



BioMaryland 2020:

A Strategic Plan for the
Life Sciences in Maryland



MARYLAND LIFE SCIENCES ADVISORY BOARD
MAY 2009



Mission Statement of the Maryland Life Sciences Advisory Board

Governor Martin O'Malley and the General Assembly established the Maryland Life Sciences Advisory Board to help Maryland:

- Develop a comprehensive state strategic plan for the life sciences
- Promote life sciences research, development, commercialization, and manufacturing in Maryland
- Promote collaboration and coordination among Maryland's research and higher education institutions
- Develop a strategy to coordinate state and federal life sciences resources to attract private sector investment and job creation in Maryland
- Develop a strategy to support federal life sciences facilities in the state, including support for education, transportation, housing, and capital investment
- Make recommendations to address critical life sciences development needs in Maryland, including access to venture capital and capital construction funding.

Advancing Maryland as a Global Life Sciences Leader

Dear Governor O'Malley and Members of the Maryland General Assembly:

The Maryland Life Sciences Advisory Board (LSAB) is pleased to submit for your consideration ***BioMaryland 2020: A Strategic Plan for the Life Sciences in Maryland***. This comprehensive 10-year plan reflects our state's identification of the bioscience industry as a strategic priority and is the result of significant assessment and deliberation over the past 18 months by members of the LSAB and its seven working groups. More than 100 leaders involved in bioscience development in Maryland—drawn broadly from industry, education, federal laboratories, and state and local economic development organizations—helped shape this Strategic Plan. Nine public LSAB meetings and two open public forums have been held throughout the state to engage Maryland's bioscience community in an ongoing dialogue to discuss how best to develop an even more vibrant bioscience industry that will create new jobs, drive sustained growth, and generate innovations for the benefit of mankind.

The LSAB, consistent with the charge you have given us, is setting out a bold, yet realistic long-term approach to building upon the fundamental strengths found in the biosciences in Maryland. *BioMaryland 2020* expands and builds upon the Bio 2020 Initiative that Governor O'Malley announced in June 2008. The LSAB hopes that you will use this document as a future roadmap in your legislative and policy efforts toward our shared goal of sustaining Maryland's leading bioscience research enterprise and leveraging innovation, talent, and resources to assure a high-quality environment for the accelerated growth and success of bioscience companies in our state.

Maryland's strengths include one of the world's leading bioscience research environments and one of the largest and fastest-growing bioscience clusters in the country. Nonetheless, despite Maryland's strong foundation and healthy gains in recent years, the LSAB recognizes that we are in a race to the future for bioscience global leadership and cannot afford to become complacent. Nearly every state in the United States, most developed countries, and many developing countries are targeting the biosciences as a growth driver for their economies. Why? Because their leaders recognize that the biosciences represent a large and fast-growing sector including a wide range of job-producing manufacturing, service, and research activities—and a diverse and global marketplace ranging from therapeutics to medical devices and diagnostics to bioagriculture and bioenergy.

What remains striking about Maryland is its still enormous untapped potential in the biosciences. Maryland must continue to maintain and strengthen its historic leadership in bioscience

research, but must also work harder and smarter to accelerate the rate at which its research strengths translate into viable start-ups, commercialized products, and more mature bioscience companies that are able to grow and sustain themselves profitably over the long term. The LSAB has identified four strategic priorities and 17 specific actions that, taken together, we believe will move us forward toward a vision in which Maryland will meet head-on the challenge of growing national and global competition in bioscience development—a vision in which the bioscience industry lives up to its potential to become a self-sustaining engine for innovation and job creation in our state.

The LSAB is fully conscious of the enormity of the economic challenges that confront Maryland in 2009. We have accordingly adjusted the recommended timelines for implementation of many of the actions proposed over the 10-year horizon covered by the Strategic Plan. At the same time, the LSAB appreciates the leadership you have shown in moving ahead in Fiscal Year 2010, despite the current challenges, with a number of the strategic priorities identified here.

We offer our thanks to all of the stakeholders in the life sciences community who generously gave their time and energy to assist in creating this Strategic Plan to help guide development of the biosciences in Maryland through 2020. We also benefited from an independent and objective analysis of Maryland's competitive position and core bioscience competencies, supported by the Maryland Technology Development Corporation (TEDCO) and prepared by the Battelle Technology Partnership Practice, one of the nation's leading technology-based economic development consulting groups

As an ongoing advisory board to the Maryland Department of Business and Economic Development that was created by statute, the LSAB looks forward to continuing to work with Maryland's elected leadership to advance Maryland's position in the biosciences and to support the implementation of this Strategic Plan in the years ahead.

Respectfully,



H. Thomas Watkins

Chair, Maryland Life Sciences Advisory Board
President and Chief Executive Officer,
Human Genome Sciences, Inc.





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The Bioscience Opportunity

Maryland's long-standing focus on the biosciences was built on the presence of its world-class research universities and federal labs. Yet, nations, states, and regions from across the globe—many without the significant base of world-class research institutions found in Maryland—are actively pursuing bioscience development for a number of compelling reasons:

- **The biosciences are composed of rapidly growing industry sectors.** According to latest Bureau of Labor Statistics data over the 10-year period ending in 2010, the bioscience industry is averaging annual job growth of 2.9 percent, nearly double the overall national employment growth projection of 1.6 percent annually.
- **The biosciences offer high-paying, quality jobs across a range of occupations** from technicians and manufacturing workers to research scientists and medical doctors. In 2006, bioscience workers, on average, were paid approximately \$29,000 more than the overall national average wage.
- **The biosciences are directed to diverse markets and include a number of industry sectors** with a common link—they apply knowledge of the way in which plants, animals, and humans function. The sector includes manufacturing, services, and research activities. The federal statistical system does not identify one complete bioscience industry classification. Battelle has identified, in collaboration with the Biotechnology Industry Organization, four major subsectors that engage in core bioscience activities: agricultural feedstock and chemicals; drugs and pharmaceuticals; medical devices and equipment; and research, testing, and medical laboratories. The biosciences also contribute to the growth of other technology sectors, such as information technology, electronics, optics, and advanced manufacturing.
- **The biosciences offer states and their communities a quality-of-life dividend.** Investment in the biosciences can lead to benefits for a state's citizens in terms of improved health care, cleaner environments, and healthier foods.

It is particularly exciting that the biosciences are at the forefront of creativity and innovation, converging with advances in engineering, information technology, and nanosciences, to address major societal issues that have profound and significant impacts on quality of life throughout the world. Bioscience research, education, and industry activities are directly relevant to the following:

- **Human Health**—Biotechnology is a fundamental driver in the development of new drugs and biotherapeutics, disease diagnostics, vaccine development, gene and cell therapies, tissue growth, organ engineering, and personalized medicine. Also, whether by natural or terrorist means, the threat of major disease outbreaks and food contamination events is a real and present danger—and biotechnology promises solutions to these threats.
- **Food Production and Security**—With a world population of 6.7 billion people, projected to grow to more than 9 billion by 2040, sustaining growth in food production is of paramount importance to human life. Every day more than 860 million people go hungry worldwide. Agricultural biosciences and associated biotechnologies focus directly on finding solutions to this problem.
- **Renewable/Green Resources and Products**—Linked with environmental sustainability is an urgent need for the development of ecologically benign resources for economic activity. Biotechnology and associated disciplines provide the expertise and resources required to develop biorenewable, biomass-based materials and products that will contribute to a sustainable, nonpolluting future. With the volatility of global fossil-fuel energy prices and growing concerns relating to carbon emissions from fossil fuels, the race is on to develop renewable energy sources with nominal environmental impacts. Biofuels have a substantial role to play in the supply of future global energy.
- **Environmental Sustainability**—Sustaining population growth and economic growth must be balanced with preservation of natural resources and environmental assets. The 20th century saw unprecedented growth in pollution, natural resource depletion, and environmental degradation. Biotechnology researchers are on the front lines of environmental quality and sustainability.

So, it is no surprise that many observers view the 21st century as the “Bio Century.”

Strategic Vision, Priorities, and Actions Recommended by the Maryland Life Sciences Advisory Board

A BioMaryland 2020 Vision for Bioscience Development

By 2020, Maryland will be globally renowned for its ability to translate its world-class bioscience research capabilities into viable and highly regarded product-oriented bioscience companies that establish new industry strengths in therapeutics, diagnostics, devices, and innovative biobased products.

Maryland will continue to advance its leading bioscience research complex and, through strategic investments and innovative programs, leverage the discoveries and talent it generates to create a high-quality environment for the accelerated growth and success of bioscience companies in Maryland.

Maryland will be clearly recognized as one of the top tier states highly specialized in overall bioscience development.

Four strategic priorities and 17 specific actions are recommended by the LSAB to move Maryland forward toward its vision for BioMaryland 2020 (Figure 1).

- **Priority One:** Ensure the sustained growth and future competitiveness of Maryland’s bioscience industry.
- **Priority Two:** Support the creation and growth of innovative bioscience companies by ensuring access to capital.

- **Priority Three:** Position Maryland for global leadership in cutting-edge areas of bioscience research and emerging and growth markets.
- **Priority Four:** Advance bioscience talent generation and workforce development.

It is anticipated that most of the actions recommended here would be implemented over a 10-year time period extending to 2020.

Figure 1. Overview of strategic priorities and actions to sustain and advance development of Maryland’s bioscience industry

Ensure the Sustained Growth and Future Competitiveness of Maryland’s Bioscience Industry	Support the Creation and Growth of Innovative Bioscience Companies by Ensuring Access to Capital	Position Maryland for Global Leadership in Cutting-Edge Areas of Bioscience Research and Emerging Growth Markets	Advance Bioscience Talent Generation and Workforce Development
<ul style="list-style-type: none"> ■ Establish the Maryland Biotechnology Center to serve as a catalyst and central resource for spurring growth ■ Establish the BioEntrepreneur Resource Program to provide one-stop assistance to bioscience entrepreneurs and emerging companies ■ Strengthen and advance BioMaryland – Maryland’s bioscience brand ■ Develop 21st century bioscience industry infrastructure in Maryland 	<ul style="list-style-type: none"> ■ Expand the Maryland Biotechnology Investment Tax Credit ■ Make permanent and expand the R&D tax credit and make it refundable to small bioscience companies ■ Establish the Maryland Life Sciences Venture Capital Trust to advance investment in Maryland bioscience companies by pension and venture funds ■ Ensure the availability of product development capital for emerging bioscience companies 	<ul style="list-style-type: none"> ■ Strengthen technology transfer at research universities and the ability to launch bioscience ventures based on university research ■ Establish Bioscience Commercialization Institutes in Maryland ■ Expand the Maryland Industrial Partnerships Program (MIPS) ■ Invest in emerging fields of bioscience research ■ Establish the Maryland Federal Lab Engagement and Collaborative R&D Program ■ Support university and community college bioscience development projects 	<ul style="list-style-type: none"> ■ Advance a systematic and coordinated statewide approach to developing bioscience career pathways ■ Create the Maryland Bioscience Workforce Skill Development Fund ■ Develop and retain bioscience scientific and entrepreneurial talent



Maryland's Position in the Biosciences

For Maryland, the bioscience cluster is a key focus for distinguishing the state on the national and global stage. Maryland's efforts in bioscience development build upon the presence of one of the world's leading bioscience research environments and the promise of a burgeoning bioscience industry base. These strengths have ranked Maryland's performance in the science and technology economy second in the nation according to a 2008 Milken Institute Report.

