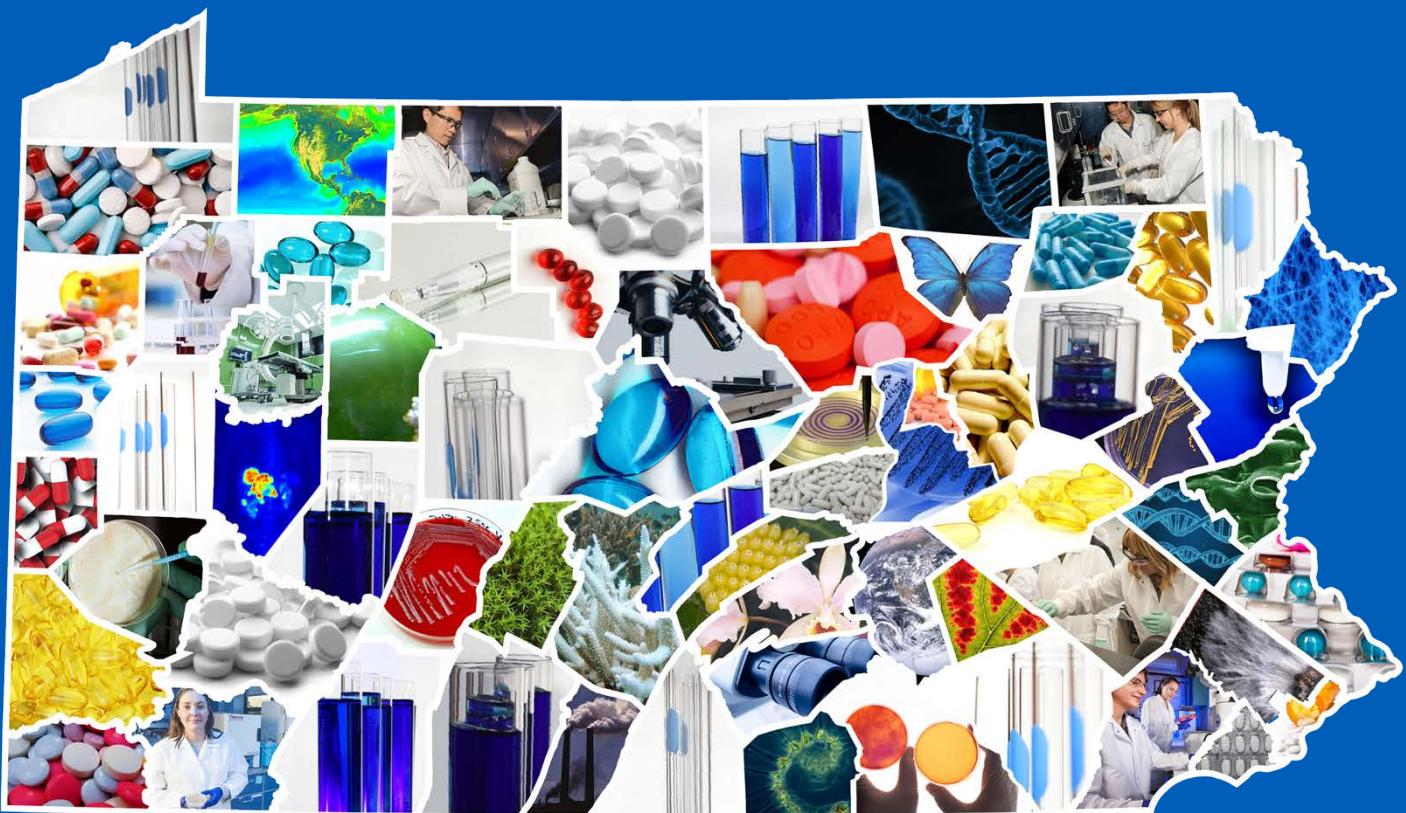




Pennsylvania Life Sciences Industry



September 2017

Prepared by:

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Life Sciences Pennsylvania is the statewide trade association for the life sciences in Pennsylvania and serves as a catalyst to ensure Pennsylvania is a global leader in the life sciences by developing a business and public policy environment which fosters life science growth and success. More information is available at <http://www.lifesciencespa.org>.

