



ARIZONA'S BIOSCIENCE ROADMAP:
TOWARD 2012

PROGRESS AND DIRECTIONS
FOR THE FUTURE

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Executive Summary

Arizona has set a bold new course to be a place of innovation in the biosciences. Other regions and states have been able to recast their economic futures around the biosciences—from New England to Maryland to San Diego and Colorado—in an effort to diversify their economies and establish a presence in the fast-growing bioscience market. The biosciences also offer one of many ways to help address an issue of importance to all citizens—health care prevention and treatment.

Arizona's Bioscience Roadmap began in 2002 with community leaders and the academic, nonprofit research, and health care communities uniting around an organizing vision and a strategic plan, with financial support and sponsorship of the Flinn Foundation. The objectives were to build capacity, drive new economic and job growth, improve access and quality improvements in medical and health care to the State's citizenry, and compete in specific niches of the significant bioscience market.

What underpins Arizona's efforts in the biosciences might be termed "**bold realism.**" Arizona is realistic in understanding that it is playing catch-up in bioscience development. The state has appropriately set its sights on positioning Arizona to become a significant national player and the major state in the Southwestern U.S. in select, focused areas of bioscience strength. Arizona has been bold in its approaches, particularly in advancing collaborations, emphasizing translational research, and building on areas of technology convergence within the biosciences—in fields like bioimaging and bioinformatics, genomics and proteomics—to surge from its strengths to new levels of national competitiveness and technology advancement. This is grounded in realistic achievements and not simply noble platitudes of global competition or chasing Federal government funding streams in disregard of their relevance to the Arizona economy.

This paper documents Arizona's five-year progress in the biosciences and identifies key gaps to be addressed during the next five years. Battelle's assessment of Arizona's Roadmap progress, and the changing landscape globally and nationally in the biosciences, suggests Arizona is well positioned to target "signature opportunities" that connect Arizona's bioscience research strengths and provide the base for Arizona to "leapfrog" other states. Arizona is now at a critical juncture where it can combine a continued focus on achieving national excellence in specific core competency areas and scientific platforms, with new opportunities to translate research into economic and health benefits for the citizens of Arizona, as well as raising Arizona to national and international leadership in targeted opportunity areas in the biosciences.

The emergence of research strengths at the State's universities and medical centers enables an additional focus to position Arizona in the biosciences for the next five years around "technology

The 2002 *Arizona's Bioscience Roadmap* established a 10-year vision for success in which "**Arizona is the leading southwestern state in select bioscience sectors, built around world-class research, clinical excellence, and a growing base of cutting-edge enterprises and supporting firms and organizations.**"

The Roadmap proposed a detailed plan of action involving four strategies and 19 actions, along with specific and tangible measures of success. Since that time, Arizona's Bioscience Roadmap has been an ongoing initiative guided by a Steering Committee composed of Arizona's biomedical institutions, economic development organizations, and civic leaders.

commercialization”—creating firms, businesses, products, and jobs from research turned into technology. Because of the stronger and deeper research base, Arizona’s universities and medical centers and its communities can develop the tools, methods, and techniques to increase the scale and velocity of newly established firms, products and jobs in the State. The considerable momentum supporting the research base in Arizona must now be leveraged to address business formation and product innovation.

MEASURING ARIZONA’S PROGRESS IN BIOSCIENCES DEVELOPMENT

With only five years of focused activities, the initial investments in research infrastructure are showing progress and dividends in terms of leveraged Federal research dollars; commercialization of university bioscience research; industry growth and development in terms of jobs, establishments and wages; as well as concrete progress in implementation of Arizona’s Bioscience Roadmap strategies and actions.

A five-year progress report on Arizona’s Bioscience Roadmap finds:

- Commitment of public/private sector leadership has been sustained
- Strong private/public partnerships have mobilized to support the Roadmap
- Ongoing efforts continue to inform the general public about the biosciences including recently released regional roadmaps for Southern and Northern Arizona.

The implementation of Arizona’s Bioscience Roadmap shows real progress, with 84 percent of the actions showing some progress and 40 percent showing substantial progress, a significant increase in the past year. New programs established by Science Foundation Arizona (SFAz) have added momentum. More than 60 percent of SFAz’s first-year funding can be directly traced to bio-related projects and programs.

Table ES-1 summarizes Arizona’s progress in Bioscience Roadmap implementation, showing strong performance in jobs, firms, wages, and in some measures of intellectual property. Research performance was strong until 2006, but shows at least a one-year deviation from what had otherwise been upward growth. Risk capital has continued to be a long term problem, but 2007 has the potential to show Arizona reaching the Roadmap target of \$100 million in total investments in State bioscience enterprises.

Table ES-1: Progress in implementation of Arizona’s Bioscience Roadmap

Metrics of Success: 2002 - 2006		
Metrics	Performance	Comments
NIH Funding	↑ 19% ('02-'06)	Slightly lagging Top 10 States (↑ 23%) and U.S. (↑ 21%)
Bio Jobs	↑ 18.5% ('02-'06)	Medical devices and Research, testing and medical labs are key segments
Bio Firms	↑ 16.7% ('02-'06)	Hospitals growing fastest at ↑47%
Bio Wages	↑ 25% ('02-'06)	Average salary: \$48.7K
Metrics of Success: 2002 – Q3, 2007		
Metrics	Performance	Comments
Bio Risk Capital	↓ 31% ('02-'Q3,07)	VC investments meet 77% of 2007 goal of \$100 m. through Q3
University IP		
• Bio Startups	↑ 150% ('02-'Q3,07)	2 → 5 and total of 39 firms
• Bio Licenses	↑ 30% ('02-'Q3,07)	20 → 26 and total of 153
• Bio Income	↑ 54% ('02-'Q3,07)	\$1.8 m. → \$3.0 m. and total of \$12.9 m.

More detail on these performance measures, developed from Battelle’s review of best practice metrics across the country, is presented in the pages which follow.

Research

Arizona has been meeting the performance measures for its research base set out in the 2002 Arizona’s Bioscience Roadmap until recently. Two specific measures of research performance were laid out in *Arizona’s Bioscience Roadmap*:

- An increase in bioscience R&D funding to Arizona research institutions at a rate equal to or greater than historic growth rate of the top 10 states over the next 5 years.
- An increase in NIH funding from \$118 million to \$214 million by 2007.

