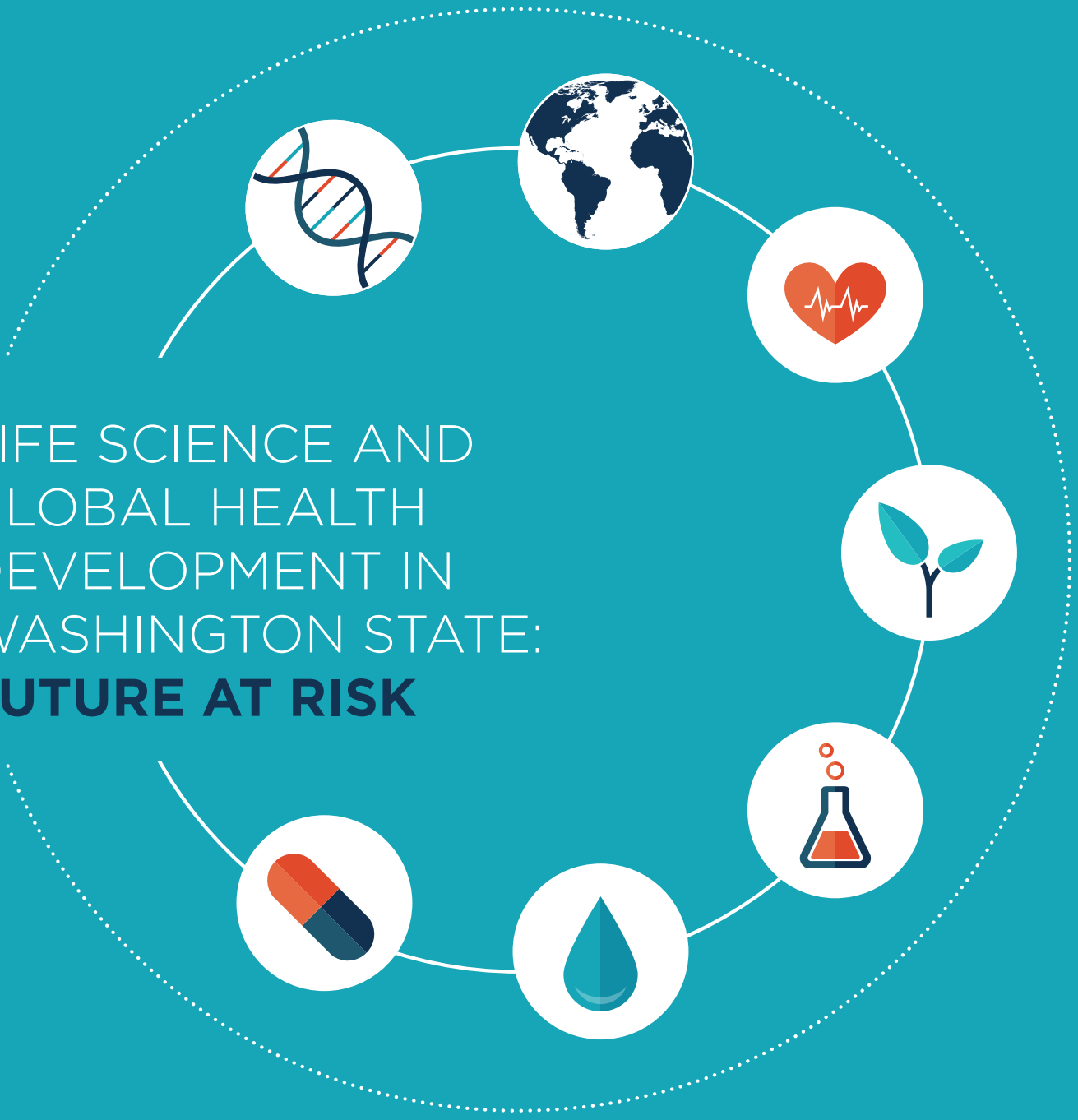

LIFE SCIENCE AND GLOBAL HEALTH DEVELOPMENT IN WASHINGTON STATE: **FUTURE AT RISK**

APPENDIX A:

Detailed Analysis of Growth Trajectory and Dynamics of Washington's Life Science Industry and Global Health Sector

Prepared for the Washington Life Science & Global Health Advisory Council by TEConomy Partners, LLC

February 2017

TECONOMY PARTNERS LLC

Innovating Tomorrow's Economic Landscape

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APPENDIX A

This Appendix provides the details on the analysis of the current situation, recent trends, and future opportunities presented in the February 2017 report, *Life Science and Global Health Development in Washington State: Future At Risk.* This report was prepared for the Washington Life Science & Global Health Advisory Council by TEConomy Partners, LLC. The Council was convened by Governor Inslee in October 2015 to take stock of Washington's position in these highly competitive sectors and highlighting opportunities for future growth.

This detailed analysis considered data across the innovation ecosystem depicted in Figure A-1, with benchmarking key data points against seven "peer" states. In addition, the team conducted extensive interviews with more than 30 industry and university leaders and stakeholders across the state as well as engaged the Council in a discussion of its findings and conclusions.

In the early years of this century, Washington's life science industry and global health sector seized the opportunities created by a world-class life sciences research complex and bolstered by state support to take a major leap forward and place it among the state's major industry drivers. From 2001 to 2011, Washington grew its life science industry, which includes some overlap with the global health sector, by more than 4,300 jobs, representing a gain of 17 percent. By comparison, total state private-sector jobs grew by just 5 percent (Figure A-2).

The strength of Washington's decade of growth led to a cluster that stood out nationally and emerged as one of the nation's most dynamic locations for life sciences and global health development. While still behind the national leaders in terms of both size and relative concentration of the industry, the state's rapid, double-digit job growth far exceeded that for the country—17 percent vs. 7 percent, respectively—and fueled its emergence as a premier hub for life sciences (Figure A-3).

These strong gains in the life science industry were no accident, but aided by state policies to spur innovation and industry growth. During this period, state policies were put in place to further accelerate growth in Washington's life science industry and global health sector.

