DRIVING INNOVATION AND ECONOMIC GROWTH FOR THE 21ST CENTURY

STATE EFFORTS TO ATTRACT AND GROW THE BIOPHARMACEUTICAL INDUSTRY

Prepared for the Pharmaceutical Research and Manufacturers of America (PhRMA)
by TEConomy Partners LLC.

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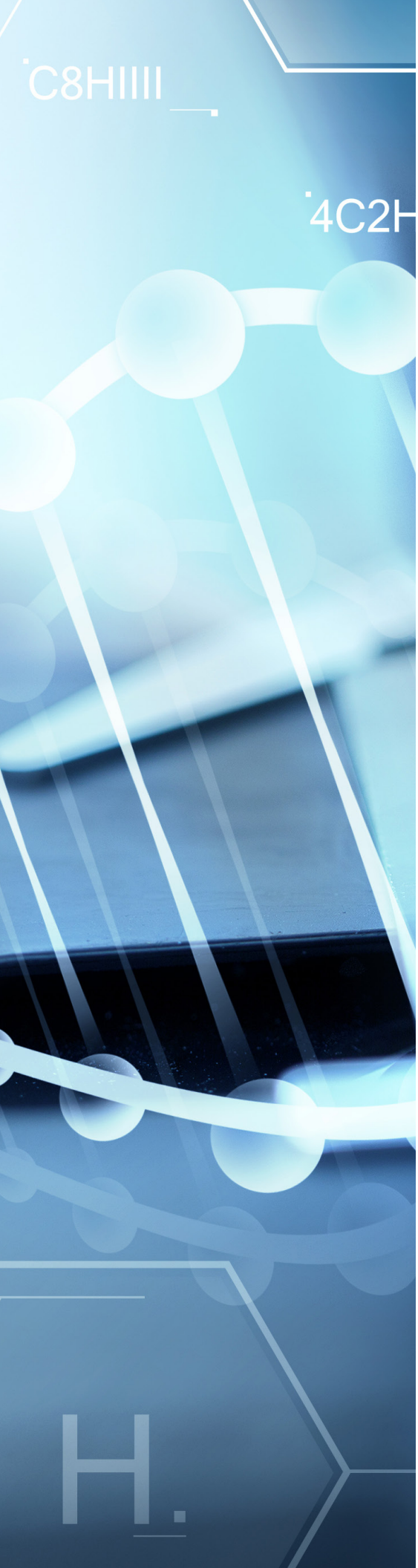

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EXECUTIVE SUMMARY

This report details the continuing rise of state policies and programs to attract, retain, and grow an innovative biopharmaceutical presence. For years, states have taken the lead in advancing strategic, innovation-led, industry cluster development efforts. A leading focus across states is growing biopharmaceutical industry clusters.

At the national level, the biopharmaceutical sector leads all industries in research and development (R&D) activity and is among the leading industries in generating patents and venture capital—**measures of its strength in commercializing new technologies and advancing high-growth potential start-up companies. These innovation strengths of the U.S. biopharmaceutical industry have resulted in significant economic impacts across the United States:**

- With nearly 854,000 workers directly employed and a substantial employment multiplier of 5.21, which includes the direct employment, the U.S. biopharmaceutical industry supported a total of 4.4 million jobs in 2014.
- With average annual wages and benefits of more than $123,000—more than twice the U.S. average across all industries—biopharmaceutical industry jobs are both high wage and high quality.

What helps drive the number of individual states that focus on biopharmaceutical industry development is the broad geographic footprint of economic activity and innovation related to the biopharmaceutical industry (see Figure ES-1). As a result of the industry's significant footprint, nearly every state has an opportunity to capture a share of this leading advanced manufacturing industry if proactive policies and initiatives are pursued.

"We have some of the most exciting, leading-edge research and development happening right here in our state—research and development that can give our loved ones a better quality and longer span of life. But our state is competing for the people and resources needed to grow this important mission-driven sector. Washington has the potential to be a global leader in global health and life sciences and over the next two years, that's my goal and that's what this advisory council will help us do."

Governor Jay Inslee of Washington, October 27, 2015, in announcing the formation of the Governor's Life Sciences and Global Health Advisory Council

"Biotech innovation is key to building a new Virginia economy, and we have made it a top priority to encourage growth in this exciting sector. This emerging industry has tremendous potential to make our Commonwealth stronger, healthier and more competitive in the 21st century economy."

Governor Terry McAuliffe of Virginia, June 8, 2016

Figure ES-1
WHY THE BIOPHARMACEUTICAL INDUSTRY MATTERS AS AN ECONOMIC DRIVER ACROSS STATES

High Economic Multiplier

Every one direct biopharmaceutical job generates another 4.21 jobs.

1 Biopharmaceutical Job → **4.21** Additional Jobs

High Wages

In 43 states the biopharmaceutical industry average wage is more than 50 percent greater than the average private-sector wage and for 24 states this premium exceeds 75 percent.

43 states with biopharmaceutical industry average wage **> 50%** more than the average private sector wage

24 states with biopharmaceutical industry average wage **> 75%** more than the average private sector wage

Broad Spectrum of Jobs

Scientists account for at least 15 percent of the biopharmaceutical workforce in 33 states, production workers account for at least 15 percent of the biopharmaceutical workforce in 19 states, and management (administrative and production) accounts for 10 percent or more in 49 states.

33 states — **Scientists** account for **≥ 15%** of the biopharmaceutical workforce

19 states — **Production** accounts for **≥ 15%** of the biopharmaceutical workforce

49 states — **Management** accounts for **≥ 10%** of the biopharmaceutical workforce

Leading Area of State Research

Biomedical research is the largest area of university research in 45 states plus Puerto Rico, and in 28 states it accounted for more than 50 percent of university-based research helping to attract industry R&D investment.

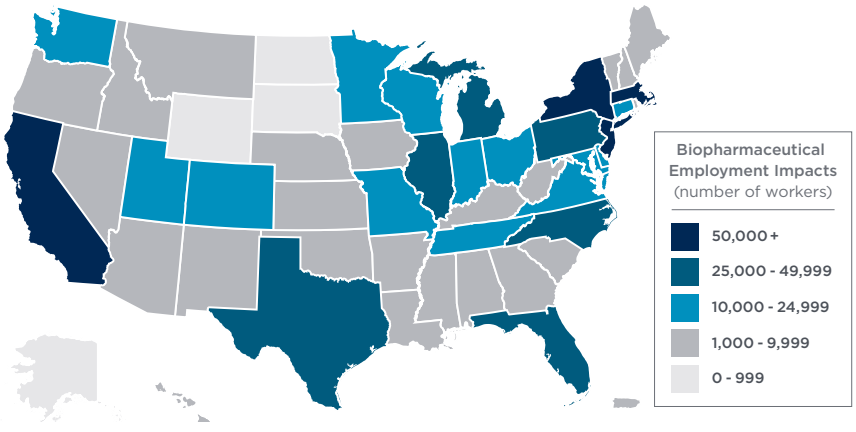
45 states where university biomedical research is the **largest** area of university research

28 states where university biomedical research accounts for **> 50%** area of university research

Industry Employment Impacts Represent Broad Geographic Footprint

The U.S. biopharmaceutical industry, with nearly 854,000 workers and a substantial employment multiplier, supported approximately 3.6 million additional U.S. jobs for a total of 4.4 million jobs in 2014.

The industry supports more than 50,000 jobs in 22 states, and more than 20,000 jobs in a total of 31 states (combining direct, indirect, and induced industry impacts).



Source: TEConomy Partners, LLC, "The Economic Impact of the U.S. Biopharmaceutical Industry: National and State Estimates," May 2016.

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Given the importance of the biopharmaceutical industry as an economic driver, it is not surprising that a detailed examination of the rise of state practices to advance the biopharmaceutical industry commissioned in 2010 by the Pharmaceutical Research and Manufacturers of America (PhRMA) found the following:

> *"During the last decade, state governments have increasingly begun to target the biopharmaceutical industry and the larger biosciences because they are economic engines providing high-wage, high-skilled jobs across a range of occupations."*[1]

Still, the bar for advancing biopharmaceutical innovation and industry development is much higher than for other innovation-led industries. Among the factors that distinguish biopharmaceutical development are the especially close ties between industry, academia, and clinical care required to advance innovation; the long, costly, and uncertain process of new product development associated with the high level of regulatory oversight and rigorous clinical trials required for biopharmaceutical product approvals; and the specialized nature of research capabilities, facilities, and talent associated with biopharmaceutical R&D.

These distinguishing characteristics have required states to pay more attention and dedicate more resources to the processes for fostering industry development as they target biopharmaceutical development. This includes heightened efforts by states supporting biopharmaceutical research across universities and industry, catalyzing the commercialization of biopharmaceutical research discoveries and new biopharmaceutical firm formation, ensuring the availability of financial capital for new and emerging biopharmaceutical ventures, and supporting the growth of biopharmaceutical companies through access to business development incentives and talent development.

The last detailed examination of state efforts to advance biopharmaceutical development commissioned by PhRMA examined the period in the midst of the Great Recession. This updated 2016 study can help understand what states have done in the aftermath and through the economic recovery. A summary of the breadth of state activities and common practices to advance biopharmaceutical development is set out in Table ES-1.

From the analysis, four key findings emerge on how states are evolving their policies:

1. **States have largely remained steadfast in their commitment to attracting and growing a biopharmaceutical presence.**

   The 2010 report noted state activities in five program areas to support biopharmaceutical development—and states remain active in each:

   - 41 states are pursuing a targeted strategy for biopharmaceutical-related development
   - 45 states are ensuring leading-edge bioscience research capacity and infrastructure
   - 48 states are advancing innovation and entrepreneurial development to leverage their R&D efforts for economic development
   - 44 states are addressing the availability of financial capital that assists biopharmaceutical companies
   - 42 states have in place supportive innovation-oriented business incentives for biopharmaceutical companies.

2. **At the same time, states continue to broaden their range of development efforts to meet new challenges to biopharmaceutical industry growth with increased efforts in advancing the science, technology, engineering, and math or "STEM" talent pipeline and promoting advanced manufacturing capacities.** This updated review considers the growing range of state activities to support biopharmaceutical development. It found the following:

1 Battelle Technology Partnership Practice, Driving State Economic Growth in the 21st Century: Advancing the Biopharmaceutical Sector, Commissioned by Pharmaceutical Research and Manufacturers of America, November 2010, page 1.

- 48 states are now advancing their STEM talent pipeline
- 17 states are promoting advanced manufacturing capacities.

3. States with a long-term commitment to developing a biopharmaceutical industry are experiencing major impacts.

Drawing on a wide range of examples of states that have stayed the course for more than 10 years or longer demonstrates the power that sustained investments can have, consider the following:

- **North Carolina:** In 1984, North Carolina developed a unique model for biopharmaceutical-related development, centered on the formation of the North Carolina Biotechnology Center (NCBiotech)—a state-chartered nonprofit development organization. Just from its long-term commitment to bioscience business development targeting emerging new ventures with a range of financing, NCBiotech-funded companies employed 2,914 workers in 2016, with the total economic impact supporting 12,666 jobs in North Carolina. Annual revenues resulting from the total economic activity of these companies generate more than five times the tax revenue, an estimated $73.6 million in state revenues in 2016, than the state's total appropriation for NCBiotech of $13.6 million.
- **Arizona:** Arizona's Bioscience Roadmap dates back to 2002, when it brought together a wide mix of bioscience industry, university, government, and community leaders to put in place a long-term strategic plan. It set out 19 actions for which demonstrated progress was made, including creating an angel tax credit, expanding R&D tax credit, forming new research institutes and capital funding, and developing workforce training efforts. The 2015 progress report notes that, since the start of the Roadmap, Arizona has generated a 49 percent increase in bioscience jobs, adding more than 36,700 since 2002, and well outpacing U.S. growth of 13.7 percent from 2002 to 2014.

> *"The second decade of Arizona's Bioscience Roadmap is well underway. In 2014 and 2015, our state saw sustained progress in its bioscience industry base, as the most visible measures of the sector's strength – jobs and wages – continued to make the case that bio is a bright spot for Arizona's economy that could become a major driver of prosperity."*
>
> 2015 progress report on the Biosciences in Arizona prepared by the Flinn Foundation on behalf of the Arizona Biosciences Steering Committee

- **Texas:** Beginning with its Industry Cluster Initiative in 2005, a long-term economic development strategy focused on advancing targeted sectors including biotechnology and life sciences, Texas has been "all in" on biopharmaceutical-related development through the Texas Emerging Technology Fund and the $3 billion Cancer Prevention and Research Institute of Texas, one of the largest single-state-sponsored biopharmaceutical-related research initiatives. Texas employment in the biopharmaceutical sector has been soaring as a result of this concerted effort, rising more than 8 percentage points higher than the nation from 2007 to 2014.

4. A number of leading biopharmaceutical states have expanded their efforts significantly in recent years, including Massachusetts and Connecticut.

Among the states that have seen new large-scale initiatives to pursue biopharmaceutical development go forward in recent years are Massachusetts and Connecticut.

- **Massachusetts:** In 2008, a $1 billion, 10-year investment in the Massachusetts Life

Sciences Initiative was made to advance a comprehensive effort overseen by a new state-sponsored nonprofit known as the Massachusetts Life Sciences Center. Its results are outstanding: 1.4 million square feet of new life science facilities, including incubators and accelerators as well as shared-use biomanufacturing facilities; $115 million in tax credits to over 75 companies that have committed to create more than 3,750 jobs; and 1,900 interns across more than 160 colleges and universities placed since 2009 at more than 450 life sciences companies. Across all of the Massachusetts Life Sciences Initiative efforts, it has been reported that $3.40 in additional nonstate funding has been leveraged for every $1 invested.

- **Connecticut:** In recent years, Connecticut has added to its biopharmaceutical development efforts with three major initiatives—the Jackson Laboratory Genomic Medicine (JAX) initiative, Bioscience Connecticut, and the Connecticut Bioscience Innovation Fund. These three initiatives together represent a commitment of $1.2 billion by the State of Connecticut. The JAX initiative is expected to create a new 300-person research institute to propel the state to national leadership in personalized medicine, while the Connecticut Bioscience Innovation Fund is a $200 million, 10-year effort to provide focused commercialization assistance to start-ups, early-stage businesses, and research organizations through competitive awards.

The commitment by states to biopharmaceutical industry development is broadly shared and suggests a national consensus on the importance of approaches to pursue continued growth in the biosciences at the state level. States recognize that supporting biopharmaceutical development requires a comprehensive and integrated approach, with 45 states being involved in five or more of the seven program activity areas reviewed in this report.

> *"In order to build the world's leading ecosystem for life sciences innovation and growth, [Massachusetts] has invested or committed more than $595 million as of the end of FY 2015 across the state, literally from Cape Cod to the Berkshires. We have leveraged those public dollars with more than $2 billion of matching outside investment. Over the past year, we have implemented new strategies, programs and partnerships in an effort to accelerate the commercialization of promising treatments, therapies, and cures that hold great potential for creating jobs, and for improving human health and patient care."*
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> Massachusetts Life Sciences Center Fiscal Year 2015 Annual Report

Table ES-1: 2016 Summary of State Economic Development Practices for Advancing Biopharmaceutical Industry Development

Program Activities	States Engaged	State Approaches
Pursuing a Targeted and/or Comprehensive Strategy for Biopharmaceutical-Related Development	41 States	• Build and sustain a shared consensus among key stakeholders from industry, higher education, and government • Design for implementation in order to drive results • Pursue a dedicated biopharmaceutical-related development entity
Ensuring Leading-Edge Bioscience Research Capacity and Infrastructure	45 States	• Sustain direct state support for biomedical research in targeted areas • Enhance university research capacities through eminent scholars • Provide matching grants for industry-university collaborations and applied research • Advance place-based infrastructure around universities to support industry co-location
Advancing Innovation and Entrepreneurial Development	48 States	• Provide proof-of-concept funding • Spur and co-invest in federal Small Business Innovation Research awards • Advance high-growth new business formation including use of entrepreneurs-in-residence and growth vouchers to access innovation services • Explore new models of dedicated venture development organizations
Addressing the Availability of Financial Capital	44 States	• Establish early-stage venture financing funds • Pursue fund-of-funds approaches for engaging more formal venture capital • Use tax incentives to create pools of venture funding
Building Advanced Manufacturing Technology Capabilities	17 States	• Address the availability of pilot scale-up facilities and leverage for training new workforce
Creating Supportive Innovation-Oriented Business Incentives	42 States	• Provide refundable incentives for R&D, especially targeted to emerging companies • Provide incentives for investors in emerging companies
Advancing the STEM Talent Pipeline	48 States	• Support K–12 initiatives for funding specialized labs, teacher professional development, and program reaching out to diverse student populations • Advance internships for postsecondary students with biopharmaceutical companies • Provide incumbent worker training in identified skill shortage areas • Support retaining foreign graduate students in collaboration with university-based innovation activities

INTRODUCTION:

WHY STATES ARE PURSUING BIOPHARMACEUTICAL DEVELOPMENT AS A LEADING INNOVATION-LED INDUSTRY CLUSTER

States across the nation have taken the lead in pursuing policies and programs to support the growth of innovation-led industry clusters. As the 2013 National Research Council study of *Best Practice in State and Regional Innovation Initiatives* explains: "In the United States, in contrast to a number of other advanced countries, until very recently virtually all initiatives to promote innovation clusters took place at the state and regional level."[2]

An industry cluster is a group of firms, related economic actors, and institutions that are located near one another and that draw productive advantage from their mutual proximity and connections.[3] The idea that state and regional development is driven by industry clusters of geographically localized concentrations of firms in related sectors that do business with each other and have common needs for trained workers, infrastructure, and technology goes back in the economic literature to the writings of Alfred Marshall in the late 19th and early 20th centuries.[4] But industry cluster development as a best practice for economic development has taken hold only in the past two decades, and its application has been primarily focused on enabling states to compete in high-growth, innovation-led development.

