

**Progress Report for Positioning Arizona for
Success in the Biosciences:
*Strategic Plans for Developing Near-Term
Technology Platform Areas of***

- ***Cancer Research***
 - ***Neurosciences***
 - ***Bioengineering***

PREPARED FOR:

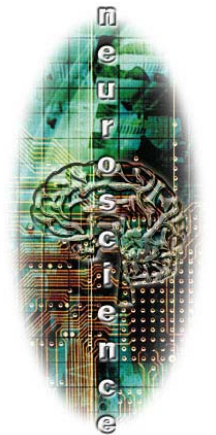
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Section 1: Preface

The biosciences are an important area of opportunity for Arizona both for raising the quality of life and generating economic growth. The Flinn Foundation, in alliance with the state's research universities and organizations and industry, has been facilitating the implementation of a strategic Arizona Bioscience Roadmap—bringing together the broad breadth of stakeholders across academia, industry, government and the broader community. The focus of this Roadmap is to enable Arizona to become a leading southwestern state in selective bioscience sectors—built around world-class research, clinical excellence and a growing base of cutting edge enterprises, supporting firms and organizations.

One key element to achieving this vision is to invest and build excellence in key technology platforms, underpinned by a strong collaborative research infrastructure. That is the focus of this strategic platforms' report.

Arizona's real hope of becoming a major player in the biosciences is to focus around a few key select areas and build stature in these. In the formulation of the Arizona Bioscience Roadmap, considerable effort was expended to identify the focus areas around which the state's bioscience research base can be further developed and national excellence established. Three technology platforms that have potential in the near term to best position Arizona in the biosciences—bioengineering research, neuroscience research, and cancer research—were identified.

Each of these areas will require significant further investments in talent, research facilities, and equipment, and will need to be developed as multi-institutional collaborations among various research organizations, research universities, hospitals, and medical centers, and the private sector as it grows in the state. At the same time, bioscience research organizations from across the state are already focusing on one or more aspects of these near term platforms, but in a relatively uncoordinated and non-strategic way for the state as a whole. Without a way to bring faculty, administrators, and other stakeholders together across institutions and research organizations, Arizona will not quickly, and perhaps never, maximize its capabilities in these select fields of the biosciences where Arizona can excel and where its research stature can be recognized and the economic benefits in terms of income, jobs, and careers can be enhanced.

With the support of the Council of Presidents and other higher education officials, the Flinn Foundation has engaged the broad community of bioscience research organizations from across the state to facilitate the development of comprehensive strategic plans in each of the three near-term technology platforms. Assisting the Flinn Foundation in this effort has been the Technology Partnership Practice of the Battelle Memorial Institute, who also assisted in the development of the Arizona Bioscience Roadmap.

Section 2: Scope of Strategic Plan for Technology Platform Areas

The goal of this strategic planning process is to establish a state-wide plan of action for building excellence in each of the three technology platform areas. In turn, this process calls for statewide perspectives and participation. The Flinn Foundation reached out to the broad community of universities and non-profit research organizations in Arizona that were engaged in biosciences research to gain their involvement in the strategic planning process. As a result, nearly one hundred senior-level researchers and administrators from across Arizona were selected by their universities and non-profit research organizations to come together and inform and shape the development of strategic plans for the technology platform areas.

The process of engagement has involved a series of monthly meetings involving intensive discussions by the Technology Platform Committee members, along with ongoing information collection and sharing. To further inform the strategic planning process, a day-long scientific retreat for each technology platform was held, involving an even broader range of research participants from the parent organizations and elsewhere.

Each Technology Platform, under the guidance of their respective Technology Platform Committees, was asked to develop a strategic plan that focuses on:

- Strategic vision and areas of focus for that technology platform area;
- Identified resource gaps and collaborative opportunities for that technology platform area;
- Proposed structure and organization for that technology platform area;
- Investment plan needed for faculty, facilities and equipment, clinical infrastructure and enabling initiatives;
- Priorities and time frames.

Supporting the development of these strategic plans were two analyses. One was the development of an inventory of assets, namely facilities, equipment and expert staff identified through the efforts of the Technology Platform members and reporting at the scientific retreat. The other was a peer analysis conducted by Battelle, which was used to validate the strategic plan approaches identified by the Technology Platform committees. These analyses are included as appendices to each platform plan.