Recent trends in Maryland's bioscience sector also show positive signs that the fundamentals of bioscience development are sound:

- **Overall bioscience industry employment in Maryland is growing robustly**, rising 14.5 percent from 2001 to 2006, adding 3,200 jobs, to reach more than 25,000 jobs. By comparison, the nation's overall bioscience industry employment grew only 5.7 percent; Maryland outpaced key competitor states such as California, Massachusetts, Pennsylvania, and New Jersey. Among the bioscience elite states, only North Carolina outpaced Maryland's bioscience industry growth.
- **Maryland is home to one of the nation's and the world's largest bioscience research complexes, notable for its federal intramural research activities and major universities as well as significant industry research activities.** Taken together, Maryland's bioscience research complex is conservatively estimated to represent nearly \$8 billion in research and development (R&D) expenditures annually—and is third in total size only to California and New Jersey, which possess major industry R&D.
- **University bioscience research grew substantially.** From 2002 to 2007, Maryland's life science research base grew 44.2 percent from \$877,598,000 to \$1.3 billion. This rate of growth was greater than the 41.6 percent national rate over the same time period.
- **Maryland remains a talent magnet in the biosciences.** Maryland has one of the most significant concentrations of highly trained bioscience research scientists in the world. This rich talent base is one of Maryland's major assets in the biosciences—and remains an anchor for future bioscience development.

Since the early 1990s, Maryland has sustained a broad set of initiatives in support of bioscience development. In fact, Maryland had one of the first bioscience strategic plans of any state, issued in 1991. Since that time, Maryland has put in place a wide array of bioscience initiatives that have promoted targeted enhanced R&D with the active engagement of industry; encouraged bioscience industry networking; fostered new bioscience start-ups; enabled development of wet-lab space and dedicated bioscience research parks; and supported bioscience workforce development, bioprocessing resources, and marketing of the state's unique research environment to encourage companies to locate in Maryland.

Nearly 20 years later—with many of the same initiatives dating from the early 1990s still in place and new ones added—Maryland is widely recognized as having one of the most advanced bioscience clusters in the world.

- Maryland ranks first among the 50 states in per capita academic bioscience R&D (FY 2006) and second in per capita National Institutes of Health (NIH) awards (FY 2007).
 - Maryland ranks second among the 50 states in the number of workers employed in bioscience occupations per million population (FY 2006).
 - Maryland ranks second in bioscience higher-education degrees awarded per million population (2006).
 - Maryland ranks third in bioscience venture-capital investments per million population (2002 to 2007).
- **Maryland has many core competencies in the biosciences that offer focused technology platforms for future growth.** Based on analyses of research grants, patents, publications, commercial establishments, presence of major centers, reputational rankings, and insights gained from more than 60 interviews with key researchers and administrators from Maryland universities, industry, federal labs, and economic development organizations, 19 bioscience core competencies in Maryland were identified. These bioscience core competencies offer a broad foundation on which Maryland can build its position and reputation in the global bioscience-based economy and suggest five broader technology platforms that will enable Maryland to exploit existing and emerging market opportunities in key areas of the biosciences, including the following:
 - Biopharmaceuticals
 - Molecular Diagnostics and Personalized Medicine
 - Contract Bioscience Research Services
 - Biodefense and Emerging Infectious Diseases
 - Biobased Products.

Despite these positive fundamentals, the most striking aspect of Maryland's current position is the still untapped potential of its bioscience base. While Maryland remains one of the leading centers for bioscience research—with sizable and high-quality university research efforts and the nation's largest concentration of federal laboratory bioscience research funding—its overall bioscience industry development still does not measure up to this base of research activity.

Even with the continued bioscience industry gains, Maryland is still less developed in its bioscience industry base than leading competitor states. One specific measure of industry development is the concentration of that industry within a state's economy compared with the nation. Those states that are highly developed in a particular industry will have a greater concentration of employment in that industry than is found in the nation. For a state to be regarded as specialized in a given industry requires a 20 percent higher concentration in jobs in that industry than is found in the nation. The leading bioscience competitor states of California, Massachusetts, New Jersey, North Carolina, and Pennsylvania all have at least a 30 percent greater concentration than the national average in bioscience industry jobs. With a mere 7 percent higher level of bioscience industry job concentration than the national average, Maryland has work ahead of it to achieve specialization in the overall bioscience industry.

Maryland's success in bioscience industry development is found in the R&D component of the overall bioscience sector. With just over 12,000 jobs, the bioscience R&D subsector represents nearly half of Maryland's overall bioscience industry employment and accounted for 69 percent of the state's growth in bioscience jobs from 2001 to 2006. Maryland is clearly a national star in bioscience R&D, with an employment concentration at twice the national average. Only Massachusetts among large bioscience states is more specialized than Maryland in its bioscience R&D. But, unlike Massachusetts, which also has a large and specialized medical device sector, Maryland's only other specialized bioscience industries are the more niche and smaller industries of *in vitro* diagnostics, with 2,400 jobs, and biological processing, with 1,527 jobs.

Looking to the future, the bioscience R&D industry is the pipeline for creation and early growth of innovative bioscience companies. While many of these bioscience R&D companies provide research services to federal labs, universities, and other bioscience companies, a significant number are focused on the development of new products, but have not yet been able to complete product development or win regulatory approval to bring their products to market. As these product-oriented bioscience R&D companies succeed, they will enter more established product-oriented subsectors of the bioscience industry, such as therapeutics, diagnostics, and devices.

Many of these product-focused bioscience R&D companies are located in Maryland to be close to the state's research complex, because they are seeking to commercialize discoveries made at Maryland's research institutions, tapping key talent or collaborating with these research institutions. In fact, among the states, Maryland receives the highest level of R&D funding to industry from the federal government; these federal funds to industry for research are by far the largest source of funding for industry research activities in Maryland.

As these product-oriented bioscience companies advance, they also generate opportunities for Maryland to attract leading global bioscience industry companies. A commonplace occurrence in bioscience industry development is the acquisition of emerging product-oriented bioscience R&D companies by larger bioscience businesses. To the extent that Maryland bioscience companies offer a strategically important new line of business or capability to larger companies, there is an excellent chance that these global bioscience companies will remain to grow and expand their presence in Maryland. Notable global companies to enter Maryland recently include AstraZeneca through the acquisition of MedImmune, Teva through the acquisition of CoGenesys, and Qiagen through the acquisition of Digene.

So, one excellent bioscience business development strategy, both for organic growth and for attracting important new entrants to Maryland, is to facilitate the evolution of product-focused bioscience companies beyond R&D to where they succeed in advancing their products to commercialization.



Strategic Priorities for Growing Maryland's Bioscience Cluster

The potential for Maryland in the biosciences is enormous, but the road ahead will not be easy. It will require vision and a high level of focus, determination, and willingness to invest for Maryland to realize its full potential to compete on a global level and grow its leadership in the biosciences. The following four strategic priorities are critically important for addressing the challenges that Maryland confronts in growing its bioscience cluster in the years ahead:

Strategic Priority One: Ensure the sustained growth and future competitiveness of Maryland's bioscience industry. Despite continued growth, the bioscience industry in Maryland is still emerging. Maryland is highly ranked and specialized in the bioscience R&D subsector; but, it is not yet specialized in the overall bioscience industry like its key benchmark peers of California, Massachusetts, North Carolina, and Pennsylvania.* Maryland has also recorded recent strong growth in other niche bioscience industries, including *in vitro* diagnostics and contract biomanufacturing, which signals a shift toward a more diversified industry base in the life sciences.

Strategic Priority Two: Address the creation and growth of innovative bioscience companies by ensuring access to capital. Bioscience venture-capital investment in Maryland has fallen sharply for two consecutive years. A close examination reveals that significant venture-capital funds are under management in Maryland, but these funds are not being invested in Maryland-based companies. At the same time, Maryland's existing initiatives to help bioscience companies meet their capital needs are all lagging in resources. And not all successful bioscience companies

will follow the path of venture capital funding. Sources of patient working capital are severely limited in Maryland for qualified bioscience companies moving a product beyond the proof-of-concept stage through the later steps involved in readying a product for market introduction.

Strategic Priority Three: Position Maryland for global leadership in cutting-edge areas of bioscience research and emerging growth markets. In the face of National Institutes of Health (NIH) funding that has failed to keep up with inflation, Maryland needs to maintain and advance its leadership position in bioscience R&D. At the same time, the state should seek to develop leadership in new fields of bioscience research such as stem cell research, nanobiotechnology, epigenetics, personalized medicine, and agbio. While Maryland has developed very successful products and services based on its research discoveries, there is still much untapped potential to leverage the state's significant bioscience research enterprise. More needs to be done to accelerate translational research and commercialization.

Strategic Priority Four: Advance bioscience talent generation and workforce development. While Maryland enjoys a high concentration in top-end bioscience research workers, bioscience industry leaders have raised concerns about the insufficient supply of production and technician-level workers. In addition, bioscience industry leaders report that it is still difficult to find experienced bioscience scientific and management talent. Immigration policies also threaten the ability to attract the world's best and brightest to join Maryland's research universities and federal labs.

BioMaryland 2020 Performance Measures

The bottom-line goal for Maryland in its next generation of bioscience growth is to achieve specialization in the overall bioscience industry by 2020 by leveraging Maryland's existing specialization in the bioscience R&D subsector. This means that Maryland would achieve a level of concentration of employment in the biosciences that is at least 20 percent greater than the U.S. national average. With a current concentration of 7 percent more than the U.S. national average, the LSAB sees this as an aggressive, but attainable goal.

Key interim performance measures to be tracked include the following:

- The growth of Maryland's bioscience industry base as measured by number of firms, employment, and their concentration relative to the nation
- The increase in bioscience R&D by Maryland companies
- The increase in number of new companies launched and products making it through clinical trials and other product approval pathways based on technologies developed in universities or federal labs
- An increase in academic bioscience R&D greater than the national average
- The increase in venture and other sources of capital invested in Maryland bioscience companies.

*A state is considered to have a specialization if the concentration of employment in an industry sector is 20 percent or more than the national average.