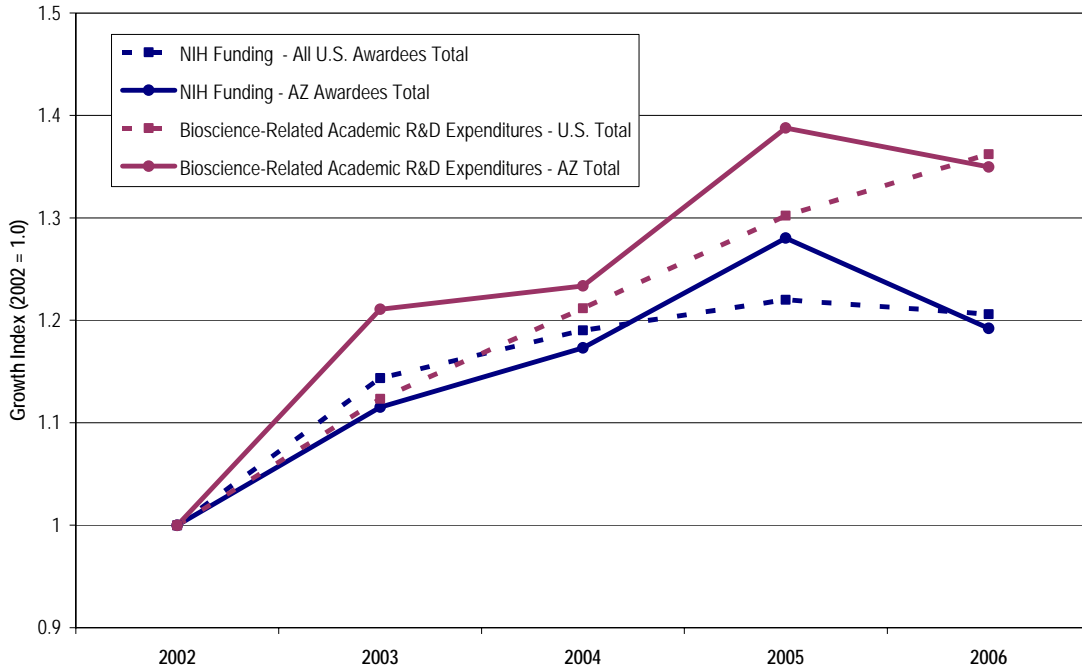
As Table ES-2 indicates, Arizona has a mixed record in meeting these performance goals.

Table ES-2. Progress on metric of success relating to research base set in Arizona’s Bioscience Roadmap

Performance Indicator	Measurable Goal	Success to Date
Academic bioscience R&D funding (NSF) and NIH Funding Growth	Reach a rate of growth in NIH/academic bioscience R&D funding equal to or greater than top 10 states	<ul style="list-style-type: none"> • Arizona recorded a gain in overall bioscience R&D of 35.0% from 2002 to 2006, slightly below the national growth of 36.2% and the average of the top 10 states of 37.3% • With 2006 performance, Arizona’s growth in NIH funding from 2002 to 2006 NIH is now slightly below the rate of the top 10 states in NIH funding—19% for Arizona compared with 23% for top 10 states.
NIH Funding Level	Reach \$214 million by 2007	<ul style="list-style-type: none"> • By 2005, Arizona had reached \$176 million in NIH funding—representing 82% of the 2007 target—but this has fallen to \$164 m in 2006.

Figure ES-1 shows how Arizona has, in general, tracked with the U.S. on these measures over the 2002 to 2006 time period.

Figure ES-1. Growth of University R&D expenditures in the biosciences and NIH research grant funding for AZ and the U.S. (2002–2006)



As shown in Figure ES-2, the most dynamic driver of growth in Arizona is its base of nonprofit research organizations, hospitals, and to some extent firms, which grew an astonishing 81.5 percent in NIH funding from 2002 to 2006. While the three state universities account for \$132 million in NIH funding in 2006, at \$32 million **roughly \$1 of every \$5 in NIH funding in Arizona is now found among these non-university organizations.** Without the establishment of TGen and the increased pace at which Arizona’s hospitals and medical centers have undertaken biomedical research, Arizona would not be keeping as close a pace with the nation in NIH funding.

Figure ES-2: Growth in NIH research grant funding in Arizona vs. Top-10 Funded States and the United States, 2002–2006

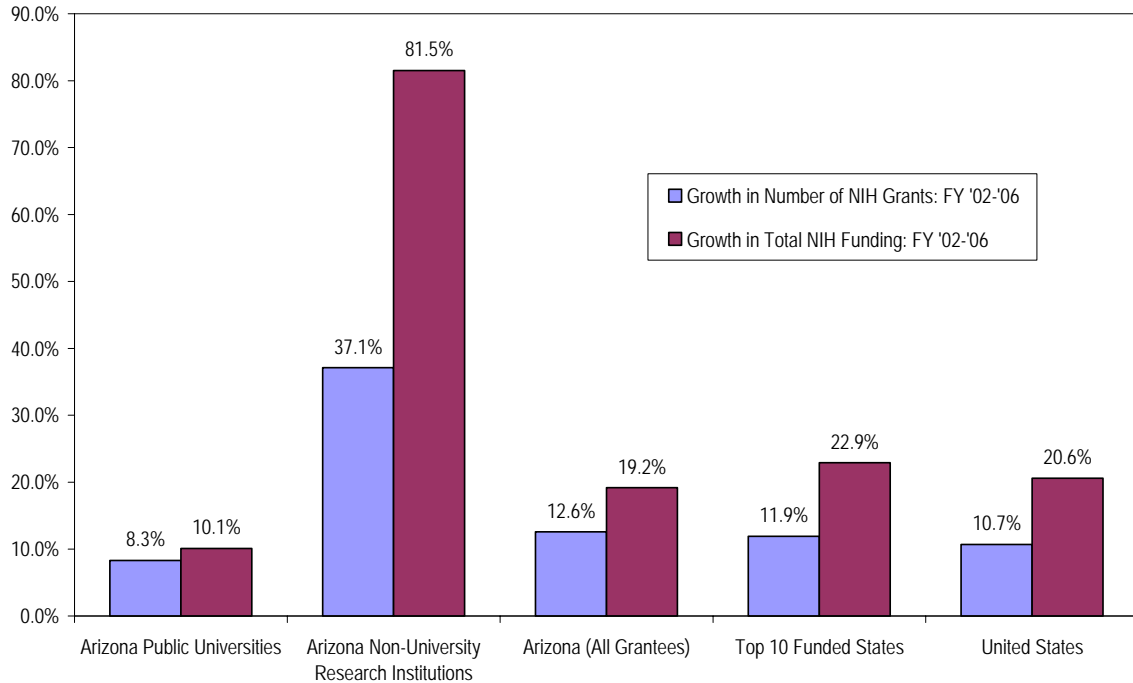
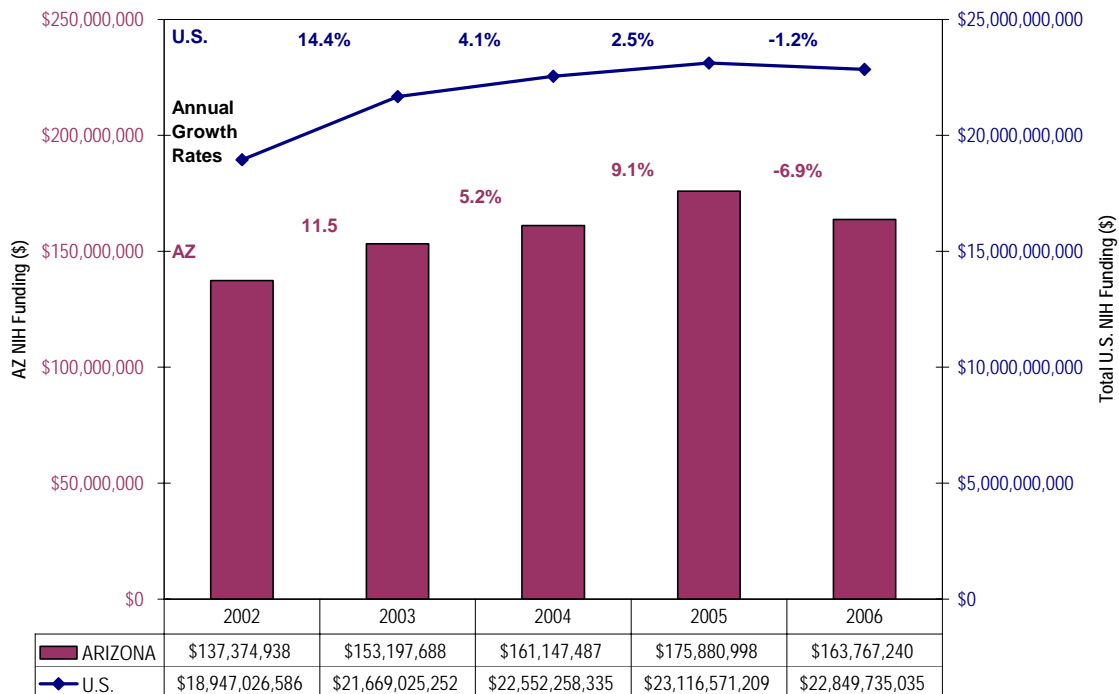