What is different today and is propelling the focus on industry cluster development is the emphasis placed on technology and innovation as drivers of 21st century economic development. Economic studies confirm the importance of focusing on innovation-led industry clusters for state economic development. According to the Information Technology and Innovation Foundation's (ITIF's) *State New Economy Index*, there is a strong relationship between state capacities in innovation and per capita income.[5] Economists at the Federal Reserve Bank of Cleveland found that increased innovation, as evidenced by growing levels of patent activities, is one of the most significant factors in determining a state's level of per capita income, outstripping other factors in growing per capita income such as tax burdens, public infrastructure, and the size of private financial markets.[6]

State efforts to pursue these innovation-based industry clusters are critical to their economic development

2 Charles W. Wessner, Editor. *Best Practices in State and Regional Innovation Initiatives.* Committee on Competing in the 21st Century; Board on Science, Technology, and Economic Policy; National Research Council, 2013, page 11.
3 Council on Competitiveness and National Governors Association, *Innovation America: Cluster-Based Strategies for Growing State Economies*, 2007, page 1.
4 For a discussion of industry cluster theory, see National Research Council's report, *Best Practices in State and Regional Innovation Initiatives*, 2013, pages 31–34.
5 There is a 0.53 correlation—which is quite strong—between the average score on ITIF's innovation index and a state's per capita income. See: Robert Atkinson and Adams Nager, *The 2014 State New Economy Index* (Washington: The Information Technology and Innovation Foundation, 2014). Similarly, The Milken Institute finds states that invest in innovation strategies emerged stronger out of the 2010 recession. See: Kevin Klowden, Kristen Keough, and Jason Barrett, *State Technology and Science Index 2014* (Washington: The Milken Institute, 2014).
6 Paul Bauer et al., "State Growth Empirics: The Long-Run Determinants of State Income Growth," Federal Reserve Bank of Cleveland, 2006, Working Paper #6.

efforts to generate high-quality jobs that can ensure a rising standard of living. As the National Governors Association and the Council on Competitiveness notes in their joint report *Innovation America: Cluster-Based Strategies for Growing State Economies:* "Cluster strategies have the potential to accelerate regional economic growth … governors are keenly interested in strategies for promoting the emergence and growth of clusters, especially in high-wage, high-growth industries."

Advancing biopharmaceutical industry development has emerged as a leading area of state economic development efforts to advance innovation clusters. What particularly makes the biopharmaceutical industry such an important state economic development target is its large-scale and geographically dispersed presence across the United States:

- **At the national level, the full economic impact of the biopharmaceutical sector is pronounced.** For every one direct biopharmaceutical job created, another 4.21 jobs are generated, reflecting the extensive base of suppliers and substantial contributions to personal spending from the wages and salaries the biopharmaceutical industry pays workers. So, the nearly 854,000 direct biopharmaceutical jobs in the United States in 2014 supported another 3.6 million additional U.S. jobs for a total of 4.4 million jobs in 2014.

- **These employment impacts of the biopharmaceutical industry have a broad geographic footprint across states.** The biopharmaceutical sector supports more than 250,000 jobs in six states (California, New Jersey, Illinois, Massachusetts, North Carolina, and Pennsylvania), more than 50,000 jobs in 22 states, and more than 20,000 jobs in a total of 31 states.

- **The direct jobs being created by the biopharmaceutical industry also comprise the high-quality, high-wage jobs that are priorities for state economic development efforts.** The average wages in the biopharmaceutical industry well outpace average private-sector industry levels across nearly all states. For 43 states, the biopharmaceutical industry wage premium exceeds 50 percent (i.e., biopharmaceutical wages are more than 50 percent greater than the average private-sector wage) and, for 24 states, this premium exceeds 75 percent.[7] These jobs within the biopharmaceutical industry run the full spectrum of occupations from scientific and engineering to production to business services, and so offer diverse career paths for workers. Scientists account for at least 15 percent of the biopharmaceutical workforce in 33 states, production workers account for at least 15 percent of the biopharmaceutical workforce in 19 states, and management (administrative and production) accounts for 10 percent or more in 49 states.[8]

- **At the same time, the capacity to innovate through biopharmaceutical research and**

> *"Today, Indiana's life sciences sector makes a $44 billion contribution to the State's economy, and accounts for nearly a third of all exports beyond Indiana's borders. When it comes to life sciences … we discover, develop and manufacture world-class products right here in Indiana. In doing so, we put tens of thousands of Hoosiers to work every day (and more all the time) in some of the best paying, highest skilled jobs that can be found anywhere in the state—or for that matter, in the United States. We've managed to build this life sciences sector that powers so much of our regional economy for one basic reason: because we're good at it."*
>
> David Johnson, President and CEO of Indiana BioCrossroads, Preface to *Advancing Indiana's Life Sciences Competitiveness and Strategic Collaborations*

7 TEConomy Partners analysis using the IMPLAN input-output model involving personal income to include self-employed and sole proprietors working in the biopharmaceutical industry, 2014.
8 TEConomy Partners analysis of Bureau of Labor Statistics, Occupational Employment Statistics data by industry sector, 2014.

development (R&D) is widely present across states. University biomedical research is the largest area of university research in 45 states plus Puerto Rico, and in 28 states it accounted for more than 50 percent of university-based research. Similarly, research and innovation activities of established and emerging biopharmaceutical companies are geographically dispersed, with a high share of patent activity found across the United States. In 2014 alone, 21 states had more than 500 biopharmaceutical-related patents issued, and 13 of these had more than 1,000 patents issued. These activities reflect the substantial R&D activity taking place in these states.[9]

- **There is also a strong footprint across states of clinical trials to advance new drug development funded by industry.** In 2013 the biopharmaceutical industry sponsored 6,199 clinical trials of medicines in the United States, reaching 1.1 million patients and involving direct spending of nearly $10 billion to conduct these clinical trials at the site level with a total economic impact, after considering the ripple effects of spending by clinical trial vendors and their employees, of $25 billion in economic activity in communities throughout the United States. This enormous effort in industry-sponsored clinical trials occurred in all 50 states and the District of Columbia with sizable spending in some states not typically associated with a large biopharmaceutical industry presence, e.g., Ohio and Tennessee. The five states with the highest number of active clinical trial sites were California (3,111), Texas (2,799), Florida (2,571), New York (2,476), and Pennsylvania (1,972). Only 7 states plus the District of Columbia had fewer than 200 clinical trial sites.[10]

Given the significant economic benefits and broad geographic footprint of economic activity and innovation related to the biopharmaceutical industry, it is not surprising that a detailed examination of the rise of state practices to advance the biopharmaceutical industry commissioned in 2010 by the Pharmaceutical Research and Manufacturers of America (PhRMA) found the following[11]:

> *"During the last decade, state governments have increasingly begun to target the biopharmaceutical industry and the larger biosciences because they are economic engines providing high-wage, high-skilled jobs across a range of occupations."*

The 2010 study documented that, as states have pursued biopharmaceutical development, they have put in place a wide array of development initiatives to support their existing and emerging biopharmaceutical firms—and to attract new ones—by creating competitive R&D incentives and infrastructure, supporting technology commercialization and entrepreneurial development, and focusing on other programs and policies to foster industry growth.

This report examines how state policies and programs to advance the biopharmaceutical industry have fared since 2010. Did the significant economic recession and its fiscal woes hold back state efforts? How are states addressing the fast pace of technological change in the biosciences? How has the growing strength of developing nations in biopharmaceutical research, manufacturing, and talent generation made a difference?

The next section examines the changing nature of state economic development efforts to emphasize innovation and the translating of distinguishing development requirements for the biopharmaceutical industry into specific programs and activities. The report also provides an in-depth examination of the types of programs and policies that states are adopting and the impact existing programs and policies are having, building on a previous report developed by the Battelle Technology Partnership Practice, *Driving State Economic Growth in the 21st Century: Advancing the Biopharmaceutical Sector.*

9 TEConomy Partners' analysis of Thomson Innovation patent database.
10 Battelle Technology Partnership Practice and PhRMA, *Biopharmaceutical Industry-Sponsored Clinical Trials: Impact on State Economies*, 2015.
11 Battelle Technology Partnership Practice, *Driving State Economic Growth in the 21st Century: Advancing the Biopharmaceutical Sector,* Commissioned by Pharmaceutical Research and Manufacturers of America, November 2010, page 1.

STATE EFFORTS TO ADVANCE BIOPHARMACEUTICAL DEVELOPMENT

State economic development efforts are transforming to emphasize innovation and creating the economic conditions in which they can win the competition to attract advanced industries. As the National Research Council in its 2013 report on *Best Practices in State and Regional Innovation Initiatives: Competing in the 21st Century* explains: "States confront stark economic challenges ... Efforts at industrial revival using traditional policy tools, including industrial recruitment and financial incentives to industry are now being complemented by more technology-based indigenous growth strategies."[12]

Devising state policies and programs to grow innovation-led industry clusters is not easy and requires a sustained commitment. The National Research Council explains that states are fostering the development of local innovation clusters through long-term investments in human capital, scientific infrastructure, and knowledge-based entrepreneurship. At the same time, other studies suggest the importance of complementing these investments with a competitive business environment in terms of taxes and regulations[13] as well as one that supports building relationships within an industry cluster.[14] Drawing upon these studies of best practices and the broader economic literature, Figure 1 illustrates the importance of a range of interconnected capacities and resources needed at the state level to support industry cluster development, namely building innovation capacity, raising the skills of the workforce, creating a competitive business tax and regulatory environment, and sustaining an ecosystem that catalyzes the connections across all of the economic actors involved in an industry cluster (see text box for more details).

Figure 1: Interconnected Economic Foundations Driving Advanced Industry Development

12 Charles W. Wessner, Editor. *Best Practices in State and Regional Innovation Initiatives.* Committee on Competing in the 21st Century; Board on Science, Technology, and Economic Policy; National Research Council, 2013, page 11.
13 National Governors Association, *Growing State Economies: A Policy Framework*, 2011–2012 Chair's Initiative.
14 Council on Competitiveness and National Governors Association, *Innovation America: Cluster-Based Strategies for Growing State Economies*, 2007.

COMMON THEMES OF STATE INNOVATION POLICIES

Building Innovation Capacity

One building block of innovation capacity is the R&D undertaken by research institutions, such as universities and federal labs, and private-sector companies in a state. Studies by the Office of Technology Policy and others have found that all areas of technology-based economic development in the United States have strong concentrations of both university and private research.[T1] According to a study prepared for the U.S. Small Business Administration (SBA), "Research universities and investment in R&D at these universities are major factors contributing to economic growth in the labor market areas in which the universities are situated."[T2]

R&D activities alone, however, do not lead to medical innovations reaching the marketplace. A range of commercialization activities are required to generate economic growth from the R&D process. Of particular importance for commercialization to take place is not only the ability of existing businesses to translate R&D into new product development, but also the level of entrepreneurial activities taking place within a state that are linked to broader technology development. A 2005 report prepared for the SBA's Office of Advocacy comparing regions with strong and weak entrepreneurial activity found that "the most entrepreneurial regions had better local economies from 1990 to 2001 compared with the least entrepreneurial. They had 125 percent higher employment growth, 58 percent higher wage growth and 109 percent higher productivity. This general finding held individually for large, medium and small sized regions but was most pronounced for large regions."[T3]

Advancing Talent Generation and Skills Development

Talent generation and skills found in the workforce is becoming an increasingly important driver for a state's capacity to compete. As the Organisation for Economic Co-Operation and Development (OECD) explains: "Employment in the knowledge-based economy is characterised by increasing demand for more highly-skilled workers … Changes in technology, and particularly the advent of information technologies, are making educated and skilled labour more valuable, and unskilled labour less so."[T4] Study after study demonstrates that communities that have enjoyed significantly higher gains in per capita income and other economic measures have higher levels of college-educated workers at a bachelor's level and above.[T5]

Even below a bachelor's level, more qualified workers with different and more technical skill sets are also essential to the future competitiveness of any region. At the sub-bachelor's level, skilled technicians produce, install, maintain, and repair the machines created by engineers and research teams, allowing firms to reduce product defects, create process innovations, and enhance productivity.[T6]

Creating a Supportive Business Environment

A competitive business environment is critical as states compete with each other and with other countries. While states must depend upon the federal government to set the broad outlines of tax, trade, and business regulations, there is still much that states can do to improve upon their own business environment. At the state level, what stands out in advancing a competitive business environment is being mindful of the cost of doing business and the regulatory environment in a state. Brookings economist Bill Gale finds that low taxes alone do not spur economic growth, instead the type of tax structure matters most.[T7] The regulatory environment, on the other hand, should often seek simplicity and efficiency. Rules for starting a business, zoning, registering property, bankruptcy, or enforcing contracts play a critical role in economic policy, and best practices exist that can be replicated.[T8] For example, the World Bank found that regulatory reform (as defined by the World Bank's Ease of Doing Business Indicator) is associated with an increased gross domestic product growth rate of 0.15 percent.[T9]

Sustaining an Innovation Ecosystem

Innovation and skills development does not happen just anywhere. It happens in places where firms tend to cluster in close proximity, whether to profit from local knowledge flows, skilled workers, or regional supplier networks.[T10] There is ample economic evidence that finds such regional ecosystems to be force multipliers to innovation and skills development.[T11] The innovative benefits for firms located near similar businesses decay rapidly with distance.[T12] Similarly, the impact of research institutions on industry development increases with geographic proximity.[T13] Such proximity facilitates increased interactions and the flow of ideas.

Another key element of ecosystems that is often overlooked is the role of physical infrastructure. According to the World Economic Forum, physical infrastructure is one of its pillars for economic competitiveness.[T14] A well-developed transport and communications infrastructure network is a prerequisite for core economic activities and services in today's global economy. Effective modes of transport—including quality roads, railroads, ports, and air transport—enable entrepreneurs to get their goods and services to market in a secure and timely manner and facilitate the movement of workers to the most suitable jobs.

T1 U.S. Department of Commerce, Office of Technology Policy, The Dynamics of Technology-based Economic Development: State Science and Technology Indicators, Washington, D.C., 2000.
T2 Bruce Kirchhoff, "The Influence of R&D Expenditures on New Firm Formation and Economic Growth," Maplewood, N.J.: BJK Associates, 2002.
T3 The Innovation-Entrepreneurship Nexus: a National Assessment of Entrepreneurship and Regional Economic Growth and Development. Powell, Ohio: Advanced Research Technologies, LLC, April 2005, page 5.
T4 OECD, "The Knowledge-Based Economy," Paris, 1996, page 7.
T5 See Paul Bauer et al, "State Growth Empirics: The Long Run Determinants of State Income Growth," Federal Reserve Bank of Cleveland, 2006, Working Paper #6.
T6 Rothwell, "Hidden STEM Economy."
T7 Brookings's scholar Bill Gale finds that Reforms that improve incentives, reduce existing subsidies, avoid windfall gains, and avoid deficit financing will have more auspicious effects on the long-term size of the economy, but may also create trade-offs between equity and efficiency. See: William Gale, "Effects of Income Tax Changes on Economic Growth," (Washington: Brookings, 2014).
T8 "Ease of Doing Business 2015," (Washington: The World Bank, 2015).
T9 Jamal Haidar, "The impact of business regulatory reforms on economic growth," *The Journal of the Japanese and International Economics,* 26 (2012): 285-307.
T10 See Mark Muro and Jessica Lee, "Hubs of Manufacturing: Let's Get Started," UpFront, August 20, 2012.
T11 Alfred Marshall, Principles of Economics, (Macmillan Publishing: London, 1890); J. Jacobs, *The Economics of Cities,* (Random House: New York, 1969); Michael Porter, "Location, Competition, and Economic Development: Local Clusters in a Global Economy," *Economic Development Quarterly,* 14 (1) 2004. Edward Glaeser, Triumph of the City, Penguin Press, 2011.
T12 Gerald Carlino and William Kerr, "Agglomeration and Innovation," *Harvard Business Review Working Paper,* August, 2015.
T13 Jacobs, Jane.The Economy of Cities. New York: Vintage Books, 1969; Lucas, Robert E. Jr. "On the Mechanics of Economic Development," Journal of Monetary Economics, 22: 3-42, 1988.
T14 See World Economic Forum's Annual Global Competitiveness Report

While these interconnected capacities and resources are shared concerns across all innovation-led industries, it is important for states to approach the development and sustainability of an industry cluster with a detailed knowledge of how that industry cluster operates. As the Council of Competitiveness and the National Governors Association explain, "The challenge is to develop effective strategies—ones that reflect an understanding of the complexities of cluster dynamics in a changing world."[15]

In the case of biopharmaceutical industry cluster development, while there are commonalities with overall innovation cluster development, certain characteristics and development needs make it stand apart in how states can promote its development.

Unique Biopharmaceutical Industry Cluster Development Requirements

The bar for a state to advance biopharmaceutical development is higher than many other advanced industries and is rising. Among the characteristics of biopharmaceutical industry development that distinguish it from other innovation clusters are the following:

- **Biopharmaceutical industry cluster development calls for especially close ties between industry, clinical care, and academic R&D, as well as with patient advocates, health insurance, and public health officials.** A close interface of "bench and bedside" is needed for biomedical innovation to move forward.[16] A study by the Tufts Center for the Study of Drug Development found that nearly 80 percent of the most transformative new drug innovations over the last 25 years resulted from collaborations between industry and academic research.[17] Greatly facilitating this industry-university collaboration was the passage of the Bayh-Dole Act of 1980, which, by allowing universities and other government-funded research organizations to retain title over their inventions, heralded a new era of linking public-sector support of research into the basic biological mechanisms and pathways of disease with industry drug discovery and development efforts. It offers the foundation for university technology transfer and serves as the basis for state efforts to promote technology commercialization.