Section 3: Overview on Platform Strategic Plans, Cross-Platform Supportive Infrastructure and Key Themes

The ideal of a statewide collaborative effort in focused areas of bioscience development is one that is often out of reach for most states with entrenched organizations and regional rivalries. In Arizona, however, the dynamics and interests for promoting this statewide approach seem well in place. Arizona has displayed a unique capability to come together and focus on the biosciences in a statewide perspective. The success of the Arizona Alzheimer's Disease Center—the only statewide Alzheimer's Disease organization recognized as a center of excellence by National Institute of Health (NIH)—and the formation of The Translational Genomics Research Institute (TGen) are two outstanding examples of this statewide approach in practice.

Not surprisingly, the outcome of this strategic planning process for Arizona in the selected technology platform areas of the biosciences is not merely a collection of individual plans from each institution, but the blending together of an integrated approach and focus, with required enhancements and key activities for building collaborative, multi-disciplinary research programs across organizations, within each platform. The key visions and focus areas for each of

these platform areas is described below, and more detailed plans of these technology platforms is presented in later chapters and appendices of this report.

Interestingly, as each of the committees met and discussed, support grew by all participants, regardless of sector or institution, for an even broader-based level of collaboration. Early in the process, the technology platform members began to identify cross-platform area enhancements needed to create and sustain an effective culture of collaboration in part for basic or fundamental research, but more importantly for translational research and commercialization, while ensuring a high quality infrastructure of resources needed to support an increasingly complex convergence of technologies and techniques found in the biosciences. These results are also presented below and in more detail in subsequent sections of the report. These cross-platform area enhancements offer Arizona a foundation for easily enabling other emerging technology platform areas in asthma, infectious diseases and diabetes, among other areas, to gain support and stronger basis to grow in the state.

TECHNOLOGY PLATFORM STRATEGIC PLANS

Each of the technology platform strategic plans is quite different from each other. The distinctiveness of each technology platform's strategy plan reflects the maturity,

stage of development, Arizona's relative position, and the different circumstances, organizations and opportunities found in each technology platform area.

Below we summarize the key elements of each technology platform strategic approach, focusing on identified niches, key investments and specific approaches.

In **bioengineering**, there was broad consensus that Arizona could best be a national leader in this emerging field, which brings together our advancing knowledge of biological processes and mechanisms with the systematic approaches and innovations found across engineering from nanotechnology to information technology to material sciences, by focusing on building up its position in three key application areas found in Arizona: neural engineering, regenerative medicine and rehabilitation engineering. These three application areas in bioengineering are linked thematically in that they focus on developing materials, devices or systems to replace diseased or damaged body parts, or enhance the capabilities and improve the quality of life for individuals with physical and cognitive impairments. Moreover, these three lead application areas would in turn each be supported by advancing enabling strengths in biomaterials, bio-sensors and actuators, and bio-imaging technologies.

The challenge for bioengineering research in Arizona is that it is a highly fragmented effort involving as many as 200 faculty members working across universities, research institutes, and hospitals in the state. Unlike other regions of the nation, there is no centralized “go to” facility and mechanism for collaboration in Arizona. This fragmentation hinders collaborations and reduces the effectiveness of the researchers to partner with clinicians and with industry. Approaching development of the bioengineering platform on an institution-by-institution approach will fall short of addressing the infrastructure challenges holistically. To realize major advances in technology and overall program

growth it is evident that a new approach is needed to sufficiently scale and build world class capabilities for undertake bioengineering research in Arizona. The potential is apparent, but the research staff is operating in a sub-optimal manner, given the current infrastructure.

Accordingly, the bioengineering platform committee is proposing a radical departure from today, namely a statewide “Bioengineering Research and Development Collaboratory” that will engage university researchers, hospitals and institutes, and small and large industry in the process of innovation, taking new technologies from laboratory to application in the shortest possible time.

