jobs, 10,000 residents, and a positive ROI for public infrastructure investments.<sup>180</sup> Simultaneously, **Explore Life**,<sup>181</sup> a civic group encouraged by King County and chaired by former Mayor Norm Rice, focused attention on the potential of South Lake Union and three additional sites to provide up to 30

---

<sup>178</sup> See <http://immunex.com/corporate/>.

<sup>179</sup> See <http://www.rii.com/>.

<sup>180</sup> See <http://www.cityofseattle.net/mayor/issues/lakeunion/>.

<sup>181</sup> See <http://www.metrokc.gov/exec/bred/business/partnerships/ExploreLife.htm>

million square feet of space for expansion of the bioscience sector into a major regional employer.

- Recognizing that the state has offered no funding for targeted growth of research capacity and commercialization since the early 1980s, Gov. Gary Locke convened what he called the **Bio21 Steering Committee**. Last year, this group of academics and industrial scientists from both the bioscience and IT sectors called<sup>182</sup> for creation of a funding mechanism that by its fifth year would be investing \$50 million a year for the following 10 years, with public funds matched 1:1. The Bio21 fund is envisioned as supporting facility enhancements necessary to attract increased R&D funding, key faculty recruitments, and commercialization. The Governor is targeting the state's tobacco settlement for funding, and in the interim, leaders are approaching regional foundations to play a leadership role like that played by the Danforth Foundation in St. Louis.

## **FOCAL AREAS AND STRATEGY ENVIRONMENT**

The state's overall technology efforts encompass bioscience, IT, nanotechnology and renewable energy technology. Within biosciences, Bio21 recommends a sharp focus on "application of information technology to the biological sciences and healthcare." The report specifies particular strengths that should be leveraged:

- Genomics
- Proteomics
- Systems biology
- Nanotechnology
- Computational biology
- Bioinformatics
- Medical informatics
- Plant, animal and microbial biotechnology.

## **RESEARCH-CAPACITY BUILDING**

Without a state program in place, capacity-building has been dominated by private fund-raising efforts. The most recent large-scale project is a 265,000 square-foot, \$150 million multidisciplinary building that will combine UW's emerging strengths in Genome Sciences and Bioengineering.<sup>183</sup> The keystone gift for this building is \$70 million from the Bill and Melinda Gates Foundation, matching \$10 million from the Whitaker Foundation and \$12 million from line-item and other federal sources. Other key projects in the region include:

---

<sup>182</sup> See [http://www.technology-alliance.com/resources/publications/BIO21\\_011204.pdf](http://www.technology-alliance.com/resources/publications/BIO21_011204.pdf).

<sup>183</sup> See <http://depts.washington.edu/meddev/Genome/pressrelease.htm>, or <http://depts.washington.edu/bioe/BUILDING/bldgfacts.pdf>.

- The Hutch is raising funds to complete a multiyear initiative to consolidate all its operations in a 14.3-acre, 2 millions-square foot campus in South Lake Union.<sup>184</sup>
- The Institute for Systems Biology has raised funds from regional corporations and philanthropies for a 65,000 square-foot, \$100 million facility<sup>185</sup> in North Lake Union, at a site not far from the university campus.
- Vulcan Ventures will relocate the Allen Institute for Brain Science<sup>186</sup> from temporary space to its own properties in South Lake Union.

## INDUSTRY PARTNERSHIPS

The **Washington Technology Center (WTC)**,<sup>187</sup> a state-funded nonprofit created the last time the state government was active in technology policy, operates a multisector matching-grant program to encourage university/industry collaborations. The WTC's **Research and Technology Development Grants** offer faculty investigators up to \$100,000 per year for up to two years, provided the award is matched 1:1 by a Washington company (a lower ratio obtains for firms smaller than 250 employees). There is also a smaller version marketed as Phase I, providing up to \$40,000 for 9 months with fixed matching requirements. Because the scale of WTC grants is modest, the program has been of use mainly to the medical devices subsector of the biosciences. Recent law gave authority to the State Treasurer (but no funding) to host an **Investment In Innovation Account**<sup>188</sup> to be administered by the WTC.

## TECHNOLOGY TRANSFER/COMMERCIALIZATION

In the 1990s, the University of Washington took back direct control of its patent and licensing programs from the **Washington Technology Foundation**, a nonprofit that had been established to avoid what had been perceived as a constraint in state law. UW eventually built an aggressive royalty portfolio but has had difficulty re-orienting itself to spin-off formation. The university is evidently hoping to lever whatever commercialization funds or mechanisms are brought into play by the Bio21 initiative to accomplish this goal. In the meantime, the Institute for Systems Biology, which already had three spin-offs to its credit, joined with three venture-capital firms and Alexandria REIT to form **Accelerator Corporation**,<sup>189</sup> whose stated goal is commercialization of ideas that could benefit from affiliation with the Institute. The Accelerator is capitalized at \$15 million. The Hutch, like many comprehensive cancer centers with strong research programs, maintains a more modest internal fund for technology development.

<sup>184</sup> See <http://www.fhcr.org/admin/facilities/facplan/future/>.

<sup>185</sup> See <http://www.systemsbiology.org/Default.aspx?pagename=facility>.

<sup>186</sup> See <http://www.brainatlas.org/default.asp>.

<sup>187</sup> See

<http://www.watechcenter.org/index.php?p=Research+%26+Technology+Development+Awards&s=73>.

