



GROWING NORTHERN ARIZONA'S
BIOSCIENCE SECTOR:

A REGIONAL ROADMAP

PREPARED FOR:

Northern Arizona Bioscience Steering Committee
with financial support provided by the Flinn Foundation

PREPARED BY:

Battelle
Technology Partnership Practice

October 2007

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Executive Summary

INTRODUCTION

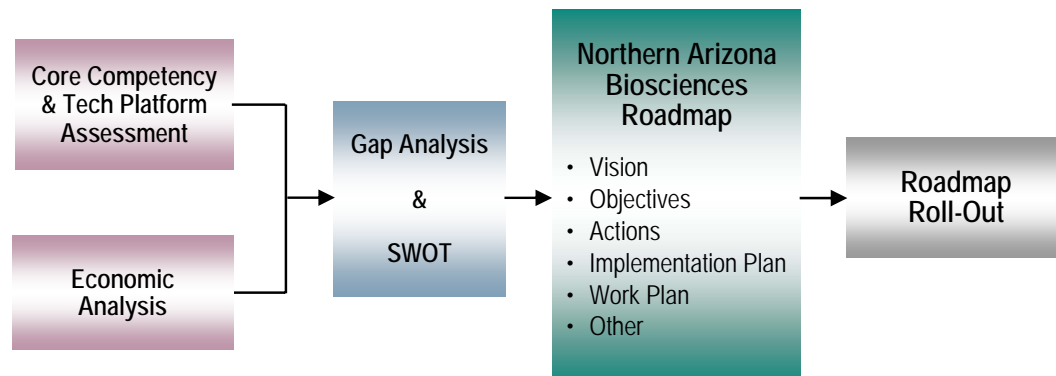
In 2002, public and private leaders in Arizona committed to making the investments necessary to position Arizona as a leading center for the biosciences. *Arizona's Bioscience Roadmap*¹ called for building the state's infrastructure around selected technology platforms, growing a critical mass of bioscience firms, and offering a business climate and environment to support bioscience enterprises. Significant progress has been made in building an environment in Arizona that is supportive of the biosciences.

Northern Arizona is an important contributor to Arizona's bioscience sector. The region is highly specialized in medical devices and Northern Arizona University (NAU) has strengths in key bioscience areas. The region is home to a number of established bioscience firms, including W.L. Gore and to a small base of start-up and emerging companies. Northern Arizona, under the leadership of the Greater Flagstaff Economic Council, NAU, and the City of Flagstaff, and with support provided by the Flinn Foundation, has developed this regional bioscience roadmap to complement the statewide effort and to focus on specific challenges and opportunities facing Northern Arizona. This Roadmap, developed with the assistance of Battelle, lays out a pathway to accomplish the following Vision:

The biosciences is a key driver of Northern Arizona's economy providing high wage jobs, high quality health care, and career opportunities for its citizens. The region is home to a vibrant cluster of bioscience companies and a global leader in medical devices.

This Roadmap was developed with guidance and input from the region's educational and research institutions, economic development organizations, bioscience companies, and other public and private leaders. The Battelle project team collected and analyzed data on Northern Arizona's bioscience industry and research bases and interviewed academic, research, business, and civic leaders to develop an understanding of the region's existing bioscience research strengths and capabilities and to gather input on the types of investments needed to enable Northern Arizona to become a well-recognized regional bioscience center. Figure 1 displays the project methodology. Key findings from these analyses are presented below.