For **cancer research**, which is nationally a long-standing and well-funded area of bioscience research with strong competitors, the cancer research platform members decided that it made sense to focus on establishing a key field of excellence and then building on that reputation. The cancer research platform identified five key niches for Arizona to focus on over the course of the next five years, with clear priority given to an integrated set of three niches to enable Arizona to gain national and international recognition in gastro-intestinal cancers, particularly colon and pancreas, in combination with drug discovery and development and imaging efforts.

The other two identified focus niches for cancer research in Arizona, skin cancer, and neuro-oncology, represent significant opportunities for cancer research in Arizona. Skin cancer is a key cancer target for Arizona, which has the highest rate of melanoma of any state. There are emerging skin cancer research programs in Arizona, particularly focused on prevention and genomics, and a broader effort is warranted on the scale of the GI cancer activities. In neuro-oncology, Arizona brings a basic neuroscience research

group at University of Arizona and the clinical resources at the Barrow Neurological Institute, but faces a key gap in translational scientists who can identify and capitalize on new therapeutic approaches.

The primary investment need in cancer research is for raising the critical mass of talented researchers, cutting across basic biological disciplines, academic physicians, epidemiologists and biostatisticians and medicinal and more applied chemists. While facilities are needed to house these researchers, and some specialized labs were identified, nothing is more important for Arizona than an aggressive effort to hire researchers to advance its identified niche areas in cancer research.

Arizona is fortunate to have an NIH-funded comprehensive cancer center at the University of Arizona, and the presence of a similar NIH funded center through Mayo Research Center. Nevertheless, there is recognition that the cancer research activities statewide need an organizing umbrella, and so an Arizona Cancer Research Alliance is proposed.

In **neurosciences research**, the platform committee recognized the need to build on strengths ranging from molecular to systems and cognitive levels, in order to gain a position of national leadership. Toward the goal of bringing Arizona to leadership in the prevention, diagnosis, and treatment of neurological disease, the committee felt that a broadly based initiative should capitalize on the strengths of Arizona's base of more than 200 neuroscience researchers, spawning heightened levels of interaction and research excellence with a special focus on increasing ties between basic and clinical investigators.

As a centerpiece of its proposal, the committee recommended the establishment of an Arizona Neuroscience Consortium,

an institute without walls which would promote and facilitate inter-institution collaboration and would provide central support for such things as data-sharing, computational expertise, and navigation through bureaucratic red tape for certain types of animal and human research. The existing Arizona Alzheimer's Research Center would serve as a model for organization and operation of the Consortium.

The committee urges the state to strengthen existing successful models of statewide collaboration (e.g., with targeted recruitments and other strategic investments already described in the Roadmap) and also to consider the opportunity to develop consortia of excellence in other targeted areas. Given Arizona's emerging strengths in Alzheimer's disease and Parkinson's disease, Arizona's highly motivated, research-oriented senior citizen population (e.g., in the vicinity of the Sun Health Research Institute), and the problems associated with our aging population, the neuroscience platform committee expressed interest in the 'understanding, tracking, treatment, and prevention of neurological aging and the disorders to which this is related' as one organizing theme to galvanize the development of neuroscience programs. Other promising themes of focus include computational neuroscience ranging from molecular genetic to neural-systems applications, multiple sclerosis and spinal cord disorders, neuro-oncology, and neurological correlates of diabetes. An important component of each of these foci will be the fostering of a range of activities from basic research to bedside treatment.

Toward these ends, the committee identified a need to bring in new research "stars" who would serve to jump-start research in a few key areas. They proposed that Arizona commit to a focused recruitment of talented, highly respected neuroscientists with expertise in glial biology, stem cell

biology, neuroimmunology, neurology, and psychiatry. A total of eight star teams are proposed for the neuroscience research platform. These stars can help bring to light the breadth and depth found across the neurosciences in Arizona, and pay enormous dividends for Arizona.

One of the challenges facing the neuroscience research platform area in Arizona is a lack of sufficient access to key facilities, such as bio-imaging, animal facilities, bioinformatics support and epidemiologists and biostatisticians, among others. Many of the needs identified by the neuroscience research platform area were endorsed more broadly by the other two platform areas, and serve as the basis for developing cross cutting infrastructure resources described below.