Washington offered incentives for life sciences and global health companies to pursue new product development by offering a business and occupation (B&O) tax credit for R&D activities and pilot-scale production activities in Washington. This R&D tax credit particularly aided life sciences and global health

FIGURE A-1: Putting Washington's Situation into an Innovation Ecosystem Perspective

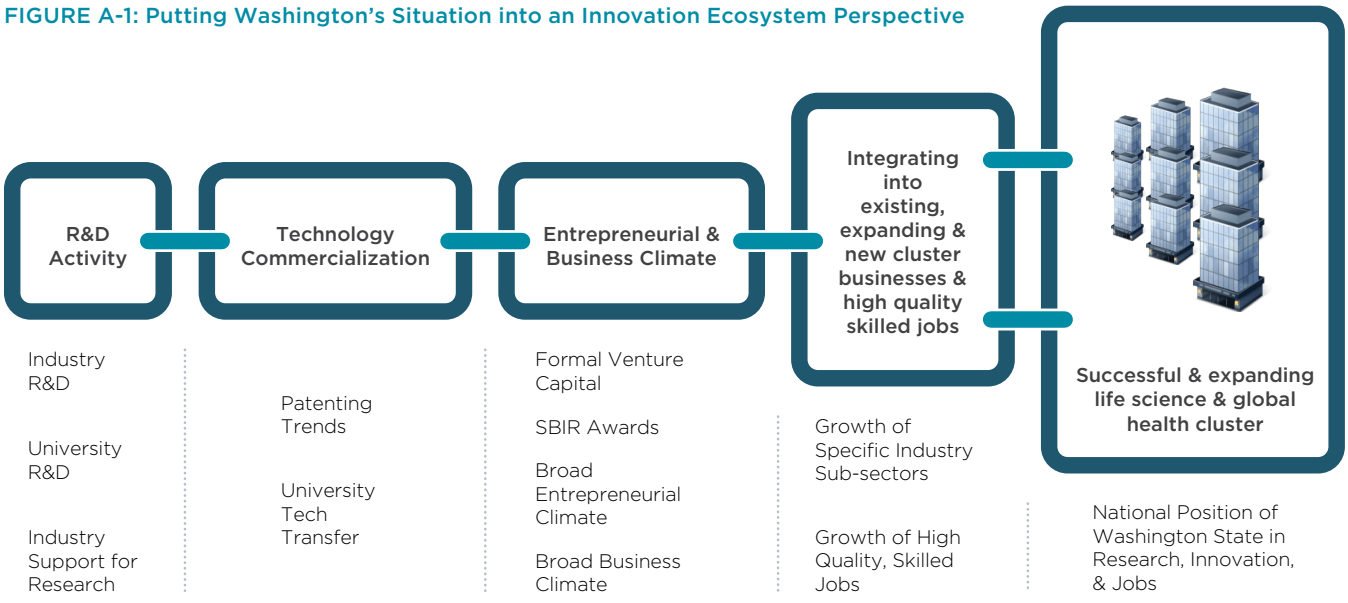
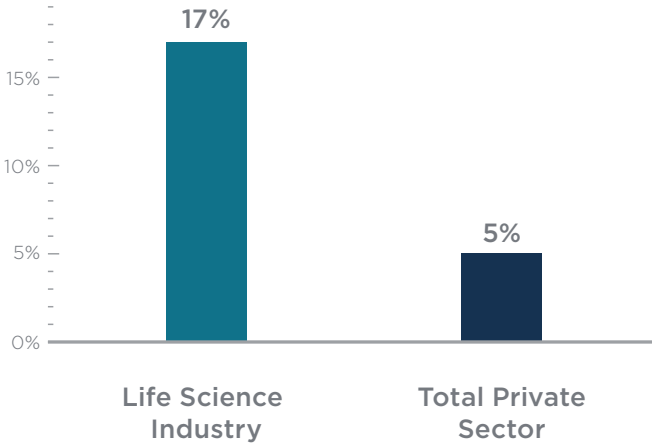


FIGURE A-2: Comparison of Job Growth in the Life Science Industry to Total Private Sector: 2001-2011



*Note: Life science industry employment includes significant overlap with the global health sector.

Source: TEConomy Partners' analysis of U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages (QCEW) data; enhanced file from IMPLAN.

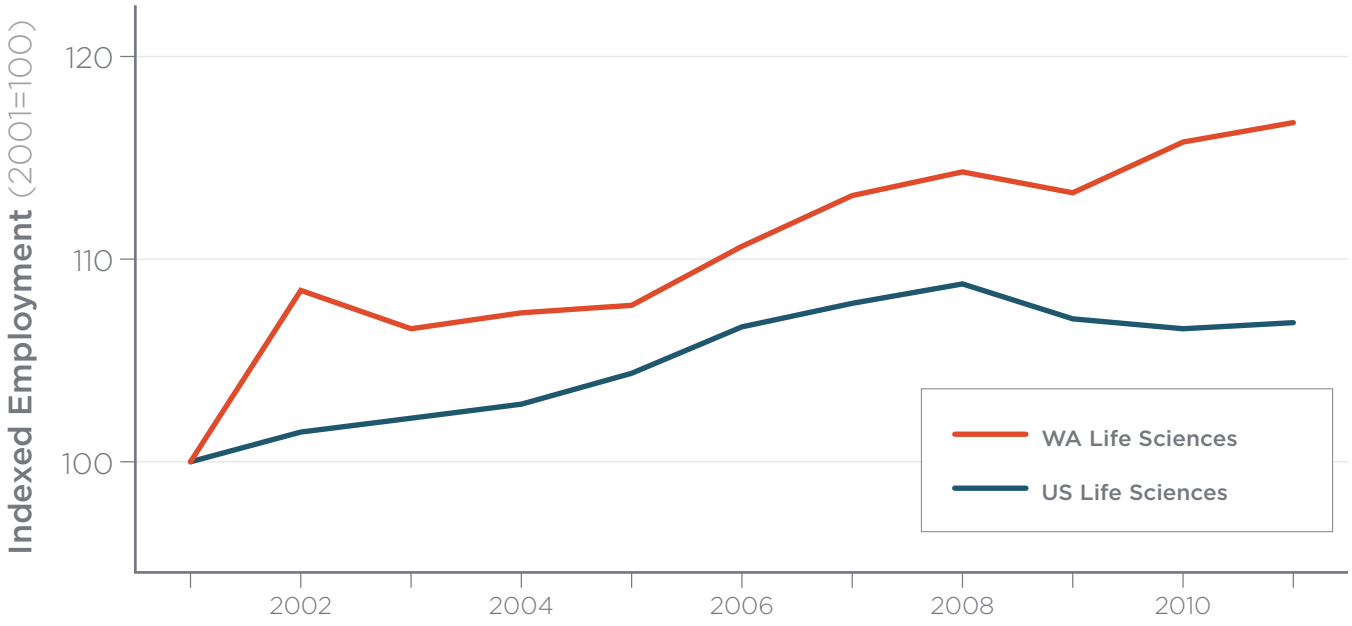
companies, which faced paying state taxes against gross receipts derived from any business activity even though they are not yet profitable. "Revenue" for such companies typically includes business income from strategic partnerships or technology licensing being invested to develop future products.