- **The pace and complexity of bioscience research is opening up new opportunities for medical discovery, but requires significant investments in cutting-edge, specialized laboratory facilities and research capacities.** Key to the revolution in the biosciences was the launching of biotechnology in the 1970s involving how we understand and manage the machinery of living things. Over the years, biotechnology has advanced at an astonishing speed and has redefined all fields of biological sciences such as physiology, immunology, biochemistry, and microbiology and has led to new biological fields such as molecular biology, genomics, systems biology, and epigenetics, among others. New techniques and instrumentation are being invented with each wave of bioscience advancement, which places a heavy burden on research institutions in states to keep pace. Given the importance of research drivers to advancing local biopharmaceutical industry drivers, state economic development of biopharmaceutical industry can create new competitive advantages by investing in cutting-edge research capacities or alternatively can fall behind other states by failing to invest in partnership with their research institutions.

  At the same time, start-up and emerging biopharmaceutical companies face difficulties in accessing the specialized facilities and advanced equipment needed to commercialize and scale-up production of new biopharmaceutical products. The costs to create these biopharmaceutical labs and scale-up facilities can run into the hundreds of

15 Council on Competitiveness and National Governors Association, *Innovation America: Cluster-Based Strategies for Growing State Economies*, 2007, page 1.
16 National Institutes of Health, *Request for Applications for Regional Translational Research Center Planning Grants*, page 4, October 2004.
17 Tufts Center for the Study of Drug Development, *Public and Private Sector Contributions to the Research & Development of the Most Transformational Drugs of the Last 25 Years*, January 2015.

KEY ELEMENTS OF THE RESEARCH AND DEVELOPMENT PROCESS IMPACTING THE TIMELINE OF MEDICAL DISCOVERY

Research and Development (R&D) builds upon insights into the mechanism of a disease to identify potential therapeutic approaches. Simply having a targeted disease process in mind is not sufficient for medical discovery to move forward. What is required is having a specific lead compound that can influence the target and potentially become a medicine after 10–15 years of R&D.

Preclinical Research Testing determines the effectiveness and safety of a particular lead compound and what formulation can work best. If key criteria on effectiveness and safety are met, then an Investigational New Drug application is filed with the Food and Drug Administration (FDA) to permit testing in humans.

Clinical Research Testing in human subjects is a very rigorous multiphase, multiyear effort that begins with a small number of healthy volunteers (20–80) in Phase I to determine the safety, tolerability, and behavior of the investigational compound in the body and the relationship between the drug's chemical structure and its effects on patients, Then, if successful, the investigational compound moves into Phase II testing with a few hundred patient volunteers with the disease to assess its efficacy and dose response. Finally, if there is an indication of efficacy, the investigational compound moves to large-scale randomized and controlled testing in Phase III.

Regulatory Review and Approval is the next step in the medical discovery process and requires that all of the data collected from preclinical studies and the clinical trial phases be submitted to the FDA for review. Only about 12 percent of the candidate medicines that enter Phase I clinical trials will be approved by the FDA. The FDA review process weighs the benefits and risks of the potential medicine in deciding whether to grant approval. It is not unusual for the FDA to require additional clinical research before approval and/or seek the advice of an independent expert panel on whether or not to approve the application.

Postapproval Research and Monitoring takes place even after FDA approval is received. Often long-term studies to collect ongoing safety and efficacy data in specific patient subgroups are required by the FDA. Any adverse events that result from the use of the medicine must be monitored and reported to the FDA, with further studies of the benefit-risk profile often required.

Payment and Coverage is increasingly becoming another hurdle impacting whether and when a medical discovery reaches patients. Simply being safe and effective is no longer sufficient to ensure coverage and payment. Payers require an ever-growing body of evidence including additional comparative data versus existing therapies before they will provide coverage and access to an FDA-approved medicine.

dollars per square foot given the needs for meeting clean room requirements for sterility and other specialized infrastructure requirements. These specialized improvements are often not supported by the commercial real estate market and can represent a significant financial burden to start-up and emerging biopharmaceutical companies, often diverting scarce venture funding for building out space needs. States have responded by creating incubators; accelerators; research parks; and specialized shared-use, scale-up manufacturing facilities to address these needs.

- **The challenges associated with long development times, scientific and regulatory uncertainty, and rising costs of bringing a new biopharmaceutical to market significantly impact the ability to commercialize biopharmaceutical discoveries into new products.** In all phases of development and product introduction (see text box), the biopharmaceutical industry faces rigorous regulatory oversight. In the drug development process, biopharmaceutical products must undergo substantial clinical testing. Increasingly, there is also the need for postapproval monitoring to ensure the safety and efficacy of a new biopharmaceutical product and for comparative effectiveness data comparing a new product with an existing one in order to gain coverage by health plans. These specialized needs for oversight and clinical testing in the midst of significant scientific advances are helping to propel the field of regulatory sciences as a critical one for biopharmaceutical development.

  Not surprisingly, the long development time, uncertainty, and rising costs of bringing a new biopharmaceutical to market significantly impact the ability to commercialize biopharmaceutical discoveries into new products.

- **The "Valley of Death" challenge of raising venture capital for start-up and emerging biopharmaceutical companies results in some development opportunities not being seized,**

leaving additional economic opportunities unrealized. The "valley of death" between a biopharmaceutical discovery and the ability to attract formal venture capital is widening. In particular, venture capital for emerging biopharmaceutical companies must compete with alternative opportunities that offer high returns in the near-term and have a lower risk profile. Many bioscience venture capitalists are increasingly focusing investments in emerging life science companies only once they are entering clinical trials. Since 2001, the share of venture capital investments in biopharmaceutical companies with products in clinical trials has increased dramatically, from 23 percent to more than 60 percent today.[18] As more venture capital firms are shifting to later-stage, less risky investments, biopharmaceutical firms in the critical preclinical stages face challenges in attracting much-needed funding. Overall, venture capital funding for bioscience and biopharmaceutical innovation is rising, but not as fast as for overall U.S. venture capital.[19]

- **Another unique challenge for biopharmaceutical development is its requirements for specialized science, technology, engineering, and math (STEM) skills.** What makes the skill needs of the biopharmaceutical industry stand out is its application of a unique and growing body of knowledge on how humans, plants, and animals function, plus the regulatory environment in which it must operate. This, in turn, places unique demands on the skills and knowledge of life science and healthcare workers, including understanding advanced molecular biology, operating specialized instrumentation, and interpreting biological data generated. In addition, the translation of biological knowledge to advancing health treatments requires specific regulatory oversight, rigorous clinical trials, and ongoing quality assurance unique to the life sciences. Increasingly, the value of biomedical applications is converging with digital innovations involved in Big Data and growth in and use of remote monitoring and diagnostics.

These distinguishing characteristics of biopharmaceutical industry development have required states to set out specialized and/or enhanced approaches tailored to the biopharmaceutical industry. Among the common ingredients that states are pursuing to seize the opportunities of biopharmaceutical development are the following:

- **Pursuing a targeted strategy for biopharmaceutical-related development** tailored to the need for collaborative development models, emphasizing translational research, and leveraging each state's bioscience industrial strengths and development assets, thereby offering an integrated approach with actions that address the specific opportunities and challenges found in each state.
- **Ensuring leading-edge bioscience research capacity and infrastructure** to enable state-based research institutions to keep pace with the scientific advances and be competitive for federal funding, as well as offer approaches to build industry-university research and development partnerships and leverage university capabilities for applied research needs of industry, including access to specialized facilities for addressing key technical issues in product development and scale-up.
- **Advancing innovation and entrepreneurial development** to address the challenges of commercialization and new firm formation, especially to address the commercial viability of scientific advances and bridge the "valley of death" before formal venture capital will invest or an existing company will license a technology.
- **Addressing the availability of financial capital** to support life-science companies through all stages of development, particularly targeting early-stage investments as new companies are formed

18 Based on venture capital data from Thomson One database with calculations from Battelle.
19 Biopharmaceutical-related venture capital has increased by 18 percent from 2007 through 2015 while total U.S. venture capital investments have increased by 39 percent during this same period.

and seek to complete preclinical testing and development and pursue initial clinical trials.

- **Building advanced manufacturing technology capabilities** that recognize the specialized nature of biopharmaceutical scale-up manufacturing, and providing industry access to shared-use bio-scale-up facilities and support education and specialized training.
- **Creating supportive innovation-oriented business incentives** that offset the high cost of R&D and encourage seed-stage funding by angel investors.
- **Advancing the STEM talent pipeline** across the biopharmaceutical development process, from production to laboratory technicians, to regulatory affairs, engineers, and research scientists with education and experiential learning programs that span K–12 to postsecondary to incumbent worker training.

Key Findings in State Biopharmaceutical Industry Development Practices: 2016

This updated 2016 survey of state efforts to support biopharmaceutical industry development finds a breadth of engagement across states in biopharmaceutical development, with proven programs having significant impacts and emerging program approaches taking form.

The key findings of this report are as follows:

FINDING #1

States have largely remained steadfast in their commitment to attracting and growing a biopharmaceutical presence.

- **Pursuing a targeted strategy for biopharmaceutical-related development:** In 2016, 41 states have explicit strategic economic development plans in place that target biopharmaceutical-related development. These efforts share many common approaches in building and sustaining a shared consensus among key stakeholders from industry, academia, and government to address needs in R&D funding and incentives, commercialization of the biosciences, entrepreneurial development and venture financing, and talent. A leading approach—as demonstrated by having a measurable impact—is to establish a dedicated biopharmaceutical-related development organization at the state level to pursue the growth of this targeted industry sector, as has been done in North Carolina and Massachusetts.
- **Ensuring leading-edge bioscience research capacity and infrastructure:** In 2016, 45 states had specific initiatives to enhance their capacity and infrastructure in bioscience research across academic institutions. States are continuing to undertake a wide variety of approaches to enhance R&D. Many states continue to directly support biomedical research, including using tobacco settlements and targeting dedicated state funding for a specific area of biopharmaceutical research funding, such as stem cell research or cancer research. Other states have focused on enhancing university research capacities by recruiting eminent scholars in targeted areas and by providing matching grants for industry-university collaborative research. Nearly all states are advancing targeted capital infrastructure investments to spur R&D and industry partnerships. This includes the build-out of specialized shared-use laboratory facilities and the development of research parks associated with universities and research institutes.
- **Advancing innovation and entrepreneurial development:** In 2016, 48 states are advancing innovation and entrepreneurial development. This includes funding efforts to accelerate the technology commercialization of university research discoveries such as proof-of-concept funding and support to companies pursuing federal Small Business Innovation Research (SBIR) grants. States are also providing entrepreneurial development programs involving biopharmaceutical industry development. These include the use of entrepreneurs-in-residence, dedicated technical

assistance, growth vouchers to access innovation services, and new models of dedicated venture development organizations to spur formation of high-growth bioscience businesses.

- **Addressing the availability of financial capital:** In 2016, 44 states are supporting activities to spur venture capital for early-stage bioscience projects. The risk and uncertainty inherent in bioscience business development is steep, and attracting funding, particularly at the critical seed and early stages, is a major challenge for commercial development. Start-up biopharmaceutical firms often experience a capital shortfall while generating the necessary preclinical safety data for an IND application as well as during clinical trials and regulatory approval process.

"The risk and uncertainty inherent in bioscience business development is steep, and attracting funding, particularly at the critical seed and early stages, is a major challenge for commercial development."

- **Creating supportive innovation-oriented business incentives:** In 2016, 42 states offered economic incentives for innovation in the form of tax credits, most commonly in the form of R&D tax credits. The rising costs and significant uncertainty surrounding biopharmaceutical-related R&D activities make it particularly important for states to offer economic incentives to biopharmaceutical companies to undertake research and to locate innovation-related activities in their state. While R&D tax credits are a common tool, only a limited number of states offer the added incentive for emerging bioscience companies still engaged in product development (and so typically not having profits against which to apply the tax credits) of exchanging or selling its unused R&D tax credits with the state for a percentage of the value of the credit. Another growing focus of incentives for innovation is angel investor tax credits to spur more early-stage investment in commercializing technology and forming new ventures.

"Another growing focus of incentives for innovation is angel investor tax credits to spur more early-stage investment in commercializing technology and forming new ventures."

FINDING #2:

States continue to broaden their range of development efforts to meet new challenges to biopharmaceutical industry growth with increased efforts in advancing the STEM talent pipeline and promoting advanced manufacturing capacities.

- **Advancing the STEM Talent Pipeline:** In 2016, nearly every state (48) now has in place STEM-related workforce and education programs and initiatives that span K–12 (most common), postsecondary education, and the incumbent bioscience workforce to meet industry's diverse skill needs from production technology to quality control and regulatory affairs to new product development and research. These efforts suggest a new prioritization and mobilization on talent and workforce not seen in 2010, and reflect that state and local communities are increasingly competing based on their ability to educate, retain, and attract a skilled talent base that meets the needs of industry. States from Iowa to Massachusetts to Arizona have placed an extraordinary focus on STEM and connected it with their biopharmaceutical and other bioscience-

"These efforts suggest a new prioritization and mobilization on talent and workforce not seen in 2010, and reflect that state and local communities are increasingly competing based on their ability to educate, retain, and attract a skilled talent base that meets the needs of industry."

based industries. Advancing STEM-related skills and education at all levels is a priority for states; and a mix of industry stakeholders are rising to the challenge with states and local governments, individual K–12 systems and schools, colleges and universities, industry associations, and individual companies.

- **Promoting Advanced Manufacturing Capabilities:** In 2016, 17 states now have advanced manufacturing initiatives related to the biopharmaceutical industry, typically offering pilot-plant facilities and targeted job training on-site. There is a growing recognition that the United States needs to be focused on not just advancing research innovations, but also capturing manufacturing activities by allowing new manufacturing processes and technologies to progress more smoothly toward implementation. As the National Science and Technology Council sets out in its 2012 *A National Strategic Plan for Advanced Manufacturing* that is guiding increased federal spending for advanced manufacturing: "The acceleration of innovation for advanced manufacturing requires bridging a number of gaps in the present U.S. innovation system ... Federal investments in advanced manufacturing technologies and capabilities must align more fully with similar investments by states and regions and by the private sector."[20]

"There is a growing recognition that the United States needs to be focused on not just advancing research innovations, but also capturing manufacturing activities by allowing new manufacturing processes and technologies to progress more smoothly toward implementation."

FINDING #3

States with a long-term commitment to developing a biopharmaceutical industry are experiencing major impacts.

When considering how state efforts to advance biopharmaceutical-related development can stand out versus their competitors, the 2016 survey points to the importance of sustaining efforts underway. Drawing on a wide range of examples of states that have stayed the course for more than 10 years or longer demonstrates the power that sustained investments can have, consider the following:

- **North Carolina:** In 1984, North Carolina developed a unique model for biopharmaceutical-related development, centered on the formation of the North Carolina Biotechnology Center (NCBiotech)—a state-chartered nonprofit development organization formed to bring together industry, government, academia, and other key stakeholders to catalyze biopharmaceutical industry development. Every year since its formation, North Carolina has continued to support the programming and activities of the NCBiotech, evolving into a comprehensive set of programs focused on supporting research,

20 National Science and Technology Council, A National Strategic Plan for Advanced Manufacturing, February 2012, pages 1 and 19.

business development, education, and strategic policy development for the industry. Through the sustained effort by NCBiotech over the last 30 years, North Carolina has become one of our nation's top bioscience industry states. While much of NCBiotech's efforts are to bring stakeholders together and support long-term investments in research, it has a demonstrated impact on business development through its direct loan program. Since 1989, 272 business loans have been made to 188 companies; of these, 102 companies are currently active. These 102 companies directly employed 2,914 workers in 2016, with estimated revenues of $2.8 billion. The full multiplier impacts on the North Carolina economy generate $4.3 billion in economic activity in the state, and create or support 12,666 jobs earning $887 million in labor income. Annual revenues resulting from the total economic activity of these companies generate more than 5 times the tax revenue, an estimated $73.6 million in state revenues in 2016, than the state's appropriation for NCBiotech of $13.6 million.

- **Arizona:** The Arizona Biosciences Roadmap dates back to 2002, when it brought together a wide mix of bioscience industry, university, government, and community leaders to put in place a long-term strategic plan. With financial support from the Flinn Foundation, the Roadmap has been guided by a broad statewide stakeholder Steering Committee. It set out 19 actions for which demonstrated progress was made, including creating an angel tax credit, expanding R&D tax credit, forming new research institutes and capital funding, and developing workforce training efforts. The Roadmap also keeps a rigorous annual reporting of Arizona's performance on bottom-line measures of success, with statewide discussions on the implications of each annual report card. Among the measures tracked annually are jobs, wages, firms, federal grants, venture capital, and university technology transfer. A recent progress report notes that, since the start of the Roadmap, Arizona has generated a 49 percent increase in bioscience jobs, adding more than 36,700 since 2002, and well outpacing U.S. growth of 13.7 percent from 2002 to 2014.

- **Texas:** Beginning with its Industry Cluster Initiative in 2005, a long-term economic development strategy focused on advancing targeted sectors including biotechnology and life sciences, Texas has been "all in" on biopharmaceutical-related development. Among its major initiatives is the Texas Emerging Technology Fund that has recruited 12 eminent scholars in biotechnology and life sciences, supported five major industry-university bioscience consortia, and invested $288 million in biotechnology and life science start-up and early-stage companies. One of the largest single-state-sponsored biopharmaceutical-related research initiatives was then launched in 2007, with the voter-approved constitutional amendment establishing the Cancer Prevention and Research Institute of Texas, a $3 billion effort. It has invested $276 million to recruit 95 leading researchers to Texas and funded over $950 million across 742 research grants. Texas employment in the biopharmaceutical sector has been soaring as a result of this concerted effort, rising more than 8 percentage points higher than the national average from 2007 to 2014.

FINDING #4:

A number of leading biopharmaceutical states have expanded their efforts significantly in recent years.

Among the states that have seen new large-scale initiatives to pursue biopharmaceutical development go forward in recent years are Massachusetts and Connecticut.