Even given the differences of each platform it should be noted that there are shared elements as well:

- **Across each of the technology platforms collaboration is viewed as a key to success.** The importance of multi-institutional collaboration was strongly embraced by each of the technology platform areas, and a set of cross-cutting technology platform infrastructure resource and collaboration mechanisms were identified (see below). More importantly, each of the technology platforms proposed specific approaches to ensure that collaboration is the hallmark of Arizona's future success.
- **All of the research platforms see a need for investments to raise the critical mass of researchers.** For cancer and bioengineering, the need is to build more critical mass in researchers in focused niches, with a broad mix of levels from promising junior faculty to rising mid-level researchers to more nationally recognized and established senior researchers.

Neuroscience differs in a highly focused effort to recruit a few star faculty and their research teams that can help elucidate the broader strengths in neurosciences research found in Arizona.

- **The technology platforms are able to provide a focus in pursuing the development of their areas.** The cancer research platform, which is a highly competitive and well-funded area of bioscience research nationally, has selected five key niches and set a clear priority on an integrated set of three niches to enable Arizona to gain national and international recognition in gastro-intestinal cancers, particularly colon and pancreas, in combination with drug discovery and development and imaging efforts. Bioengineering, which is a more emerging research area, fueled by the rising opportunities of linking new biological understandings with innovations in engineering domains, also has a focused approach with three key application areas identified for Arizona including neural engineering, regenerative medicine and rehabilitation engineering. In contrast, the neuroscience research platform is a deep area of activity in Arizona spanning basic, enabling tools and disease-oriented clinical research with a multitude of opportunities across these research areas. The neurosciences research platform, while recognizing the numerous methodological and basic research strengths found in Arizona, brings one established and one developing multi-institutional consortium of excellence in the Alzheimer's Disease Consortium and the Parkinson's Disease Consortium, respectively. These efforts in Alzheimer's Disease and Parkinson's Disease can be furthered to position Arizona as a leading center for the understanding, tracking, treatment, and prevention of

neurological aging and the disorders to which they are related. Key to the future success for the neurosciences research platform is embracing these models of statewide collaboration as means for advancing other identified areas of neurosciences research.

- **A lack of facilities in biosciences across Arizona impedes the ability of the state to be competitive in specific bioscience fields.** The bioengineering research platform was perhaps the most focused on the need for specific facilities to enhance its competitiveness in its focus niche areas, but the neuroscience research platform clearly identified facility gaps and shortages as a key

handicap in advancing research programs and recruiting. Even for the cancer research platform, where raising the critical mass of cancer researchers was the key priority, the ability of Arizona to attract these researchers will depend on having high quality lab space available and adequate start-up packages for basic equipment. While the state has recently committed over \$400 million to new facilities, it remains unclear how and to what degree these new facilities will be connected to the platform opportunities identified in this document. This is an area for further discussion and resolution

CROSS CUTTING ISSUES AND COMMON THEMES

The common elements noted above in the technology platform strategy plans is the tip of the iceberg. In fact, there were many areas of common investment needs identified by three Technology Platform committees. These cross cutting needs break out into two groupings:

- Specific technical facilities and capabilities that support development of each of the bioscience platforms and future platforms.
- Key collaborative mechanisms needed to enable Arizona to seize the potential of its bioscience research in advancing medical therapies, new products and bioscience ventures.

Supportive Technical Facilities and Capabilities

Among the shared technical facilities and capabilities identified by the Platform committees were:

- **Imaging facilities** – The use and development of imaging is a cross cutting strength of Arizona in the biosciences, and increasingly a critical tool for advancing bioscience research. While there are significant needs for greater availability of imaging facilities, it is also critical to recognize that imaging technology is in a constant state of development and so a complementary imaging research component is needed to ensure the state's competitive position. An Arizona Bioimaging Consortium is proposed to encompass these two dimensions of greater access to state-of-the-art facilities and development of novel imaging technologies.

In terms of access to facilities, a particular concern is the need to address ensuring dedicated time for human research, which often gets squeezed out by clinical demands. Small animal imaging is a growing area of focus as imaging technologies become key in biomedical research. Currently there is only one such facility in the

state located in Tucson, which is at or near capacity. Also, there is a need for separate facilities between human research and animal research, even beyond small animals, because of cross-species virus contamination. Finally, the need is not only for imaging facilities, but for staffing capacity to assist with programming and image analysis. This staffing need can be provided on a shared basis. It should be noted that this shared imaging facility infrastructure does not substitute for specific initiatives within Technology Platform areas for more research and development of advanced medical imaging systems.