From Strategies to Actions

The LSAB recommendations address the strategic priorities that it believes are critically important to Maryland's success in growing its bioscience cluster in the years ahead. Figure 2 sets out across the bioscience development life-cycle the challenges that Maryland faces and shows how specific programs and actions come together to address them. It is important to recognize that Maryland is already undertaking many effective programs, which simply need to be scaled up or consistently funded. There are also challenges that call for new actions. The Appendix provides a more detailed look at each of the 17 actions recommended by the LSAB.

Figure 2. Challenges and proposed actions across the bioscience development life-cycle.

	Research	Drug Discovery and Prototype Design	Preclinical Development and Proof of Concept	Bio Firm Formation and Growth	Firm Attraction and Expansion
Maryland Challenges	<ul style="list-style-type: none"> Leverage Federal Lab Presence Stay at Cutting Edge of Research 	<ul style="list-style-type: none"> Address the "Valley of Death" in Commercialization of Bioscience Innovations 		<ul style="list-style-type: none"> Early-Stage Capital Entrepreneurial Talent Realizing Product Development Fragmented Service Delivery 	<ul style="list-style-type: none"> Branding Scientific and Production Talent Fragmented Service Delivery
Enhancements of Existing Programs	<ul style="list-style-type: none"> Enhance Funding for Stem Cell Research and Nanotechnology Support University Bioscience Capital Projects 	<ul style="list-style-type: none"> Expand the Maryland Industrial Partnership Program Expand the TEDCO University Tech Development Fund and Maryland Tech Transfer Fund Strengthen Technology Transfer at Maryland's Research Universities 		<ul style="list-style-type: none"> Expand the Maryland Biotechnology Investment Tax Credit Make Permanent and Expand the R&D Tax Credit Replenish the Maryland Venture Fund 	<ul style="list-style-type: none"> Strengthen and Advance the Maryland Bioscience Brand Develop 21st Century Bioscience Industry Infrastructure
New Initiatives	<ul style="list-style-type: none"> Invest in Emerging Fields of Bioscience Research 	<ul style="list-style-type: none"> Establish the Maryland Bioscience Commercialization Institutes 		<ul style="list-style-type: none"> Establish the Maryland Life Sciences Venture Capital Trust Product Development Loan Fund Establish the BioEntrepreneur Resource Program 	<ul style="list-style-type: none"> Advance Coordinated Statewide Approach to Developing Bioscience Career Pathways and Workforce Development Create the Maryland Bioscience Workforce Skill Development Fund
Establish the Maryland Biotechnology Center as a catalyst and central resource for providing assistance to bioscience entrepreneurs and emerging companies and for spurring growth of the biosciences in Maryland					



Strategy and Action Plan to ... Ensure the Sustained Growth and Future Competitiveness of Maryland's Bioscience Industry

Situational Assessment

Despite continued growth, the bioscience industry in Maryland is still emerging. Maryland is highly ranked and specialized in its bioscience R&D subsector, but it is not yet specialized in the overall bioscience industry like its key benchmark peers of California, Massachusetts, North Carolina, and Pennsylvania.* Maryland has also recorded recent strong growth in other niche bioscience industries, including *in vitro* diagnostics and contract biomanufacturing, which signals a shift toward a more diversified industry base in the life sciences.

If Maryland is to accelerate the growth and competitiveness of its bioscience industry base, it needs to:

■ **Be more effective in the range and delivery of services offered to the bioscience industry.** Services and support programs offered by the State of Maryland to bioscience entrepreneurs and early-stage companies in the state—although often highly effective—are widely viewed by industry as fragmented, unnecessarily difficult to identify, and requiring too much paperwork for applications and reporting. Maryland is also viewed by industry as lacking an organizational focus to advance development of the Maryland bioscience cluster.

■ **Strengthen bioscience industry development efforts.**

In marketing for bioscience industry development, it is important to recognize that the opportunities in the biosciences are actively being pursued by many regions across the nation, as well as by other countries. For Maryland to distinguish itself in this increasingly competitive environment, it must ensure that it is addressing the needs of its current bioscience companies, while also aggressively pursuing new opportunities that fit well strategically. It is clear, even with Maryland's many competitive advantages, that success in intelligently growing Maryland's bioscience industry into the future will require careful differentiation from other states and regions—and a first-class program of branding and marketing.

■ **Invest in bioscience infrastructure.** Increasingly, states and regions are focusing on the physical environment in which the growth of technology-based industries takes place. Bioscience firms, in particular, tend to cluster close to each other and to other research institutions, including universities and academic medical centers. In addition to wanting to be near their collaborators, they also require access to wet-lab space, shared equipment, and business services. States and regions seeking to grow their bioscience cluster realize that they must invest in the physical infrastructure to provide an attractive location for their bioscience companies and research institutions.

*A state is considered to have a specialization if the concentration of employment in an industry sector is 20 percent or more than the national average.

Proposed Actions to Ensure Sustained Bioscience Industry Growth in Maryland

- **Establish the Maryland Biotechnology Center (MBC)** to bring a more integrated statewide focus to the state’s bioscience development efforts, address the fragmented programs that have emerged over the past 15 years, and create a results-driven approach that can propel Maryland’s bioscience efforts as a model for the 21st century.
- **Establish the BioEntrepreneur Resource Program** to provide bioscience entrepreneurs and emerging companies a central point of contact to match them with funds available across Maryland’s early-stage financing programs; facilitate early-stage private investment; assist with permitting and bureaucratic impediments; offer mentoring, networking, access to professional business and intellectual property (IP) resources; and help with workforce development challenges.
- **Strengthen and Advance BioMaryland—Maryland’s Bioscience Brand**—to foster proactive outreach and marketing to targeted segments of the biosciences nationally and internationally through a branding campaign, a leader-to-leader initiative, and a statewide ambassadors network, led by the MBC in partnership with regional and local economic development organizations.
- **Develop 21st century bioscience industry-related facility infrastructure** in Maryland that feature incubators, research parks, and multi-tenant commercial bioscience facilities to ensure a high-quality physical infrastructure to support the growth and continued development of clusters of bioscience activity.

Examples of Best Practice

North Carolina Biotechnology Center

The North Carolina Biotechnology Center is a private, nonprofit organization created by the North Carolina legislature in 1984. The Center is dedicated to developing the biotechnology sector statewide by supporting research, business, and education. The portfolio of programs NCBC offers includes a wide array of business loans; support for collaborative research projects; assistance aimed at connecting early-stage companies with larger corporations, venture financiers, angel investors, and university licensing offices; an industrial fellowship; monthly networking forums and an annual in-state biotech conference; listings of available commercial wet-lab space; and entrepreneurial education produced in cooperation with the Council for Entrepreneurial Development and the state Small Business and Technology Development Center. The total budget of NCBC in FY 2006–2007 was \$17.6 million, of which \$13.1 million came from a state appropriation.

i2E—Oklahoma Technology Commercialization Center

i2E, a nonprofit center funded by the state’s Oklahoma Center for the Advancement of Science and Technology, assists Oklahoma technology start-ups through a highly structured, six-stage commercialization model with access to entrepreneurial mentors and a network of qualified professional service experts. i2E also enables emerging technology companies to access public capital programs, including the Technology Business Finance Program, through which companies can apply for up to \$100,000 annually for commercialization activities including R&D, prototype creation, equipment purchase, and even creation of marketing materials. Successful graduates of the commercialization process and TBF may be introduced to the Oklahoma Seed Capital Fund, which can make up to 10 equity investments a year in the range of \$250,000 to \$700,000 each. Significantly, i2E also offers access for qualified companies to its own statewide network of angels. i2E reports as evaluation metrics that it has assisted more than 550 companies since 1998, with 300 companies making it through the structured process, of which 100 have secured more than \$261 million in state, informal, and formal investment capital.

Research Triangle and St. Louis Branding

Best practices in bioscience marketing call for an “alliance” approach coupled with strong internal marketing. An active alliance marketing program brings together the state, county, and local economic development organizations; universities; local bioscience industry organizations; and companies to recruit outside investments and new business expansion. Alliance-related activities include active presence at trade shows, overseas and other trade missions, and even developing sister-state/sister-city relationships.

Two areas that have been very successful in using these approaches are Research Triangle and St. Louis. In North Carolina, the North Carolina Biotechnology Center helped to identify and recruit life science companies with fly-ins of executives and tours with strong industry and university involvement. St. Louis has formed a Coalition for Plant and Life Sciences in close partnership with the St. Louis Regional Chamber and Growth Association (RCGA) that enables highly coordinated outreach marketing involving universities, incubators, professional organizations, and others.

But, an alliance marketing approach is possible because of an active focus on internal marketing to build the needed community support and enable all key segments of the community to be involved in the outreach effort. Internal marketing for North Carolina included outreach to local schools in promoting life science careers and active news stories on life science industry developments. St. Louis has had great success in its internal marketing through the use of networking as well as utilizing the RCGA’s Technology Gateway Life Sciences Network.



Maryland Biotechnology Center

The Maryland Biotechnology Center (MBC) is proposed to serve as a catalyst and central resource for spurring growth of the bioscience industry and bringing a more integrated statewide focus to the state's bioscience industry development efforts. MBC would be responsible for the following major programs and initiatives:

- **Coordination of ongoing Maryland activities in support of the bioscience sector** to enhance their reach and customer service focus, and to ensure sharing of information across all segments of the bioscience community.
- **Creation and administration of the BioEntrepreneur Resource Program**, which would provide one-stop assistance to bioscience entrepreneurs and early-stage companies in obtaining access to capital, help with workforce development, and overcoming financial, legal, and financial hurdles.
- **Administration of an expanded Maryland Biotechnology Investor Tax Credit program**, which encourages early-stage investment in Maryland biotech companies.
- **Creation and administration of the Maryland Bioscience Translational Research and Commercialization Initiative**, which would provide the specialized infrastructure and translational research capacity required to accelerate and retain commercialization activity in Maryland.
- **Leading the creation of the Maryland Life Sciences Venture Capital Trust** to advance investment by pension and venture funds in the Maryland bioscience industry.
- **Creation and administration of the Maryland Bioscience Product Development Loan Fund**, to address a significant gap in Maryland's support for emerging bioscience companies.
- **Advancement of bioscience career pathways and workforce creation and development** through investment in education and training, and working closely with biotechnology companies to develop appropriate curricula in biotechnology and manufacturing.
- **Facilitation of partnerships, alliances, and networking activities**—through initiatives to link Maryland's bioscience companies with one another, sources of capital, service providers, and the state's federal and academic life science institutions.
- **Building the BioMaryland brand and marketing Maryland on a national and global basis** to ensure that Maryland's leadership position in the biosciences is recognized and continues to grow.
- **Monitoring progress in planning and implementation of Maryland's bioscience agenda**, measuring progress, identifying gaps and needs, and ensuring a results-driven approach to bioscience development in the state.