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Executive summary

Amid rapid change brought on by new forms of competition, new regulations, and innovation, the Life Sciences industry in Pennsylvania is in the process of reinventing itself. The Life Sciences industry has historically been a strong contributor to Pennsylvania's economy. Following the financial crisis, the pace of growth has slowed in the face of increased costs, heightened uncertainty, changes in regulations and risk factors, and greater demands for efficiency. These forces are reshaping the industry in new ways, forcing companies to adopt new technologies, integrate data analytics into their management and operational practices, and reassess the business models used to develop new products and deliver goods and services to the market. Employment in this industry increased on net by fewer than 1,000 jobs during the five years between 2011 and 2016, but stronger net hiring during 2015 and 2016 more than offset all of the job losses that occurred between 2011 and 2013.

Innovation in Pennsylvania's Life Sciences industry has also been advancing at a rapid rate. Through increased federal funding, patent applications, and entrepreneurship, Pennsylvania maintains a lead over much of the rest of the country in terms of research and development (R&D) in Life Sciences.

Compared with other states, Pennsylvania's Life Sciences industry faces several unique challenges. Two of the most important challenges center on the Commonwealth's success rate in attracting and retaining the capital needed for continued investment in Life Sciences. The first challenge is the attraction and retention of entrepreneurial capital. Although it is difficult to measure entrepreneurial capacity directly, anecdotal evidence suggests that a dearth of Pennsylvania-based entrepreneurs with experience in Life Sciences ventures is a limiting factor for the industry's rate of expansion in the Commonwealth.¹ The second challenge, closely related to the first, lies in the attraction of venture capital and angel investors. Compared with states such as California and Massachusetts, Pennsylvania ranks relatively lower when it comes to venture capital investment, as discussed later in the report. Although Pennsylvania boasts a favorable relative share of federal health and science research grants and

¹ Information based on a series of informational interviews conducted with technology transfer program coordinators of several major Pennsylvania universities.

production of doctoral recipients in Life Sciences disciplines, the Commonwealth lags below its peers in attracting venture capital investment, securing a disproportionately lower share of capital than that flowing into companies in California and Massachusetts. Similarly, the number of patents issued for Life Sciences discoveries lags well behind Massachusetts and California.

The purpose of this report is to summarize the contribution of the Life Sciences industry to the Pennsylvania economy during 2016. Below are some key findings from this study:

Study's Key findings:



Life Sciences in Pennsylvania

Small Business Oriented: More than half of the Life Sciences industry establishments operating in Pennsylvania in 2016 are comprised of **fewer than 10 employees**.

Uneven Growth: Between 2011 and 2016, Pennsylvania experienced modest Life Sciences employment growth in comparison to peer states. This is primarily due to a **decline in pharmaceutical manufacturing** in the Commonwealth and concurrent **gains in research, testing and medical laboratories**. While two peer states, New Jersey and Indiana, experienced a decline in Life Sciences industry employment over this period, all other peer states grew more rapidly than Pennsylvania.



Research Excellence

Funding Leader: Pennsylvania had the **highest 2016 National Science Foundation (NSF) funding rate** in comparison to peer states and was awarded the **second highest NSF & National Institute of Health (NIH) funding per capita** in comparison to peer states.

Patented Contributions: Pennsylvania was a top contributor to innovation, boasting recipients of **4,317 patents** over the prior 5 years, among the top 5 states nationally.



Academic Contribution

Acclaimed Universities: The Commonwealth was home to **7 of the top 100 universities** ranked in 2016 according to the Shanghai Index, including 2 universities in the top 100 Biological Sciences Program.

Producing the Next Generation of Experts: Pennsylvania universities conferred a **doctorate degree to 578 recipients**, ranking 4th highest in the nation during 2015.