Figure ES-1: Project Methodology

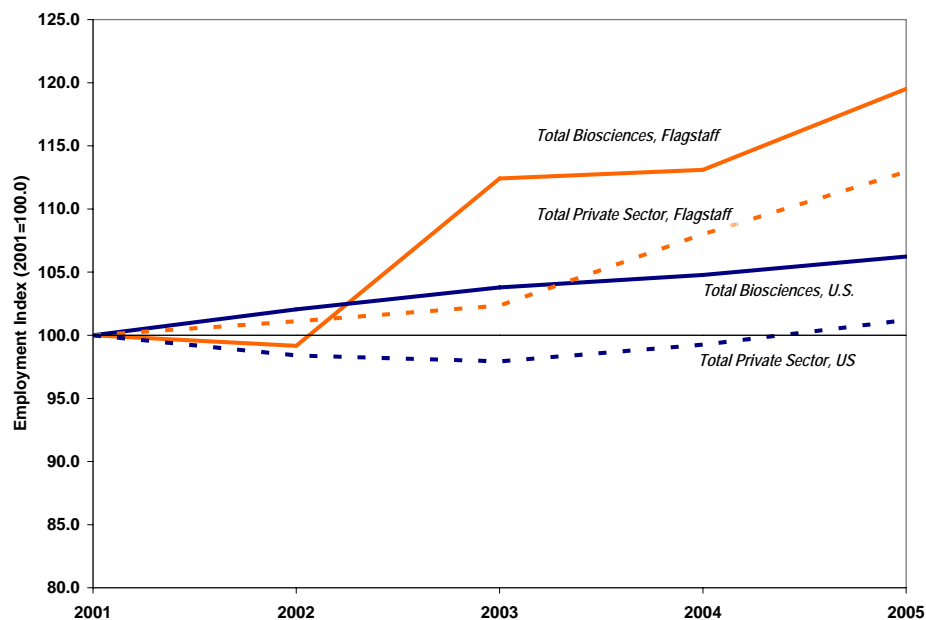


¹ *Platform for Progress: Arizona's Bioscience Roadmap*. Prepared for the Flinn Foundation by Battelle Technology Partnership Practice. December 2002.

NORTHERN ARIZONA'S BIOSCIENCE INDUSTRY

Bioscience employment in the Flagstaff metropolitan area grew three times faster than that of the nation between 2001 and 2005. See Figure ES-2. The biosciences employed more than 5,500 in Coconino and Yavapai Counties in 2005, spanning 37 business establishments. In Flagstaff, the biosciences employed 4,199 in 2005 across 12 business establishments. Local bioscience firms have increased payrolls in the metropolitan area by nearly 700 jobs or 19.5 percent since 2001, outpacing a national bioscience industry that added 6.2 percent to its employment base during this period.

Figure ES-2. Flagstaff MSA and U.S. Job Growth in the Biosciences and Total Private Sector, 2001-2005 (Index, 2001=100.0)



Source: Battelle calculations based on Bureau of Labor Statistics, QCEW/ES202 program data and Minnesota IMPLAN Group, Inc.

Similar to Flagstaff, the Prescott MSA has experienced strong job growth in the biosciences in recent years. Though modest in size, Prescott's bioscience sector boosted employment by 12 percent since 2001 and in 2005 stands at more than 1,300 jobs in total. At the same time, the region increased its number of bioscience business establishments from 18 to 25.

The Flagstaff metro area accounts for 5.4 percent of Arizona's bioscience jobs, although the region accounts for only 2.9 percent of total statewide employment. The location quotient for the Flagstaff MSA reached 1.98 in 2005, meaning the region is almost twice as concentrated in the biosciences as its counterparts nationally. The relative concentration of total bioscience jobs in the region is considered to be "specialized."

Medical devices and equipment is the fastest growing bioscience sub sector and the most specialized, due to the presence of W.L. Gore. Flagstaff's large medical device sector relative to its total private employment yields a very high location quotient—7.80 in 2005. The LQ highlights a specialized local industry that is nearly eight times more concentrated than at the national level. *In Battelle's 2006 national report for the Biotechnology Industry Organization (BIO), the Flagstaff*

*metropolitan area ranked third among all small metro areas (166 total) for its LQ in the medical devices and equipment subsector in 2004.*²

Hospitals are the largest employer in the region’s bioscience sector. In 2005, the hospital sector in Flagstaff accounted for 70 percent of the total sector and in Prescott, the share was 86 percent. The hospital subsector employed 2,944 in 2005 across 3 establishments in Flagstaff. Reflecting the metropolitan area’s strong population growth in recent years, local hospital jobs have increased by 13 percent since 2001. Job growth in the Flagstaff subsector has outpaced a robust national sector by nearly 2 to 1 since 2001 as the national sector added 7 percent to its employment base. In 2005, two hospital establishments employed 1,132 in Yavapai County. The subsector LQ for 2005 was 0.60. Local hospitals added 135 jobs in the Prescott MSA from 2001 to 2005, a 13.6 percent increase in its employment base.