Strategy and Action Plan to ... Support the Creation and Growth of Innovative Bioscience Companies by Ensuring Access to Capital

Situational Assessment

Business development in the biosciences requires not only significant R&D dollars, but also substantial funds necessary to bring a new product or service to market. Major costs beyond the research stage include market assessment, prototype development, and clinical trials, followed by actual product launch production, distribution, and sales. Sufficient capital is necessary to grow a business through each major stage and milestone.

bioscience firms that do not have profits against which to take tax credits. Furthermore, the Maryland R&D tax credit is capped at \$3 million each for the basic and growth components. The average Maryland R&D tax credit oversubscription is sevenfold, meaning that companies are receiving only \$1 for every \$7 of credit for which they qualify.

- The Maryland Venture Fund is the principal state program helping technology-based companies advance from seed stage through initial product development.

Key Facts on Bioscience Venture Funding in Maryland

- Venture funding in Maryland's bioscience companies totaled \$1.1 billion during the period from 2005 through the second quarter of 2008, which places it on par with North Carolina but behind other benchmark states.
- Though venture capital investments can fluctuate on a year-to-year basis, Maryland's have declined consistently since 2006, while the nation and benchmark states continue to increase their level of bioscience venture-capital investment.
- Maryland has a higher level of venture capital firms investing in bioscience companies than either Pennsylvania or North Carolina. However, only 15 percent of the bioscience venture-capital investments are made by venture capital firms located in Maryland, compared with 42 percent invested by locally based venture-capital firms in North Carolina and 38 percent invested by locally based venture-capital firms in Pennsylvania.

Maryland's existing initiatives to help bioscience companies meet their capital needs are all lagging in resources:

- Demand for Maryland's Biotechnology Investment Tax Credit program, which appears to be highly successful in encouraging individual "angel" investors to invest in Maryland biotechnology companies, greatly exceeds the current annual \$6 million cap as evidenced by the fact that investors waited in line for as many as 17 hours to apply for the \$6 million in credits that became available on July 1, 2008.*
 - Maryland's R&D tax credit rate is 3 percent for basic R&D expenditures and 10 percent for growth R&D expenditures, making it the lowest among the benchmark states identified by the LSAB (California, Massachusetts, Pennsylvania, North Carolina, and New Jersey)—and Maryland's tax credit program is subject to renewal, which makes it difficult for companies to plan. A few states have made their granted R&D tax credits refundable or transferable, which is particularly attractive to emerging
- Unfortunately, the total funding allocated to the Maryland Venture Fund has declined from \$9 million in FY 2001 to \$2 million in FY 2009. In contrast, other states are stepping up their investment, with more than 20 states having established public venture programs. Ohio's Third Frontier program is investing \$263 million in its Pre-seed Fund Initiative, which is supporting the development of regional seed funds throughout the state. Michigan allocated \$109 million for early-stage financing in 2008 through its 21st Century Fund.
- Maryland has no targeted public pension fund vehicle for addressing opportunities to invest in emerging bioscience companies. In the past, the Maryland Venture Capital Trust—a fund of funds targeted to early-stage venture-capital funds willing to target the investment of a specified percentage of their funds in Maryland companies on a good faith effort—generated a return of 10 percent and ended up generating \$327 million in venture capital under management, a 1 to 17 ratio for investments by the Trust.

*"Biotech Start-Ups Covet Tax Credit," *Washington Post*, July 7, 2008.

- Not all successful bioscience companies will follow the path of venture capital funding. Sources of patient working capital are severely limited in Maryland for qualified bioscience companies moving a product beyond the proof-of-concept stage through the later steps involved in readying a product for market introduction. Financing is needed to finalize product development, address regulatory questions, and scale up production.

Proposed Actions to Support Creation and Growth of Innovative Bioscience Companies by Ensuring Access to Capital

- **Expand the Maryland Biotechnology Investment Tax Credit** to encourage angel investors to invest directly in qualifying Maryland bioscience companies.
- **Expand and make permanent the R&D tax credit** to encourage increased bioscience company R&D in Maryland by ensuring that emerging bioscience companies have access to the credit and by making the R&D tax credit partially refundable to Maryland bioscience companies with fewer than 50 employees.
- **Establish the Maryland Life Sciences Venture Capital Trust** to offer an attractive vehicle for private equity investment in Maryland life sciences companies by pension and venture capital funds.
- **Ensure the availability of product development capital for emerging bioscience companies** by returning full funding to the Maryland Venture Fund, and by creating the Maryland Bioscience Product Development Loan Fund to help bioscience companies progress from seed stage through product development to commercialization.

Examples of Innovative State R&D Tax Credit Programs

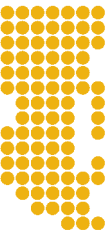
Connecticut's R&D tax credit is generous, simple, and refundable under certain circumstances. The state offers a "non-incremental" credit of between 1 percent and 6 percent on qualified research expenditures (federal definition), scaling upward with the level of expenditure, along with a special 6 percent credit for qualified small businesses (defined as gross income less than \$100 million). The state also offers a credit of 20 percent on the increment in qualified research expenditures over the base year, again per federal definitions. For small businesses (defined as grossing less than \$70 million), the state will refund in cash 65 percent of the value of R&D credits that cannot be used for lack of tax liability, in lieu of a carryforward option. Firms automatically receive the credit if they qualify.

Wisconsin Angel Investor Tax Credit

Wisconsin was highlighted by both the National Governors' Association (NGA) and Angel Capital Association (ACA) as having an angel tax credit that is well integrated with the state's overall efforts. The program is administered by the Wisconsin Angel Network to support statewide development of regional angel funds or groups. The program offers 25 percent credit against personal income tax for investment in qualifying companies. The individual tax payer is capped at \$500,000 in equity investment, and the overall program is capped at \$3 million a year or \$30 million over the 10-year authorization.

Indiana Future Fund

- \$73 million fund created in 2003
- Capitalized with investments by state pension fund, state teachers retirement fund, Eli Lilly, and Anthem Blue Cross/Blue Shield and endowments of four universities
- Required:
 - 60 percent of investments to Indiana-focused or -based venture funds
 - 70 percent of funds invested at early stage
 - 60 percent of investments to Indiana companies
 - 60 percent of investments to life sciences, targeted to specific technology platforms
- Invested in six local and national funds
- Managed for BioCrossroads by Credit Suisse (www.indianafuturefund.com)



Strategy and Action Plan to ... Position Maryland for Global Leadership in Cutting-Edge Areas of Bioscience Research and Emerging Growth Markets

Situational Assessment

Driving innovation in the bioscience sector are the R&D activities of a range of institutions, both public and private. Maryland's bioscience research complex—reaching across university, federal lab, and industry R&D—amounts to nearly \$8 billion in annual spending and is third in the nation behind California (\$15 billion) and New Jersey (\$10 billion). On a per-capita basis, however, Maryland has the most concentrated base of bioscience R&D in the nation.

Maryland stands alone in its huge intramural funding base from the U.S. Department of Health and Human Services, with \$4.9 billion as of 2004. This is not surprising given that the state is home to the NIH and its affiliated centers of research. Additionally, Maryland is home to the U.S. Department of Agriculture, Department of Commerce, Department of Defense, and Department of Homeland Security labs that engage in bioscience research. The breadth and depth of Maryland's federal labs in the biosciences is a significant and unique state asset. However, for the most part, Maryland's research universities and federal labs work within their own institutional walls. One notable exception is the Center for Advanced Research in Biotechnology (CARB), which is a partnership of the University of Maryland Biotechnology Institute and the National Institute of Standards and Technology (NIST). CARB is advancing the measurement, analysis, and design of biomolecules, a field known as structural biology.

In university R&D in the biosciences, Maryland is about average in size among the benchmark states (\$1.3 billion), though California is clearly the national leader and a major outlier in this context (\$4.2 billion). Maryland's academic institutions have grown their bioscience R&D expenditures at a rapid rate. Since 2002, academic R&D in the state has grown by 44 percent, just outpacing total national institutional growth at 42 percent.

Where Maryland lags behind other major bioscience states is in the size of its industry R&D. At \$1.5 billion in 2006, Maryland's industrial R&D in the biosciences was the lowest among the benchmark states. Moreover, a significant amount of the funding support for Maryland industry R&D actually comes from the federal government through contracts and Small Business Innovation Research (SBIR) grants. Maryland needs to maintain and advance its leadership

position in bioscience R&D. At the same time, the state should seek to develop leadership in new fields of bioscience research such as stem cell research, nanobiotechnology, epigenetics, personalized medicine, and agbio.

While Maryland has developed very successful products and services based on its research discoveries, there is still much untapped potential to leverage the state's significant bioscience research enterprise. More needs to be done to accelerate translational research and commercialization. While basic scientific discovery lies at the heart of every commercial innovation in the life sciences, failure to convert that discovery into tangible application—in the clinic, the home, the workplace, or the laboratory—can often leave unharvested opportunities to die on the vine.

There is a formidable gap between the discovery of a key molecule, disease marker, or biological mechanism and the development of a therapeutic agent or diagnostic test that has been sufficiently validated to permit experimental use in humans or in the field. Bridging this gap, in the case of a therapeutic agent, requires assay development, validation, primary screening, compound modification, secondary screening, safety testing, production, and clinical trials or other satisfaction of regulatory demands. These processes lie beyond the capabilities of most academic laboratories and would divert them from their fundamental mission, which is to provide the basic discoveries on which applications themselves are based. The biotechnology and pharmaceutical sectors are increasingly reluctant to consider commercialization of an academic research product until it is ready for later-stage clinical testing.

Maryland has put programs in place to advance technology commercialization, but they focus primarily on the initial commercialization steps and are not well funded. These include the following:

- The Maryland Technology Development Corporation's (TEDCO's) University Technology Development Fund, which supports precommercial research on university IP, and Maryland Technology Transfer Fund, which provides funds to companies that wish to develop products or services in collaboration with universities and federal laboratories.



- The Maryland Industrial Partnership (MIPS) program has a proven track record of working with industry to accelerate the commercialization of technology by funding collaborative university-industry product R&D projects. Despite the fact that funding for MIPS was recently increased from \$1.35 million to \$2.05 million, resources this past year were available to support only 44 of the 78 fundable projects, so approximately 44 percent of fundable projects for MIPS were not supported. Moreover, MIPS does not extend to The Johns Hopkins University (JHU), which is a major omission in leveraging university-industry partnerships for the benefit of Maryland's private-sector growth, as well as other Maryland post-secondary institutions, such as the state's network of community colleges.

The University System of Maryland (USM) technology transfer operations are also underfunded. Maryland's public research universities are being asked to handle their technology transfer mission with considerably fewer appropriately qualified staff and less funding to support and advance patent applications than comparable institutions in other states.

Lastly, it is critical that Maryland's public colleges and universities have continuing access to state capital funds to ensure that they have the laboratories and equipment necessary to enable their researchers to compete successfully for bioscience R&D dollars and to continue to produce talented bioscience graduates.