In addition, the state put in place a sales and use tax deferral policy for businesses conducting R&D or pilot-scale manufacturing operations or expanding or diversifying operations through facilities renovations or equipment purchases in "High Technology" sectors or fields including biotechnology. The R&D tax incentives were first authorized in 1994 then renewed in 2004.

Following the recommendations of a *Bio 21 Report* in 2004, Washington created the Life Sciences Discovery Fund (LSDF) in 2005 to invest funds from the state's Master Tobacco Settlement Agreement in research and commercialization that offered significant impact for health and economic returns to the state. The state's investment of $90 million in LSDF funding has yielded significant economic benefits and impacts:[1]

- Leveraged an additional $634 million or $7 dollars for every $1 of state investment;
- Assisted 40 start-up companies with commercialization assistance;
- Generated more than 4,000 direct and indirect jobs from LSDF grants and follow-on funding.

FIGURE A-3: A Decade of Growth in the Life Science Industry*, 2001-2011



*Note: Life science industry employment includes significant overlap with the global health sector.

Source: TEConomy Partners' analysis of U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages (QCEW) data; enhanced file from IMPLAN.

1 Economic impacts reported from the LSDF website: http://www.lsdfa.org/about_grantees.

Washington also took steps to boost the state's position in global health through the targeted Global Health Technologies Competitiveness Program, which was created in 2010. This program, administered by the Washington Global Health Alliance and referred to as the Washington Global Health Fund, provided funding to global health organizations to "manufacture and commercialize products with developing world applications, and create jobs in Washington." Over a five-year period, the Fund awarded $1.2 million in grants to 13 companies. These investments leveraged $2.3 million in additional investments and created 39 jobs. Most importantly, they created and had significant impact in addressing global health challenges ranging from clean water technologies to mosquito traps that were eventually used in the response to Zika.

During this decade of industry growth and targeted state policies and programs, a stronger innovation ecosystem for life sciences and global health emerged. The bar for advancing life sciences and global health innovation and industry development is much higher than for other innovation-led industries. Among the factors that distinguish life sciences and global health development are the following: the especially close ties between industry, academia, and healthcare delivery ("the clinic") 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 human-health-related product approvals; and the specialized nature of research capabilities, facilities, and talent associated with life sciences and global health development.

Factors Distinguishing Life Sciences and Global Health Development

Cluster development of the life science industry and global health sector 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. There is a close and needed interface of "bench and bedside" for biomedical innovation to move forward.[1] 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 were the result of collaborations between industry and academic research.[2]

The pace and complexity of life sciences research are opening up new opportunities for medical discovery, but require significant investments in cutting-edge, specialized laboratory facilities and research capacities. New techniques and instrumentation are being invented with each wave of life sciences 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 the 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 wet-lab facilities and advanced equipment to commercialize and scale up production of new biopharmaceutical products. These specialized tenant 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 needed to respond 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, uncertainty, and rising costs of bringing a new biopharmaceutical to market significantly impacts the ability to commercialize biopharmaceutical discoveries into new products. In all phases of development and product introduction—from preclinical development to clinical testing in humans to postapproval marketing to good manufacturing practices—the biopharmaceutical industry cluster faces rigorous regulatory oversight. The result of the growing complexity of science and the stringent regulatory oversight is a lengthy, uncertain, and costly process to bring a new biopharmaceutical product to market. From the time a potentially promising candidate medicine is identified, it takes on average 10 to 15 years for a medicine to make its way through the entire R&D process to approval by the Food and Drug Administration (FDA). And only 12 percent of investigative medicines entering clinical trials are ultimately approved

by the FDA—less than half of the percentage approved a mere decade ago. The average cost to develop a new medicine is estimated at $2.6 billion, including the cost of failures, and evidence suggests these costs are on the rise and are even higher when accounting for the research that continues after a medicine has been approved. In fact, the cost of development has more than doubled over the last decade.[3]

The "Valley of Death" challenge of raising venture capital for start-up and emerging biopharmaceutical companies leaves many development opportunities stranded and 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 biosciences venture capitalists are increasingly focusing investments in emerging life sciences 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.[4] This dynamic limits the ability of biopharmaceutical firms in the critical preclinical stages to attract much-needed funding. Overall, venture capital funding for biosciences and biopharmaceutical innovation is rising, but not as fast as overall U.S. venture capital led by the steep increase in investments in information technology (IT) areas.[5]

Both existing and emerging biopharmaceutical companies face an even more long-term challenge to their economic competitiveness—the availability of a robust science, technology, education and math (STEM)-related talent pipeline. Forecasts developed by the Georgetown University Center on Education and the Workforce project steady demand and rapid growth for STEM-related occupations, with expected national employment growth of 17 percent by 2018, compared with just 10 percent growth among all jobs.[6] In addition to new jobs created, demand for STEM-related talent will be compounded by job openings created by the retirement of the baby-boom generation. The Health Research Institute of PricewaterhouseCoopers (PwC) conducted extensive interviews with life sciences executives in 2012 and found 51 percent, the largest share among the 19 industries they interviewed, report hiring is now more difficult than before, with just 28 percent expressing confidence they will have access to top talent.[7]

1 National Institutes of Health, Request for Applications for Regional Translational Research Center Planning Grants, page 4, October 2004.
2 Tufts Center for the Study of Drug Development, Public and Private Contributions to the R&D of the Most Transformational Drugs of the Last 25 Years, January 2015.
3 J.A. DiMasi, H.G. Grabowski, R.A. Hansen, "Innovation in the pharmaceutical industry: new estimates of R&D costs," Journal of Health Economics, May 2016, 47:20–33.
4 Based on venture capital data from Thomson ONE database with calculations from Battelle.
5 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.
6 A.P. Carnevale, Nicole Smith, Michelle Melton, STEM: Science, Technology, Engineering, Mathematics, Georgetown University Center on Education and the Workforce, October 2011.
7 PwC 15th Annual Global CEO Survey, 2012.