Compared with their counterparts in the total private sector, Northern Arizona bioscience workers are earning nearly \$20,000 more per year. In addition, the major regional bioscience subsectors—hospitals and medical device manufacturing—are at or near the top in both regions. In both Flagstaff and Prescott, bioscience workers earn more than \$45,000 on average compared to only \$27,000 - \$28,000 for their counterparts in the overall private sector.

Table ES-1. Average Annual Wages in N. Arizona MSAs for the Biosciences and other major industries, 2005

Northern Arizona: Average Annual Wages by Industry, 2005		
Industry	Flagstaff MSA	Prescott MSA
Medical Devices & Equipment	\$46,466	\$44,806
Total Non-Hospital Biosciences	\$46,041	\$36,405
Total Biosciences	\$45,363	\$45,279
Hospitals	\$45,074	\$46,774
Management of Companies & Enterprises	\$44,920	\$69,120
Wholesale Trade	\$44,733	\$40,090
Manufacturing	\$43,958	\$33,850
Health Care & Social Assistance	\$40,641	\$32,965
Finance & Insurance	\$40,472	\$42,707
Information	\$38,432	\$43,751
Research, Testing, & Medical Labs	\$35,651	\$35,713
Prof., Scientific & Technical Services	\$35,273	\$35,233
Transportation & Warehousing	\$34,062	\$30,137
Real Estate & Rental & Leasing	\$32,449	\$29,434
Construction	\$28,258	\$30,052
Total Private Sector	\$27,194	\$28,026
Retail Trade	\$22,180	\$23,978
Accommodation & Food Services	\$14,564	\$14,546

Source: Battelle calculations based on Bureau of Labor Statistics, QCEW program data from IMPLAN.

In summary, Northern Arizona is an important contributor to the state’s bioscience industry sector. The region’s bioscience sector exhibited strong growth from 2001 to 2005. This is particularly impressive as Northern Arizona’s non-hospital bioscience employment is found primarily in the medical device subsector, which experienced employment losses nationally while growing rapidly in Northern Arizona.

² See “Growing the Nation’s Bioscience Sector: State Bioscience Initiatives 2006,” by Battelle Technology Partnership Practice and SSTI, April 2006. The full report can be accessed online at <http://www.bio.org/local/battelle2006/>.

At the same time, bioscience employment in Northern Arizona is highly concentrated in one company, W.L. Gore, which accounted for most of the employment growth. Total employment and the number of bioscience establishments are small. Northern Arizona needs to build on its medical device and hospital sectors while at the same time diversifying its bioscience industry base in other areas.

NORTHERN ARIZONA'S BIOSCIENCE RESEARCH STRENGTHS

Northern Arizona's bioscience R&D base is growing rapidly but remains small. Northern Arizona's bioscience R&D base grew from approximately \$6 million in FY 1997 to more than \$16 million in FY 2005. This growth was driven primarily by growth in the biological sciences. The total bioscience R&D base, however, remains small. In comparison, the bioscience R&D base in Southern Arizona was \$255 million in FY 2004.

The quality of the bioscience research being conducted at NAU is high as demonstrated by NIH awards. NIH funding, generally considered the "gold standard" of funding for biomedical research and basic biological sciences, increased from \$1.4 million to \$2.6 million at NAU between 2001 and 2005. The average increase in NIH funding awarded to NAU researchers of 20 percent annually greatly exceeded the 10.2 percent increase in NIH funding at the national level.

In addition to biomedical research, Northern Arizona has a research base in environmental biology. Between 2000 and 2006, Northern Arizona received \$8.1 million in NSF funding from the Division of Environmental Biology. Publication and citation data show a high rate of publications and citations in the Environment/Ecology field, as well. Other areas in which Northern Arizona has a strong publication record include plant sciences, earth sciences, and animal sciences.