Proposed Actions to Position Maryland for Global Leadership in Cutting-Edge Areas of Bioscience Research and Emerging Growth Markets

- **Strengthen technology transfer at universities and expand the ability to launch bioscience ventures based on university research** by increasing funding for TEDCO's University Technology Development Fund and the Maryland Technology Transfer Fund, and by increasing funding for USM technology transfer offices to a level consistent with funding at comparable universities nationwide.
- **Establish Bioscience Commercialization Institutes** to provide the translational R&D infrastructure to accelerate and retain commercialization activity in Maryland by advancing therapeutics, diagnostics, and devices in collaboration with the private sector.
- **Expand the Maryland Industrial Partnership (MIPS) program** so that all qualified bioscience projects can be funded and JHU and other higher-education institutions can participate fully in the MIPS program.
- **Promote investment in emerging fields of bioscience R&D** to ensure that Maryland's bioscience research complex remains at the cutting edge of emerging fields, such as stem cell research and bionanotechnology.

- **Establish the Maryland Federal Lab Engagement and Collaborative R&D Program** to foster the development of federal lab/university/industry collaborations through promoting shared use of specialized research facilities and equipment, seeding innovative partnerships, supporting strategic faculty hires, advancing joint graduate programs, encouraging clinical research partnerships, and encouraging industry outreach.

- **Support university and community college bioscience development projects included in the state's capital budget plans.** The future of the biosciences in Maryland will depend on the continued excellence of the state's academic bioscience research complex. Research universities with high-quality research labs and core facilities with sufficient space are likely to attract a disproportionate share of federal funds, since faculty workspace is at a premium at universities throughout the country.

Georgia's Venture Lab Program

In 2002, the Georgia Research Alliance created a statewide VentureLab program modeled on a successful Georgia Tech Program. Venture Lab identifies university technology, evaluates its commercial value, and awards grants to fund additional development work for those judged to have commercial potential. Commercialization grants are awarded in three phases:

- Phase I grants of up to \$50,000 to validate the technology
- Phase II grants of up to \$100,000 for prototype creation
- Phase III grants of up to \$250,000 to complete a business plan and launch the company.

Venture Lab makes Venture Fellows, experienced start-up business professionals, available to act as advisors to university scientists and engineers interested in starting a company based on their research. The Venture Fellows advise a number of companies, eventually joining one as a member of the senior management team.

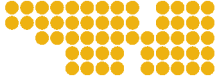
The Harvard Laboratory for Drug Discovery in Neurodegeneration (LDDN)

LDDN was launched in mid-2001 with \$37.5 million to further research on neurodegenerative diseases with an initial focus on Alzheimer's disease. The basic research and operational focus for LDDN is the discovery of chemical entities that can be used as lead structures in the development of drugs for neurodegenerative diseases. On the academic side, the LDDN has access to tremendous resources in the Boston/Cambridge community.

In addition to assay development, high-throughput screening, and informatics, LDDN is one of the few academic units to offer expertise in medicinal chemistry.

To date, the LDDN has created more than 40 drug discovery collaborations with investigators from the Harvard Medical community and beyond. One drug discovery candidate has already led to the launch of a new company. Several LDDN projects have advanced to testing in animal models of the disease and planning is underway for similar studies of additional promising drug candidates.





Strategy and Action Plan to ... Advance Bioscience Talent Generation and Workforce Development

Situational Assessment

Workforce development is a critical requirement of the bioscience industry in Maryland and elsewhere. Higher education is, of course, critically important; however, the largest share of employment opportunities in the biosciences nationally is found in production and technician positions, typically requiring associate’s and bachelor’s degrees. Production occupations comprise more than 50 percent of the occupations in the medical devices and equipment industry, more than 40 percent of the occupations in the pharmaceutical industry, and more than 30 percent in agricultural chemicals.

Taking all of the bioscience-related occupations together, Maryland has a specialized concentration of these core jobs—recording a 44 percent greater concentration of key bioscience talent than the national average. By comparison, only Massachusetts and Pennsylvania among the benchmark states have higher concentrations of bioscience-related jobs.

Maryland has a specialized concentration of a range of high-skilled science, engineering, and technician jobs:

- Biological scientists (all other)
- Microbiologists
- Biological technicians
- Epidemiologists
- Biomedical engineers
- Medical scientists.

While Maryland enjoys a high concentration in top-end bioscience research workers, bioscience industry leaders have raised concerns about the insufficient supply of production and technician-level workers. This is area where the state’s community colleges should play a major role. In addition, bioscience industry leaders report that it is still difficult to find experienced bioscience scientific and management talent. This is a common experience in most states and regions seeking to grow their bioscience industry base. A concerted effort is needed to grow scientific and management talent able to work effectively in Maryland’s bioscience industry.

There is also a strong requirement that bioscience workers be lifelong learners and able to master new skill sets. Critical skill shortages can emerge quickly in the biosciences and pose major impediments to industry growth in particular niche areas.

The bioscience industry in Maryland benefits from a number of excellent individual programs in bioscience education and career development. However, a number of challenges confront Maryland in bioscience workforce development, including the following:

- Lack of a statewide approach to gaining industry involvement to guide bioscience workforce development across secondary and postsecondary institutions.
- A need for improved program articulation in the biosciences between community college and 4-year degree programs.
- Lack of a statewide program to introduce high school students to bioscience career opportunities. A potential model for improvement may be found in Project Lead The Way, a widely heralded career-technical education program that has developed a new biomedical science program and is advancing it in 10 Maryland high schools using federal funds gained as a result of Maryland’s strong performance in the Workforce Investment effort.
- Uneven funding of higher education that makes it difficult to build and maintain programs in bioscience education.

An excellent bioscience career education and training model has developed in Montgomery County, where Montgomery College has partnered with the Montgomery County Public Schools to provide bioscience summer middle school teacher training, high school biotechnology academies, and early entry of high school students into community college courses in preparation for associate degree training and baccalaureate degree transfer. Students will have opportunities to participate in internships and part-time employment in the existing business incubator and/or the planned Science and Technology Park on the Germantown Campus of the college.

Proposed Actions to Advance Bioscience Talent Generation and Workforce Development

- **Support expansion of the Project Lead The Way (PLTW) Biomedical Sciences high school program across high schools in Maryland.** Maryland has had a very successful experience with PLTW’s Engineering Program, some portion of which is now offered by nearly 100 Maryland high schools, 33 of which offer a fully certified PLTW engineering program. Maryland is currently advancing the PLTW Biomedical Sciences program successfully in 10 high schools.
- **Promote program articulation systematically on a statewide basis** for biotechnology, bioscience, and associated life sciences degrees across high schools, community colleges, and 4-year degree colleges.
- **Establish a Maryland Bioscience Workforce Skill Development Fund** to support creation of the programs, curricula, instructional labs, and teacher professional development that respond to the specific needs of the bioscience industry.
- **Develop bioscience industry scientific and entrepreneurial talent** by establishing the Maryland Bioscience Talent Bridge Program to enable bioscience companies to employ postdoctoral students and recent Ph.D.’s—and by exploring ways to make the benefits of Maryland’s standard-setting entrepreneurial education programs more readily available across the state.

A detailed study of best practices in bioscience workforce development was conducted by Battelle for its work with the Maricopa Community College System, one of the nation’s largest community college systems, in late 2003. Maryland and the following five states were examined because of their workforce development efforts:

- California
- Texas
- Georgia
- Oregon
- Washington.

Several key themes emerged for advancing a successful bioscience workforce program:

Significant industry involvement. This is perhaps the most universally held success factor found across programs in the benchmark states. As one program director explained: “Because they work so closely with industry, the students are trained exactly as industry needs them.”

Hands-on laboratory approach to curriculum taught by those in industry. This ensures that students understand real-world work requirements and applications. Industry instructors are particularly important in teaching courses related to regulatory affairs, such as good laboratory and good manufacturing practices.

Across the many programs discussed in this analysis, barriers such as the following were raised that reflect resources applied:

Lack of standardization within the bioscience industry on skills for specific types of positions. The variation in industry needs makes it difficult to address skills consistently, as is done for medical techs or IT positions, placing a burden on programs and limiting their broader effectiveness.

Insufficient numbers of trained faculty members.

Weak marketing of programs to industry. Efforts are needed to build the personal relationships that help develop confidence in the programs being offered, to overcome bias against those who hold associate of arts degrees. Many of those interviewed commented that higher education does not know how to market itself.

Lack of statewide coordination. A patchwork of programmatic efforts with little scale or strategic focus is emerging across the benchmark states, making it difficult to gain the resources needed to support the growth of programs. California and Washington are the states that come closest to addressing this need for coordination.

Lack of access to laboratory facilities. This is a problem even for many of the campuses in California.



Strategic Actions by the Numbers

Table 1. Summary of strategic priorities, proposed actions, and funding to advance the biosciences in Maryland

Strategic Priority	Action Proposed	Proposed Funding Through 2020
<p>Priority One: <i>Ensure the sustained growth and future competitiveness of Maryland's bioscience industry</i></p>	<p>Establish the Maryland Biotechnology Center</p>	<p>Annual base funding of \$6 million, with scheduled increases to \$8.5 million in FY 2013–2015 and \$12.0 million in FY 2016–2020. This will allow the Maryland Biotechnology Center to keep up with growing demand for services.</p>
	<p>Establish the BioEntrepreneur Resource Program</p>	<p>Annual budget of approximately \$1.5 million, primarily for staff support, development of incentives for certified resource networks, and marketing and outreach. This budget would be included in the current \$6 million budget of the proposed MBC.</p>
	<p>Strengthen and advance BioMaryland—Maryland's bioscience brand</p>	<p>\$500,000 per year for initial branding and follow-on earned media, outreach at targeted industry trade shows, developing conferences, etc., with increases over time to keep up with inflation. It is recommended that the budget for branding and marketing continue to increase along with proposed increases in funding for the MBC—to \$850,000 in FY 2013–2015 and \$1.2 million in FY 2016–2020.</p>
	<p>Develop 21st century bioscience industry infrastructure</p>	<p>\$2.0 million annually to fund the Maryland incubator support fund. The MBC would work with DBED, local economic development organizations, and the state's universities and federal laboratories to assess the need for additional investment in bioscience multi-tenant facilities and multi-use research park developments.</p>
<p>Priority Two: <i>Support the creation and growth of innovative bioscience companies by ensuring access to capital</i></p>	<p>Expand the Maryland Biotechnology Investor Tax Credit</p>	<p>Increase cap from \$6 million in increments to \$24 million.</p>
	<p>Make permanent and expand the R&D tax credit and make it refundable to small bioscience companies</p>	<p>Increase the cap and specifically target \$3 million to bioscience companies with 50 or fewer employees. A goal of \$24 million in total funding is proposed by 2020 reflecting a fully funded 3% investment tax credit for bioscience companies.</p>
	<p>Establish the Maryland Life Sciences Venture Capital Trust</p>	<p>State investment of \$10 million to seed the Maryland Life Sciences Venture Capital Trust. The goal would be to achieve \$100 million in funds for investment from the state and other pension funds, matched 3:1 by private funds.</p>
	<p>Ensure the availability of product development capital for emerging bioscience companies</p>	<p>The LSAB recommends that funding of the Maryland Venture Fund be restored as quickly as feasible to the \$9 million level last seen in FY 2001 and then in increments to \$24 million by FY 2020—and that the Bioscience Product Development Loan Fund be funded and maintained at a level of \$5 million.</p>