Attracting Capital

A Need for Investment: During 2016, Pennsylvania only secured \$147 million in venture capital (VC) funding, ranking 13th nationally. A lack of venture capital may serve as a limiting factor for the Life Sciences industry in Pennsylvania, as companies that are unable to secure sufficient funding early in their

lifecycle may be unable to stage significant expansions necessary to become dominant in their industries.



Economic Contribution

Job Provider. The Life Sciences industry in Pennsylvania directly **employed 112,000 people** during 2016 and was responsible indirectly for an additional 230,000 jobs through business purchases and household expenditures.

Generating Output. The industry generated a total (direct and indirect) **state economic output of \$88.5 billion**, comprised of a direct economic impact of \$48.8 billion and indirect economic impact of \$39.6 billion.



Commonwealth Support

Well Developed Support. The Commonwealth of Pennsylvania offers several supportive incentive programs across various industries which are often utilized by companies in the Life Sciences industry

Understanding the life sciences industry

Life Sciences encompasses not only human health services (comprising biotechnology, pharmaceuticals, and medical devices) but also industries related to the development and application of science and technology to improving human health and the environment. Companies operating in Life Sciences are engaged in the research and development, manufacturing and commercialization of products and services that advance healthcare, and environmental management and protection.²

Although there is no official definition of Life Sciences sector for measuring activity or economic contribution at the local, regional, or national level, this report leveraged sectors defined by the North American Industry Classification System (NAICS)³ to create a consistent definition of Life Sciences that reflects the industry's unique contours in Pennsylvania. For the purposes of this study, the definition is heavily informed by the guiding principal that Life Sciences companies are involved directly or indirectly in biomedical or human health research, product development, and innovation. This definition of the Life Sciences value chain encompasses R&D, design and production of biotechnology, pharmaceutical and medical device products. The definition includes specific allied logistics, wholesale and technical consulting services. Together, these major value chains form the core of the Life Sciences industry's economic value added.

Excluded from the definition of Life Sciences are entities whose primary activity involves the delivery of medical services (excluding hospitals, ambulatory services and offices of physicians), marketing or customer support, or consulting activities. These entities are not engaged primarily in fostering or sustaining research and innovation. In addition, primarily agricultural industries are excluded from the definition of Life Sciences.

The Methodological Appendix outlines the specific NAICS codes that comprise Life Sciences for the purposes of this report.

² Source: 'What is Biotechnology?', Biotechnology Innovation Organization website, as accessed on April 20, 2017; 'Life Sciences Ontario Sector Report 2015', 2015, Life Sciences Ontario, as accessed on April 20, 2017.

³ NAICS is the standard system used by Federal agencies for classifying businesses. NAICS was developed by the Office of Management and Budget.

Life sciences snapshot: Pennsylvania

Pennsylvania is home to a thriving Life Sciences industry. The industry is built on a foundation of small businesses across the Commonwealth and is supported by strong contributions from world-class research institutions. Collectively, these establishments constitute some of the commonwealth's leading businesses contributing both direct and indirect economic and fiscal impacts.