In terms of advancing imaging research, there are broad-based needs—from molecular imaging to PET radiotracers to other modalities—that Arizona, with its deep strengths in optics and other key technologies, is well positioned to advance. Arizona also has strong capabilities in advancing image analysis, including advanced computational modeling and biosignal processing.

- **Animal facilities** – Conducting research in animal models is key for moving innovative discoveries towards translation into new therapies and medical practices. Across the Technology Platform areas, there was expressed a strong need for additional facilities to house both small and large animals, as well as more in-state capacity to develop transgenic animal models. Existing animal facilities in the state require expansion and are not well-distributed to serve the broad range of bioscience research facilities in the state. It was noted that many research institutions are having to import their animal models, which is causing significant delays in their research activities.

- **Bioinformatics** – Bioinformatics is revolutionizing bioscience research, enabling use of powerful new tools that develop information on basic biological processes from genes to proteins. Particularly in the Cancer and Neuroscience platforms, researchers are actively exploiting the use of these new tools, such as micro-array analyses to genotyping. However, properly designing the use of these tools, handling the large data being generated and interpreting that data, are difficult tasks and further capacity-building is needed across Arizona. With the formation of TGen, Arizona has a unique resource in bioinformatics. In just a short time, significant research relationships between TGen experts and Arizona bioscience researchers are being established. To more broadly leverage the expertise of TGen, it is critical to establish a training and technical assistance resource that utilizes TGen expertise even in situations when TGen is not closely linked to the specific research activity. The goal is to establish a service-oriented core facility in concert with TGen to address the full set of integrated needs from data base development, hardware and software configuration and data analysis.
- **Biostatistics and epidemiology enhancement** – Arizona has a paucity of biostatistics and epidemiology expertise to help in the design and interpretation of results from clinical research activities. Members of the Technology Platform have indicated that with earlier and more intensive involvement of biostatisticians and epidemiologists, Arizona bioscience researchers can improve the quality of their proposals for conducting clinical research and also provide a more rigorous basis for understanding risk factors and helping to direct future research inquiries.

- **Tissue repository** – Related to the growth of genomics and bioinformatics is having access to tissue samples in which these research tools can be applied. Arizona is well-known for the Sun Health brain bank and other key tissue banks, but to advance future research a more comprehensive and focused approach is proposed that reaches across the state and seeks to develop broader types of tissue. It is proposed that in addition to specific tissue repository development identified for Arizona’s specific technology platform that consideration be given to establishing a more comprehensive whole organ and tissue sample repository that can enable future research activities.

Complementing these expanded tissue repository efforts would be a unique and signature statewide tissue preservation research center to provide the highest quality tissues for diagnostic and therapeutic purposes supporting all of the technology platform areas.

Collaborative Mechanisms for Advancing Translational Research and Commercialization

The cross cutting issues among the bioscience research platforms reached far beyond the technical infrastructure into the very fabric of promoting translational research that connects basic research with clinical research studies and commercialization support that can advance new drug therapies, medical procedures and devices into the marketplace.

A number of specific collaboration issues were raised by the Platform committees:

Information sharing and broadening the ability for outreach and collaboration among bioscience researchers

as well as with the growing base of bioscience companies in Arizona. Fundamental to the idea of building up bioscience platform areas is the idea of how to bring together the broad base of researchers found across multiple institutions and growing community of bioscience companies in Arizona as a community. There was a concern that the strengths of Arizona were being missed and not well understood because of how biosciences research activities were spread geographically across the state.

The Platform committees also identified the need to improve capacity for seeking out and identifying researchers with certain expertise, as well as outreach to private practice physicians to create greater awareness of resources available that can address improving medical treatments.