Figure ES-3 reveals that Arizona, like the U.S., has grown in NIH funding, and in the early years of Roadmap implementation outpaced U.S. growth. In 2006, for the first time, the state lagged. The most recent period, 2005 to 2006, shows that while overall NIH extramural funding declined, Arizona funding took a larger hit—declining by 6.9 percent or over \$12 million in one year.

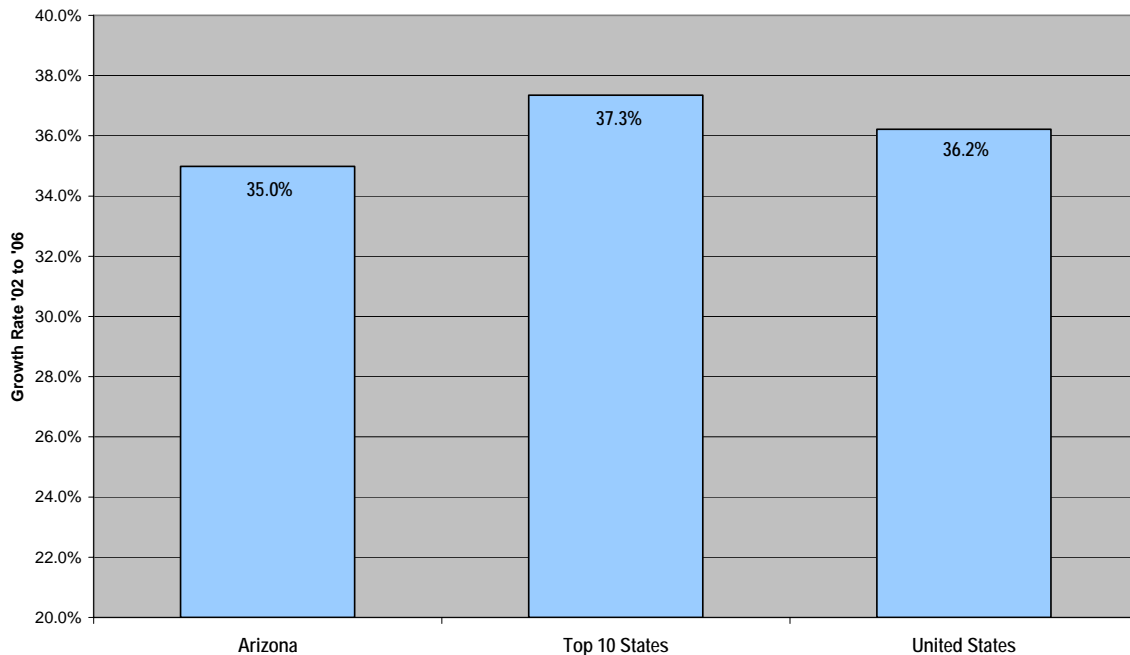
Figure ES-3. NIH funding trends for Arizona and U.S., 2002–2006



Arizona is still playing catch-up in biomedical sciences. While Arizona NIH funding has increased significantly in recent years, its proportionate share of the total NIH funding base has not increased. Arizona’s NIH research funding accounts for only 0.72 percent of the total NIH research budget. This low level of funding in biomedical research is also reflected in a similar market share of 0.73 percent in the university research expenditures in the medical sciences—which includes federal, state, industry, and foundation sources of research support.

Using NSF’s data on all academic R&D spending, Arizona’s academic bioscience-related R&D accounts for less than 50 percent of all research performed in the state’s academic institutions in 2006. Figure ES-4 shows that overall bioscience-related academic R&D actually declined by 2.7 percent from 2005 to 2006, with most of this decline coming from the biological sciences (declining 8.2 percent or \$11.5 million) and agricultural sciences (declining 13.7 percent or \$10.1 million) disciplines.