Targets of Opportunity for Northern Arizona

The biosciences present so many opportunities for the future that it is extremely important for a state or region to have a strong basis of understanding of where its opportunities will lie within a very broad universe of bioscience disciplines, opportunity areas, and possibilities. The areas of greatest opportunity for developing technology platforms are those in which a region has:

- Existing research strengths
- Bases of commercial activity emerging or established within the region with genuine opportunity to create a base in the near future
- Distinct opportunities to leverage the region's comparative advantages to create competitive marketplace advantages
- Significant product market potential
- Links to, or reinforcements of, other bioscience strengths and core research competencies, thereby helping to enhance other fields as a platform expands.

Previous work conducted by Battelle for the Flinn Foundation has identified Arizona statewide bioscience technology platforms and much progress has been made in advancing development in the state along these platform pathways. Analysis of the bioscience R&D core competencies in Northern Arizona shows that the region plays an important contributory role in most of the ten statewide technology platforms. The four platforms in which Northern Arizona is a very important contributor are: cancer, bioengineering, bioagriculture, and infectious diseases.

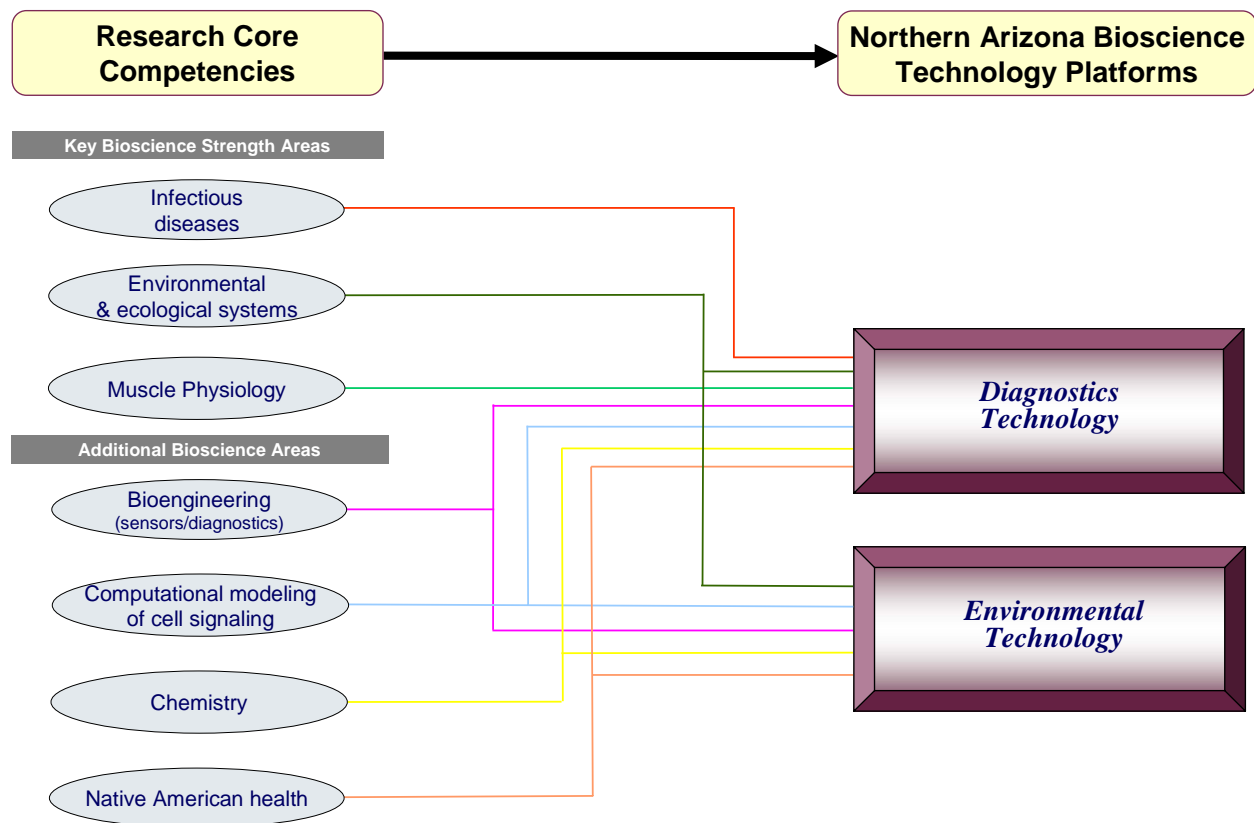
To identify the specialized niches for Northern Arizona, Battelle employed a methodology that uses the “marketplace” of academe, including peer-driven recognition systems, e.g., publications, citations, and federal fund awards, along with extensive number of interviews with research leaders, to identify targets of opportunity. Based on this analysis, Battelle documented Northern Arizona’s research core competencies and recommended associated technology platforms, which can form the basis for the future growth of Northern Arizona’s bioscience sector.