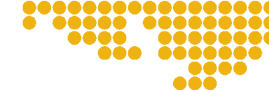


Table 1. Summary of strategic priorities, proposed actions, and funding to advance the biosciences in Maryland (continued)

Strategic Priority	Action Proposed	Proposed Funding Through 2020
<p>Priority Three: <i>Position Maryland for global leadership in cutting-edge areas of bioscience research and emerging growth markets</i></p>	<p>Strengthen technology transfer at universities and expand ability to launch bioscience ventures based on university research</p>	<p>\$5 million annually to support the University Technology Development Fund and Maryland Technology Transfer Fund; \$3.5 million annually to augment technology transfer activities at the University of Maryland System; one-time cost of \$200,000 for a study of university technology transfer practices.</p>
	<p>Establish Bioscience Commercialization Institutes</p>	<p>It is recommended that Maryland target up to \$100 million by 2020 to establish and fund four Bioscience Commercialization Institutes to accelerate and retain bioscience commercialization activity in Maryland. Each Institute would be funded at up to \$5 million per year with matching fund requirements for projects undertaken.</p>
	<p>Expand the Maryland Industrial Partnership program (MIPS)</p>	<p>\$6 million annually to fund the MIPS program, with 60 percent targeted to bioscience projects.</p>
	<p>Promote investment in emerging fields of bioscience research</p>	<p>\$20 million annually for the Stem Cell Initiative and \$5 million for the Nanobiotechnology initiative through FY 2020—which ensures the continuity and sustained effort needed to propel Maryland forward. Additional annual funding of \$50,000 is recommended to support the LSAB Bioscience Research Initiatives Review Committee. Future recommendations for funding to support emerging fields of bioscience research would be developed by the Committee.</p>
	<p>Establish the Maryland Federal Lab Engagement and Collaborative R&D Program</p>	<p>\$2 million annually targeted to the development of federal lab/university/industry collaborations, with a matching fund requirement.</p>
	<p>Support university bioscience development projects</p>	<p>Funding levels reflected in long-range state capital budget plan.</p>
<p>Priority Four: <i>Advance bioscience talent generation and workforce development</i></p>	<p>Enhance coordinated statewide approach to developing bioscience career pathways</p>	<p>\$1.6 million annually for implementation of Project Lead the Way over the next 5 years; \$1.4 million annually to support the Talent Bridge Program; and one-time funding of \$250,000 to support the development and implementation of an articulation plan.</p>
	<p>Establish a Maryland Bioscience Workforce Skill Development Fund</p>	<p>\$1 million per year for the Bioscience Industry Skill Development Program Fund for all activities including need identification, curriculum development, professional training, instructional equipment grants, on-line hosting, and teacher mentoring.</p>
	<p>Develop and retain bioscience scientific and entrepreneurial talent</p>	<p>The LSAB recommends that the Maryland Bioscience Talent Bridge Program target grants of 20 fellowships per year, to ensure an impact over time. The cost per Fellow is estimated to average \$70,000 per year, with an annual total cost amounting to \$1.4 million. The MBC should engage in the development of entrepreneurial education efforts, seeking private sponsors for key activities such as networking, lecture series, and peer mentoring.</p>



Appendix

Appendix: Detailed Strategic Actions

Action One: Establish the Maryland Biotechnology Center to serve as a catalyst and central resource for spurring growth of the bioscience industry in Maryland

Proposed Activities: The Maryland Life Sciences Advisory Board (LSAB) proposes that the Maryland Biotechnology Center (MBC) be established to coordinate and, in certain instances, consolidate Maryland support for the continued growth and success of the bioscience and biotechnology industry in the state. Working closely with industry partners, the MBC will concentrate on efforts to help create new bioscience enterprises, sustain the growth of successful bioscience enterprises, and leverage the state's unique life sciences assets in the academic and federal sectors to advance Maryland's position as a global biotechnology leader. The MBC would initially be created within the Maryland Department of Business and Economic Development (DBED), and funded by DBED. It would be led by an Executive Director and advised by the LSAB.

Over time it is critical to ensure that the continuity and focus of the MBC can be sustained and gain broad support of key stakeholders. To make this possible, the LSAB recommends that the MBC become a quasi-public development entity similar to many of the leading state technology development organizations across the nation, including the North Carolina Biotechnology Center, the Ben Franklin Centers in Pennsylvania, the Massachusetts Technology Collaborative and the newly formed Massachusetts Life Sciences Center, and Maryland's own Technology Economic Development Corporation. As a quasi-public entity, the MBC would still be accountable to Maryland's elected officials and would still receive funding from Maryland state government, but it would have more stability over election cycles and could establish the meaningful ties to the bioscience community that will allow it to be a trusted central resource and catalyst.

MBC responsibilities are proposed as the following:

- Coordination of ongoing Maryland activities in support of the bioscience sector
- Creation and administration of the BioEntrepreneur Resource Program
- Administration of the expanded Maryland Biotechnology Investor Tax Credit
- Creation and administration of Maryland Commercialization Institutes

- Leading creation of the Maryland Life Sciences Venture Capital Trust
- Creation and administration of the Maryland Bioscience Product Development Loan Fund
- Advancing bioscience career pathways and workforce development
- Facilitation of partnerships, alliances, and networking activities
- Building the BioMaryland brand and marketing Maryland on a national and global basis
- Monitoring progress in planning and implementation of Maryland's bioscience agenda.

Performance Measures:

- Percent of bioscience companies served
- Cycle time to receive assistance
- Client satisfaction as determined by surveys
- Achievement of the objectives of programs for which the Center would be responsible

Lead Organization(s):

The MBC will initially be housed within DBED.

Action Two: Establish the BioEntrepreneur Resource Program to provide one-stop assistance to bioscience entrepreneurs and early-stage companies

Proposed Activities: The BioEntrepreneur Resource Program, a priority focus of the MBC, will provide one-stop assistance to bioscience entrepreneurs. The Program will be designed to improve the quality of deal flow, link bioscience entrepreneurs to key support resources, and stimulate early-stage private investment by state sources, angel investors, and venture capital funds. The Program will focus its entrepreneurial service on the intensive process of vetting new bioscience ventures through the use of a structured commercialization assistance model to provide day-to-day support to entrepreneurs. The Program would bring a strong focus on understanding technologies and markets for core bioscience areas in Maryland through its staff expertise and would not seek to become a general entrepreneurship center. Through its BioEntrepreneur Resource Program, the MBC would offer the following:



- One-stop help with access to sources of capital
- Ready access to expertise of knowledgeable bioscience business service providers
- Programs to encourage active entrepreneur and investor networking
- Assistance with permitting processes, regulatory hurdles, and unnecessarily bureaucratic impediments
- A source of information and assistance on business formation, intellectual property, and other legal issues important to bioscience entrepreneurs and early-stage companies
- Assistance with workforce development, serving as a central portal for access to sources and development of talent across Maryland.

Performance Measures:

- Firms assisted
- Leveraged funds
- Client satisfaction as measured by client surveys
- Jobs created
- New products introduced and sales generated
- Business survival metrics (e.g., 5 year)

Lead Organization(s):

The BioEntrepreneur Resource Program will be provided by the MBC.

Action Three: Strengthen and advance BioMaryland—Maryland’s bioscience brand

Proposed Activities: The MBC would be the ideal organization under which to consolidate responsibility for marketing the BioMaryland brand. The LSAB recommends that the MBC take the lead in developing and implementing a coordinated and defined branding and marketing campaign in conjunction with the state’s existing regional economic development organizations, such as the Tech Council of Maryland/MdBio, the Greater Baltimore Alliance, and county economic development offices. This would include raising the visibility of BioMaryland in the biotechnology and life science industry at a national and global level, generating and qualifying prospects, coordinating the BioMaryland “Leader to Leader” initiative, engaging leaders in the Maryland bioscience community as BioMaryland Partners, and assisting DBED in its packaging of deals to qualified prospects. This will require a dedicated marketing program and knowledgeable staff within the MBC, along with resources for key programmatic activities. The marketing initiatives to be undertaken by the Center would include the following:

- **Branding Campaign** to be developed by an experienced professional marketing/public relations firm
- **A BioMaryland “Leader to Leader”** initiative to strengthen and integrate existing relationships between Maryland bioscience industry leaders and corporate prospects in other regions and countries to assist DBED’s bioscience industry attraction efforts
- **“BioMaryland Partners”**—a statewide network of knowledgeable industry volunteers who would serve as on-call ambassadors for Maryland’s bioscience community.

Performance Measures:

- Awareness of Maryland brand (periodic survey of key industry leaders)
- Media placements on Maryland brand
- MBC monitoring of DBED’s internal statistics on qualified bioscience leads generated, prospects identified, and deals closed

Lead Organization(s):

The MBC would work in partnership with regional and local economic development organizations including the Tech Council of Maryland/MdBio, the Greater Baltimore Technology Council, the Economic Alliance of Greater Baltimore, and county economic development agencies.

Action Four: Develop 21st century bioscience industry–related facility infrastructure in Maryland

Proposed Activities: Maryland has a number of regions that are already home to or have emerging bioscience industry clusters. Investments will need to be made in facilities, transportation, and housing to ensure that these regions remain attractive to bioscience companies and bioscience workers. In addition to these general infrastructure investments, the LSAB proposes that the following:

- Maryland’s incubator development fund should be reestablished under the administration of the Maryland Technology Development Corporation (TEDCO) to allow incubator feasibility studies and provide capital to those found to have the greatest opportunity for succeeding.
- Maryland should continue to use its existing economic development programs, such as the Maryland Economic Development Assistance Authority and Fund (MEDAAF) and the Maryland Industrial Development Financing Authority (MIDFA), to support tenant fit-out of wet-lab space as needed.

- Maryland and its universities and community colleges should continue to invest in fostering bioscience clusters of industry, research, and education activities at targeted sites throughout the state through the development of mixed-use research park campuses that house bioscience companies, educational facilities, and research operations.

Performance Measures:

- Employment in incubator tenant and graduate companies
- Net new square feet of wet-lab space in multi-tenant buildings
- High incubator occupancy rates

Lead Organization(s):

TEDCO has responsibility for administering the incubator development program. The MBC working with DBED should work with companies to ensure that financing is available for the development of additional wet-lab space as needed. MBC should work with local economic development organizations and Research Parks Maryland to promote mixed-use development that incorporates space for research growth, multi-tenant facilities and housing, and other amenities.