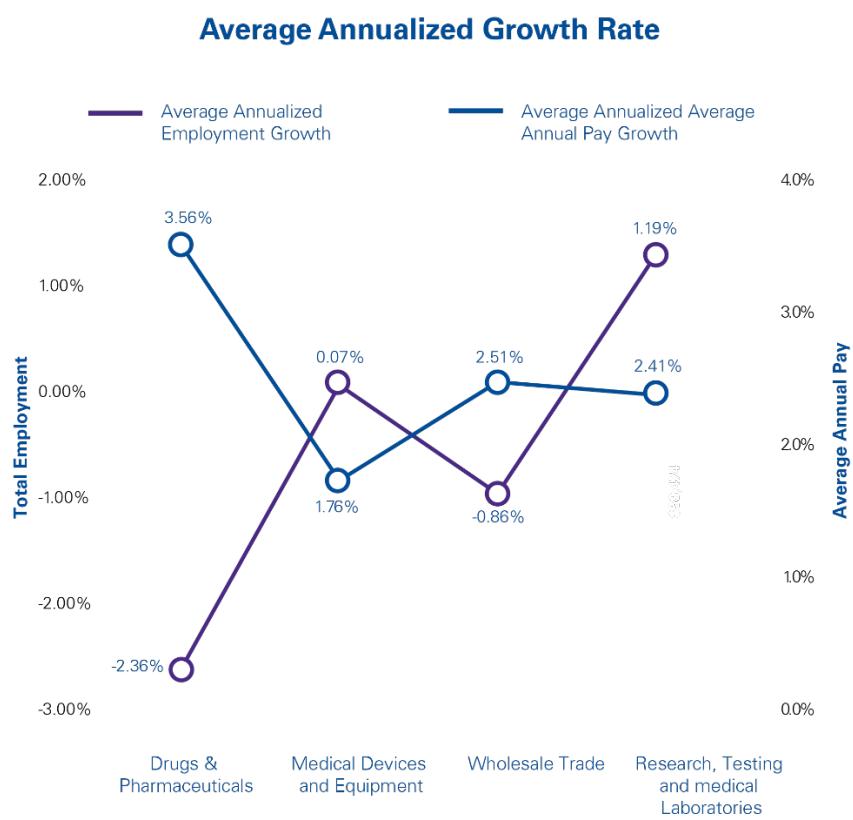
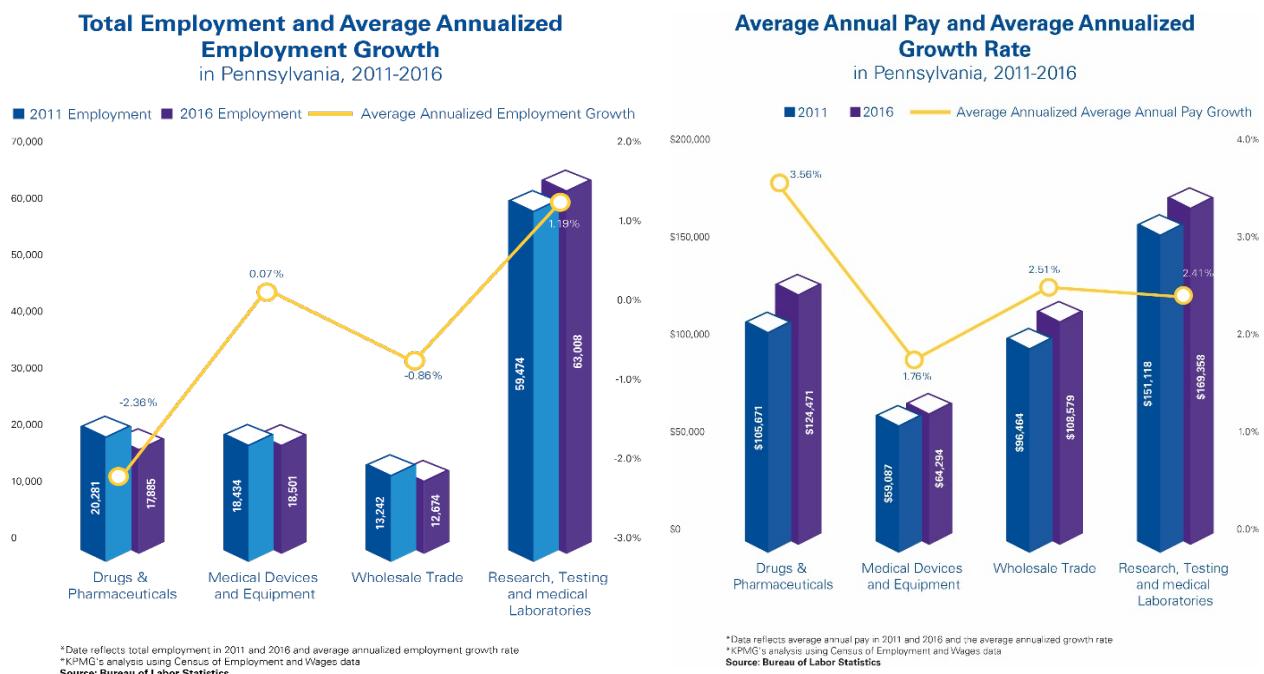
In 2011, there were a total of 2,722 Life Sciences establishments in Pennsylvania.⁴ That number grew by 4.4 percent over the five-years ending in 2016. This rate of growth is slightly below the rate of change in peer states and is below the U.S. average. In recent years, growth in Life Sciences across Pennsylvania has been accompanied by the formation of smaller firms and establishments; as a result, overall employment in Pennsylvania's Life Sciences grew on net by about 0.6 percent during the same period.