- **Massachusetts:** In 2008, a $1 billion, 10-year investment in the Massachusetts Life Sciences Initiative was made to advance a comprehensive effort overseen by a new state-sponsored nonprofit known as the Massachusetts Life Sciences Center. While already a leading biopharmaceutical state, Massachusetts helped to solidify its prominence with this effort. Roughly half the funding is

focused toward increasing the R&D infrastructure across Massachusetts, resulting in 1.4 million square feet of new life science facilities, including incubators and accelerators as well as shared-use biomanufacturing facilities. In industry support, more than $115 million in tax credits to over 75 companies were awarded through the Life Sciences Targeted Tax Incentive Program for companies that commit to creating new long-term life science jobs in Massachusetts, resulting in commitments of more than 3,750 jobs. Plus, STEM workforce initiatives have been advanced including a widely used student internship challenge that has supported nearly 1,900 interns since 2009 at more than 450 life sciences companies from across more than 160 colleges and universities. It was reported that 8 out of 10 students participating had an increased interest in working in Massachusetts, and 6 out of 10 companies used the program to identify future employees. Across all of the Massachusetts Life Sciences Initiative efforts, it has been reported that $3.40 in additional nonstate funding has been leveraged for every $1 invested.

- **Connecticut:** In recent years, Connecticut has added to its biopharmaceutical development efforts with three major initiatives—the Jackson Laboratory Genomic Medicine (JAX) initiative, Bioscience Connecticut, and the Connecticut Bioscience Innovation Fund. These three initiatives together represent a commitment of $1.2 billion by the State of Connecticut. The JAX initiative is expected to create a new 300-person research institute focused on personalized medicine and systems genomics and is complemented by an $800 million expansion of the University of Connecticut Health Sciences Center. Meanwhile, the Connecticut Bioscience Innovation Fund is a $200 million, 10-year effort to provide focused commercialization assistance to start-ups, early-stage businesses, and research organizations through competitive awards that emphasize collaboration, interdisciplinary research, and commercial return on investment.

In the sections that follow, each program activity area is considered in depth with an explanation provided of the rationale for the program area, its application to the unique nature of biopharmaceutical development, and leading examples of state efforts that have demonstrated impact.

STATE DEVELOPMENT PRACTICES:

PURSUING A TARGETED STRATEGY FOR BIOPHARMACEUTICAL-RELATED DEVELOPMENT

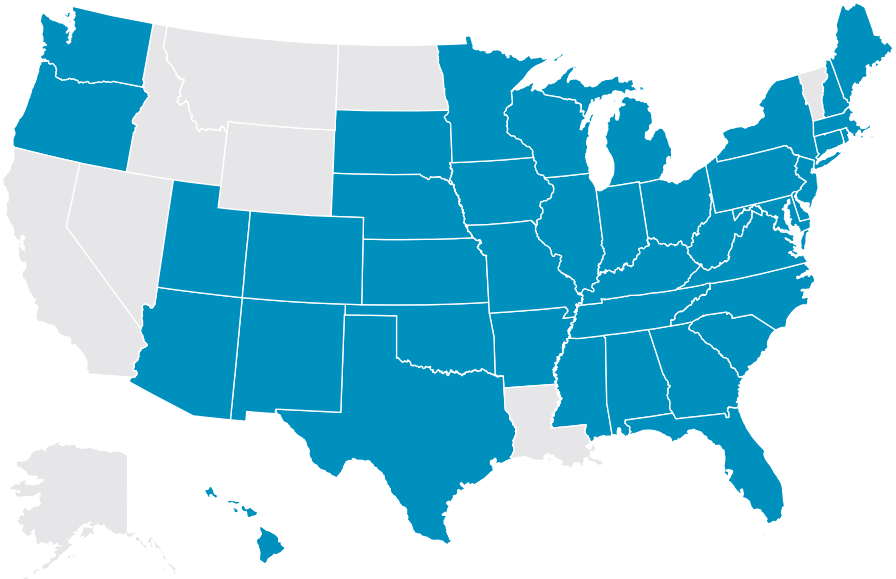
Targeted strategies for biopharmaceutical development recognize that, with the right strategies specifically tailored to each state's bioscience industrial strengths and development assets, their ability to retain existing life science companies, spur the development of start-ups, and attract and grow other companies is possible. But, setting a winning strategy requires having an integrated approach with detailed actions that address the specific opportunities and challenges found in each state.

The assessment identified 41 states with some form of statewide strategy or focus on attracting and growing the biopharmaceutical industry or broader biosciences.

Importance for Biopharmaceutical Development

- In advancing biopharmaceutical development, it is critical to recognize that not all states and regions are built alike in their industry focus and R&D base, and it is these differences that can best define how a state can succeed in pursuing development opportunities. To be successful, a state and its regions must differentiate themselves and build specialized areas of expertise.
- States vary significantly in the availability and quality of resources critical to attracting and advancing biopharmaceutical development, from talent to capital to physical infrastructure. All too often, states attempt to copy the perceived leaders in a field without regard to their own potential areas of comparative advantage.
- The biosciences have unique development requirements, including specialized talent and facility needs, and a challenging product development life cycle that is extremely R&D intensive. The R&D and manufacturing processes require various capabilities from scientific and analytic skills to a wide range of statistical and data processing expertise to clinical, engineering, construction, manufacturing, and distribution expertise and include a broad range of industry–public-sector collaborations.

41 States Identified with Targeted Industry Strategies/Emphasis



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Leading Practices

While having a comprehensive strategy to foster biopharmaceutical development is a critical step, it is not sufficient to drive results. Best practices in attracting biopharmaceutical R&D and manufacturing require a strategic approach that: (1) builds and sustains a shared consensus among key stakeholders from industry, higher education, and government; and (2) is "designed for implementation" in order to drive results.

Having a dedicated biopharmaceutical-related development entity in the state has been found to be one of the most critical components in states with a robust biopharmaceutical presence. The North Carolina Biotechnology Center (NCBiotech), a state-chartered, nonprofit development organization that has successfully attracted and retained a range of companies in the biopharmaceutical space, is viewed as a model for other states. Massachusetts more recently has followed the approach of North Carolina and is pursuing its own tailored strategy through a dedicated biopharmaceutical development entity in order to help ensure the effectiveness of $1-billion-plus initiatives in the state to advance its efforts to grow and sustain a biopharmaceutical industry presence.

- ILLUSTRATIVE EXAMPLE

North Carolina Biotechnology Center

Overview

NCBiotech was formed by the State of North Carolina to bring together industry, government, academia, and other key stakeholders to catalyze biopharmaceutical industry development.

NCBiotech has implemented a comprehensive set of programs that fuel long-term economic and societal benefits to North Carolina through support of biotechnology research, business, education, and strategic policy statewide. Through the sustained efforts of NCBiotech over the last 30 years, North Carolina has become one of our nation's top bioscience industry states.

Accomplishments:

- NCBiotech's small business loans are having a major impact. By 2016, 102 active companies in North Carolina had received early-stage financing from NCBiotech. These 102 companies directly employed 2,914 workers in 2016, with estimated revenues of $2.8 billion. Through their full multiplier impacts on the North Carolina economy—involving how direct industry growth generates additional economic activity through purchases of supplies and services from other businesses and by personal spending by its workers—these companies generate $4.3 billion in economic activity in the state, and create or support 12,666 direct jobs earning $887 million in labor income. Annual revenues resulting from the total economic activity of these companies generate more than 5 times the tax revenue, an estimated $73.6 million in state revenues in 2016, than the state's appropriation for NCBiotech of $13.6 million.

> *"It's sometimes not so much the dollar amount of these [NC] Biotech Center loans that makes them so important. It's their timing. They buy a young company time to get to the next level. And the vetting involved helps recipients demonstrate their investment worthiness to others."*
>
> Eric Barnett, M.D., Executive Vice President of Business Development, Piedmont Pharmaceuticals

- NCBiotech helps attract life science companies to North Carolina. Over 2015–2016, NCBiotech reports at least a dozen life science companies headquartered outside the United States started or expanded operations in North Carolina. This includes Novo Nordisk's $1.8 billion expansion, which stands as the single largest manufacturing investment in North Carolina history. At the present, 71 life science companies headquartered in 20 countries now

have a presence in North Carolina and employ more than 17,000 people in the state.

- ILLUSTRATIVE EXAMPLE

Massachusetts Life Sciences Center

Overview

Massachusetts created the Massachusetts Life Sciences Center (MLSC) to oversee implementation of the state's 10-year, $1 billion Life Sciences Initiative to pursue a comprehensive and targeted approach to life sciences development.

Implementing the Life Sciences Initiative includes financing for university R&D facilities, bioscience research, and a set of tax credits directed at bioscience companies. MLSC is actively engaged in the following:

- A research consortium in neurosciences;
- Supporting infrastructure investments at research institutions;
- Providing research matching grants for universities and industry to pursue collaborative research projects;
- Cultivating international partnerships;
- Operating business incubator and accelerator facilities and programs;
- Overseeing a targeted tax incentive program; and
- Promoting STEM education through grants to K-12 and internships for postsecondary students with life science companies.

Accomplishments:

Since 2008, the MLSC has directly invested or committed more than $595 million and leveraged more than $2 billion in third-party investment. Every $1 of taxpayer money that the MLSC has invested has attracted more than $3.3 in additional, outside investment. This has created a portfolio of approximately $2.6 billion in public-private investments in the state's life sciences ecosystem that would not have existed without the Life Sciences Initiative.

In its 2015 annual report, MLSC highlighted key accomplishments in 2015 that demonstrate its comprehensive approach to strengthening the economic foundations for Massachusetts to advance bioscience development:

- Equipment and Supply Grants to 44 high schools and middle schools across the state totaling nearly $3.8 million;
- $1 million towards the development of an Ebola diagnostic test;
- $550,000 awarded to two companies and two middle schools to conduct research on the International Space Station;
- More than $2.2 million in grants awarded to early-stage companies toward the completion of R&D milestones;
- Tax incentive awards to 11 companies totaling more than $19 million; and
- Placement of 430 interns at companies across the state.

But, industry response is what stands out regarding the success of MLSC. With the active marketing efforts and programs of MLSC highlighting the

> *"Many of these companies had little to no presence here seven years ago. Over the past year we have embraced and incorporated the term, 'life sciences stampede' into our message to the world, and we have continued to attract companies large and small from across the globe, bringing thousands of jobs and important new healthcare technologies with them."*
>
> Massachusetts Life Sciences Center Fiscal Year 2015 Annual Report

state's world-class academic institutions, access to a talented workforce, and vibrant innovation infrastructure, many of the largest life science companies in the world in recent years have announced intentions to launch or expand their presence in Massachusetts, including Baxter, GE Healthcare, and Shire. MLSC reports that 15 of the top 20 global leaders in biopharma now have a presence in Massachusetts, and many, like Pfizer, Biogen, Novartis, Shire, and Sanofi Genzyme each have over 1,000 employees in the state.

STATE DEVELOPMENT PRACTICES:

ENSURING LEADING-EDGE BIOSCIENCE RESEARCH CAPACITY AND INFRASTRUCTURE

The discovery, development, manufacture, and delivery of new medicines is highly complex and reliant on a range of scientific and technological expertise. The R&D ecosystem includes not only robust private-sector capabilities, but also a robust public sector reflective of the complementary roles performed by each. Recognizing the close collaborations and partnerships between private company researchers and academic medical researchers, states with a strong life-science cluster have centers of academic research excellence. States are increasingly focused on differentiating themselves from other states to attract innovative companies and often place an emphasis on building and sustaining academic research excellence. The assessment identified 45 states with bioscience-related R&D programs and initiatives and/or initiatives aimed at building out bioscience-related infrastructure such as research parks with a life science focus. The R&D programs utilize approaches from direct state funding to research matching grants to build and expand research capacity.

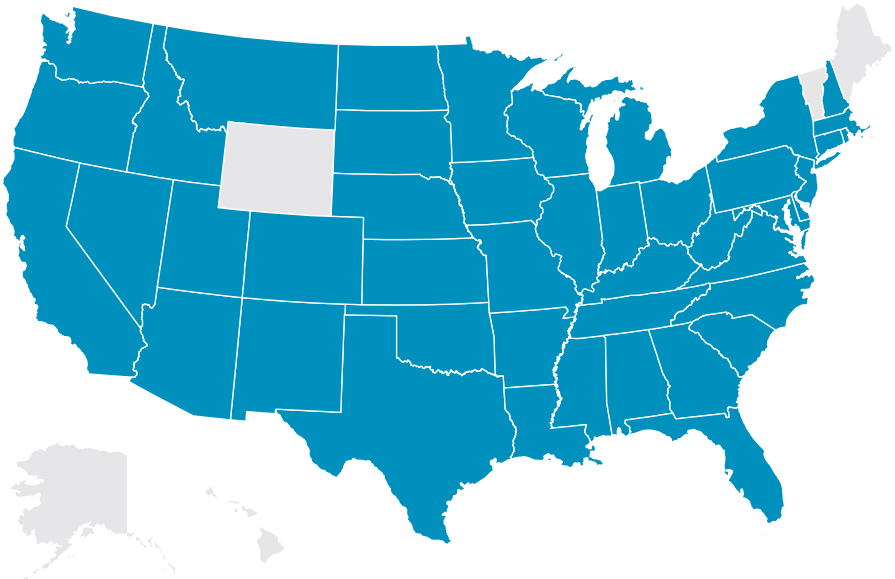
Importance for Biopharmaceutical Development

There is a close relationship between industry and university research at the state and regional level. This reflects the fact that innovation is propelled by specific state and regional capabilities found in localized concentrations of firms in a related industry that do business with each other and draw on local university expertise and local investment.

The evidence on the importance of the interactions of industry and research universities in propelling innovation-led development is substantial:

> *"Academic collaborations have become an increasingly important component of the pharmaceutical industry's overall innovation strategy."*
>
> Andrew Dahlem, Ph.D., Vice President of Operations for Lilly Research Laboratories at Eli Lilly and Co. on the launching of new Strategic Pharma-Academic Research Consortium for Translational Medicine, June 10, 2014

45 States Identified as Building Research Capacity and/or R&D Infrastructure



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- Studies of the impact of research institutions on industry development find that impacts increase with geographic proximity.[21] Such proximity among and between industry and universities facilitates increased interactions and the flow of ideas.

Increasingly, states are recognizing that the stature of their universities should be measured not only by the "size" of their research and talent generation activities, but also by the "translation" of that research base into fostering industry clusters and generating new companies. More directly, research universities across the nation are becoming anchors for an exciting array of economic development initiatives including collaborative and multidisciplinary research centers and innovative new curriculum and educational programs needed for high-skilled talent generation.

- In turn, these university-based economic development initiatives are also becoming critical to sustaining the growth of academic research by attracting the best and brightest faculty and students, who are seeking a dynamic environment in which there is a proactive entrepreneurial culture and supportive infrastructure to move from research activities to technology commercialization and public- and private-sector collaborations.

- Of particular note are emerging efforts in multi-institutional/multicompany research collaborations, including the Tuberculosis Drug Accelerator Consortium with the goal of developing five new preclinical drug candidates; and the Strategic Pharma-Academic Research Consortium for Translational Medicine bringing the University of Indiana, Washington University, Ohio State University, and Northwestern University together with Eli Lilly and Takeda Pharmaceuticals to advance research on autoimmune diseases. In addition, many companies are pursuing more "open innovation" approaches. Academics typically work directly with private-sector researchers through a variety of arrangements, which can range from access to research tools such as molecular profiling and screening tools to access to company scientists including sharing of lab space. Among the companies with formal open innovation programs are AstraZeneca, Eli Lilly and Company, GlaxoSmithKline, and Merck & Co.

Leading Practices

Practice: Direct State Support for Biomedical Research.

A number of states provide funding for biomedical research at state universities, including to address specific health issues within their state. Funding sources include, but are not limited to, dedicated taxes, tobacco settlement funds, and general revenues.

- ILLUSTRATIVE EXAMPLE

Pennsylvania Commonwealth Universal Research Enhancement (CURE) Program

Overview

This program, administered by the State Department of Health using tobacco settlement funds, makes grants to Pennsylvania-based organizations for biomedical research, clinical investigations, and health services research. With the grant funding, researchers are conducting

> *"In June 2001, Pennsylvania made a bold and unprecedented commitment to the life science industry by dedicating up to $1.6 billion in funding from the Tobacco Master Settlement Agreement to support research, encourage early-stage funding, and enhance venture capital in the state. The resulting three novel, highly effective programs have worked in a coordinated way to advance both healthcare and Pennsylvania's high-growth companies."*
>
> Pennsylvania's Strategy for Life Sciences Leadership for the Next Decade, 2012, developed by government, industry, and university leaders

21 Robert E. Lucas Jr., "On the Mechanics of Economic Development," *Journal of Monetary Economics*, 22, 1988, pages 3–42. Naomi Hausman, *University Innovation, Local Economic Growth, and Entrepreneurship*, National Bureau of Economic Research, Paper CES 12-10, June 2012.

research in a wide range of areas such as cancer, cardiovascular disease, diabetes, immunology, infectious diseases, neuroscience, cell biology, bioengineering, and substance abuse.

Accomplishments

Since its inception in 2001, the CURE Program has awarded approximately $800 million in CURE Program grants and has funded more than 1,900 health research projects. The State Department of Health reports that, of the 361 research grants completed as of June 30, 2013, study findings have been reported in more than 1,825 peer-reviewed articles and 85 patents have been filed. It is also noted that researchers have leveraged an additional $1.2 billion in funding to continue their research.

- ADDITIONAL EXAMPLES:

Arkansas Biosciences Institute: The institute was established by a voter-approved referendum on how best to use Tobacco Settlement Proceeds and enacted into law by the Arkansas General Assembly in 2001. The support of the Arkansas Biosciences Institute for bioscience research across five institutions in Arkansas has been used to assist core laboratories, recruit new faculty, and pursue early-stage research projects. In 2014, ABI reached a critical milestone of $500 million dollars in research funding raised beyond the state's investment. Plus, for every $1 of state investment, ABI-funded researchers have generated an additional $3.61 in nonstate extramural funding.