<sup>188</sup> See [http://www.leg.wa.gov/sl/1003-S2\\_sl.txt](http://www.leg.wa.gov/sl/1003-S2_sl.txt).

<sup>189</sup> See <http://www.systemsbiology.org/Default.aspx?pagename=spinoffcompanies>.

## VENTURE CAPITAL

The Washington Research Foundation, a nonprofit that formerly served as patent and licensing agent for UW, now uses the surplus it banked during that period in part to finance **WRF Capital**,<sup>190</sup> a \$25 million seed-stage fund that invests in companies with strong ties to UW and other nonprofit research institutions.

The Washington Technology Center has signed a memorandum of understanding<sup>191</sup> with the **Washington State Investment Board** (manager of the state's public pension funds) that will allow companies in Washington priority access to the general partners in those venture firms in which the Board has a stake. Otherwise, the Board tracks the level investment that ultimately ends up in Washington-based companies but has no specific program for targeted investing. The Bio21 initiative may include provision for additional, targeted, seed-stage investing.

## RESEARCH PARKS/INCUBATORS

The Seattle area has no conventional university-related research park in a formal sense. However, several widely dispersed sites are now competing for leadership in housing bioscience companies including university and institutional spin-offs. Among these, the first to gain substantial traction is **South Lake Union**, which seems to be emerging as a de facto research park for UW. This development district was originally cleared for a 1960s-era cross-town freeway that was never built and remained industrial and underutilized for some time. South Lake Union began developing a research character in 1993 when Fred Hutchinson Cancer Institute opened a new facility there. Two years later, when plans for a major new city park faltered, Vulcan Properties (owned by Microsoft co-founder Paul Allen) took control of 50 acres near the Hutch, including both old industrial property and vacant land.

Initially visualizing a mixed-use office district, Vulcan found itself developing space for biomedical tenants that wanted proximity to the nascent research cluster. Occupants of the district now include **Merck/Rosetta Inpharmatics**, the **Seattle Biomedical Research Institute** (an independent institute formed in 1976),<sup>192</sup> **Children's Hospital**, **Zymogenetics** (co-founded in 1981 by two UW faculty members),<sup>193</sup> and a small university presence in the Vulcan headquarters building. Partly because UW is landlocked at its built-out campus in North Lake Union, the university eventually decided to join the gathering momentum, and committed to 105,000 square feet in the old gas-company building rehabilitated into laboratory space by Vulcan. The university hopes to raise \$60 million for this project and envisions it may expand by an additional 300,000 to 700,000 square feet. The "Blue Flame" building will house 300 UW researchers in groups that specialize in particular clinical challenges, such as cardiovascular or women's health.

Other areas invested by Explore Life for their potential to house bioscience development are:

- Developing and existing business parks in **Bothell**, on the far side of Lake Washington, where there is considerable strength among IT startups;

---

<sup>190</sup> See [http://www.wrfseattle.org/capital/about\\_wrf\\_capital.asp](http://www.wrfseattle.org/capital/about_wrf_capital.asp).

<sup>191</sup> See <http://www.watechcenter.org/?p=WTC-WSIB%20Partnership&s=209>.

<sup>192</sup> See <http://sbri.org/about/index.asp>.

<sup>193</sup> See <http://www.zymogenetics.com/about/history.html>.

- **Seattle Port Terminal 91**, which the autonomous Seattle Port<sup>194</sup> is promoting as a life science base, though opposed by the Mayor. This neighborhood is not far from the Elliott Bay area housing several properties owned by Alexandria REIT and rented to Amgen/ImmuneX, **Corixa**, UW and **Dendreon**.
- **Renton**, a working-class community near Sea-Tac airport where Boeing is shrinking its facilities and workforce, and the county is eager to see redevelopment.

## HUMAN RESOURCES

**Shoreline Community College** offers a curriculum aimed at laboratory specialists.<sup>195</sup>

The **Center for Technology Entrepreneurship**<sup>196</sup> at UW Business School puts together interdisciplinary business development teams including graduate students in bioengineering.

## BUSINESS ENVIRONMENT

The last two years has seen extremely strong support for bioscience development from the current and former mayors of Seattle, the independent **Port of Seattle** commission,<sup>197</sup> and the current governor of Washington State (who recently signed into law an expansion of the state's exemption of research-based companies from its business and occupation taxes.<sup>198</sup>

## SUMMARY OF LESSONS

- In Seattle the primary entrepreneurial drivers have been institutions other than UW (notably the Hutch and ISB) and the private sector (Vulcan) led the issue of research park development, albeit with strong municipal support.
- Cyclical and competitive threats to the software and aerospace industries have forced a focus on “convergent” technologies that can give the bioscience sector a competitive advantage in the currently challenging environment.

---

<sup>194</sup> See <http://www.portseattle.org/about/>

<sup>195</sup> See <http://elmo.shore.ctc.edu/biotech/default.htm>

<sup>196</sup> See [http://depts.washington.edu/cte/about\\_overview.shtml](http://depts.washington.edu/cte/about_overview.shtml).

<sup>197</sup> See <http://www.portseattle.org/business/realestate/development/northbay/index.shtml>.

<sup>198</sup> See [http://dor.wa.gov/Docs/Pubs/SpecialNotices/2004/sn\\_04\\_HighTechIncentives.pdf](http://dor.wa.gov/Docs/Pubs/SpecialNotices/2004/sn_04_HighTechIncentives.pdf).