What this suggests is that a tightly integrated research, development, commercialization, and manufacturing ecosystem needs to be in place to advance life sciences and global health. Plus, not all states and regions are built alike in their research and innovation strengths in life sciences and global health. With continued advancements and specialization found in biosciences research, it is important that states identify the areas of focus and core competency among their research drivers as a key building block for a comprehensive, integrated biosciences strategy.

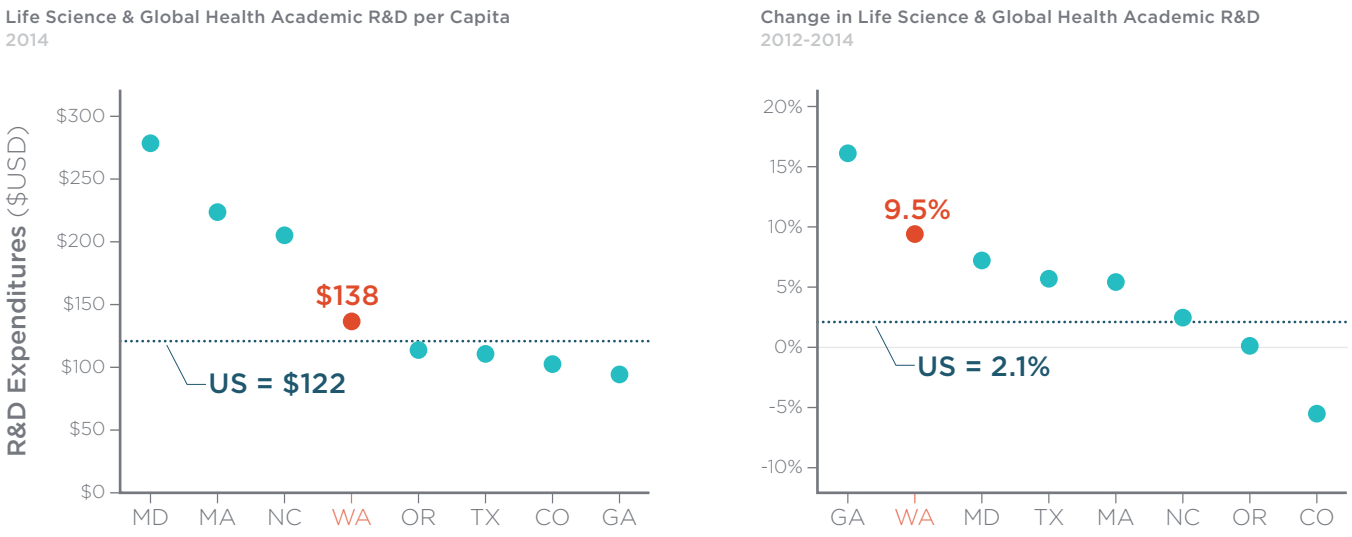
Washington's progress over the first decade of the 21st century reflects tangible gains in its research, innovation, and commercialization ecosystem and a distinctive position in leading areas of life sciences and global health innovation, which continues to be in place. Among the strengths of the ecosystem comprising Washington's life science industry and global health sector are the following:

Academic research is significant and outpacing national growth in Washington. Washington has an annual life sciences and global health research investment that exceeds $1 billion, led by the University of Washington (ranking ninth in the nation in National Institutes of Health (NIH) funding among all universities in Fiscal Year 2016 and fifth among public universities), Washington State University (ranking tenth in the nation in agricultural research), the Fred Hutchinson Cancer Research Center and many other nonprofit research institutes. In both per-capita levels of research and growth trends, Washington stands above the U.S. average and is a leader among the benchmark states (Figure A-4).

The diversity and breadth of life sciences-related research initiatives and assets in Washington are impressive, with examples that include the following:

- The Paul G. Allen School for Global Animal Health at Washington State University is working to solve the challenges of infectious diseases around the globe and in particular where humans and animals interact.
- As noted previously, Washington State University is a national leader in agricultural sciences research with more than $92 million in ag-related R&D in 2014, a figure that has more than doubled since the early 2000s. As the state's land-grant institution, the University operates a large-scale network of cooperative agricultural extension activities at 39 sites across Washington to engage with citizens in life-long learning and improving the quality of life.

FIGURE A-4: Life Sciences and Global Health Academic R&D Expenditures, 2012–2014, Per Capita Levels and Trends vs. the United States and Comparison States



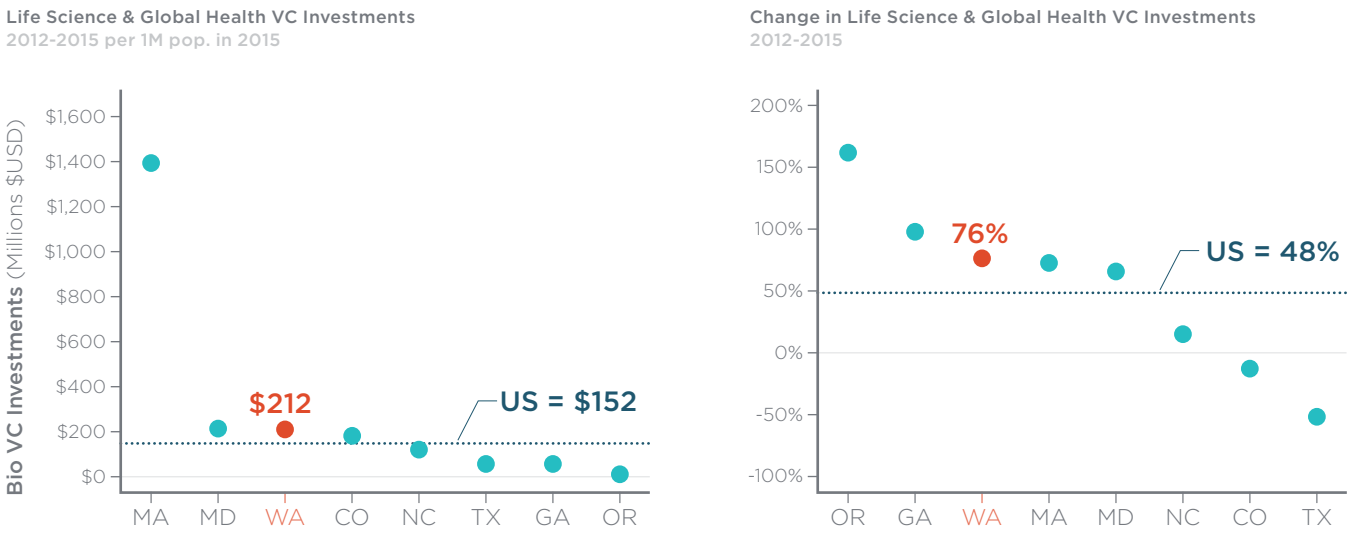
Source: TEConomy Partners' analysis of National Science Foundation Higher Education Research and Development Survey