California Institute for Regenerative Medicine (CIRM): The mission for CIRM is to "accelerate stem cell treatments to patients with unmet medical needs." The institute was created by voter approval in 2004 that authorized $3 billion in funding for research at institutions across California. A 2009 independent study of initial economic impacts of CIRM conducted by The Analysis Group estimated the facilities grants alone would create 13,000 "job-years" of employment (jobs that last one year) between 2008 and 2011 and bring in $100 million in tax revenue to the state. By 2014, the CIRM programs were expected to have created more than 38,000 job-years and generated $285 million in state tax revenues.[22]

> *"Overall, [the Institute] has done a remarkably good job setting priorities and directing voter-approved funds to projects that have given California a prominent position in regenerative medicine."*
>
> Harold T. Shapiro, President Emeritus and Professor of Economics and Public Affairs, Woodrow Wilson School of Public and International Affairs, Princeton University, Princeton, New Jersey

Maryland Stem Cell Research Fund: The Fund, established in 2006, is designed to promote state-funded stem cell research and cures through grants and loans to public and private entities in Maryland. In 2013, the fund was expanded to include a preclinical and clinical research grant award for biotechnology companies pursuing novel stem-cell based therapeutics with at least one clinical site in Maryland. An independent assessment of the fund found that it has helped raise the state's competitiveness for federal research funding with Maryland advancing from eighth place in federal stem cell research funding in FY2009 with $40.3 million in funding to third place in FY2012 with $114.4 million.

Connecticut's Regenerative Medicine Research Fund (RMRF): Formerly called the Connecticut Stem Cell Program and founded in 2005, the RMRF provides millions of dollars in grants each year to scientists who are conducting biomedical or embryonic or human adult stem cell research that shows clinical promise. The RMRF had allocated nearly $90 million toward stem cell research as of June 2014 and has supported 170 research projects at various universities and companies. A review of program accomplishments from 2007

22 "Creating Jobs," CIRM website, see: https://www.cirm.ca.gov/our-impact/creating-jobs.

to 2012 found that the $69 million invested over that period leveraged an additional $290 million in additional funds from other sources and generated about 200 invention disclosures, approximately 150 patent applications, and three stem-cell-related start-up companies.

Practice: Enhancement of University Research Capacities.

These efforts often involve recruiting eminent faculty, equipping laboratories, and supporting university research centers. An example of how a sustained statewide effort to build research can grow an economy is the Georgia Research Alliance (GRA).

- ILLUSTRATIVE EXAMPLE

Georgia Research Alliance

Overview

The Georgia Research Alliance (GRA) works to expand the research and commercialization capacity across Georgia's research universities to "launch new companies, create high-value jobs and transform lives."[23]

GRA has focused its efforts on recruiting eminent scholars to Georgia research universities who not only excel in scholarship, but also have an orientation toward commercialization and entrepreneurship. To date, 70 scholars have been recruited of which 38 are in the biomedical sciences. From 2007 to 2012, GRA invested $30 million annually to recruit talent, equip laboratories, seed promising companies, and support research, which leveraged an additional $395 million annually from federal, philanthropic, industry, and university sources.

Accomplishments

A longer look at GRA's economic impact—since the organization's 1990 founding—shows that GRA has driven a total of $3.8 billion in direct federal and private investment in Georgia and helped launch more than 150 active companies and created more than 6,000 highly skilled science and technology jobs.[24]

- ADDITIONAL EXAMPLES:

The Utah Science Technology and Research Initiative (USTAR) has recruited 25 leading life science researchers in a wide array of research fields, including arrhythmia, human nutrition, neurosciences, medical device, medical imaging, bionanotechnology sensors, and infectious diseases.

The Cancer Prevention and Research Institute of Texas, a $3 billion initiative passed by the voters in 2007, has invested $276 million to recruit 95 leading researchers. The Texas Emerging Technology Fund, operated by the state, has funded nearly $50 million to recruit 12 leading researcher recruitments in biotechnology and life sciences.

Practice: Matching Grants for Industry-University Collaborative Research.

Given the scientific and research challenges related to addressing our most costly and challenging diseases, it is not surprising that programs directly supporting industry-university research efforts have a proven track record. The State Science and Technology Institute (SSTI), the leading national association of technology-based economic development organizations, in its 2006 A Resource Guide for Technology-based Economic Development, highlights this approach as a best practice, but notes that "such programs are effective only if they are able to provide companies with an entrée to the university and help them find the faculty with the expertise and facilities that they require."[25]

23 "GRA Staff," GRA website, see: http://gra.org/page/1011/staff.html.
24 "Driving science and technology economic development in Georgia," GRA website, see: http://gra.org/page/1025/about_gra.html.
25 State Science and Technology Institute, *A Resource Guide for Technology-based Economic Development*, prepared for the Economic Development Administration of the U.S. Department of Commerce, August 2006, page 24.

- ILLUSTRATIVE EXAMPLE

The Maryland Industrial Partnerships (MIPS) Program

Overview

The Maryland Industrial Partnerships (MIPS) Program facilitates academic-industrial, public-private partnerships connecting researchers at Maryland's public universities to businesses across the state. Using matching funds, companies can leverage the research infrastructure and expertise of the universities for biopharmaceutical R&D helping drive innovation that creates new jobs and benefits patients through new treatments.

MIPS, administered by the University of Maryland, provides up to $100,000, matched by the company partner, for university-based research projects that help companies develop new products. MIPS projects help companies find solutions to technical challenges, as well as develop products, processes, or training materials. MIPS projects are conducted by university faculty and graduate students in conjunction with company researchers. The Life Sciences Advisory Board strategy reported that approximately 40 percent of the companies assisted by MIPS have been bioscience companies.

Accomplishments

An assessment of the first 25 years of MIPS activity, prepared in 2012, found that it did the following:

- Supported 1,032 joint industry-university research collaborations over its first 25 years;
- Leveraged $37 million in state funding with $127 million in industry direct and in-kind funding;
- Resulted in $3 billion in sales, supporting 3,615 direct jobs in Maryland in 2011 alone;
- With the multiplier-based economic impacts, generated a total impact of $4.8 billion in economic activity in Maryland, supporting 15,191 jobs earning $1.1 billion in labor income during 2011.

Practice: Expansion of Research Infrastructure.

States also are seeking to expand their research infrastructure to include commercial space for innovative companies as well as access to incubation and commercialization services in close proximity to academic medical institutions. There is an increasing need to include in traditional research parks more amenities that create high-value locations necessary to attract top talent and promote the networking found in denser urban-like environments with attractive live-work-play environments.

- ILLUSTRATIVE EXAMPLE

The Virginia Biotechnology Research Park in Richmond

Overview

The Virginia Biotechnology Research Park Corporation, a nonprofit, nonstock corporation, was created in 1992 when Virginia Commonwealth University (VCU) and the City of Richmond agreed to designate the site as a life sciences research park. In 1993, the Commonwealth became a full partner in the Corporation by creating the Virginia Biotechnology Research Park Authority, a political subdivision of the state with broad powers and authority to own and develop properties and facilities for the purpose of enhancing Virginia's biotechnology industry, including authority to issue bonds.

The Virginia Biotechnology Research Park is a 34-acre research park adjacent to the VCU academic medical center in the urban core of Richmond. The park is currently home to approximately 60 life science companies, research institutes, and state and federal labs, employing over 2,400 scientists, engineers, researchers, and related staff. Employers on site include early- and mid-stage companies; multinational pharmaceutical, environmental, and consumer product companies; national healthcare organizations managing the nation's solid organ transplant program, as well

as a number of international companies. The Park includes the following:

- A long-standing incubator facility, the Virginia Biotechnology Center;
- The Virginia Biosciences Commercialization Center to assist later-stage companies with products and services that are closer to market, and to serve as a "soft landing" center to foreign bioscience companies looking to enter U.S. markets; and
- An entrepreneurial mentoring organization, the Dominion Resources Innovation Center.

Accomplishments

The Virginia Biotechnology Center has done the following:

- Facilitated the formation of approximately 70 bioscience companies since its creation in 1995.
- Resulted in a 34-acre research park with 60 companies that employs over 2,400 people.

> *"It's very clear that innovation is on the minds of many people in the Richmond [VA] region. The conversations I've had in many places across the innovation and entrepreneurial communities affirm the actions we are taking to establish a regional innovation system. And as VCU moves solidly into the top 50 public research universities nationally, the university's alignment with the Research Park is key."*
>
> Dr. Michael Rao, President, Virginia Commonwealth University

- ADDITIONAL RECENT EXAMPLES:

Mission Bay. Mission Bay represents one of the largest, most significant development projects in the nation, transforming a former rail yard in San Francisco into a modern, mixed-use Innovation District development with a premier biotechnology and health sciences research and education base at its core, led by a 43-acre research campus for the University of California at San Francisco (UCSF) that opened in 2003. Today, the Mission Bay development has catalyzed life science industry development into the City of San Francisco—growing from one company located in the District when UCSF opened its campus, to more than 100 by 2013.

Practice: Broader Industry-University Consortia and Other Collaborations to Advance Biopharmaceutical-Related Research.

These efforts are newer and their impact is still emerging:

The Indiana Biosciences Research Institute (IBRI) was launched in 2013 as a statewide public-private partnership with an initial $25 million state commitment that has now been matched by corporate and philanthropic funders. The institute is developing a novel operating model, with industry providing a major source of funding and defining the institute's research focus to optimize commercialization opportunities. Industry executives from Eli Lilly and Company, Roche Diagnostics, Dow AgroSciences, Indiana University Health, Cook Medical, and Biomet Zimmer have been critical in advancing the institute in partnership with BioCrossroads (a nonprofit life-science development organization), state government, and Indiana's research institutions. The institute will initially focus on conducting precompetitive research on the most pressing global and local interrelated human health issues: cardiovascular disease, diabetes, obesity, and nutrition.

Massachusetts Neuroscience Consortium involves a collaboration of the Massachusetts Life Sciences Center with biopharmaceutical companies to pool funding in support of research to identify and validate novel targets for treating

chronic and debilitating neurological diseases anchored in recognized human disease pathways. Founding industry consortium members include AbbVie, Biogen, EMD Serono, Janssen Research and Development, Merck & Co., Pfizer, and Sunovion Pharmaceuticals. The MLSC used its convening power to bring these companies together to form a new model for collaboration with the research community in order to accelerate the pace of discovery. First-round awardees were announced in 2013, involving three grants focused on Alzheimer's disease, two grants focused on neuropathic pain, and one grant each focused on multiple sclerosis and Parkinson's disease. A second round is underway and is focused on neurodegenerative and neuroinflammatory diseases, neuropathic pain, and treatment-resistant depression.

STATE DEVELOPMENT PRACTICES:

ADVANCING INNOVATION AND ENTREPRENEURIAL DEVELOPMENT

Research capacity and infrastructure by themselves do not generate economic development results. Capabilities to foster the commercialization of university-based research and the start-up of new businesses need to be addressed. The key issues regarding technology commercialization involve how to bridge the gap between inventions and discoveries made in research institutions and commercial development of those research discoveries undertaken by businesses.

One important step in moving inventions and discoveries to the marketplace is the efforts of technology transfer offices within the research institution to identify new research discoveries; determine those discoveries with potential market and technology value that should be legally protected as intellectual property; and then identify interested companies to negotiate licenses, foster acquisition by other entities, or agree to pursue a new company spin-out.

Complementing, but distinct from technology transfer, for advancing innovation are the technology commercialization activities that are involved in new technology and product development, whether for existing or new firms, that are beyond what some entities can organize effectively themselves. Commercialization activities include undertaking the detailed technology and market assessment against current products in the marketplace, developing the product or technology itself, and optimizing its engineering and design to meet price points of the marketplace and the stringent demands of national and international biomedical regulations.

In the case of new firm spin-outs, it also involves many of the initial steps in business formation, such as putting the business and management team in place and securing the initial sources of equity and working capital to launch the company.

Table 1 helps to show the distinctions in advancing innovation between technology transfer and technology commercialization.

48 States Identified as Accelerating Innovation, Commercialization, and/or Entrepreneurial Development

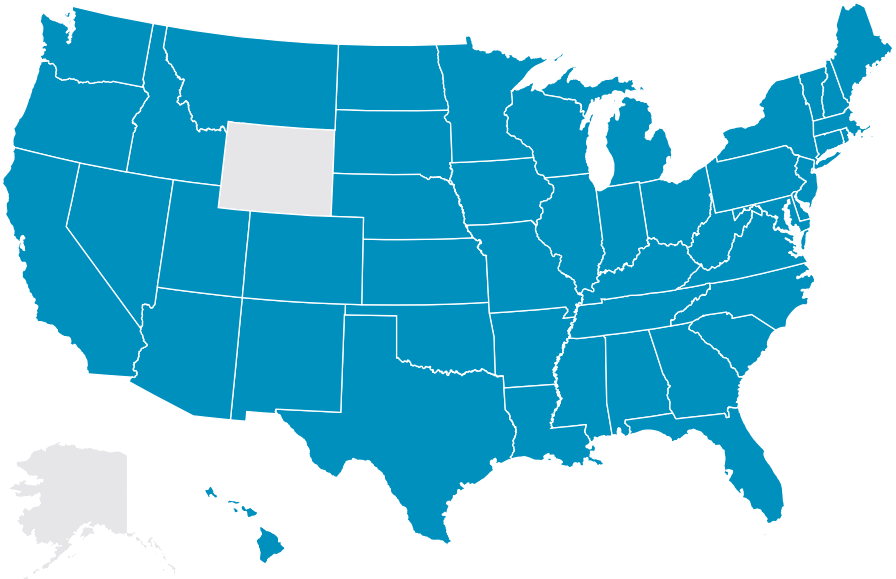

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Table 1: Technology Transfer vs. Technology Commercialization – Stages

	Technology Transfer		Technology Commercialization		
Innovation Stage	Discovery	Translational Research	Technology Development	Product Development	Production/ Marketing
Outcome	• Invention Disclosure • Publication	• Proof of Concept • Patent/Trade Secret • Licensing	• Engineering Optimization • Product Prototype • Pre-seed Business	• Initial Product • Start-up Business or New Program (for established companies)	• Mass Production • Established Company

Source: Adapted from National Institute of Standards and Technology, "ATP and Venture Capital Funding Criteria Differ," http://www.atp.nist.gov/factsheets/1-c-9.htm.

The assessment identified 48 states with programs and initiatives aimed at accelerating innovation, commercialization, and/or entrepreneurial development in the biopharmaceutical industry or broader biosciences.

Importance for Biopharmaceutical Development

- Building capacities for technology commercialization is critical for attracting and growing biopharmaceutical-related economic development. Best practice makes clear that universities and academic medical centers cannot alone create a high-functioning innovation ecosystem, but instead are critical partners and stakeholders.
- There is a need to further advance the commercialization potential of university research discoveries. Many promising research discoveries have unanswered questions concerning their commercial value. Before a private investor is willing to spend funds to undertake the commercial development, especially for costly new biomedical products, they need to have further studies undertaken that answer some key questions, such as how well the research discovery works in live animals or whether it can be replicated under different conditions. Without this proof-of-concept stage, many significant research discoveries with commercial value may go untapped. The difficulties are in determining the sources of the resources and the manner of their management.

> *"Medical innovation depends upon extensive interactions between universities and industry, with knowledge and technology transferring in both directions. These interactions have had important public health and economic benefits."*
>
> Annetine Gelijns and Samuel Thier, "Medical Innovation and Institutional Interdependence," JAMA, January 2, 2002, page 1.

Leading Practices

Practice: Proof-of-Concept Funds are becoming a recognized tool to help advance promising university discoveries by addressing questions related to the commercial viability of these new discoveries to attract initial investors.

- ILLUSTRATIVE EXAMPLE

Colorado Advanced Industries Accelerator Fund (formerly the Colorado Bioscience Discovery Evaluation Grant Program)

Overview

To validate the commercial potential of research discoveries and technologies and reach critical commercialization milestones.

The Colorado Bioscience Association partnered with the state to create the Bioscience Discovery Evaluation Grant Program that supported research infrastructure, commercialization, and funding for emerging and early-stage companies and commercialization infrastructure. The Grant Program served as a template for the state's broader Advanced Industries Accelerator Program into which it is now being integrated.

Accomplishments

Under the Bioscience Discovery Evaluation Grant Program, 163 proof-of-concept grants were made from 2007 to 2013 involving funding of just under $10 million, which led to the following:

- 38 new companies formed;
- Over $290 million of follow-on capital funding; and
- 34 licenses issued.

> *"Through the infrastructure grants provided within the Bioscience Discovery Evaluation Grant Program (BDEGP) and now through the Advanced Industries Accelerator Program, the state's research institutions have created new programs that assist emerging bioscience companies in bringing new technologies to commercialization. The CBSA encourages the state to maintain and grow these programs and support the public institutions in developing more partnerships with the private sector."*
>
> Colorado Bioscience Association State Policy Priorities

- ADDITIONAL EXAMPLES:

Iowa's Innovation Programs: The programs, established in 2007, build upon the state-funded Demonstration Fund to support high-technology prototype and concept development activities by small- and-medium-sized companies that have a clear potential to lead to commercially viable products or services. Through 2013, 37 bioscience projects were funded at nearly $4.5 million, which is roughly one-third of the total funds invested. An independent economic and fiscal impact study of the Demonstration Fund's efforts from 2007 to 2012 found that the 127 investments made, totaling about $13 million, generated 600 direct jobs and annual revenue growth of $87 million, based on survey results from 79 of the firms assisted (a number of firms received multiple awards and some closed or eventually declined the investment).[26]

California Institute for Quantitative Biosciences (QB3). Established in 2000, QB3 represents a partnership between the University of California system, state government, and industry with strategic collaborations across each entity. The institute has developed a range of support for entrepreneurs including a network of incubators, a venture capital fund, a "start-up in a box" program, Small Business Innovation Research/ Small Business Technology Transfer (SBIR/STTR) workshops, and "Bridging-the-Gap" Awards that address the funding gap QB3 has seen between traditional federal research funding and start-up commercial funding. The QB3 Incubator Network spans 40,000+ square feet of space, and more than 70 resident companies that have created hundreds of jobs and raised $513 million in investments from public and private sources from 2005 to 2013. QB3 also has a strong track record in advancing strategic research alliances, including with Pfizer, Johnson & Johnson, and GE Healthcare.