Action Five: Expand the Maryland Biotechnology Investment Tax Credit

Proposed Activities: The LSAB proposes that (1) the amount appropriated to the reserve fund in the state budget for the Maryland Biotechnology Investment Tax Credit be raised in increments from its current level of \$6 million to \$24 million by fiscal year (FY) 2020 and (2) the amount available to any single qualified company be limited to no more than 10 percent of the total funds available in the year in which the credit is awarded.

Performance Measures:

- Firms assisted
- Dollars invested in biotechnology companies
- Jobs created
- Business success indices (employment growth, products or services, survivability)

Lead Organization(s):

The MBC would be responsible for administering the expanded Biotechnology Investment Tax Credit.

Action Six: Make permanent and expand the R&D Tax Credit

Proposed Activities: The LSAB recognizes the importance of Maryland’s R&D Tax Credit program to innovation in the state and proposes the following changes:

- Eliminate the sunset provision and allow the R&D credit to become a permanent feature of Maryland’s tax code, thus allowing companies to plan and project more reliably.
- Raise the cap by \$3 million for both basic and growth credits and target these additional amounts to bioscience companies with 50 or fewer employees, consistent with the state’s decision to prioritize development of the bioscience industry.
- Make Maryland’s R&D tax credit refundable to bioscience companies with 50 or fewer employees up to the first \$1.5 million in eligible credits, reflecting the reality that few small bioscience companies are profitable and many, even with highly productive R&D programs, are struggling to survive to the point of commercialization.
- Raise the cap on the overall R&D tax credit over time to raise the effective level of the credit to achieve and maintain the statutorily intended benefit to participating companies.

Performance Measures:

- Increase in R&D expenditures by Maryland bioscience companies
- Increase in the total number of bioscience companies participating in the program
- Increase the overall credits received per company
- Job growth and other business success metrics of companies receiving R&D credits

Lead Organization(s):

DBED administers the Maryland R&D Tax Credit program. The MBC would monitor the program metrics with respect to its impact on the bioscience industry.



Action Seven: Establish the Maryland Life Sciences Venture Capital Trust to advance investment by pension and venture funds in the Maryland bioscience industry

Proposed Activities: The LSAB proposes that the Maryland Life Sciences Venture Capital Trust be established (1) to offer an attractive vehicle for private-equity investment in life science companies by the Maryland State Retirement and Pension System and (2) to attract additional private-equity investment in Maryland life sciences from venture capital funds both within and outside the state, while also offering the realistic expectation of a competitive rate of return on investment with an investment profile consistent with modern “prudent person” or “prudent expert” standards of investment. The Maryland State Retirement and Pension System would not be required by law to invest in the new fund of funds, but the System’s Board of Trustees would be asked to consider investing in the Maryland Life Sciences Venture Capital Trust as part of its allocation to private-equity investment. Specifically, LSAB proposes the following:

- DBED, in cooperation with the Maryland State Retirement and Pension System, would conduct a comprehensive assessment and develop an implementation plan for creating the Maryland Life Sciences Venture Capital Fund.
- Once the implementation plan is approved, establish the Trust with an initial \$10 million seed investment from the State of Maryland.
- The Trust would be created under law as a public instrumentality governed by an appropriate number of trustees to be appointed by the Governor on advice and consent of the General Assembly.
- The Trust would be empowered to solicit participating investments from any source, including the state retirement and pension system (with both the decision regarding whether to invest, as well as the amount of any investment left entirely to the discretion of fund trustees).
- The Trust would be given the power to negotiate terms with investee venture-capital funds and charged with investing in venture funds focused on early-stage, mid-stage, and late-stage private-equity investment in life science companies, which agree to match the money invested by the Trust with money invested by private investors in at least a 1:3 ratio.

Performance Measures:

- Achieving the Trust target of at least \$100 million in total funds for investment by the Trust
- Investment return ratio achieved by Trust for the Maryland State Retirement and Pension System and other participating investors
- Funds invested in Maryland bioscience companies
- Jobs created by bioscience companies invested in

Lead Organization(s):

The Fund would be administered by a newly created organization, the Maryland Life Sciences Venture Capital Trust. DBED, working in cooperation with the Maryland State Retirement and Pension System, would design the Trust and develop an implementation plan.

Action Eight: Ensure the availability of product development capital for emerging bioscience companies

Proposed Activities: The LSAB believes that it is important to ensure adequate availability of capital to support early-stage life science companies as they move from seed stage through initial product development in their progress toward commercialization. The LSAB proposes that the following specific steps be taken:

- **Increase the appropriation to the Maryland Venture Fund** to the FY 2001 level of \$9 million annually as quickly as feasible, and then in increments to \$24 million by FY 2020, to ensure that the state can provide seed financing and matching investment in first rounds of equity financing.
- **Establish the Maryland Bioscience Product Development Loan Fund at a level of \$5 million to address the gap in Maryland support**—to be administered by the MBC. Not all successful bioscience companies will follow the path of venture capital funding. Sources of patient working capital are severely limited in Maryland for qualified bioscience companies moving a product beyond proof-of-concept stage through the later steps involved in getting a product ready for market introduction. Financing is needed to finalize product development, address regulatory questions, and begin the scale-up of production. It is proposed that the Maryland Bioscience Product Development Loan Fund be established within the MBC to provide long-term working capital loans of up to \$500,000 to qualified bioscience companies in the later stages of product development and market introduction. Periodic progress reports and occasional site visits would be required.

Performance Measures:

- Firms assisted
- Leveraged funds
- Jobs created
- New products introduced and sales generated

Lead Organization(s):

The Maryland Venture Fund will continue to be operated by DBED. The Maryland Bioscience Product Development Loan Fund will be implemented by the MBC.

Action Nine: Strengthen technology transfer at research universities and the ability to launch bioscience ventures based on university research

Proposed Activities: The LSAB recommends that Maryland continue to advance efforts to strengthen university technology transfer and the ability to create bioscience ventures from university research, including the following steps:

- **Increase funding for technology transfer and proof-of-concept development funding by TEDCO to \$5 million per year**—expanding the resources available through both the University Technology Development Fund (UTDF) and the Maryland Technology Transfer Fund (MTTF). Allow these programs to grow over time and increase funding in accordance with demand and opportunity.
- **Increase funding for scientifically and commercially skilled technology transfer personnel and for patent expenses and monitoring in the University System of Maryland to a level consistent with funding levels at comparable universities nationwide.** This would require \$1.5 million for personnel and \$2 million for patent funding/monitoring.
- **Conduct a comprehensive review of internal and extramural policies and procedures that affect the university–private-sector collaboration** for the development and commercialization of technology discovered at Maryland’s state universities. An independent review of technology transfer and R&D collaboration policies and procedures, and their impact on university–private-company relationships, is recommended to identify issues that limit the number and scope of collaborations in Maryland.

Performance Measures:

- Inventions disclosed
- Number of patents generated
- Number of licenses granted
- Prototypes created and proof-of-principle demonstrated
- New products (investigational new drug [IND] applications, clinical trials, regulatory approvals, etc.)
- Start-up companies launched within and outside Maryland with university technologies

Lead Organization(s):

The MTTF and UTDC will continue to be administered by TEDCO. The University of Maryland System will administer the technology transfer program. The MBC will oversee the bioscience venture fellows and implementation and commission of the study of university technology transfer practices.

Action Ten: Establish Bioscience Commercialization Institutes in Maryland

Proposed Activities: The LSAB recommends that Maryland advance a comprehensive initiative for bioscience technology commercialization involving the formation of new Maryland Bioscience Commercialization Institutes. These Bioscience Commercialization Institutes are needed to provide the translational R&D infrastructure to accelerate and retain commercialization activity in Maryland and would target the technology platform areas identified in the core competency study.

The Institutes would be organized, funded, and implemented over time through the MBC through a competitive request-for-proposals (RFP) process. It is critical that these Bioscience Commercialization Institutes represent multi-institutional collaborations that involve industry participation in order to have the scale and path to market to be successful.

The Maryland Bioscience Commercialization Institutes could be implemented in phased fashion but would ultimately encompass laboratory facilities and research staff, accessible to academic and commercial clients, thus constituting a bridge between academic and commercial partners. The Maryland Bioscience Commercialization Institutes would enter into joint development agreements with Maryland university and federal research institutions to advance promising discoveries that meet rigorous market assessment and due diligence tests. At the same time, the Institutes would consider partnerships with private companies or private-sector initiatives. The services available under an Institute would either be contracted from available resources in Maryland or would be developed and managed by the Institute, either directly or through partnerships.



Each Institute formed should concentrate its expertise, such as in small molecule therapeutics, biological therapeutics, device development, or diagnostics, as the technologies required for development in each of these areas differ somewhat. Given Maryland's strong technology platform in biopharmaceuticals, the LSAB recommends that the first Maryland Bioscience Commercialization Institute be formed for drug discovery and development. This drug discovery and development commercialization institute should provide or contract for capabilities in assay development, high-throughput compound screening, informatics, medicinal chemistry, preclinical testing, and regulatory expertise required for advancing drug discovery and development based on discoveries made in the state's universities, both public and private, as well as federal laboratories.

Performance Measures:

- New products (Investigational New Drug [IND] applications, clinical trials initiated, drug and device filings and approvals, etc.)
- Start-up companies launched

Lead Organization(s):

The MBC will oversee the implementation of the Maryland Bioscience Commercialization Institutes.

Action Eleven: Expand Maryland Industrial Partnership program (MIPS)

Proposed Activities: The LSAB proposes that the MIPS program be expanded in the following manner:

- **Expand MIPS to include Johns Hopkins University (JHU) and all other public or private institutions**, reflecting the underlying intent of the program, which is to promote university-industry product R&D partnerships throughout Maryland, rather than through the University System of Maryland alone.
- **Recognize the higher cost of bioscience projects by funding them up to \$100,000 per qualified fundable project**, regardless of company size. (The current MIPS limit is \$100,000 for all companies except start-up companies, defined as those with 12 or fewer employees, which are currently limited to \$90,000.)
- **Increase overall annual MIPS funding to \$6.0 million**, with the requirement that 60 percent of total funding be allocated to bioscience projects, up from approximately 40 percent in the past year.

Performance Measures:

- Number of bio-related project applications and awards versus total
- Matching funds
- Key business milestones achieved (e.g., products developed, products introduced to market, sales generated. etc.)

- Jobs created
- Cost per job created

Lead Organization(s):

University of Maryland and JHU will work together jointly to administer the expanded MIPS program targeted to the biosciences in a manner consistent with the basic design of the existing program. The MBC will oversee the development of this expanded MIPS program targeted to the biosciences.