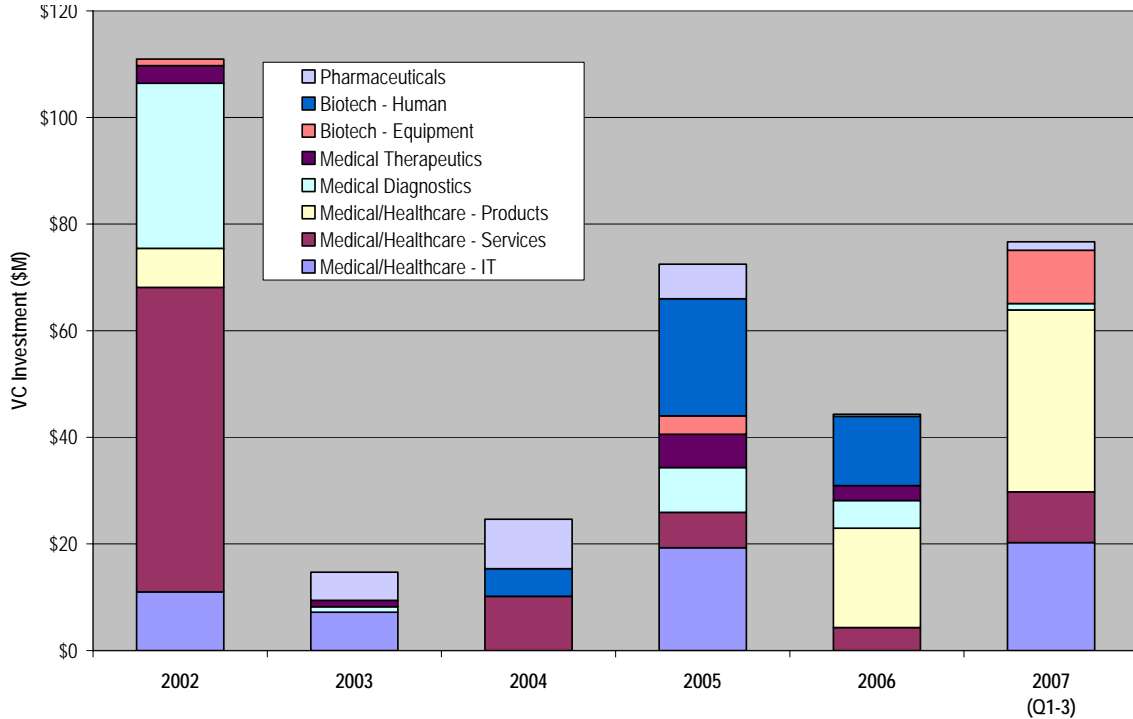
Figure ES-4: Growth in bioscience-related academic R&D expenditures, FYs 2002–06



Venture Capital

Arizona’s bioscience-related VC investments through three quarters of 2007 already exceed the level of investments in all of 2006. Even with these strong three quarters, Arizona’s growth rate in bioscience-related investments from 2002 to Q3, 2007 still shows a decline of 31 percent—compared to U.S. growth over the same period of 26 percent. ***However, it is important to consider trends to avoid single-year anomalies in reporting—removing a single large Arizona deal in 2002 would give Arizona a trend for 2002 to Q3, 2007 very similar to the U.S.*** At current rates, a strong fourth quarter could place Arizona bioscience venture investments almost equal to their level of 2002, a significant rebound from the previous four years in Arizona. Furthermore, Arizona’s Bioscience Roadmap set a target of \$100 million in venture capital bioscience investments in the State by 2007. With three quarters of the year completed Arizona is already at 77 percent of this target for 2007.

Figure ES-5: Distribution of Arizona bioscience VC investments by segment and year: 2002–Q3, 2007



Bioscience Industry Employment

Arizona’s bioscience firms continued to add jobs in 2006, with double-digit employment increases in four out of five major bioscience subsectors since 2002. In total, the state bioscience sector now employs nearly 81,000 persons (80,909) spanning 745 individual business establishments across the state (see Table ES-3). The labor market performance of the bioscience sector has been exceptional in recent years, as the base of state jobs increased by 18.5 percent since 2002 and the number of establishments increased by 16.7 percent. With these rapid gains, Arizona has far outpaced their counterparts in the national sector where employment increased by 5.9 percent during the same period. Arizona is truly emerging with respect to forming an industry bioscience cluster.

Over the year (2005 to 2006), Arizona added 57 bioscience establishments, up 8.3 percent. Employment rose by 3,643 jobs or 4.7 percent. Most of the new jobs were in the hospitals subsector—up 3,164 or 4.9 percent. Medical device firms increased their employment by 290 jobs from 2005 to 2006, a 6.5 percent job gain for the subsector.

A strong year for the AZ Biosciences, 2005–06:
Establishments: Up 57; 8.3%
Employment: Up 3,643; 4.7%

Table ES-3: Arizona bioscience employment metrics by major subsector, 2002–2006

Arizona Bioscience Employment Metrics					
Industry Subsector	2006 Establishments	Percent Change Estab, '02-06	2006 Employment	Percent Change Empl, '02-06	2006 Location Quotient
Total Biosciences	745	16.7%	80,909	18.5%	0.72
Non-Hospital Biosciences	632	12.5%	13,143	20.6%	0.52
Agricultural Feedstock & Chemicals	18	-47.1%	502	-9.5%	0.24
Drugs & Pharmaceuticals	35	30.7%	1,108	17.1%	0.18
Medical Devices & Equipment	262	4.5%	4,792	25.3%	0.58
Research, Testing, & Medical Labs	317	26.7%	6,741	21.0%	0.77
Hospitals	113	46.8%	67,766	18.0%	0.79

Source: Battelle analysis of BLS QCEW data from IMPLAN.

Figure ES-6: Growth in Arizona bioscience employment and establishments, 2002-2006