The Battelle team identified two unique technology platforms that build upon Northern Arizona’s core research competencies and can be sources of innovative technologies and products for its economy. They are:

- Diagnostics Technology
- Environmental Technology.

Figure ES-4 shows the relationship between Northern Arizona’s core competencies and these two platforms.

Figure ES-4: Relationship Between Northern Arizona’s Research Strengths and Northern Arizona Technology Platforms



LEVERAGING THE REGION’S UNIQUE ASSETS

Northern Arizona has a number of unique assets on which to build its bioscience base. These include:

- **A growing base of medical device companies and health care institutions and a nascent research, testing, and medical laboratory sector.** Overall, Flagstaff is almost twice as specialized in the biosciences as the nation and within medical devices and equipment is nearly eight times more specialized than the nation and ranks third among all smaller metropolitan areas in the country in medical devices and equipment employment specialization. Flagstaff ranks only second to Glenn Falls, NY, among such competitor regions as Minneapolis, Bloomington, Indiana, and Kalamazoo, Michigan, in medical device employment per establishment. Its medical device firms have nearly seven times the employment per establishment as the U.S. as a whole. **The region should build on the presence of W.L. Gore and seek to develop a stronger supplier chain of medical device firms in the region.**
- **NAU, USGS, and TGen North.** Northern Arizona has a small but excellent bioscience research base with expertise in specific areas of the biosciences. These institutions have the capacity to develop new, innovative technologies that could form the basis for new, start-up bioscience companies that could complement the region’s existing base in medical devices and hospitals. NAU also offers strength in science education to help address workforce issues over the long term as well as offering courses and degrees responsive to the growing bioscience employer base.
- **Coconino Community College and Yavapai College.** The region’s community colleges are expanding their offerings in the biosciences and working to meet the workforce needs of existing employers. The colleges are in a position to ensure that the region is able to develop a skilled bioscience workforce to meet the future needs of the region’s expanding bioscience sector.

Competitive Advantages
➤ Quality of life that appeals to many talented individuals
➤ Emerging base of bioscience companies that offer high-wage jobs
➤ Northern Arizona University <ul style="list-style-type: none"> ▪ Tech Platform Strengths ▪ Students and Graduates
➤ Strong talent pool <ul style="list-style-type: none"> ▪ CCC and Yavapai College
➤ Developing technology infrastructure <ul style="list-style-type: none"> ▪ Science and Tech Park ▪ Incubator ▪ USGS campus ▪ Tech Park at Embry Riddle ▪ TGen North

Challenges
➤ High cost of housing and worker shortages
➤ Lack of diversified bioscience employment base
➤ Inability to retain more of the graduates of the region’s colleges and universities
➤ NAU has a small research base and limited interaction with industry
➤ K-12 schools are not graduating students with sufficient STEM skills and the schools have limited funding to address these needs
➤ Lack of entrepreneurial support infrastructure <ul style="list-style-type: none"> ▪ Lack of risk capital
➤ Transportation improvements needed
➤ Business climate with City perceived as challenging in spite of City’s innovative and creative approaches, e.g., USGS, S & T park, etc.