- The Allen Institute, encompassing both the Institute for Brain Science as well as the Institute for Cell Science, is conducting large-scale research for breakthroughs in the biosciences under an "open science model," meaning discoveries, tools, and data are shared openly with the broader scientific community.
- ASCENT, the Aviation Sustainability Center, also known as the Federal Aviation Administration Center of Excellence for Alternative Jet Fuels and Environment, is conducting aviation research in bio-based fuel solutions, among other areas, and is led by Washington State University and the Massachusetts Institute of Technology (MIT).
- Major new biomedical and public health-related data initiatives such as the Hutch Data Commonwealth at Fred Hutchinson Cancer Research Center, which is focused on providing access to innovative big data capabilities to researchers at the Center and enhancing translational research through data-driven science. In addition, the University of Washington's Population Health Initiative, focused on advancing the health of people around the world, spans several major focus areas including "diagnostics and critical assessment." This initiative leverages the University's unique capabilities in health measurement housed in the Institute for Health Metrics and Evaluation, for data-driven discovery and analysis.

A steady stream of high-potential new start-ups is being generated in Washington, with improved performance in technology transfer by its research institutions and above-average growth in venture capital investments. The state is progressing in its generation of new start-ups in biopharma, closely related to top-tier research anchors with active commercialization efforts, and in medical devices based on the strong legacy of the industry in Washington. Since 2012, Washington has seen above-average levels of venture capital invested in its life sciences and global health companies as well as above-average growth (Figure A-5). The $1.5 billion in venture capital invested in these Washington companies from 2012 through 2015 went to 67 Washington companies, just over 40 percent of which are at the seed or early stage, matching the national share of life science-related investments at these critical early stages.

While Washington is performing well in its venture-backed biopharmaceutical companies, there is concern by key stakeholders about the limited

FIGURE A-5: Life Sciences and Global Health Venture Capital Investments, 2012–2015, Per Capita Levels and Trends vs. the United States and Comparison States



Source: TEConomy Partners' analysis of Thomson Reuters Thomson ONE database.

availability of locally based sources of venture capital funding to grow these companies in Washington. Moreover, medical devices venture financing is almost nonexistent locally. Consequently, many young companies with promising discoveries are not able to reach their full potential in Washington and are natural targets for acquisition and relocation.

University and other institutional technology transfer activities are leading to a growing number of new Washington start-ups and well above-average technology licensing activity. While these are not solely life science-related outcomes, they signal strong commercialization successes from state research institutions. Start-ups emerging from the University of Washington, Washington State University, and the Fred Hutchinson Cancer Research Center (the three institutions that participate in the annual Association of University Technology Managers survey) have steadily risen in recent years from 16 start-ups in 2012 to 25 start-ups in 2014. Meanwhile, these institutions are licensing their technologies at about twice the national average rate—about two licenses/options executed per $10 million in research expenditures compared with about one for all U.S. universities. And this is translating into significant dollars for Washington institutions in licensing income—nearly $759,000 for Washington institutions per $10 million in research compared with $394,000 per $10 million for all U.S. universities.

Collaborations and partnerships among stakeholders are abundant. Industry and academic stakeholders often cite a culture of collaboration and partnerships in Washington among industry, universities, and research organizations. These partnerships are evident not only within the state, but also have a substantial footprint and role internationally for global health organizations. The Washington Global Health Alliance *Landscape Study,* for example, identified nearly 2,000 partnerships between Washington global health organizations and other entities across the world. This figure has grown rapidly from 600 partners identified in 2009.

There is strength in the scientific and technician-level workforce. Washington stands out in its concentration of scientific and technician-level workforce in occupational fields related to the life science industry and global health sector. The state has a "specialized" concentration of employment relative to the nation (e.g., a 20 percent or greater concentration as measured by a location quotient) across an array of scientific occupations, including biological scientists, epidemiologists, medical scientists, and natural sciences managers. Among the technician workforce, both biological technicians and dental lab technicians have a highly specialized concentration as well. In the medical devices subsector, stakeholders cite a substantial base of engineering and product development talent. In addition, a consistent theme of strong "quality of life" was expressed as a major positive for talent attraction and retention.

Leading innovation strengths are driving industry growth. Several areas of current and historical innovation in the life science industry and global health sector are giving Washington a leading industry position for growth.

In Washington, one of the oldest and sustained medical technology strengths is in ultrasound technologies, whereby high-frequency sound waves are used to create an image of the body's soft tissues, organs, and fetal anatomy, as well as enabling the display of blood flow characteristics. The roots of this strength date back to the late 1960s with the technology breakthrough by Donald Baker, then a faculty member at the University of Washington, who revolutionized medical ultrasound through the use of pulsed Doppler technology rather than continuous sound waves. In 1974, Dr. Baker joined forces with a newly founded Seattle-area company called Advanced Technology Laboratories, Inc., (ATL), which went on to become one of the leading diagnostic ultrasound-imaging companies in the world and is now part of Philips Medical Systems. In turn, ATL created the engineering and entrepreneurial talent that continues to keep Washington a leader in ultrasound technologies. Washington is one of the most active in generating ultrasound patent innovations, with nearly 300 patents from 2012 through 2015. The industry

base includes established companies such as Philips, Siemens, SonoSite, and EKOS, as well as emerging venture capital-backed companies, such as OtoNexus Medical Technologies.

A more recent industry innovation strength found in Washington is cancer immunotherapy. Immunotherapy is an innovative treatment approach that bolsters a patient's immune system to retackle the diseases that their immune system is no longer able to control. To date, the most active use of immunotherapy is in cancer treatment. The first therapeutic cancer vaccine to receive approval from the FDA was Seattle-based Dendreon's Provenge immunotherapy in April of 2010 for treating prostate cancer. There is now an extensive pipeline of new therapeutic vaccines being advanced, primarily to treat cancers given their deadly consequences and the toxicity of conventional chemotherapies. These same therapeutic vaccines for fighting cancer may be able to be tailored for other diseases.