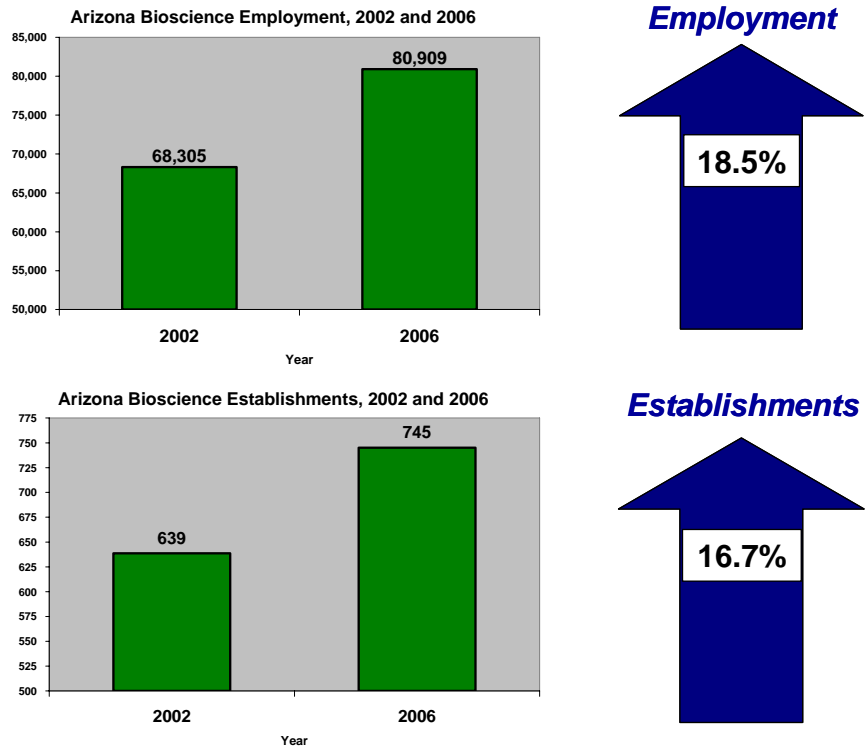
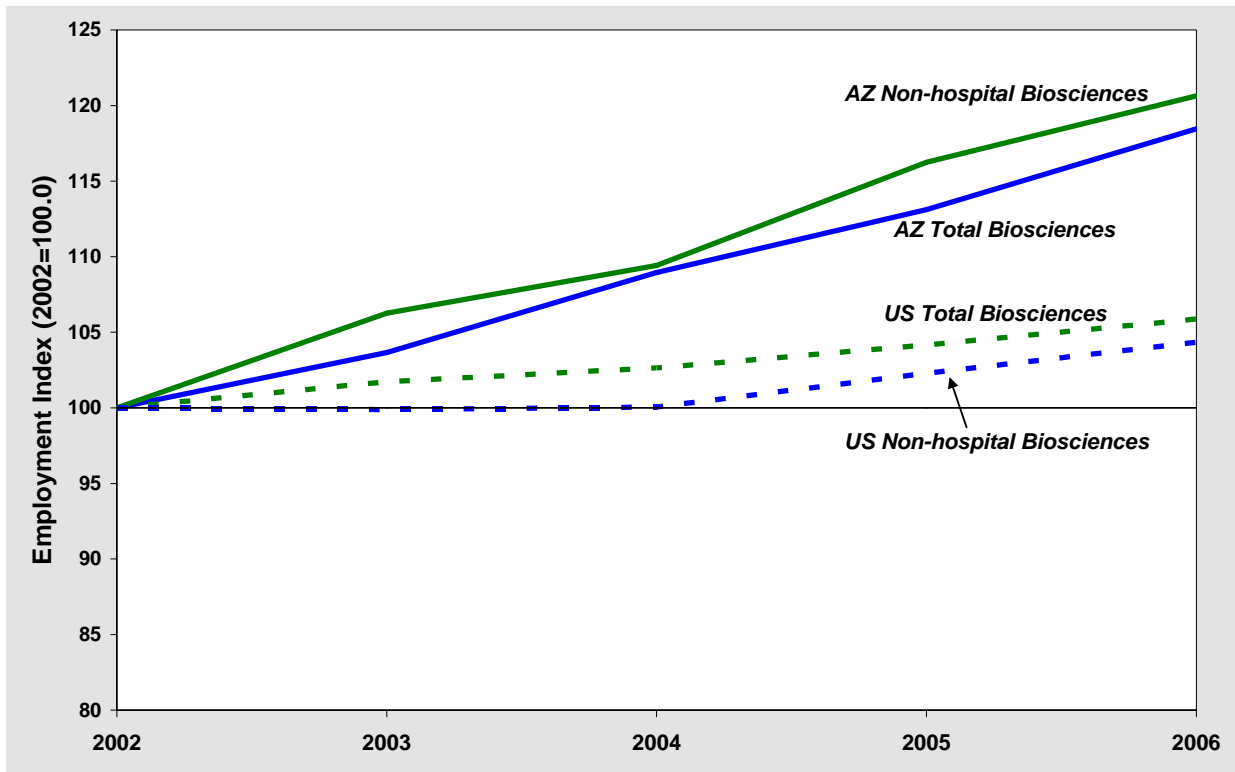
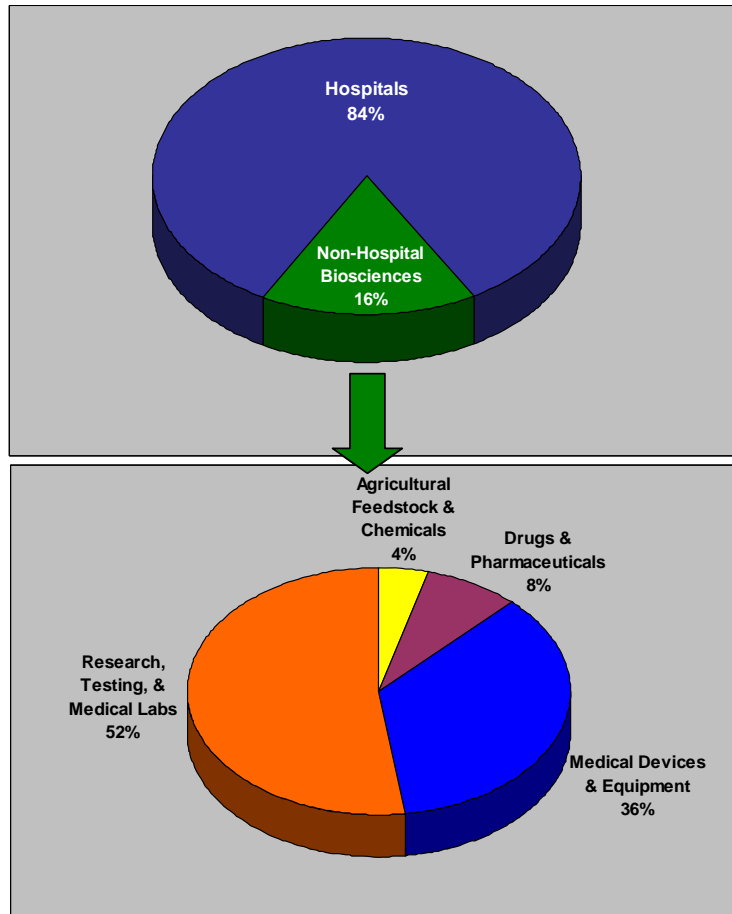


Figure ES-7: Trends in bioscience employment for Arizona and the U.S., 2002–2006 (Indexed, 2002=100)



The majority of Arizona’s bioscience industry jobs are in hospitals, accounting for 84 percent in 2006. The remaining 16 percent in the non-hospital sector include a sizable number in research, testing, and medical labs as well as in medical devices and equipment. The composition of the state’s bioscience industry in 2006 is shown in the pie charts in Figure ES-8.