Proposed new resource: Web-based Collaboratory for the Biosciences. The Collaboratory would integrate advanced tools such as virtual collaboration work spaces where teams of researchers can work together on sharing test results, interpreting these results and developing papers and proposals to more typical video conferencing capabilities and web sites of researcher directories. In essence, the Collaboratory would provide a virtual community for the biosciences, which would add value to developing and conducting research, as well as serve as the means for connecting researchers, physicians and those in industry together.

Broadening clinical research and streamlining clinical trials processes. Across the Platform committees a key issue for Arizona was how to advance clinical research to take the successes from the bench to the bed, which brings up squarely the issue of “how are we going to involve clinicians.” It is well recognized that there is the researcher

world and the practicing physician world and they are separated by culture, focus and reward systems.

One key opportunity where the world of researchers and MDs can and need to meet is that of advancing clinical trials activities in Arizona. Clinical trials activities are central for advancing new therapies and medical applications. Arizona lacks the ability to easily have its broad range of biomedical research institutions to partner and advance clinical trials in a more concerted manner. Discussions identified a need for establishing a clinical trials consortium that could facilitate and broaden the coordination of clinical trials activities across the state.

Specific types of facilitation activities the consortium might undertake include:

- Development a community/statewide IRB.
- Need to clarify and strategize HIPAA issues to allow access to patient tissues, clinical information and screening for potential patient entry to protocols.
- Broaden base of involvement of physicians into clinical trials activities, especially Phase I and Phase II.

Establishing a “Special Population Alliance” in Arizona.

One place where the issues of broadening collaboration and advancing clinical research meet is that of working together with special population groups in the state. Arizona has a significant concentration of specialized population groups, from Native Americans to Hispanics to elderly, which have unique public health issues and offer important insights into biomedical research. While there have been tangible successes, much more can be done, but only if a genuine partnership approach can be taken that actively involves

these specialized communities at the start and ensures that they are helping to guide the effort.


For Native Americans, it is very important that researchers understand that they cannot just walk onto a reservation and do research. It takes two to three years of ground work in order to write a proposal; plus a need to be flexible and make protocol changes. It will take even longer to complete the work.

To facilitate this need for partnerships and capacity for researchers to have a ready mechanism for working with specialized population groups, it is proposed that a Special Populations Alliance be created that would support a statewide intermediary allowing for a more predictable and proactive approach, without having to recreate the partnering process.

Promoting Technology Commercialization. Major need in Arizona to create a more flexible, pro-active capability for technology commercialization that can add value in further developing and marketing of intellectual property and augment the activities in technology transfer found across research institutions. This involves undertaking market assessments, investing in proof of concept research activities and developing business plans and new ventures.

There are also a range of important public policy issues that must be addressed including:

- Identified need for a more consistent, upfront understanding of how intellectual property rights, cost sharing and allocation of indirect grant reimbursements and indemnification and liability concerns are addressed when researchers across multiple institutions collaborate. It was suggested that a form of an umbrella agreement be developed, rather than trying to address these issues



situation by situation. Ultimately, there is a need to build trust across the parties involved. This requires getting high level leadership involved, including the Arizona Board of Regents.

- Also need to address specific issues that arise in IP. One key problem is restrictions on improving patents with additional research funding. Another need is for improved means for bundling patents to create platforms for new company formation that goes beyond a single university.

Establishing more flexible funding approaches for teaming and collaborations. At the heart of these collaborative needs expressed by the Platform committees was the need for more flexible funding approaches that

promote teaming. Rather than being solely focused on competitive grantmanship, there was a concern that Arizona needed a more strategic approach to seizing opportunities in which the state served as a partner with institutions in pursuing significant opportunities that served as the pre-competitive phase towards building highly competitive research teams for federal funding. This approach was successfully demonstrated by the Arizona Alzheimer's Disease Research Center and is central to how each of the Platform committees proposes to manage the implementation of its strategic plans.

The proposed funding to support these cross cutting technical resources and collaborative mechanisms are set out in the section on Cross-cutting Infrastructure Resources.

Section 4: Metrics for Success

The notion behind the strategy plans for each of the Platform areas is that investment is needed to move forward. But the flip side of investment is the need and discipline of measuring return. There are many dimensions for measuring the return to investing in bioscience research activities, which go to the heart of the goals and objectives of Arizona's Bioscience Roadmap, namely:

- Generating more success in attracting bioscience research funding to Arizona;
- Leveraging the institutions and capabilities found across the state;
- Generating economic development successes in commercialization and new business formation;
- Improving the public health of Arizona's residents.