Led by the region's academic research institutions, including Fred Hutch, Seattle Children's, and the University of Washington, Washington is a leader in immunotherapy research. This research strength is being translated into a demonstrated leadership position in commercialization, with 578 patents generated in immunotherapies across research institutions and industry, and a strong base of venture-backed companies, which received $661 million in venture investments from 2012 to 2015, representing 43 percent of all life sciences venture funding in the state and standing seven times higher in its concentration nationally. In addition, Fred Hutch recently announced a new state-of-the-art immunotherapy clinic for treating cancer patients that will more than double the current level of clinical trials.[2]

Other areas of innovation in life sciences and global health that are emerging in Washington include the following:

- **Ag Biotech and Marine Biosciences.** Washington is among the national leaders in scholarly research activity related to fisheries, marine and freshwater biology, horticulture, agricultural engineering, and agronomy. State institutions have received major U.S. Department of Agriculture research grants in crop disease and pest management products and strategies and in food product and supply chain safety. In addition, major National Science Foundation (NSF) grants have been awarded in plant genomics and biological oceanography and marine ecology. Washington's agbioscience-related strengths extend to the development of aviation biofuels previously noted, as well as other bio-based products and bioprocessing research.

  Through the Agricultural Research and Extension Service at Washington State University, with its experimental research stations across the state, advances in new tree fruit and grain varieties provide the innovations to support Washington's significant agricultural and food processing sector, representing 12 percent of the state's economy and ranking first in the United States across 11 commodity groups and key food and beverage products including juices and wine.

- **Precision Medicine.** This promises to reshape how medical care and treatment are provided by utilizing recent scientific breakthroughs on how a person's unique genetic make-up makes them susceptible to certain diseases and can help predict which medical treatments will be safe and effective for each patient and which ones will not. Washington is active in next-generation sequencing of the genome, genomic profiling, and biomarker identification, which are critical technologies for bringing precision medicine forward. Major NIH centers are found in Washington for genetic organization and function and improved strategies for cancer screening using biomarkers and imaging technologies, plus large NSF grants are in place on genetic sequencing and modeling.

- **Health Information Technology.** This is being heralded as one of the most promising technology advances for improving the quality and efficiency

2 For more information on The Bezos Family Immunotherapy Clinic, see: http://www.seattletimes.com/seattle-news/health/bezos-family-lends-name-to-new-fred-hutch-immunotherapy-clinic/.

of healthcare delivery and is a critical enabling technology for accountable care models sweeping the nation and the ability to bring connected health directly to patients. Immediate benefits of widespread and consistent use of health IT include improved healthcare quality, prevention of medical errors, reduced healthcare costs, streamlined administrative procedures, and expanded access to affordable care. In the longer term, information gathered from the implementation of health IT infrastructure will yield greater public benefits through health informatics that uses IT to analyze clinical data and improve patient outcomes. A 2015 Cambia Grove study identified 90 healthcare IT start-ups in Washington, with key areas of focus in care coordination, improving healthcare efficiency and delivery, and unlocking data as a health resource and decision tool.[3] Washington has a higher share of its patent activity in health IT and closely related bioinformatics than the nation, suggesting that there is a strong innovation capacity to Washington's health IT position.

In the years ahead, the new medical school at Washington State University may bring a focus in rural health that could leverage strengths and advances in precision medicine and health IT emerging in Washington.

Interestingly, these areas of strength in research and innovation overlap strongly with what the Washington Global Health Alliance's 2015 *Landscape Study* found was likely growth areas for the global health sector, namely the following:

- Diagnostics—which are key in precision medicine approaches;
- Nutrition innovation (i.e. fermentation and insects as food sources)—which can leverage the agbiosciences strengths in Washington;
- Vaccine development—which draws upon advancements in immunology research;
- Biotech—which taps into advances from next-generation sequencing and genomic profiling to immunotherapies;
- Digital health—which includes and is closely tied to health IT but also includes technology areas such as wearable devices, telemedicine, and precision medicine;
- Global development and agriculture research—which can draw upon the state's marine and agbiosciences strengths.

In summary, the progress made by Washington in advancing its life science industry and global health sector is impressive. Washington took a major leap forward and was living up to its potential by combining its national leadership in research with robust industry growth across the life sciences and global health. In doing so, Washington put itself on a proven path, as had been demonstrated by Massachusetts and California in the 1990s, to leverage its research strengths to emerge as an industry powerhouse in life sciences and global health. Looking forward, there are many growth opportunities ahead for Washington's life science industry and global health sector that leverage the state's research and innovation strengths.

Warning Signs of Economic Stagnation Loom

Despite continued life science industry growth nationally and across most states and the momentum driving the Washington life science industry over a decade, Washington's industry is now shedding jobs. The warnings extend beyond industry stagnation to signs of slowing industry innovation.

Since 2011, the life science industry has shed more than 900 jobs or 3 percent of its employment base (Figures A-6 and A-7).[4] At the national level, the life science industry has grown by 2.7 percent. Among the largest 20 states in the life sciences, Washington was one of just three to experience a net job loss during