Figure ES-8 Employment composition of the Arizona bioscience sector, 2006



Bioscience Wage Levels

State bioscience workers earn, on average, \$48,674 in 2006 or \$9,000 more than the average worker in the entire private sector (see Table ES-4). Driven by high-wage subsectors such as research and testing, and pharmaceutical manufacturing, the average non-hospital bioscience wage is even higher—\$53,369 in 2006, or nearly \$14,000 more than the average worker. Higher wages in these bioscience subsectors reflect the strong relative labor demand for this high-skilled, well-educated workforce.

Table ES-4: Average annual wages for Arizona bioscience workers and other major state industries, 2005 and 2006

Arizona Average Annual Wages by Industry, 2005 & 2006			
Industry	2005	2006	Increase, 05-06
Management of Companies & Enterprises	\$ 63,473	\$ 66,311	4.5%
Finance & Insurance	\$ 57,142	\$ 58,895	3.1%
Manufacturing	\$ 54,617	\$ 57,627	5.5%
Professional, Scientific, & Technical Services	\$ 54,981	\$ 57,527	4.6%
Research, Testing, & Medical Laboratories	\$ 50,559	\$ 57,031	12.8%
Drugs & Pharmaceuticals	\$ 54,188	\$ 56,274	3.8%
Total Non-Hospital Biosciences	\$ 49,329	\$ 53,369	8.2%
Information	\$ 47,959	\$ 51,151	6.7%
Medical Devices & Equipment	\$ 47,429	\$ 48,958	3.2%
Total Biosciences	\$ 45,182	\$ 48,674	7.7%
Hospitals	\$ 44,369	\$ 47,763	7.7%
Real Estate & Rental & Leasing	\$ 39,965	\$ 43,008	7.6%
Health Care & Social Assistance	\$ 40,684	\$ 42,962	5.6%
Transportation & Warehousing	\$ 40,259	\$ 42,151	4.7%
Construction	\$ 38,067	\$ 40,907	7.5%
Agricultural Feedstock & Chemicals	\$ 41,000	\$ 39,875	-2.7%
Total Private Sector	\$ 37,709	\$ 39,526	4.8%
Retail Trade	\$ 27,479	\$ 28,393	3.3%

University Intellectual Property

The trend line for Arizona's public universities in technology transfer and commercialization particularly in the biosciences is moving in the right direction. Table ES-5 shows that the number of bioscience startups from university intellectual property/research has gone from two in 2002 to five so far in 2007, with the cumulative number of bioscience startups over that five-year time period totaling 39 firms.

Table ES-5: All Arizona University Entrepreneurship: Biosciences Only Patents, Licenses and Startups from University IP

Metric	2002	2003	2004	2005	2006	Q'3.2007
Invention Disclosures Received	93	94	84	136	119	103
Total U.S. Patent Applications Filed	59	70	70	59	42	110
U.S. Patents Issued	13	12	19	16	20	25
Licenses & Options Executed	20	19	25	33	28	26
Adjusted Gross License Income Received	\$1,845,889	\$1,129,999	\$1,727,272	\$1,857,508	\$3,318,339	\$3,044,167
Bioscience Startups from University IP	2	6	11	10	5	5

Table ES-5 also shows that bioscience invention disclosures have continued to grow, as have patent applications filed, and patents issued. Licenses have increased by 30 percent with 28 executed in 2006 and a total of 153 licenses for biosciences-related intellectual property over the 2002–Q3, 2007 period. Finally, even as the number of startups increases (with return to the university increasingly being based on equity, not royalty income) royalty income received has increased significantly to over \$3.3 million in 2006 and \$3 million in three quarters of 2007 from a level of \$1.8 million in 2002. Over the 2002–Q3, 2007 time period, total income totals \$12.9 million, excluding value of equity taken in firms.

UPDATING ARIZONA’S BIOSCIENCE ROADMAP: FROM CORE COMPETENCIES TO SIGNATURE OPPORTUNITIES.

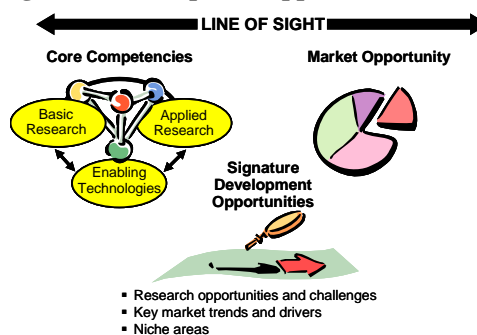
Arizona’s Bioscience Roadmap is a dynamic plan. To remain effective, new developments and opportunities need to be understood and incorporated. Battelle concludes that Arizona is now at a critical juncture where it can be more selective in its focus on “signature opportunity areas,” while it continues to build national excellence in bioscience research. The emergence of strengths in the research base also enables an additional focus around “technology commercialization”—creating firms, businesses, products and jobs from research turned into technology. The next phases of Bioscience Roadmap implementation will require a focus on these two areas. This will serve to maintain the strong momentum already underway and further position Arizona to achieve the vision laid out in 2002.

The significant investments of the past five years have helped Arizona realize a strong record of progress. At the same time, these investments are reshaping opportunities for bioscience development in the state.

Bioscience research competencies go hand-in-hand with growing signature opportunities for development in the broad, diverse, and emerging markets and industries comprising the biosciences. Core competencies by themselves do not generate “signature” areas of focus. Rather, core competencies serve as building blocks for development opportunities that draw upon multiple core competencies and allow a state to participate in growing and emerging market opportunities (Figure ES-9).

Investments since 2002 in Arizona’s research infrastructure and programs at its universities, private research institutes, and medical centers has deepened and strengthened its platforms. Furthermore, Arizona also has research strengths such as electronics, optics, and advanced manufacturing—all critical to the biosciences. And, Arizona has been building and increasing its capacity in the three big “O’s”—genomics, proteomics, and bioinformatics. Together Arizona is seeing a strong research convergence that enables the State and its partners to focus on signature opportunities cutting across platforms and disciplines.