26 Econsult Solutions, *The Economic and Fiscal Impacts of the Demonstration Fund on the Iowa Economy,* February 2013.

Practice: State Assistance to Firms Pursuing Federal Grants.

Each federal agency with an extramural R&D budget that exceeds $100 million is required to allocate 2.5 percent of its R&D budget to the SBIR program. These federal agencies develop specific technology topic areas that they are seeking small businesses to address. The SBIR program provides funding in phases, with the first phase being focused on validating the technical feasibility and the second phase on furthering product development and evaluating the commercialization potential. The STTR program is another federal initiative aimed at advancing innovation R&D and seeking to bridge the gap between basic science research and commercialization of the resulting innovations. The STTR program aims to enhance the transfer of technology between small businesses and research institutions through cooperative R&D and to increase private-sector commercialization of federal R&D.

- ILLUSTRATIVE EXAMPLE

Connecticut's SBIR Acceleration and Commercialization Program

Overview

The program is designed to increase the participation of Connecticut-based firms in the federal SBIR and STTR grant programs.

The Small Business Innovation Office of Connecticut Innovations offers support at three different phases as companies advance through the federal SBIR/STTR program:

- Phase Zero. Even before a company receives an SBIR/STTR award, it can apply for support, including SBIR conference fee reimbursements, proposal accounting support, application reviews, and strategy sessions.
- Phase I awardees can receive up to $100,000 to increase the chances of receiving a Phase II funding award and accelerating commercialization.
- Phase II award winners can receive up to $200,000 with a required 50 percent external match for bridging the "valley of death," the phase prior to commercialization when they may need to file patents, develop a marketing strategy, and conduct other activities to bring their technology to market.

Accomplishments

Connecticut Innovations reports that, since the program was launched in March 2012, 54 companies have received $2.1 million, which in turn has leveraged $19.7 million in federal and private financing support.

Practice: New Business Development and Entrepreneurial Development.

Many state-supported bioscience initiatives seek to further entrepreneurial and new business development. This typically involves having seasoned entrepreneurs to serve as mentors and other forms of technical assistance to entrepreneurs and their emerging ventures. Often, some form of early-stage, seed investments are also made to help in new company formation, plus the availability of specialized bioscience wet-lab space at affordable leasing rates is also provided. Given the localized nature of entrepreneurship, many states support the use of regional intermediaries to deliver these new business development and entrepreneurial development efforts.

- ILLUSTRATIVE EXAMPLE

Illinois PROPEL Entrepreneurship Center

Overview

PROPEL is a commercialization assistance program targeted specifically at raising the success rates of life science start-ups in Illinois.

PROPEL, a partnership of Illinois Biotechnology Organization (iBIO) and its affiliated iBIO Institute, provides peer-based entrepreneurial coaching panels that seek to sharpen business plan presentations, CEO roundtables, connections with professional service firms, a variety of workshops,

and technical assistance. PROPEL also provides Entrepreneurship Center Matching Grants of about $5,000 to help life science entrepreneurs obtain professional services for comprehensive business planning.

Accomplishments

As of February 2014, PROPEL has worked with over 90 companies, and its active companies have raised nearly $110 million in capital, grants, and loans and received more than 70 issued U.S. and international patents. One quarter of its assisted life science companies are led by women, and 20 percent are led by minorities.

> *"As a very early stage investor, I have several PROPEL companies in my portfolio. PROPEL programs give these startups a leg up. None of these startups are sure bets, but the rigors of PROPEL's work with them substantially de-risks the enterprise compared to what it might otherwise look like at such an early stage."*
>
> Cliff Turner, "Angel" Investor

> *"iBIO Institute and the state of Illinois should be extremely proud that the Bay Area, often heralded as the world's leading entrepreneurial hub, is using PROPEL as its model for entrepreneurship support."*
>
> Gail Maderis, President and CEO of BayBio in San Francisco

- ADDITIONAL EXAMPLES:

Pittsburgh Life Sciences Greenhouse (PLSG): Established in 2001, PLSGs are located in three regions of the state with substantial bioscience industry and research hubs. Each has customized its program offerings to the needs and characteristics of its region with Pittsburgh's focus on growing emerging life science companies and nurturing executive-level talent. Since its formation in 2001 to 2014, PLSG has made approximately $20 million of direct investments to 75 companies, which has leveraged over $900 million of additional capital for the region.

Oregon Translational Research and Development Institute (OTRADI): OTRADI was launched in 2007 as a nonprofit Oregon Signature Research Center (one of three established to date) with a focus on commercializing bioscience research. OTRADI partners with both public and private entities including emerging bioscience companies, research universities, and economic development organizations to "discover, develop, and commercialize" across drugs, diagnostics, medical devices, and other bio-related products. The results for OTRADI have been promising with the initial $12.4 million in state investment in OTRADI leveraging more than $100 million in private, federal, and foundation funding for Oregon, an 8:1 return on state money. Since 2011 OTRADI's work has helped to create or retain at least 230 bioscience jobs in Oregon. OTRADI's partnerships with more than 150 researchers at universities throughout the state have added $3.5 million in licensing revenue for those universities in Oregon.

> *"The state's investment in OTRADI is paying real dividends. The [OTRADI Bioscience Incubator] gives us one more tool to help bioscience businesses and entrepreneurs create the kinds of jobs that are diversifying Oregon's economy."*
>
> John W. Morgan, Oregon Innovation Council Chair

Practice: Support and Advance New Venture Formation.

This approach to venture development features a more proactive effort to leverage the capabilities of serial entrepreneurs to launch new companies and serve as the management team leading the new start-up in its initial product development phase, including raising initial angel and product development capital.

The venture development organization then recruits a permanent management team once a number of key milestones are reached, such as technology and market validation, adequate capital in place, and the demands for ongoing executive management becomes more full-time.

- ILLUSTRATIVE EXAMPLE

  Colorado Institute for Drug, Device and Diagnostic Development (CID4)

  Founded in 2009 with funding support from the Bioscience Discovery Evaluation Grant Program, CID4 is a nonprofit to advance the Colorado bioscience ecosystem through company creation and job growth. This state-funded program involves actively working to identify, fund, and actively manage emerging life science technologies, through an ongoing technology solicitation process engaging Colorado universities, researchers, and inventors. CID4 has eight early-stage companies under its guidance as of early 2015.

STATE DEVELOPMENT PRACTICES:

ADDRESSING THE AVAILABILITY OF FINANCIAL CAPITAL

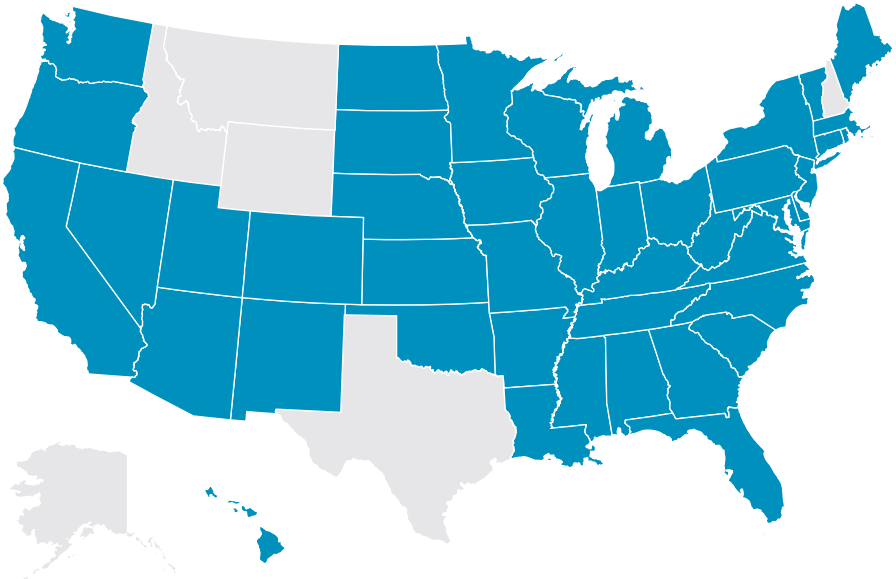
The costs and effort associated with developing and bringing a technology product or service to market can also be very substantial. While the need for financial capital applies to all technology-based companies, bioscience companies need to access larger amounts of capital, for longer time periods, to cover the efforts needed to complete clinical trials and obtain regulatory approvals before products can be introduced into the market. It is not just the higher costs of developing new therapeutics and devices that make bioscience venture investing more challenging. There is often significant uncertainty as to how long clinical trials, testing, and regulatory approval will take coupled with a significant probability of failure, especially for novel therapeutics and devices.

The assessment identified 44 states with venture financing programs or other related initiatives targeted toward the biosciences.

Importance for Biopharmaceutical Development

- The risk and uncertainty inherent in bioscience business development are steep, and attracting funding, particularly at the critical seed and early stages, is a major challenge for commercial development. Start-up biopharmaceutical firms often experience a capital shortfall while generating the necessary preclinical safety data for an IND application as well as during clinical trials and regulatory approval process.
- Biopharmaceutical companies are active in venture investing and getting the cutting edge of new models to venture development that link venture capital to more integrated services to foster new firm creation. Johnson & Johnson's Innovation Centers, for example, offers an integrated model of new venture development including incubation facilities, entrepreneur mentoring, and venture financing. Another example is the Accelerator Corporation started in Seattle and now expanding

44 States Identified with Venture Financing Programs



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to New York City with investments from Eli Lilly, Johnson & Johnson, and Pfizer, among others, that partners with academic institutions in a structured process to bring together a full range of venture start-up services led by a core team of serial entrepreneurs to identify and evaluate the commercial potential of promising bioscience discoveries and technologies and then serve as the initial management teams to form and advance new start-up companies within dedicated bioscience incubation space.

- Recent trends in venture capital financing suggest a shift toward later-stage investing, which often leads to a shortfall in the critical early rounds.

Leading Practices

Practice: Early-Stage Venture Financing.

States are active in supporting a range of direct venture financing approaches involving loans and more equity-like investments.

- ILLUSTRATIVE EXAMPLE

Indiana's Bioscience Venture Fund of Funds

Overview

BioCrossroads has established two bioscience-oriented fund of funds (1) to catalyze venture capital funding of emerging bioscience companies in Indiana and (2) to advance relationships for emerging Indiana bioscience companies with broader regional and national venture capital funds.

In 2003, BioCrossroads established the Indiana Future Fund to bring venture financing to Indiana, investing $73 million across six venture capital firms. In December 2009, BioCrossroads established the $58 million INext Fund as a successor fund, with four venture capital firms receiving investments to date. This fund of funds approach in Indiana is complemented by Indiana BioCrossroads Seed Capital Funding. The seed capital funds of BioCrossroads provides early-stage capital needed for life science businesses to commercialize and validate their technology and begin the road to growth prior to their ability to attract capital from venture capitalists. Multiple seed funds have been organized by BioCrossroads totaling $14.25 million from a variety of state, philanthropic, and industry support.

> *"Indiana's hardly a mecca for venture capital and other capital funding for business, but in at least one area — the life sciences — it outperforms the nation."*
>
> Jeff Swiatek, "Study: Indiana outpacing U.S. in life-science funding," Indianapolis Star, October 30, 2014

Impacts

A 2014 study commissioned by BioCrossroads to provide an independent assessment of the impact of public and private efforts to advance innovation capital for the biosciences found:[27] Indiana has made substantial gains in life science venture capital investment over the past decade. Total venture capital investment in the life sciences in Indiana over the period 2003 to 2013 rose to $349 million across 100 deals and 39 companies.

- ADDITIONAL EXAMPLE:

Utah Capital Investment: Formerly known as the Utah Fund of Funds and founded in 2003, this venture capital initiative is a $300-million State of Utah economic development program aimed at providing access to alternative or nontraditional capital for Utah entrepreneurs. To date, $785 million has been invested in 73 Utah companies by Utah capital portfolio funds since its inception, of which 60 remain in operation, and 4,069 new Utah jobs have been added.

27 *Re-Examining the Need for Innovation Capital to Advance Life Science Development in Indiana*, prepared by Battelle Technology Partnership Practice, October 2014.

Practice: State Tax Credit to Create Investment Pool.

- ILLUSTRATIVE EXAMPLE

Tennessee Small Business Investment Company Credit Act

The state created a state-sponsored, "venture capital type" program that provides capital to local venture capital companies. Rather than trying to use a fund of funds mechanism or limited use of tax incentives, Tennessee created a pool of capital that was competitively awarded to venture capital firms formed in Tennessee and competitively selected by the state as Tennessee Investment Companies or TNInvestcos. The TNInvestcos were each allocated rights to $20 million in tax credits and have sold the future years' tax credits for up-front capital from the state's insurance companies to invest in Tennessee businesses. The 2013 Annual Report indicates that 132 Tennessee companies received direct investments of $108 million from TNInvestcos, and follow-on capital from other sources of $221 million. These 132 TNInvestco companies had employment of 1,605 jobs, of which 687 were new jobs generated after investment.[28] Other states, such as Maryland and Pennsylvania, have implemented similar tax credit approaches to generate venture capital investment in their states.

28 See: https://www.tnecdit.net/WebFiles/Transparency/TNinvestco/tninvestcoannualreport_2013.pdf.

STATE DEVELOPMENT PRACTICES:

BUILDING ADVANCED MANUFACTURING TECHNOLOGY CAPABILITIES

The fast pace of technological advancements is also impacting advanced manufacturing processes. The President of the International Society for Pharmaceutical Engineering explains as follows:

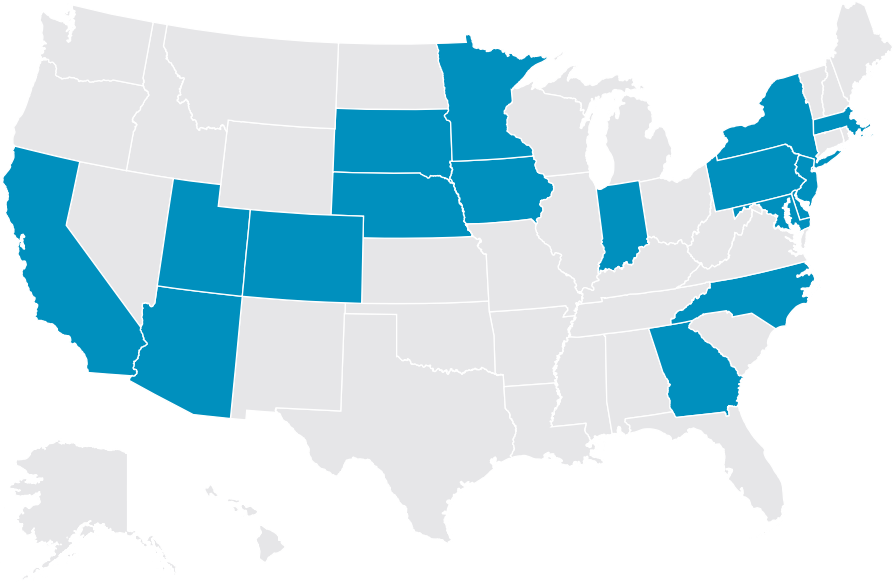
> *"The challenges facing pharmaceutical manufacturing have increased dramatically ... The advent of biologics, more widely distributed supply chains, and many other influences demand greater investment; better integration of product, quality and manufacturing design; and greater industry collaboration overall. Quality controls, corrective and preventive actions (CAPAs) and root cause analyses that were once more straightforward are highly complex today, and the industry could benefit from agreement on how to use and apply technology to achieve greater gains in all areas, including quality and safety."*[29]

The assessment identified 17 states with advanced manufacturing initiatives related to the biopharmaceutical industry, for example, offering pilot-plant facilities and targeted job training on-site.

Importance for Biopharmaceutical Development

- For the United States to stay competitive in manufacturing biopharmaceuticals, it needs to lead in deploying technologies and excelling in manufacturing innovations and high productivity.
- The demands for adopting advanced manufacturing technologies are placing rising demands for a highly technical production workforce to support biopharmaceutical manufacturing, with specific skills in bio-scale-up manufacturing to three-dimensional printing to use of robotics and smart sensors to integration of advanced computing systems into manufacturing operations.

17 States Identified with Biopharma-related Advanced Manufacturing Initiatives



29 Nancy Berg, "Today's Pharma: Big Challenges, Big Expectations," *Pharmaceutical Manufacturing*, May 22, 2012 http://www.pharmamanufacturing.com/articles/2012/084/

Leading Practices

Practice: Shared-Use Biomanufacturing Facilities Tied to Education and Training.

States are actively advancing the availability of shared-use biomanufacturing facilities to assist emerging biopharmaceutical companies in making the leap from the research bench to the production of biologic medicines for preclinical testing and clinical trial use, as well as offering specialized training programs in bioprocessing.