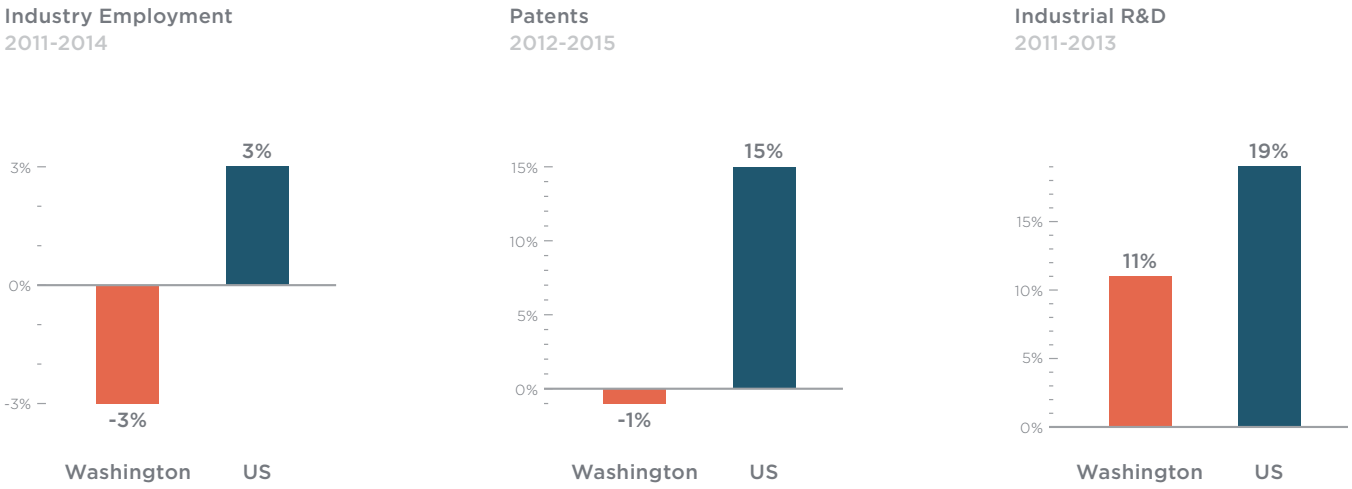
3 Cambia Grove, *WA State Health IT Startup Landscape*, September 2015.
4 Life science industry employment includes significant overlap with the global health sector, though a separate *Landscape Study* developed for the Washington Global Health Alliance has found the global health sector recorded net job growth during the 2009–2013 period.

the three-year period to 2014. Recent employment declines mean Washington lost life sciences market share to competitor states during that three-year period. It was the only state among the peers analyzed to shed jobs since 2011.

In addition to the life science industry shedding jobs overall, outside of a very small gain in the state's modest agbiosciences subsector, there have been no bright spots experiencing job growth. Since 2011, Washington has seen the following net employment declines among its life sciences subsectors:

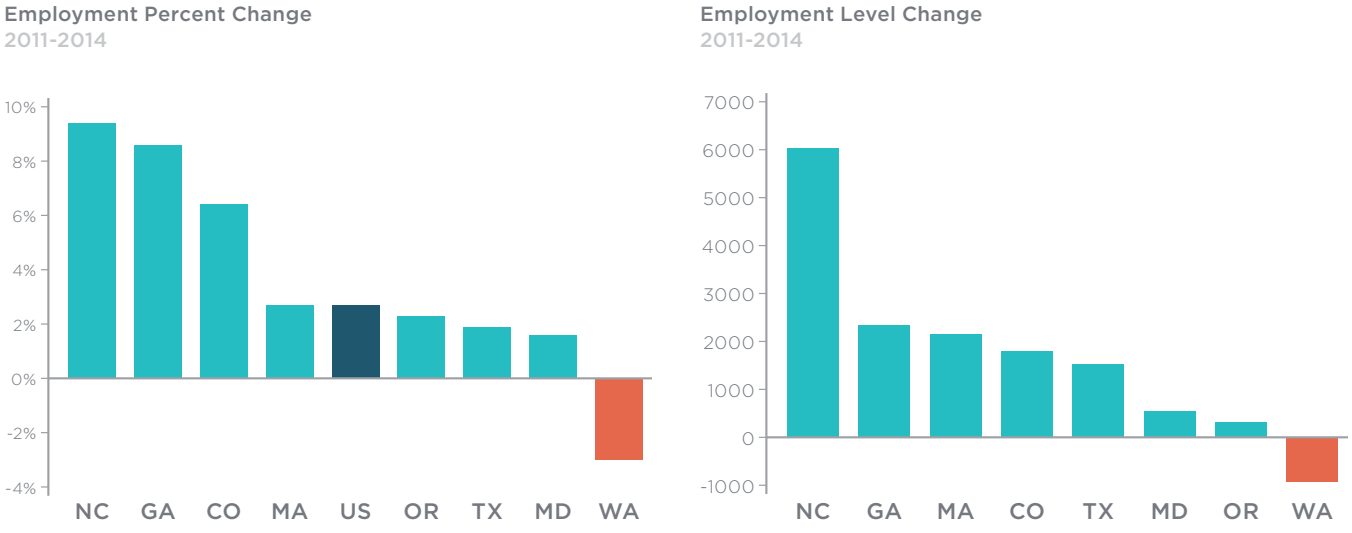
- Research, Testing, and Medical Laboratories, the state's largest life sciences subsector, has had an employment decline of 5.8 percent;
- Bioscience-related Distribution employment is down 1.2 percent;
- Medical Devices and Equipment employment is down 3.4 percent; and
- Drugs and Pharmaceuticals employment is down 0.4 percent.

FIGURE A-6: Warning Signs of Stagnation in the Life Sciences and Global Health in Washington



Source: TEConomy Partners' analysis of U.S. Bureau of Labor Statistics, QCEW data, enhanced file from IMPLAN; Thomson Reuters Thomson Innovation patent analysis database; NSF Business R&D and Innovation Survey.

FIGURE A-7: Recent Trends in Life Science Industry Employment*, Washington vs. Comparison States, 2011–2014



*Note: Life science industry employment includes significant overlap with the global health sector.

Source: TEConomy Partners' analysis of U.S. Bureau of Labor Statistics, QCEW data, enhanced file from IMPLAN.

TABLE A-1: Industrial R&D in Life Science–Related Subsectors and Relative to University Life Sciences R&D, Washington and Comparison States, 2013

Category	2013 Industrial R&D for Pharmaceuticals and Medical Equipment and Supplies (Millions USD)	Ratio of Industrial to University R&D, 2013
United States	$56,529	1.47
Washington	$524	0.53
Colorado	$331	0.59
Georgia	$270	0.31
Maryland	$991	0.62
Massachusetts	$5,961	3.97
North Carolina	$1,328	0.67
Oregon	$101	0.23
Texas	$789	0.27

Source: TEConomy Partners' analysis of NSF Business R&D and Innovation Survey.

Meanwhile, the state's private sector as a whole is rebounding from the recession and has increased employment by more than 8 percent since 2011. And, while recent data show a drugs and pharmaceuticals subsector that is holding relatively steady, an investigation by TEConomy found that some of the job loss resulting from the closure of Amgen's Seattle operations may not have been included in the data through 2014 and therefore could be seen in future years' data.[5]

Along with this reversal in job growth, there are other signs that the life science industry in Washington is losing its competitive edge. The state experienced a small decline in life science–related patent activity in recent years (-1 percent from 2012–2015), running counter to a strong growth trend nationally (up 15 percent). Plus, Washington's industry R&D expenditure grew 8 percentage points below the national growth in life sciences R&D of 19 percent.