Action Twelve: Promote investment in emerging fields of bioscience research

Proposed Activities: The LSAB proposes the following:

- Establish the LSAB Bioscience Research Initiatives Review Committee with minimal funding, to work with the LSAB and the MBC to provide ongoing consideration of newly emergent fields of bioscience research, and to make recommendations to the LSAB regarding potential support. The LSAB would then consider these recommendations in the broad context of its role in guiding the MBC and advising the Governor's office and the Maryland General Assembly of actions and programs that may be important to the future development of the bioscience industry in Maryland. The members of the LSAB Bioscience Research Initiatives panel would include five to seven distinguished scientists representing a range of academic institutions, federal laboratories and the private sector. The LSAB proposes that \$50,000 annually be allocated to this effort within the MBC to support coordination of meetings and communications, distribution of materials, etc.
- Increase funding for the Maryland Stem Cell Research Fund from \$19 million to \$20 million. The LSAB would continue to monitor the implementation of changes in federal regulation and funding of stem cell research to evaluate future needs and recommend allocation of funds supporting emerging fields of bioscience research.
- Increase funding for the Maryland Nanobiotechnology Initiative from \$2.4 million to \$5 million.

Performance Measures:

- Number of institutions involved
- Leverage of new R&D funding in the targeted technology area
- Publications generated in peer-reviewed journals from the research
- Inventions disclosed
- Patents issued
- Number of spin-out companies developed from research
- Number and value of licenses generated
- New products introduced
- Sponsored research

Lead Organization(s): MBC, TEDCO, Maryland Stem Cell Commission

Action Thirteen: Establish the Maryland Federal Lab Engagement and Collaborative R&D Program

Proposed Activities: The LSAB recommends that Maryland promote and foster the development of federal lab/university/industry collaborations through a dedicated fund to accomplish the following:

- Support a web-based inventory to enable shared use of specialized research facilities and equipment
- Foster partnerships through seed funding to advance joint centers, shared-use infrastructure, cooperative research and development agreements (CRADAs), and pilot research projects
- Support strategic faculty hires
- Develop joint federal lab–university graduate programs
- Clinical research partnerships between federal labs and academic health centers and other hospital settings
- Encourage outreach to industry for multi-institutional research projects and centers.

It is expected that Maryland will have many opportunities for multi-institutional collaborations that involve industry participation, and it is recommended that a competitive RFP process would be implemented by the fund. The RFP process for collaborative multi-university initiatives would focus on assessments of the following:

- 1) Availability of federal R&D funding in the proposed research collaboration area
- 2) Maryland's competitive position compared with other leading research concentrations in the selected research platforms, based on publications and grant activities
- 3) Market potential, including consideration of the timing of market opportunities, extensiveness of technology issues that need to be addressed and whether they are more basic or applied in nature, and potential for types of industry collaboration and whether they be more with major companies, start-ups, or a combination
- 4) Economic linkages to the Maryland bioscience industry base, including the level of industry activity and Maryland's competitiveness in those sectors that are closely linked with the selected research platforms.

Performance Measures:

- Increase in academic R&D funding in the targeted technology area
- Number of spin-out companies developed around technology developed by centers
- Number and value of licenses generated
- New products introduced by companies participating in the collaborations

Lead Organization(s):

MBC and TEDCO

Action Fourteen: Support university bioscience development projects

Proposed Activities: The LSAB strongly supports the state's capital budget process and uninterrupted investment in planned bioscience research facilities at Maryland's public colleges and universities. Facilities up for capital investment in the near term include:

- Chemistry Building Renovation at the University of Maryland, College Park (UMCP)
- Smith Hall Addition/Renovations at Towson University
- Natural Science Lab/Crawford Science Building Expansion at Bowie State University
- Health Sciences Facility III at the University of Maryland, Baltimore (UMB).

In addition, future needs of Maryland's community colleges include expansion and renovation of chemistry, biotechnology, and life science labs at Cecil College; renovation of a science building at Harford Community College; new Bioscience Education Centers at Howard Community College and Montgomery College (Germantown); and a new Microbiology Lab at Prince George's Community College.

Performance Measures:

- Increase in research funding associated with new capital investments
- Retention and recruitment of federally funded faculty within new funded facilities or users of core laboratory facilities
- Enhanced industry-campus interactions (incubator performance, workforce training, collaborative partnerships and sponsored activities)

Lead Organization(s):

The Maryland Board of Regents, University System of Maryland, Maryland Higher Education Commission, and Maryland Community Colleges



Action Fifteen: Advance coordinated state-wide approach to bioscience career pathways

Proposed Activities: The LSAB recommends that Maryland advance from the current dependence on individual and sometimes fragmented approaches to bioscience education toward a more coordinated and systematic statewide approach to developing bioscience career pathways. Specifically, the LSAB recommends the following steps to advance career pathways and bioscience workforce development in Maryland:

- **Support implementation of the new Project Lead The Way Biomedical Sciences High School Program across high schools in Maryland.** A critical component of Maryland's long-term strategy to develop its future bioscience workforce is career and technical education focused on applying education related to science, technology, engineering, and math (STEM) to introduce high school students to bioscience career opportunities. Project Lead The Way (PLTW) is a widely heralded career-technical education program that stands out in its ability to engage students who may not be top performers, in classes that include high-performing students. PLTW also does well in attracting girls and minorities to technology-focused career learning. The historic PLTW focus has primarily been engineering. Recently, PLTW has developed a Biomedical Sciences program with eight state sponsors, including the State of Maryland.

The LSAB recommends that the state ramp up efforts to bring the PLTW Biomedical Sciences Program on line in high schools throughout the state. The goal would be to add 20 new high schools each year for the next 5 years to bring the total to at least 100 high schools with all school districts in the state represented.

- **Promote program articulation for biotechnology, bioscience, and associated life sciences degrees across high schools, community colleges, and 4-year degree colleges.** The recent Governor's Workforce Investment Board (GWIB) bioscience workforce study identifies six community colleges offering biotechnology or bioscience degree programs at the associate level, with two other community colleges in the planning phases; but, there is not a statewide policy to ensure program articulation.

The LSAB recommends that a one-time study be conducted by the MBC in cooperation with the Maryland Higher Education Commission (MHEC) at a cost of \$250,000 to assess how best to advance program articulation in biotechnology programs across associate to bachelor degree programs, with linkage to the new PLTW Biomedical Sciences program.

Performance Measures:

- Number of students in biotechnology-related programs at high school, community college, and university level (A.S., A.A.S., B.S., M.S., Ph.D.)
- Graduates from biotechnology-related programs
- Placement of graduates seeking full-time employment in the biosciences in jobs in Maryland

Lead Organization(s):

MBC, Maryland State Department of Education (for PLTW), and MHEC and Maryland Community Colleges (for articulation approaches)

Action Sixteen: Establish a Maryland Bioscience Workforce Skill Development Fund

Proposed Activities: Maryland needs a statewide bioscience workforce effort that has the resources to work alongside education and training providers to help create the programs, curriculum, instructional labs, and teacher professional development that respond to the specific needs of the bioscience industry. Typically, education and training providers are able to maintain programs, but have a difficult time finding the resources to update or create new programs.

It is proposed that grants of up to \$100,000 be available for updating and creating the curriculum and teacher professional development components for new bioscience programs at the postsecondary or workforce training levels. Bioscience education or workforce development programs qualifying for these grants would need to have identified employers seeking workers with the skills to be developed to serve as a program steering committee.

Additional funding should be available to support the instructional lab equipment needs of approved bioscience career development programs offered by postsecondary education or training providers. These grants should be available to programs with a proven track record of training and placing graduates in bioscience jobs or new programs being launched and having successfully developed curriculum and teacher professional development components.

The MBC should retain the right to make use of the curriculum and teacher professional development components of individual programs with other postsecondary and training providers in Maryland to spur their use in different parts of the state.

Over time, the Fund should consider ways to host the curriculum and teacher professional development of vetted, proven programs in an on-line environment with lesson plans, student e-portfolios, and teaching tips as well as providing support for teacher networking and mentoring by master teachers in specific program areas.

Performance Measures:

- Graduates from biotechnology-related programs
- Placement of graduates seeking full-time employment in the biosciences in jobs in Maryland
- Filling key skill shortage areas for Maryland bioscience industry

Lead Organization(s):

MBC and work in concert with specific postsecondary institutions

Action Seventeen: Develop and retain bioscience industry scientific and entrepreneurial talent

Proposed Activities: It is proposed that Maryland support the development of bioscience entrepreneurial and executive talent by

- Developing a bioscience talent bridge program to help provide a transitional pathway from academia to industry and
- Encouraging programs that provide entrepreneurial education for bioscience students and entrepreneurs.

The **Maryland Bioscience Talent Bridge** Program would provide fellowships to enable bioscience companies to employ postdoctoral students and recent Ph.D.'s. Maryland graduates a significant number of people with bioscience graduate degrees and attracts many of the nation's top postgraduate degree professionals to work at the National Institutes of Health, U.S. Food and Drug Administration, and its university and medical centers; but, there is no clear pathway to transition from academia to industry. Mid-level scientific positions typically require both postdoctoral training and industry experience; yet, few companies provide transitional opportunities—so this highly educated group tends to fall between the cracks, viewed as overqualified for technician positions and not yet qualified for researcher positions.

The Maryland Bioscience Talent Bridge Program, to be administered by the MBC, would help postdocs and recent Ph.D. graduates gain the initial industry experience necessary for them to receive consideration as candidate employees by Maryland's small bioscience companies. Such a program would also benefit the companies by providing them with a recruiting pathway through which they could provide training without incurring undue costs to bring potential permanent employees up to speed. Interest in such fellowships would likely be high, as evidenced by a recent symposium and career fair sponsored by Rockville Economic Development, Inc., TEDCO, National Institute of Standards and Technology (NIST), and others, which attracted more than 500 postdocs. The MBC would also offer networking events, workshops, and experiential learning opportunities.

Explore development of entrepreneurial education for bioscience graduate students and postdocs.

Maryland has a number of entrepreneurial development programs, some considered national models. The University of Maryland's Dingman Center for Entrepreneurship is recognized worldwide as a leader in enterprise creation; and the Alex Brown Center for Entrepreneurship at the University of Maryland, Baltimore County (UMBC) was designated a Kauffman Campus in 2007. Maryland's ACTIVATE program has helped women entrepreneurs commercialize technologies from UMBC, UMB, University of Maryland Biotechnology Institute, UMCP, JHU, National Aeronautics and Space Administration, National Cancer Institute, and NIST. The LSAB recommends that the MBC explore ways to make entrepreneurial education programs and resources more readily available and targeted to bioscience graduate students and postdocs, by offering lecture series, project-based short courses, and peer mentoring.

Performance Measures:

- Number of talent fellowship recipients that remain employed in Maryland two years after completion of fellowship
- Number of bioscience graduate students and postdocs entering bioscience industry

Lead Organization(s): MBC and work in collaboration with federal laboratories and universities



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