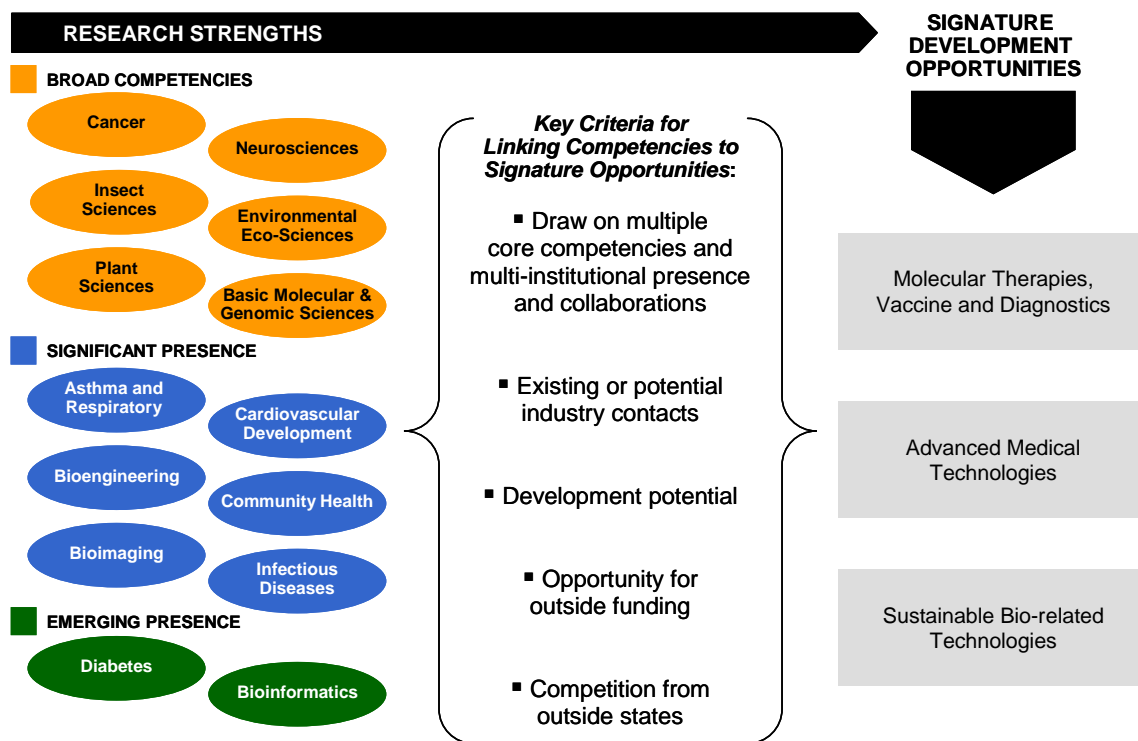
Figure ES-9: Translating core competencies into signature development opportunities



But, bioscience research is not an end in itself, but rather a means for Arizona to move ahead in overall bioscience development. The core competency developed to date needs to be translated into “signature opportunity areas for Arizona that align the state’s bioscience research core competencies to its local bioscience industry base and the development potential of growing bioscience markets (see Figure ES-10). Battelle has identified three signature opportunities:

- Molecular therapeutics, vaccines, and diagnostics
- Advanced medical technologies
- Sustainable bio-related technologies.

Figure ES-10: Linkage of Arizona’s bioscience research core competencies to signature development opportunities



To realize the potential of these signature development opportunities, Arizona must continue to invest and achieve national stature in its areas of research competency. It must also leverage these bioscience research core competencies for broader bioscience development by linking with the ongoing economic development activities of the Roadmap, such as accelerating technology commercialization, increasing venture capital, addressing workforce development, and supporting commercial bioscience wet-lab development.

COMMERCIALIZING TECHNOLOGY – TRANSFERRING DISCOVERIES TO THE MARKETPLACE

Research alone will not offer well-paying jobs for the state’s citizenry, nor improve health care prevention, unless it can link the bench with the bedside through new products, treatments, diagnostics, and prevention. It is clear that the dual objectives of the Roadmap—building a critical mass of research and a critical mass of bioscience enterprises—will not be achieved by addressing research exclusively.

As Arizona continues to invest in the research enterprise, as it should, it must also increase its focus and commitment to technology commercialization. Very small strategic investments in technology commercialization can provide exponential return on the monies invested while contributing to the improved health care dividend desired.

Technology transfer and technology commercialization are not the same thing

Technology transfer is the passive management of a research organization’s intellectual property. Technology transfer involves disclosure of discoveries, the determination of the need for patent protection, and the licensing of the intellectual property (to either a third-party organization or to create a new business) to pursue the development of a product, process or other intervention based on the discovery, and its associated license. Each of Arizona’s public universities has a technology transfer function to handle the intellectual property discoveries and innovations resulting from their faculty and student’s research (ASU and UA have their own offices; NAU’s technology transfer function is administered by ASU). The State’s private research institutions, such as TGen, also have offices responsible for technology transfer, and, many of the State’s hospitals and medical centers are developing a similar capability.

Technology commercialization, however, involves moving beyond legal protection and licensing. It requires developing the technology into a product/service to meet the need(s) of customers in the marketplace. Technology commercialization is often called applied research. Unlike the stages of technology transfer (shown in Table ES-6) where the research is created from the search for improved knowledge and understanding, technology commercialization targets the needs of a specific customer and, ultimately, results in a profit from its sales and use.

Table ES-6: Technology Transfer vs. Technology Commercialization – Stages

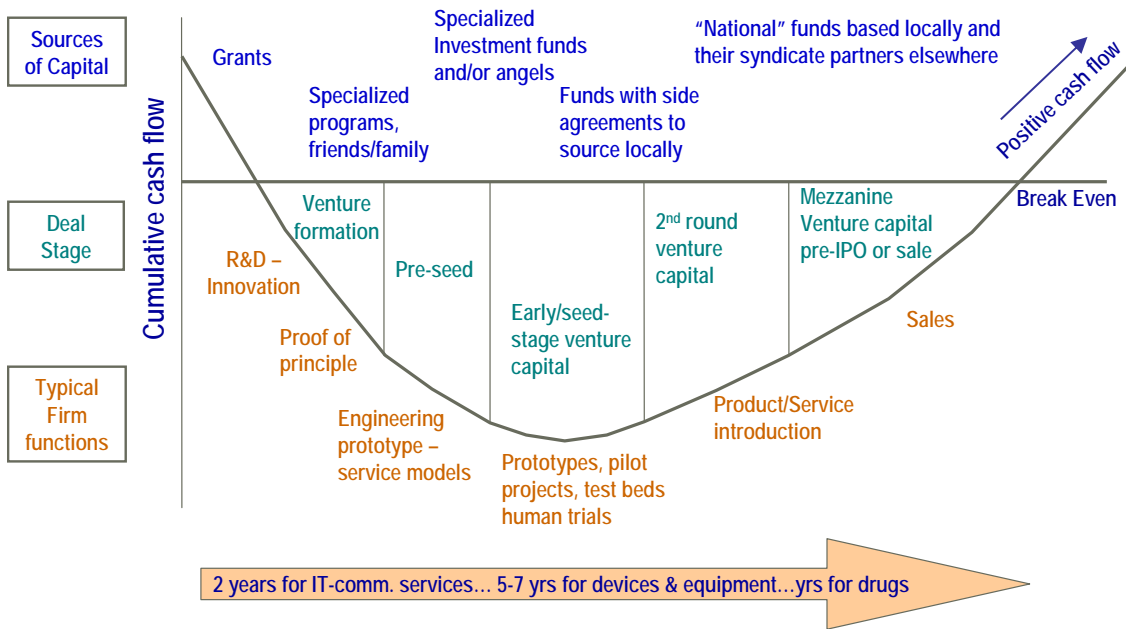
	Technology Transfer		Technology Commercialization		
Technology Development Stage	Discovery	Translational Research	Technology Development	Product Development	Production/Marketing
Outcome	<ul style="list-style-type: none"> Invention Disclosure Publication 	<ul style="list-style-type: none"> Proof of Concept Patent/Trade Secret License 	<ul style="list-style-type: none"> Engineering Optimization Product Prototype Pre-seed business 	<ul style="list-style-type: none"> Initial Product Start-up business or new program (for established companies) 	<ul style="list-style-type: none"> Mass Production Established company