- **Proximity to Phoenix.** To date, much of the growth in the biosciences in Arizona has occurred in Tucson, and, to a lesser extent, the Greater Phoenix area. Northern Arizona is well positioned to partner with bioscience institutions in Phoenix and to provide a location for expansions as Phoenix’s bioscience business community expands. The growth of the bioscience sector in Phoenix also means that bioscience companies in Northern Arizona will have more opportunities **for** partnering with firms in the Phoenix area and accessing specialized bioscience services.
- **Image as both a tourism destination and a region with a very attractive quality of life.** Northern Arizona’s quality of life can be used to attract bioscience talent to the region, which will in turn make it a good location for bioscience companies. In addition, the region has a long history of attracting international travelers because of its location near the Grand Canyon and other outdoor attractions. Northern Arizona can take greater advantage of the fact that it is a destination site for global travelers to build its bioscience image and brand.

STRATEGIES AND ACTIONS

The strategies proposed for Northern Arizona focus on leveraging the region’s assets—its colleges and universities, the presence of a global biomedical company, its proximity to Greater Phoenix, a growing health service sector, and a very attractive quality of life—to grow its bioscience sector. Specific strategies proposed to accomplish this include:

Strategy One: *Improve the business climate in Arizona for bioscience industry development and growth.* Three actions are proposed to accomplish this objective: 1) Northern Arizona must continue to invest in technology infrastructure, such as incubators, technology parks, and transportation improvements; 2) creative ways must be found to overcome the region’s high cost of housing, which is making it difficult to attract and retain workers; and 3) the region must seek to diversify its bioscience industry sector by growing its existing base in medical devices through an enhanced supplier chain, attracting biomanufacturing operations, and building a research, testing and medical labs industry base.

Strategy Two: *Build the region’s research base in the identified platforms and facilitate commercialization of research findings.* NAU has an excellent but small bioscience research base. The university should 1) seek to grow this research base around the two Northern Arizona specific platforms by adding research faculty positions, making investments in facilities and equipment, and placing greater focus on undergraduate and selective graduate science programs; 2) seek to promote greater commercialization of research findings by establishing a senior level capacity to steer, catalyze, and cement its relationship with industry and to coordinate intellectual property management with Arizona State University and build greater institutional capacity directly over time; and 3) establish a commercialization function and providing funding for early-stage commercialization activities.

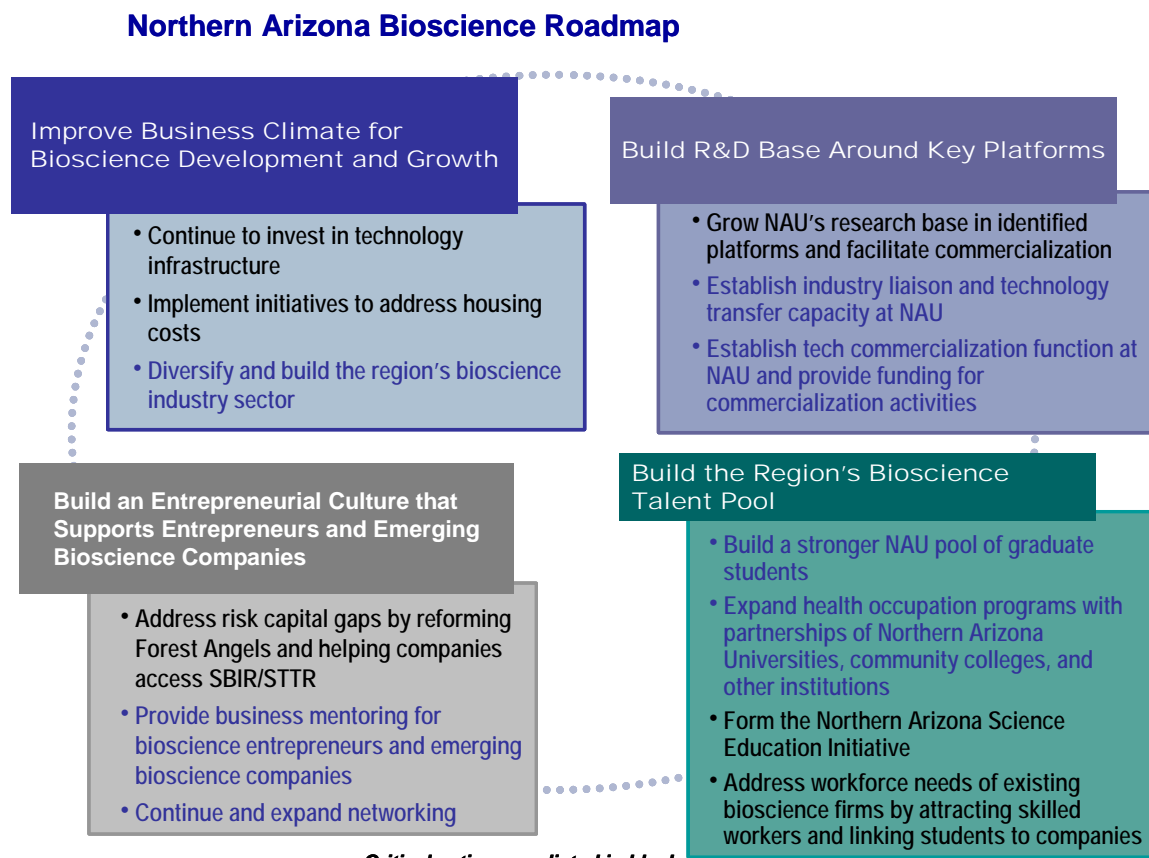
Strategy Three: *Build the region’s bioscience talent pool.* To address existing worker shortages, employers need to tap the region’s current student population developing new career paths for non-experienced entry level workers and providing opportunities for them to gain work experience while they are still in school. To meet future workforce needs, the region needs to encourage more students to consider careers in the biosciences and to take the courses that will prepare them for such careers. In addition, because of rapid changes in technology, it is essential for the bioscience workforce to constantly be educated on a lifelong basis—which necessitates the building of career ladders whereby a student from high school on can enter and exit with various skill levels, moving from a technician level to a post doc or scientist if he or she should desire at some point in his or her career. To meet existing and future