- ILLUSTRATIVE EXAMPLE

North Carolina's Advanced Manufacturing Facilities

Overview

North Carolina has had a long-standing effort in targeting biomanufacturing as a competitive advantage for the state. North Carolina colleges and universities offer advanced manufacturing facilities for contract services and workforce training. Program activities include the following:

- Golden LEAF Biomanufacturing Training and Education Center (BTEC) at North Carolina State's Centennial Campus houses 63,000 square feet of fermentation, cell culture, recovery, purification, and analytical lab space for training North Carolina State students and industry professionals in bioprocessing. BTEC also offers its space and expertise for protein production and purification, process/technology development, and analytical testing/development, serving both industry and other academic labs. Undergraduates, graduate students, and working professionals come to BTEC for hands-on learning in the latest biomanufacturing technologies.
- NCBioNetwork Capstone Center, offered by the North Carolina Community College System, is co-located at the BTEC in Centennial Campus. It offers a simulated industry Current Good Manufacturing Practice (cGMP) environment for hands-on instruction. Four community college certificates are offered by the Capstone Center. Courses can be taken individually and focus on a variety of critical skill sets within areas important to biomanufacturing: GMP, aseptic manufacturing, operations in biotechnology processes, industrial microbiology, good laboratory practices (GLP), High Performance Liquid Chromatography (HPLC), and validation.
- Biomanufacturing Research Institute and Technology Enterprise (BRITE) at North Carolina Central University (NCCU) provides 31,000 square feet of laboratory space for applied research in areas related to biomanufacturing and biotechnology, with a number of core facilities such as monoclonal antibody production.

> *"BTEC is not only great for educating students … [about] the many aspects of biomanufacturing but also in equipping them with the soft skills necessary to succeed in the work place."*
>
> Kasi Barker, graduated with a Master's in Biomanufacturing in December 2014 and is now working at Grifols

Accomplishments

As of the end of 2015, BTEC has provided hands-on education and training in biomanufacturing to over 1,700 participants from more than 150 organizations through its professional development courses. These include start-up companies as well as more established biopharmaceutical companies, such as Amgen, Biogen, Merck & Co. and Novartis.

BTEC began offering bioprocess and analytical services in 2009 to utilize unused capacity, provide extra revenues to compensate for shrinking state funding, and bolster its curricula. University researchers and start-up companies use BTEC's services to advance their technologies at prices they can afford. In 2014–2015, 24 projects were

completed. Since 2009, BTEC's project portfolios and associated revenues have grown 20 percent annually.

- ADDITIONAL EXAMPLE:

  Massachusetts's Shared-Use Manufacturing Facilities Network: Since 2008, Massachusetts has invested in a network of shared-use manufacturing facilities, typically associated with academic and research institutions. Investment in shared use, biomanufacturing scale-up facilities is a key component of the capital investment program of the Massachusetts Life Sciences Center. This capital program is designed to provide grants for capital projects that support the life sciences ecosystem in Massachusetts by enabling and supporting life sciences workforce development and training, R&D, commercialization and/or manufacturing in the Commonwealth. A network of shared-use, biomanufacturing scale-up facilities are now established across Massachusetts to serve as innovation accelerators for emerging biopharmaceutical companies.

STATE DEVELOPMENT PRACTICES:

CREATING SUPPORTIVE INNOVATION-ORIENTED BUSINESS INCENTIVES

Economic incentives for innovations can take a number of forms to support both the R&D and capital investments necessary for biopharmaceutical-related development, fostering a company's ability to take a product from discovery to development to delivery to patients.

The assessment identified 42 states with economic incentives that focus on advanced technology industries including biopharmaceuticals, most commonly in the form of R&D tax credits.

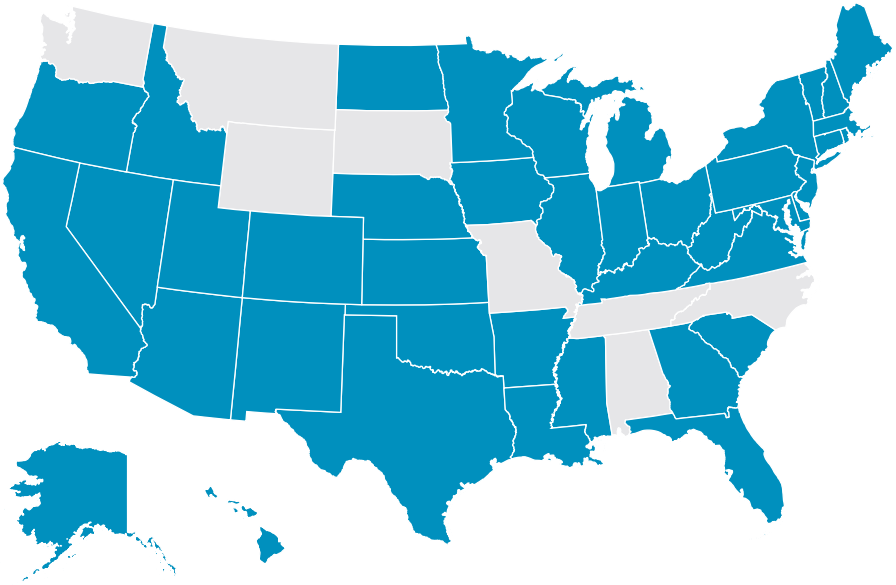
Importance for Biopharmaceutical Development

- R&D tax credits are an important policy tool used across the world to attract research investments by companies. The availability of R&D tax credits can ease the cash flow demands that bioscience companies face as they seek to navigate the long process of bringing a new technology or product to market. The rising costs and significant uncertainty and length of time surrounding biopharmaceutical R&D and manufacturing activities make it particularly important for states to offer economic incentives to biopharmaceutical companies to undertake research and to locate innovation-related activities in their state.

> *Several studies have been performed demonstrating that these state R&D tax credits increase R&D spending at the margin by lowering the cost of capital relative to other nations and by attracting investments that might have been made in other U.S. states."*
>
> Ross DeVol, Kristen Harris, and Minoli Ratnatunga, California's Innovation Economy: Policies to Maintain and Enhance It, Milken Institute, December 2015, pages 45–46

At the federal level, the R&D tax credit is structured as an incentive for incremental increases in research funding by companies, and it is set at a 20 percent tax credit level. Most states also provide incentives for incremental increases in R&D, though the tax credit level varies substantially

42 States Identified with Economic Incentives Focused on Innovation



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across states. Some states, such as Connecticut, Maryland, and Utah, offer a R&D tax credit on the base amount as well as for incremental increases, often at a higher rate.

Another important difference across state R&D tax credits is whether they allow for companies without sufficient tax liabilities to benefit from the value of the tax credit by making the credit refundable. Particularly for emerging biopharmaceutical-related companies still engaged in product development, which can take 10 to 15 years, refundable tax credits can be a very impactful incentive that helps these emerging companies further their new product development efforts.

Some states also limit the value of their R&D tax credits, either imposing budget limits or restricting how much tax liability can be reduced for any individual company. These limitations lower the value of R&D tax credits and create uncertainty for companies that can undermine the incentive to companies to pursue R&D.

Table 2 sets out many of the key components of state R&D tax credits for the 45 states profiled with active bioscience development efforts.

- Another innovation-oriented tax incentive that is becoming more common across states is angel investment tax credits. Angels are high-net-worth individual investors who make high-risk seed- and early-stage investments in technology ventures.

> *"Because angel investors are valuable in helping companies bridge the gap between the earliest stages, when they usually appeal to friends and family for financial support, and later stages, when they seek support from venture capitalist, many states have introduced policies to mitigate the high level of risk and encourage the formation of angel groups."*
>
> State Science and Technology Institute, "How Effective are State Angel Tax Credits?" March 20, 2013

Often angel investors are serial entrepreneurs, who combine mentoring and business advice with their investments. Many angel investors are part of networks or groups that consider opportunities collectively and in many cases invest together. With formal venture capital shifting toward later-stage investing, angel investors are becoming an ever-important source of seed- and early-stage capital to help new business ventures form and reach critical new product development milestones. State tax incentives to angel investors are particularly important for biopharmaceutical development which has longer investment time frames and higher uncertainty around the success of new venture efforts to commercialize their technologies into approved products.

Leading Practices

Practice: Refundable R&D Tax Credit.

This is one of the most common approaches used across the world for encouraging innovation-led development. Ten states currently offer some form of refundable R&D tax credits, including Connecticut, Hawaii, Iowa, Louisiana, Nebraska, New York, Virginia, and West Virginia.

- ILLUSTRATIVE EXAMPLE

Connecticut's R&D Tax Credit

Overview

To encourage R&D activities and investments in Connecticut by making them more economically viable.

Connecticut's R&D Tax Credit provides a refundable 6 percent R&D tax credit for small businesses with gross income of less than $100 million. For these small businesses, unused R&D credits can be sold to the state for 65 percent of their value, or can be carried forward. For other businesses, Connecticut's R&D tax credit varies based on the level of R&D expenses, from 1 percent to 6 percent.

Impacts

The Connecticut Business and Industry Association reports that, since the adoption of the R&D tax credit in 2000, $109.2 million in credits have resulted in $3.14 billion of investments in Connecticut.

Practice: Incentives for Investing in Emerging Companies.

A number of states seek to improve access to capital for early-stage bioscience and other technology companies by providing individual and corporate investors a tax credit for their investments. Most states offer these investor credits across all technology companies, while a number target the biosciences.

- ILLUSTRATIVE EXAMPLE

Wisconsin's Early-Stage Business and Qualified New Business Venture Investment Credits

Program Objective

Wisconsin's Early-Stage Business Investment Credits are targeted toward and available to certified early-stage businesses developing innovative products, processes, or services.

Program Design and Activities

To qualify, a company must be headquartered in the state, have at least 51 percent of its employees based in the state, have fewer than 100 employees, be in operation for less than 10 years, offer significant potential for job growth or generating capital investment, and have not received aggregate private equity investments of more than $10 million. Once a company is certified as a Qualified New Business Venture (QNBV) by the Wisconsin Economic Development Corporation, then the company can receive up to $8 million in investments from a qualified investor. The investors, meanwhile, who can be angel investors (accredited/sophisticated investors), an angel network, or a qualified venture capital fund, can receive a transferable tax credit of up to 25 percent with no limit on the amount of credits an investor can claim by investing in more than one qualified company.

> *"Startups have the power to make things happen in Wisconsin. Through technology that transforms the everyday, these companies are improving the way we live, not only in Wisconsin but around the world. The Qualified New Business Venture (QNBV) Program has helped to create an environment in our state that is both conducive to new business development and attractive to global investors, thus setting the stage for our state's prosperous future."*
>
> Reed E. Hall, Past Secretary and Chief Executive Officer, Wisconsin Economic Development Corporation

Impacts

From its inception in 2005 through 2012, the QNBV Program has distributed $58.8 million in tax credits. More importantly, the companies in the program have attracted over $916 million in capital that has been invested in new technologies. In 2012, 44 new companies received QNBV certification, bringing the number of companies currently in the program to 160.

- ADDITIONAL EXAMPLE

Maryland Biotechnology Investment Incentive Tax Credit: Established in 2006, Maryland Biotechnology Investment Incentive Tax Credit assists the state's early-stage life-science companies in raising funding. It provides a refundable income tax credit equal to 50 percent of an eligible investment to investors in qualified Maryland biotechnology companies. During the first eight years of the program, it has stimulated investment of more than $120 million in qualified Maryland biotech companies, with almost 70 companies taking advantage of the credits.

Table 2: Key Features of State R&D Tax Credits

State	Level of R&D Tax Credit	Is a Portion of R&D Tax Credit Refundable?	Is there a Cap on Funding for R&D Tax Credits?	Covers Incremental Increases in R&D
Alabama	None			
Arizona	24% for first $2.5 m and 15% for >$2.5 m	Yes, 75% of credit for companies with less than 150 employees	State budget limit of $5 m on refundable portion	Yes
Arkansas	20% and 33% for Strategic Areas & Targeted Companies	Yes, for R&D by Targeted Companies at a 33% tax credit level	State budget limits refundable portion and Strategic Areas up to $50,000 tax credit	Yes
California	15%	No		Yes
Colorado	Limited to enterprise zones at a 3% tax credit level of qualified R&D expenses			
Connecticut	20% on incremental; Sliding scale on nonincremental up to 6%	Yes	No	Both Incremental and Nonincremental
Delaware	20% for small businesses and 10% for larger businesses	No	$5 m total budget cap + Cannot exceed 50% of taxpayer tax liability	Yes
Florida	10% for companies in targeted industries (includes life sciences)	No	$23 m total budget cap and Cannot exceed 50% of taxpayer tax liability	Yes
Georgia	10%	No	Cannot exceed 50% of taxpayer tax liability	Yes
Hawaii	20% but limited only to high-tech companies that conduct more than 50% of its activities in R&D	Yes	No	Yes
Idaho	5%	No	No	Yes
Illinois	6.5%	No	No	Yes
Indiana	15% for R&D increases up to $1 m and 10% for R&D increases above $1 m	No	No	Yes
Iowa	6.5% regular rate and additional supplemental R&D tax credit if qualifying for state's high-quality jobs program or located in enterprise zone	Yes	No	Yes
Kansas	6.5%	No	25% of credit	Yes
Kentucky	Tax credit of 5% on construction of research facilities			
Louisiana	40% to 8% sliding scale based on size of company	No	Limit R&D tax credit to 70% of incremental increases	Yes
Maine	5%	No	Cannot exceed 50% of taxpayer tax liability and limited to 75% of credit value above $25,000	Yes
Maryland	3% base R&D and 10% on incremental R&D growth	Yes for small businesses	If either base or incremental credits exceed $4.5 m then prorated	Both Incremental and Nonincremental
Massachusetts	10% basic and 15% on research costs related to contributions to universities, hospitals, or other research organizations	No	No	Yes
Michigan	1.9%	No	No	Yes
Minnesota	10% up to $2 m in incremental R&D expenses and 2.5% >$2 m	No	No	Yes
Mississippi	None			
Missouri	None			

Table 2: Key Features of State R&D Tax Credits (Continued)

State	Level of R&D Tax Credit	Is a Portion of R&D Tax Credit Refundable?	Is there a Cap on Funding for R&D Tax Credits?	Covers Incremental Increases in R&D
Montana	None			
Nebraska	3%	Yes	No	Yes
New Jersey	10% of base R&D and 10% on incremental R&D growth	Yes for small businesses	No	Yes
New Mexico	4% on base R&D expenditures, with supplemental 4% if meet payroll increases with R&D increases	No	Up to $5 m of R&D expenditures	Nonincremental
New York	10% for strategic businesses, including biotech and pharmaceuticals that meet job-growth targets or make substantial capital investments	Yes	Credit capped at 3% of research expenditures made	Yes
North Carolina	None			
North Dakota	25% for first $100,000 in incremental expenses and 8% >$100,000	Yes, up to $100,000 for qualified companies	No	Yes
Ohio	7%	No	No	Yes
Oklahoma	None			
Oregon	5%	No	Maximum credit to company is $1 m annually	Yes
Pennsylvania	10%	Yes, approved small technology companies	Total budget cap of $55 m (with 20% set aside for small businesses)	Yes
Rhode Island	22.5% for incremental R&D expenses up to $111,111 and 16.9% >$111,111	No	Cannot exceed 50% of taxpayer tax liability	Yes
South Carolina	5%	No	No	Yes
South Dakota	None			
Tennessee	None			
Texas	5% with 6.25% for R&D expenses with university	No	Cannot exceed 50% of taxpayer franchise tax liability	Yes
Utah	5% of incremental R&D expense, plus additional 5% made to qualified research organizations that exceeds base amount; 7.5% of research expenses for the year	No	No	Incremental and Nonincremental
Virginia	15% of first $234,000 research expenses with higher rate of 20% if expenses with university	Yes	Total budget cap of $7 m with prorated benefits if cap exceeded	Nonincremental
Washington	None			
West Virginia	None			
Wisconsin	5.75%	No	No	Yes

Source: Adapted from KBKG summary of state R&D tax credits (see http://kbkg.com/research-tax-credits?gclid=CMGK8bDewc8CFUdehgodzh8Bgg), augmented by searches of state web sites by TEConomy.

STATE DEVELOPMENT PRACTICES:

ADVANCING THE STEM TALENT PIPELINE

A varied and successful bioscience industry base requires, at its core, a mix of specialized skill sets unique to the industry and spanning the continuum of talent from laboratory technicians and precision production workers to PhD-level scientists, engineers, and other researchers. In addition, the importance of talented management teams with experience in the biosciences cannot be overstated. These teams often take the reins from scientists or postdoctoral researchers, who have developed the initial technology, and lead the company to success.

Meeting the needs of industry for a talented bioscience workforce must include both nurturing local home-grown talent and competing in the national and international markets for top-level bioscience scientific and experienced management talent. In particular, growing, retaining, and attracting entrepreneurial talent for bioscience start-ups are critical steps for leveraging the innovations being generated by academic medical centers.

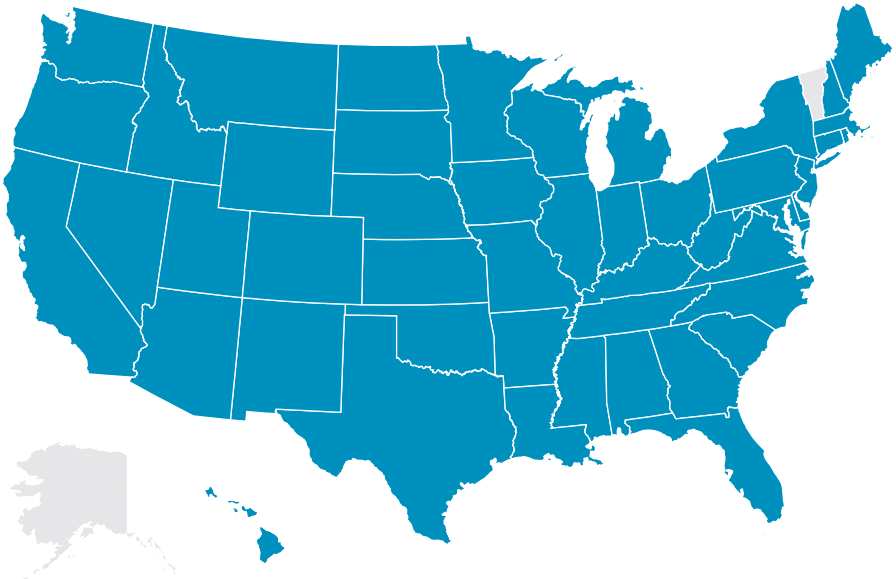
The assessment identified 48 states with STEM-related workforce and education programs and initiatives that span K–12 (most common), postsecondary education, and the incumbent bioscience workforce.