Source: Adapted from NIST, "ATP and Venture Capital Funding Criteria Differ," <http://www.atp.nist.gov/factsheets/1-c-9.htm>

Moving From Research Discovery to Addressing the Valley of Death

The focus of technology commercialization is turning basic research into firms and products with sales in the marketplace. Many refer to the funding cycle issues as the "Valley of Death" as illustrated in Figure ES-11. Battelle suggests that *gaps within the Valley of Death are impeding Arizona's ability to maximize its investments from its successes* in building a stronger research base in its universities, private research institutes, and its medical centers and hospitals.

Figure ES-11: Research Discoveries -Valley of Death



This "Valley of Death" helps illustrate the need for a continuum of support, services, and assistance from the private and public sectors as a technology enterprise is conceived, developed, formed, grown, and reaches maturity. Tools needed include due diligence, proof of concept, and engineering optimization in developing the technology and identifying the product. In addition, bioscience entrepreneurs in Arizona must address a fairly long continuum of risk capital needs to start, develop, and grow their firms.

What many people do not realize is that the costs associated with developing and taking a technology product or service to market are also very substantial. The development of new technologies is a very expensive process running, in some cases, into millions of dollars.

The State's research and medical institutions are increasingly seeing research turned into technology and firms. And they demonstrate the increasing deal flow and opportunities biosciences represent. **But the State is not optimizing its research base nor seeing the same impact of deal flow, venture financing, and growing technology companies as found in other high tech bioscience hot spots such as Boston, Seattle, Salt Lake City, or San Diego.**

Three inter-related gaps face Arizona in technology commercialization:

1. **Commercialization Tools.** Resources to undertake the market and technology assessments, prototype development and engineering optimization to determine if the research can be turned into a product and/or a firm.
2. **Business Mentoring.** Business service support and mentoring to help with business planning, sales and marketing, and other aspects of incubating a new firm and accelerating its product innovation.
3. **Risk Capital Creation.** Risk capital available to fund the initial startup and operations phases of a business.

Actions to address these gaps are summarized below:

1. Commercialization Tools

The key components include the necessary resources available for research organizations and others to offer the following tools:

- Due diligence
- Proof of concept fund support including testing, experiments
- Market and technology assessments
- Prototype support
- Engineering optimization

2. Business Mentoring

The key components for addressing how business mentoring support is offered and practiced include:

- Bioscience Entrepreneur Network
- Entrepreneurs in Residence/Executive Corps programs
- Startup angel capital funding through a statewide Biosciences Angel Initiative

3. Risk Capital Creation

Five specific actions are suggested:

- Create a stronger resident venture capital industry with a stronger set of funds to attract outside the state dollars and the sources of capital to Arizona entrepreneurs

- Explore an accelerator model addressing issues of risk capital, space, and serial entrepreneurial management talent concurrently
- Increase support to entrepreneurs to seek and win more SBIR/STTR awards
- Recruit and educate venture and other risk capital investors outside of Arizona about the State’s biosciences base
- Encourage an increased base of capital formation for Arizona individual and institutional investments in risk capital including an Arizona BioSeed Fund

ARIZONA’S BIOSCIENCE ROADMAP: THE NEXT FIVE YEARS TO 2012

Arizona’s maturing research base enables the state to more closely focus on signature opportunities that bring together collaborators from the research and clinical settings; from academe, industry and nonprofits; from diverse fields of expertise and study. Because of this maturity, Arizona is now in a better position than five years ago to make serious efforts to grow the critical mass of focused biomedical research and of bioscience firms. The State has recognized bio stars in firms such as W.L. Gore, Medtronic, Ventana, and Sanofi-aventis—already located here—but it is clear that an increased rate of bio business opportunities can emerge if the State can enhance its technology commercialization infrastructure. This suggests some refinement in the goals, objectives and actions for Roadmap implementation over the next five years.

Battelle’s revised goal for Arizona is to:

***Develop Arizona as one of the nation’s foremost
biomedical research and bioscience commercial centers
over the next 20 years***

This can be accomplished through the following objectives and actions:

- **OBJECTIVES**
 - Leapfrog research opportunities
 - Catalyze bioscience commercialization
- **ACTIONS**
 - Make strategic investments in research infrastructure
 - Make strategic investments in commercialization
 - Recruit intellectual capital
 - Provide guidance, support and information on the biosciences

Going forward, research and technology commercialization become the twin focal points for the Bioscience Roadmap. This requires focusing on “signature opportunities” and continuing to build Arizona’s translational research capacity. Strong efforts are required to advance bioscience

commercialization, bringing together the many participants from developers and builders to venture capitalists, higher education institutions, medical centers, and private research institutes.

SUMMARY

Arizona is at a critical juncture in its quest to become the major Southwest bioscience center. Significant progress has been made; resources have been secured; and there has been a considerable alignment across medical institutions, research institutes, higher education institutions, government, and others. While it continues to be important to focus strategically on the research base around competencies, research does not by itself create the technologies and innovations in the marketplace, create jobs, introduce products, or impact health care treatment and prevention.

Arizona's private and public sectors must jointly address gaps and deficiencies in "technology commercialization" to gain the economic and health benefits that might be derived from this research. The dollars required to create new cutting edge enterprises are not huge—indeed they are less than is needed to build a strong "research engine"—but they are critically important. Without sufficient investment in building its technology commercialization enterprise, Arizona will be challenged to create a sufficient and critical mass of firms and products, and it will not fully realize its potential to improve the quality of health care and diversify Arizona's economy.