For each of these areas of focus, we propose a number of specific measures for success.

Success in research and development

- Generation of publications
- Growth in research funding, emphasizing programs and centers not just PI grants
- Cost-benefit: Cumulative research growth versus investment
- Research productivity: Average research funding per faculty

- Translation of innovation to application: Linkage of basic innovations to implementation of therapeutics, bioengineered system or techniques

Success in collaboration

- Joint research projects, including across institutions, physician-researcher projects
- Joint research publications
- Industry support

Success in commercialization and economic development

- Generation of new IP associated with investments – disclosures, patents and licensing
- Increased venture capital investment
- New firm start-ups in Arizona
- Job/Sales impact of collaborations with Arizona firms

Success in improved public health

- Increase in clinical trials activities
- Patients treated in clinical research activities
- Improvement in treatment/incidence of specific diseases

Section 5: Funding Plan

A comprehensive funding plan aligns the projected investment funds required with expected sources of funding. At this point in development, this analysis is a preliminary one and it is expected that as the plans are revised a more rigorous funding plan will be developed.

In this preliminary presentation of the funding plan, we present the first five year time period, with the understanding that it is only over a longer term period that the full returns of the investments being made will be realized. What is

impressive is that even within the first five years significant new income from federal grants can be achieved.

Bringing together the investment plans for each of the platform technology areas, with the cross-cutting support resources, results in a five year budget in a range from \$519 million to \$685 million. The following table sets out the costs by platform area as well as funding for new positions, recruitment packages, equipment/operations, space and other collaborative support mechanisms.

	Five Year Total	Platforms			Cross-cutting Support Resources
		Neurosciences	Cancer	Bioengineering*	
Position					
Academic Faculty	\$96.8–\$133.0M	\$13.9–\$18.0M	\$20.8–\$30.0M	\$36.8–\$59.7M	\$25.3M
Post-Doctoral Fellow	\$7.7–\$12.2M	\$1.2–\$2.5M	\$1.2–\$1.8M	\$2.7–\$5.3M	\$2.6M
Graduate Student	\$5.7–\$7.9M	\$0.7–\$1.0M	\$0.8–\$1.2M	\$1.8–\$3.3M	\$2.4M
Support	\$67.4–\$74.0M	\$0.7–\$1.0M	\$0.5–\$0.6M	\$15.7–\$21.9M	\$50.5M
Subtotal	\$177.6–\$227.1M	\$16.5–\$22.5M	\$23.3–\$33.6M	\$57.0–\$90.2M	\$80.8M
Recruitment	\$105.8–\$140.2M	\$24.0–\$29.0M	\$33.6–\$40.2M	\$29.2–\$52.1M	\$19.0M
Equipment/Operations	\$135.6–\$171.4M	\$8.8–\$10.8M	\$20.0–\$29.0M	\$60.4–\$85.2M	\$44.2M
Other	\$23.8–\$24.1M	\$1.2–\$1.4M***	\$1.4–\$1.5M	\$8.2M	\$15.2M**
Space	\$72.7–\$117.8M	\$11.4–\$22.5M***	\$15.0–\$30.0M	\$20.3–\$39.3M	\$26.0M
TOTAL	\$518.6–\$684.6M	\$61.9–\$86.6M	\$93.3–\$134.3M	\$178.2–\$278.5M	\$185.2M

* Includes Central Administration investment of \$3.1M
 ** Ongoing support, technology commercialization development fund.
 *** Funds for Collaborative Research

In terms of sources of funding there are many potential sources, including:

- State program funds, which would be new state appropriations. It is expected that this would involve appropriations of \$10 million in year one, \$20 million in year two and \$40 million for years 3–5.
- State capital funds going towards new space requirements, which would be an allocation of a limited portion of the state’s recent \$440 million bond issuance to cover the \$73 million to \$118 million of space funding needs.
- New private and philanthropic contributions, expected to total approximately \$40 million over the first five years, starting at \$3 million in year one and growing by \$3 million annually.
- Federal grants generated by new faculty hires, which is expected to be \$750,000 (direct) annually per full professor, \$400,000 (direct) annually per associate professor and \$200,000 (direct) annually per assistant professor. These federal grants will generate two sources of revenues—salary coverage and indirects. For the salary coverage, it is estimated that only 50 percent of faculty member salaries will be covered, but 100 percent

of salaries will be covered for post-docs, technicians and graduate students. Indirects are estimated at 30 to 40 percent of the grant.