Importance for Biopharmaceutical Development

In today's knowledge-based economy, state and local communities are increasingly competing based on their ability to educate, retain, and attract a skilled talent base that meets the needs of industry.

Talent is one of the essential ingredients for a successful biopharmaceutical industry across all industry activities. Talent represents not only the general skills of the workforce to produce top-quality, innovative goods and services quickly and efficiently, but also the specialized capacity found among world-class scientists and engineers to invent, advance discoveries, and develop new technologies, as well as the entrepreneurs, managers, corporate financial analysts, accountants, marketing staff, and business consultants needed to bring these technological advancements to the global marketplace. States have

48 States Identified with STEM-related Workforce and Education Initiatives



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begun to place increased importance on ensuring that they have a pipeline of STEM talent to support their innovative industries.

Leading Practices

STEM activities that support a bioscience talent pipeline are an emerging area of state policies. Still, some notable areas of activities are emerging with a number of states taking the lead, particularly North Carolina, Massachusetts, and Illinois. Perhaps the best way to see the development of these STEM activities is across the talent pipeline from K-12 to postsecondary to the incumbent workforce.

Practice: K–12 Specialized Labs and Teacher Professional Training.

- ILLUSTRATIVE EXAMPLE

California Life Sciences Institute

Program Objective

The California Life Sciences Institute (CLSI)—a nonprofit organization supported through collaborations, partnerships, and funding from individuals, sponsors, and foundations—works to bring together industry with educational institutions to improve STEM education and to advance student awareness of and preparation for life-science career opportunities. CLSI STEM education programs include the following:

Program Design and Activities

A comprehensive effort includes a number of program activities:

- **CLSI Bio-Community,** which operates a central website portal where bioscience companies and their employees can identify opportunities to promote STEM education and learning opportunities in California's grade-K-through-postgraduate classrooms, particularly those that are underresourced and made up of students of diverse socio-economic backgrounds.
- **CLSI Bio-Link Depot,** where California bioscience companies can donate their equipment, supplies, and consumables to the Depot for use in local schools, giving them a "second-life" in the classroom.
- **CLSI's Amgen Bay Area BioGENEius Challenge,** a biotech research competition for high school students. Projects are presented to industry judges with winners receiving cash prizes and the chance to interact with industry leaders at the annual BIO International Convention.
- **From the Laboratory to Leadership,** which works to develop the managerial skills of experienced science professionals through a four-day course focused on everything from team-building and delegation to managing resources and running effective meetings.
- **The BioCollaborative,** which offers e-learning and e-communities with a varied set of industry-driven overview and more in-depth courses (4 "tracks" and 25 "modules") in both science and business for professionals. Two industry certificates can be pursued either in the Life Science Immersion Program or the Industrial Biotechnology Immersion Program.

Impacts

The following are among the reported outcomes of CLSI:

- The Depot has supported more than 200 teachers and 85,000 students at the high school and college levels providing STEM education and hands-on laboratory training.
- From the Laboratory to Leadership has served more than 3,000 managers from 300 life science companies.

- ILLUSTRATIVE EXAMPLE

Massachusetts Life Sciences Center STEM Equipment and Supplies Grant Program

Program Objective

The STEM Equipment and Supplies Grant Program of the state-funded Massachusetts Life Sciences Center (MLSC) enables the purchase of lab and other equipment to train students in bioscience technology and research to increase student interest and achievement in STEM fields.

Program Design and Activities

The grant program funds the purchase of equipment and supplies for high schools and middle schools, and provides grant support to nonprofit organizations offering STEM-related programs reaching out to a diverse student population.

Impacts

To date, the STEM efforts have awarded more than $12 million to over 100 different high schools, middle schools, and nonprofit organizations and leveraged more than $1 million in life-science industry matching funds.

- ADDITIONAL EXAMPLE:

Illinois iBIO Institute's EDUCATE Center

Program Objective

As teachers and districts develop new curricula to meet the Common Core State Standards, the iBIO Institute's EDUCATE programs (established in 2007) bring cutting-edge science from regional bioscience companies to develop world-competitive educators and inspire student interest in science. The iBIO Institute's EDUCATE Center connects Illinois classrooms with the real world of biotechnology and science-based industry; hands-on biotechnology lab activities; tours of industry R&D facilities; and authentic, interdisciplinary problem-based learning experiences. Its teacher professional development workshops—TalentSparks!—has reached over 800 teachers and, through them, over 70,000 students. Its after-school program for girls, Stellar Girls—developed with support from Astellas USA Foundation—inspires girls in grades 3 to 8 to enter into STEM careers. Independent external evaluation shows that TalentSparks! teachers and their students significantly improve their knowledge of STEM concepts and careers with average gains of approximately 9 percentage points on both science and mathematics content assessments. Measurable program outcomes include significant gains in teacher best practices in science education and significant gains of an average of 19 percentage points on science content tests by fifth- and sixth-grade Stellar Girls and 13 percentage point gains for seventh- and eighth-grade Stellar Girls.

Practice: Postsecondary STEM Efforts

- ILLUSTRATIVE EXAMPLE

Science Foundation Arizona's (SFAz) Graduate Research Fellows Program

Overview

The SFAz Graduate Research Fellows Program seeks to advance the pool and growth of top talent in Arizona's three research universities; to develop job candidates in high-tech fields, including many in the biosciences and biomedicine; as well as to develop and attract the research expertise and activity they bring into the state.

The program provides financial support for candidates' tuition through their graduate studies; in addition to their research responsibilities, the fellows work 6 to 8 hours per week in K–12 schools to help mentor students and/or teachers in STEM-related areas.

Impacts

Since 2007, the program has funded 297 fellows in Arizona. Some of these fellows have been involved in creating companies in Arizona.

> *"It's critical for Arizona to continue to have an ongoing flow of high-tech talent for our workforce as well as to be conducting research that allows these bright minds to capitalize on ideas for our marketplace. In just a few years, we've already seen the creation of start-up companies providing real value to the community from research we initially funded…The continuation of our GRF program is imperative for Arizona."*
>
> William Harris, Science Foundation Arizona's President and CEO

- ADDITIONAL EXAMPLE:

Iowa's Student Internship Program: The Iowa Student Internship Program, established in 2008, is designed to support postsecondary student interns for small- to medium-sized companies in the biosciences and other targeted industries. The program provides companies with state grant funding of up to $3,100 for internships with a 2-to-1 private-sector match (so a company would need to fund $6,200 to reach full state funding). From 2008 to 2012, 45 student internship positions were to bioscience companies, or roughly 10 percent of all internship placements.

Practice: Incumbent Worker STEM Efforts

- ILLUSTRATIVE EXAMPLE

EARN Maryland Initiative

Overview

EARN, standing for "Employment Advancement Right Now," is a promising effort to support regionally based, industry-led workforce development projects to address critical skill gaps needed for available jobs.

EARN is a competitive program focused on growing specific industry sectors through industry partnerships that document the need for workforce training through an initial planning grant and then conducts the training through a follow-on implementation grant.

Accomplishments

Two biopharmaceutical industry programs have been funded through the EARN Initiative:

- BIOTrain hosted at Montgomery College began in 2013 and provides a number of short courses that address the needs identified by bioscience companies in Montgomery County, including drug development, process improvement, and protein purification.
- Biotechnology Baltimore Strategic Industry Partnership involves a newly formed molecular biological manufacturing, distribution and pharmacokinetics company, Baltimore BioWorks, Inc., with a proven nonprofit training provider, the BioTechnical Institute, to train minority high-school graduates to become laboratory technicians through an intensive nine-week course of lectures, laboratory exercises, and internships covering skills such as clean room practices, techniques in cell culture, FDA-sanctioned GMP, laboratory safety and GLP, cleaning and sterilization, and techniques in molecular biology.

- ADDITIONAL EXAMPLES:

Oregon Bioscience Association's Customized Workforce Training Programs: Responding to strong employer demand for skilled bioscience professionals, the Oregon Bioscience Association has been actively developing customized workforce training since 2006, with focused emphasis on biotechnology and medical devices. Oregon Bio has helped to train more than 1,700 Oregon professionals.

The Massachusetts **Global Entrepreneur in Residence Pilot Program** is a novel program recently authorized by the Massachusetts legislature to enable foreign graduate students in

STEM fields to gain H-1B visa applications outside of existing caps. Students are partnered with universities that act as sponsors for these students who will work part-time with the university in their field of study and part-time on a new early-stage venture the foreign graduate student is helping to lead. The program is being administered by the Massachusetts Technology Collaborative, the state's quasi-public technology development organization, and the two university sites for the effort are at the venture centers of UMass Boston and UMass Lowell.

LOOKING TO THE FUTURE

This 2016 report on state economic development activities for advancing the biopharmaceutical industry finds nearly every state engaged in targeted programs to advance biopharmaceutical-related development. This broadly shared focus by states underscores the importance of the industry as an economic driver across states.

What also stands out is the intensity with which states are pursuing activities in biopharmaceutical development. Forty-five states are involved in five or more of the seven program activity areas reviewed in this update (Table 3). This suggests that states recognize the importance of having comprehensive and integrated approaches to supporting biopharmaceutical industry development.

It is also encouraging to see the commitment states are making to sustain their focus on biopharmaceutical industry development. Those states that have a long track record of engagement, such as North Carolina, Arizona, and Texas, are demonstrating significant results. It is just as encouraging to see that states with a long track-record in biopharmaceutical industry development are looking to expand their efforts to advance the industry. In particular, Massachusetts and Connecticut have made significant efforts in the last 10 years in marshalling new resources and working aggressively to advance the industry.

But, moving toward the end of the second decade of the 21st century, new economic realities regarding the challenges of biopharmaceutical development will deepen and states will need to raise their game to meet them.

One challenge is the rising need for public-private collaborations to address the gap between promising bioscience discoveries and the advancement of new cures and treatments. This reflects the more complex diseases being explored and increasingly more sophisticated scientific and technological approaches being undertaken in biopharmaceutical R&D. At the same time, industry is under pressure to continue to identify efficiencies in R&D and manufacturing as it faces more global competition. Further complicating the environment is that venture capital needed to foster new bioscience firm formation and growth faces strong competition from alternative opportunities that offer the prospect of more near-term returns, particularly in web-based applications, and the harnessing of “Big Data.” As a result, bioscience venture capital has shifted from early-stage bioscience companies developing new products to those in later stages of development that are ready to enter clinical trials.

- **The result of this difficult environment for biopharmaceutical innovation is to raise the importance of state investments in alternative research models, particularly industry-university research collaborations.** The Indiana Biosciences Research Institute (IBRI) and the Oregon Translational Research and Development

Institute (OTRADI) are two examples of alternative research models that states may increasingly pursue. In each case, industry is helping to drive translational research. In the case of OTRADI, the focus is on making available a new shared resource for high-throughput drug discovery, which is overseen by an industry-led nonprofit organization that also focuses on commercialization services. In the case of IBRI, which was launched in 2013, industry is co-investing with the state and local foundations in a new research institute whose research agenda is being shaped by industry and will be carried out by newly recruited eminent scholars working closely with academic institutions and industry research teams. Neither OTRADI nor IBRI has been in place long enough to call it out as a high-impact best practice. But, each suggests a promising direction that may inform future state efforts.

- **A very different approach to spur more collaboration and overcome the challenges to translational research is the growing focus on "place-making" for spurring biopharmaceutical development.** Place-making involves creating highly sought-after live-work-play communities anchored by research institutions and industry that can attract talent and improve the prospects for commercialization through networking and creating more entrepreneurial energy. There is increasing focus on more place-based strategies even among highly successful bioscience states and regions to create new and more attractive physical environments that can support and attract technology-based economic development. Examples include the rise of Mission Bay in San Francisco, California, and South Lake Union in Seattle, Washington.

Looking to the future, states are expected to continue to focus on attracting and growing biopharmaceutical clusters or ecosystems given the economic benefits. This report documents a wide range of policies and programs that show promise.

State Activities Across Major Program Efforts for Biopharmaceutical Development

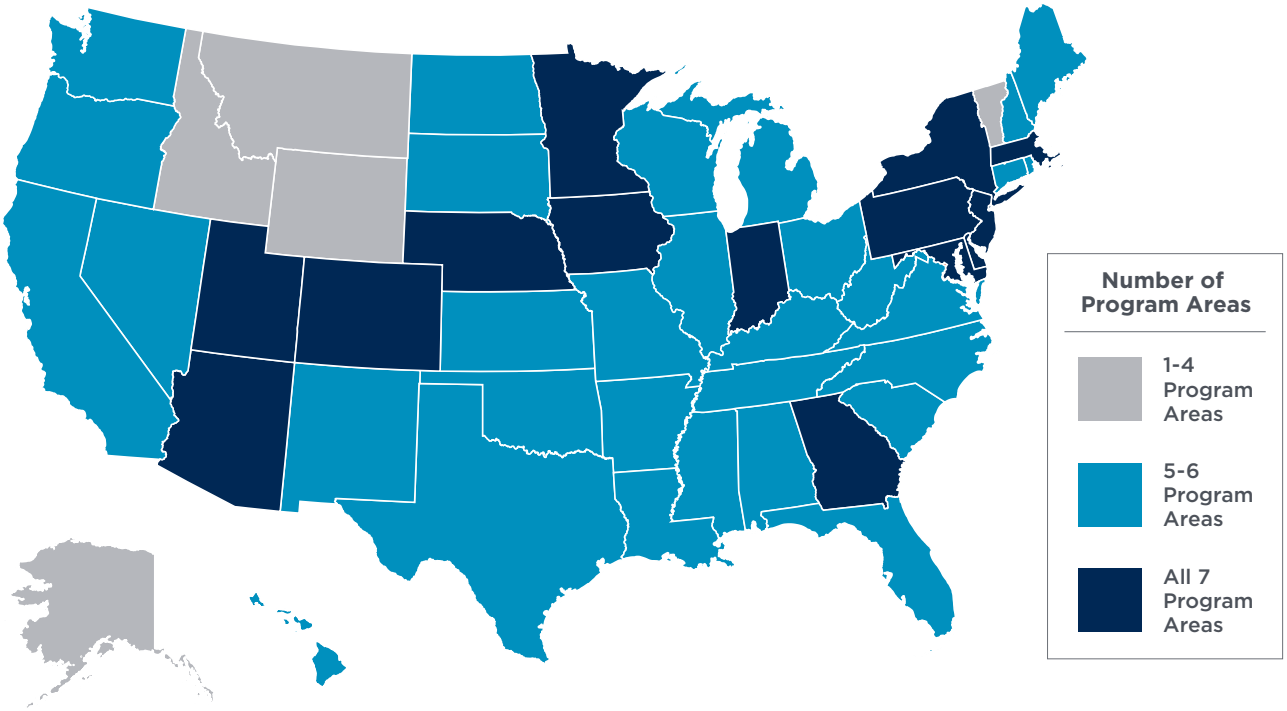

Table 3: State Activities Across Major Program Efforts for Biopharmaceutical Development

State	Targeted Strategies	Building Research Capacity and/or R&D Infrastructure	Accelerating Innovation, Commercialization and/or Entrepreneurial Development	Venture Financing	Building Advanced Mfg.	Economic Innovation Incentives	STEM Educ. & Workforce Dev.
Alabama	•	•	•	•			•
Alaska						•	
Arizona	•	•	•	•	•	•	•
Arkansas	•	•	•	•		•	•
California		•	•	•	•	•	•
Colorado	•	•	•	•	•	•	•
Connecticut	•	•	•	•		•	•
Delaware	•	•	•	•	•	•	•
Florida	•	•	•	•		•	•
Georgia	•	•	•	•	•	•	•
Hawaii	•		•	•		•	•
Idaho		•	•			•	•
Illinois	•	•	•	•		•	•
Indiana	•	•	•	•	•	•	•

Table 3: State Activities Across Major Program Efforts for Biopharmaceutical Development (Continued)

State	Targeted Strategies	Building Research Capacity and/or R&D Infrastructure	Accelerating Innovation, Commercialization and/or Entrepreneurial Development	Venture Financing	Building Advanced Mfg.	Economic Innovation Incentives	STEM Educ. & Workforce Dev.
Iowa	•	•	•	•	•	•	•
Kansas	•	•	•	•		•	•
Kentucky	•	•	•	•		•	•
Louisiana		•	•	•		•	•
Maine	•		•	•		•	•
Maryland	•	•	•	•	•	•	•
Massachusetts	•	•	•	•	•	•	•
Michigan	•	•	•	•		•	•
Minnesota	•	•	•	•	•	•	•
Mississippi	•	•	•	•		•	•
Missouri	•	•	•	•			•
Montana		•	•				•
Nebraska	•	•	•	•	•	•	•
Nevada		•	•	•		•	•
New Hampshire	•	•	•			•	•
New Jersey	•	•	•	•	•	•	•
New Mexico	•	•	•	•		•	•
New York	•	•	•	•	•	•	•
North Carolina	•	•	•	•	•		•
North Dakota		•	•	•		•	•
Ohio	•	•	•	•		•	•
Oklahoma	•	•	•	•		•	•
Oregon	•	•	•	•		•	•
Pennsylvania	•	•	•	•	•	•	•
Rhode Island	•	•	•	•		•	•
South Carolina	•	•	•	•		•	•
South Dakota	•	•	•	•	•		•
Tennessee	•	•	•	•			•
Texas	•	•	•			•	•
Utah	•	•	•	•	•	•	•
Vermont			•	•		•	
Virginia	•	•	•	•		•	•
Washington	•	•	•	•			•
West Virginia	•	•	•	•		•	•
Wisconsin	•	•	•	•		•	•
Wyoming							•
TOTALS	**41**	**45**	**48**	**44**	**17**	**42**	**48**