Washington's life sciences and global health research base, while large and robust, is out of balance in terms of its composition of academic versus industrial research relative to the national average. While Washington's academic life sciences R&D is more concentrated and growing faster in recent years than the nation, its concentration and recent growth in life science–related industrial R&D are below average (Table A-1).

At the national level, R&D expenditures among private industry in pharmaceutical and medical device manufacturing (the only primary life science subsectors delineated in the NSF industry data) are 47 percent greater than those across all life sciences and global health–related R&D at the nation's universities. For Washington, this relationship is quite different, with industry performing well below the R&D levels of the state's universities. In states like Massachusetts, the strength and concentration of industry R&D are even more pronounced with its companies performing nearly four times the level of its universities.

Discussions with industry and university stakeholders in the life sciences and global health bring to light the following weaknesses and challenges across several key facets of the life sciences and global health innovation ecosystem contributing to the current stagnation.

Difficulties in Generating and Attracting Top Talent. Issues and challenges around finding, attracting, and retaining talent are a common theme among both the life science industry and global health sector. In the life sciences, stakeholders lament the lack of a "critical mass" of companies that has meant difficulties in attracting management talent to grow emerging companies. This has been exacerbated by the loss of large anchor companies in pharmaceuticals, such as Amgen after its acquisition of locally grown Immunex and Merck following the acquisition of Rosetta Inpharmatics. More recently, Bristol-Myers Squibb—which acquired ZymoGenetics in 2010—announced its intention to close down its Lake Union site, retaining a small manufacturing workforce in Bothell. In addition, pharmaceutical industry leaders cite a shortage of specialized talent not only in management, but also in regulatory knowledge and functions, and in manufacturing expertise.

5 Published articles refer to the Seattle Amgen layoffs largely occurring in 2015, though some job cuts may have begun in 2014; a total of 660 jobs were expected to be lost.

In the global health sector, talent and workforce are among the most pressing challenges the sector faces. Top executive–level talent is cited as a challenge to find and often to recruit to Greater Seattle. Stakeholders told the project team that recruiting global health leaders and other top talent from the East Coast is often difficult as candidates believe that leaving the Greater DC-Baltimore global health hub leaves them on the outside in terms of influence and career options; however, this concern is often alleviated once candidates learn more about Seattle's leading position in global health and the depth of its sector. The Washington Global Health Alliance has convened human resource leadership from local global health organizations to focus on this issue and intends to continue to do so.

Gaps in Development Resources for Growing Life Sciences and Global Health Companies. Industry and university stakeholders see an industry that is "front-loaded" on discovery and commercialization, with progress in generating new start-ups that leverage the state's broad and deep research base. However, these start-ups then enter an ecosystem with gaps in development resources that hold them back from becoming mid-sized and larger companies. These gaps identified include the following:

- Disincentives of the B&O tax and the particular burden it places on many state life sciences companies that are not yet profitable but working on product development and strategic alliances;
- Weaknesses in the depth of entrepreneurial networking and mentoring;
- Lack of available and affordable wet-lab space, particularly for emerging ventures and especially in Seattle; and real estate more broadly for both life sciences and global health firms;
- Limited availability of growth capital and lead venture capital investors beyond seed-stage financing.

Industry Executives are Concerned about the State's Commitment to Life Sciences and Global Health Development. A consistent theme voiced by industry leaders, after witnessing the disbanding of the LSDF and Global Health Fund as well as the R&D tax credit and deferral, is major concern about Washington's commitment to and prioritization of these sectors. Stakeholders are deeply worried about their ability to compete with other states and regions that are offering these types of incentives, funding opportunities, and other dedicated resources specifically to the life science industry and cite a lack of political support and public awareness of the industry as key challenges.

By addressing these challenges, Washington can reinvigorate its life sciences and global health economic development and build on the gains made in the past decade to join those states that have leading life science and global health industry clusters aligned closely with their research strengths. Alternatively, if these challenges remain unaddressed, Washington risks missing an important opportunity to leverage its tremendous R&D assets in the life sciences and global health to establish a leading advanced manufacturing industry. These industries further diversify the state's traditional manufacturing industries, generating high-quality, high-paying jobs and representing a source of innovation for other leading industries in the state, namely closely related healthcare and agriculture and food processing.

APPENDIX A

SUPPLEMENTAL TABLE ON INDUSTRY DEFINITIONS

Table A-2 presents the industry definition of the life sciences utilized in this report and developed by TEConomy Partners in partnership with the Biotechnology Innovation Organization (BIO). The industries are based on the North American Industry Classification System (NAICS).

TABLE A-2: Life Science Industry Definition

Life Science Subsector	NAICS Code	NAICS Description
Agricultural Feedstock and Chemicals		
	311221	Wet Corn Milling
	311222	Soybean Processing
	311223	Other Oilseed Processing
	325193	Ethyl Alcohol Manufacturing
	325221	Cellulosic Organic Fiber Manufacturing
	325311	Nitrogenous Fertilizer Manufacturing
	325312	Phosphatic Fertilizer Manufacturing
	325314	Fertilizer (Mixing Only) Manufacturing
	325320	Pesticide and Other Agricultural Chemical Manufacturing
Drugs and Pharmaceuticals		
	325411	Medicinal and Botanical Manufacturing
	325412	Pharmaceutical Preparation Manufacturing
	325413	In-Vitro Diagnostic Substance Manufacturing
	325414	Biological Product (except Diagnostic) Manufacturing
Medical Devices and Equipment		
	334510	Electromedical and Electrotherapeutic Apparatus Manufacturing
	334516	Analytical Laboratory Instrument Manufacturing
	334517	Irradiation Apparatus Manufacturing
	339112	Surgical and Medical Instrument Manufacturing
	339113	Surgical Appliance and Supplies Manufacturing
	339114	Dental Equipment and Supplies Manufacturing
Research, Testing, and Medical Laboratories		
	541380*	Testing Laboratories
	54171*	Research and Development in the Physical, Engineering, and Life Sciences
	621511	Medical Laboratories
Bioscience-Related Distribution		
	423450	Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers
	424210*	Drugs and Druggists' Sundries Merchant Wholesalers
	424910*	Farm Supplies Merchant Wholesalers

*Includes only the portion of these industries engaged in relevant life sciences activities.