- Increased federal funding generated for existing faculty due to cross-cutting facilities and support resources. It is estimated that across the 400 to 500 faculty in Arizona an average annual increase of \$50,000 in grant income will be generated, of which roughly \$30,000 will be generated for salary coverage and indirects.
- Fee for Service revenues from Core Support Facilities from state wide useage of core facilities by other research organizations are estimated at 10–20 percent of total core expenses.

These sources of income generate a hefty level of funding, but there remains a targeted gap over the five years of \$53 to \$106 million that can be addressed through a combination of efforts, including generating additional sources, particularly collaborative equipment and program grants from NIH, additional fund-raising especially from key philanthropists seeking to make a contribution to public health and further refinements on timing and level of investments.

Source	5 Yr Total
State Program Funds ¹	\$150M
State Capital Funds ²	\$73–\$118M
Federal Grants generated from new hires	\$125–\$160M
Increased federal funding for existing faculty	\$60–\$75M
Core Support – Fee for Service	\$18–\$36M
New Private/Philanthropic	\$40M
Target Gap	\$53–\$106M
TOTAL	\$519–\$685M

Section 6: Organization and Structure

Each of the platform plans contain specific organizational approaches and mechanisms to move forward their agendas and strategies in the months and years ahead. Financial support will be required for the planning and coordination to make these collaborating mechanisms and organizations real and to build momentum. Details on each of the proposed structures and mechanisms are found in the respective platform's plans. In addition, there is the need for securing the funding and financial commitments necessitated by these plans and responsibility for stewardship of the overall set of plans in the future. The Flinn Foundation has established the Arizona Biosciences Steering Committee to play several roles including:

- Catalyze and steer private and public actions in support of Roadmap implementation for both scientific platform and economic development work group recommendations
- Educate and inform opinion leaders on Arizona's opportunities, progress, and needs in the biosciences
- Identify progress, remaining gaps, and encourage action
- Serve as stewards of the Bioscience Roadmap

In addition to the organizational mechanisms established for the Bioscience Roadmap and for each platform plan, a third area that will need addition in the coming years is mechanisms and approaches to encourage translational focus, clinical research, and other ways to link the “bench” with the “bed,”—research applications to health care prevention and treatment. A number of mechanism and organizations have been established to address this, from ABC and ARC to others, but this area will require more focus and attention. Progress has been made in recent months to link these efforts, including collaboration among and between Tucson, Phoenix, their respective universities and clinical practices at a range of institutions including Banner, BRI and Mayo. This area must and will need to be continued to be a focus in platform implementation.

Section 7: Summary and Conclusion

Arizona is pioneering a new and novel approach to building its long term position in the biosciences. Starting with the Biosciences Roadmap, released in December, 2002, followed with intensive interaction among scientists, clinicians, and others in development of full fledged plans for each of the near term core competencies and platforms identified in that roadmap, Arizona is positioning itself to become a significant player and major state in the Southwestern U.S. in selective, focused areas of strength. The platforms laid out in this document show both efforts to date to think collaboratively on how Arizona can further build on its strengths and the opportunities and needs that must be addressed if these focus areas are to fully blossom and serve as the fundamental base on which Arizona's biosciences future blooms and flourishes. No other state, to our knowledge, has taken such a fundamental comprehensive approach to not only identifying its strengths and competencies, but moving forward to develop plans across institutions to further build its research stature. While other states and regions talk about their research base, few have gone the extra mile to bring the relevant research, clinical, and business partners together.

This preliminary plan, subject to further discussion, input and elaboration during the remainder of 2003 and into 2004, will result in a complete, final document to be presented to the Arizona Biosciences Steering Committee later in 2004. Your thoughts and ideas are most welcome and should be addressed to:

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