workforce needs, the following is proposed: 1) build a stronger pool of NAU graduate students; 2) expand health science programs in Northern Arizona and throughout the state; 3) form a Northern Arizona Science Education Initiative to create a science talent pipeline; and 4) undertake activities to attract skilled workers to the region and to better link students to companies by offering internships and part-time employment.

Strategy Four: *Build an entrepreneurial culture that supports bioscience entrepreneurs and emerging bioscience companies.* To grow a critical mass of bioscience companies, Northern Arizona must encourage entrepreneurs, provide in-depth support to new bioscience companies, and create a climate that is supportive of bioscience companies. Northern Arizona can foster the growth of start-up bioscience companies by 1) addressing risk capital gaps by encouraging the re-formation of the Forest Angels Group and helping companies to access the SBIR/STTR program; 2) providing business mentoring for bioscience entrepreneurs and emerging bioscience companies; and 3) continuing and expanding researcher, bioscience company, and service provider networking.

These four strategies and the thirteen actions proposed to achieve them are outlined in Figure ES-5. It is anticipated that a majority of these actions would be implemented over a five-year time period by the private and public sectors in Northern Arizona.

Figure ES-5: Overview of Strategies and Actions



Immediate Work Plan Priorities

Immediate work plan priorities are those steps the private and public sectors in Northern Arizona should undertake within the first 12 months of implementation. Several critical priorities need to be implemented right away, while others will need to be planned and resources secured before they can move forward.

The following actions should be undertaken in the first year of implementation of the strategy:

- City of Flagstaff, NAU, Flag 40, and other groups need to reach a consensus on near-, mid-, and long-term approaches to address the housing situation—it is unlikely there is a magic bullet option which will meet all needs and requirements;
- Convene angel investors to determine interest in re-constituting the Forest Angels Group and what support or assistance, if any, they need;
- Convene public and charter schools, community colleges, and NAU to develop pathways for bioscience careers addressing curriculum, articulation, resources, and other impediments to making Northern Arizona a science education center of excellence that will be able to build and retain its own talent pool over the long-term;
- Continue to implement the Science and Technology Park, including incubator build-out and planning for an accelerator/multi-tenant space;
- Work with the Arizona Department of Commerce and the U.S. EDA to get funding for the development of the technology park at Embry Riddle in Prescott; and
- Work with Science Foundation Arizona to which actions if any they will invest dollars in to move the Northern Arizona Bioscience Roadmap forward.
- Work with the Arizona Board of Regents and Department of Commerce officials as well as Science Foundation Arizona and private sponsors to secure resources for 1) enhancing technology transfer and commercialization capabilities at NAU; 2) creating a technology commercialization fund at NAU; and 3) increasing support for NAU graduate students.
- Work with Arizona’s Bioscience Roadmap Steering Committee to address the need for a BioSeed Fund and other risk capital.

Resources

Because so many of the actions will require further discussion it is not possible to estimate the total cost of these actions. However, it should be noted that a number of these items are already underway, e.g., incubator, science and technology park, etc., thus the public investment that will be required to implement the actions in the Roadmap will be primarily in the areas of research, technology and its commercialization, and education and training. The private investments required will include risk capital. Because of the progress already being made, Northern Arizona is not likely to have a huge resource requirement to move forward with this Regional Roadmap. More important are the issues of stewarding the Roadmap and its implementation.

Organization and Structure

The Steering Committee formed to provide guidance and oversight in the formulation of the Northern Arizona Bioscience Roadmap should continue to meet to steer and steward this effort in its

implementation. Membership of the Committee should be broadened to include representation from Prescott and Payson. Additional industry representatives from these areas should be given strong consideration.

Measures of Success and Accountability

Specific measures to guide progress in Roadmap implementation include:

1. Assessing Flagstaff's and Prescott's cost of living relative to other communities in Arizona and the West, including housing affordability (Indexes);
2. Maintaining Flagstaff's specialization in medical devices and broadening Northern Arizona's bioscience specialization to at least one other industry area (measured by LQ levels);
3. Tracking graduates in bio-related areas by level—Associate, Bachelor's, Graduate and Northern Arizona's retention rate of such graduates; and
4. Tracking statistics on success in commercialization of research: disclosures, patents, licenses, equity, and spin-offs

CONCLUSION

Flagstaff is making considerable progress on items important to the region's future in the biosciences. The region, due to the strong presence of W.L. Gore, is a recognized global player already in the biosciences. The growth of NAU research base; increased faculty interest in entrepreneurship; world class research around strengths in infectious diseases, environmental and ecological systems, and plant sciences; and the opportunity to build on its science education reputation to address regional needs, such as biomedical engineering, place Northern Arizona in a favorable position to grow its bioscience sector.

But there are challenges to address led by the interrelated issues of cost of living/housing costs and shortages of workers with most major employers in the community having a significant number of job openings. Some of this shortage is due to limitations in what is produced from the education system at the high school, community college, and university levels. But, some of it is also due to national shortages of skilled and experienced bioscience workers.

Two fundamental issues will determine whether Northern Arizona succeeds in the biosciences. Novel and creative solutions will be needed to address the issues of affordable housing and worker shortages. While there has been much discussion and debate over the housing issue, and it is not the purpose of this Roadmap to solve that problem, suffice it to say that if this problem is not solved it will be increasingly difficult for employers—biosciences or others—to stay, let alone expand. And it will limit efforts to recruit and attract suppliers to existing medical device firms to come to Flagstaff. Building a private-public consensus on solutions is critical, as Prescott has found in its efforts, and it will require creative and flexible responses by business, university, and city government leaders.

Addressing, if not totally solving, the housing issue will directly and indirectly help address the worker shortages. But, ultimately, the worker shortage suggests the region rethink how it builds its talent pool in the long term. This is hardly a short-term solution but providing more opportunities for part-time employment for college and high school students and increasing the scale of internships and co-op programs will increase the ability of the region's employers to attract these students upon graduation. In turn, this requires building career ladders and requires employers to adjust deployment of personnel as

they build their workforce from within the community. Education institutions have to more rapidly respond to such a strategy by considering advanced biomedical engineering programs at NAU; health occupation programs at Coconino Community College (CCC), Yavapai College, and NAU; and entrepreneurship programs emerging from the College of Business at NAU and elsewhere.