From 2011 to 2016, total Life Sciences industry employment in Pennsylvania grew from 111,430 to 112,068. Total average annual pay per employee in 2016 was \$137,976, increasing by 13.9 percent since 2011.

The single largest sub-sector of the Pennsylvania Life Sciences industry, Research, Testing, and Medical Laboratories, employed 63,008 individuals in 2016 and was the fastest-growing subsector over the prior five-year period. This sub-sector also saw strong growth in average earnings, which increased 12.1 percent to \$169,358 per employee in 2016 from \$151,118 per employee in 2011.

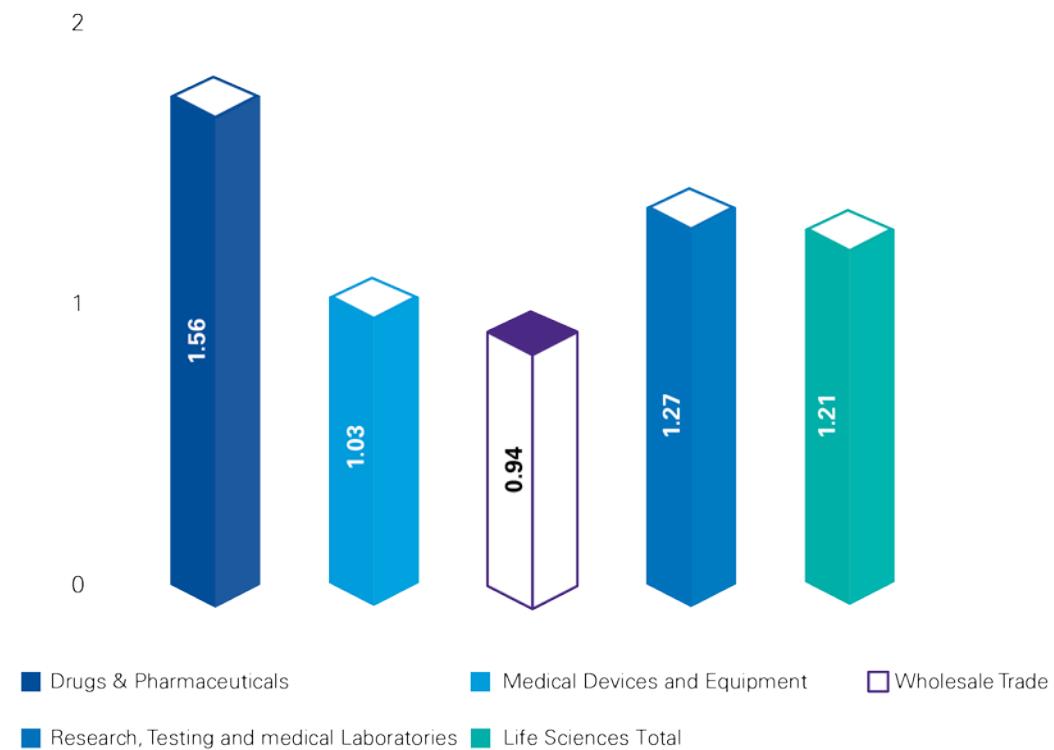
⁴ Source: Quarterly Census of Employment and Wages (QCEW), Bureau of Labor Statistics.

Figure 1: Life Sciences Snapshot



Pennsylvania's Life Sciences industry is a major component of the Commonwealth's industrial structure. Overall, Life Sciences comprises a larger share of Pennsylvania's economy than it does the U.S. economy as a whole. Measured using location quotients⁵, Pennsylvania boasts the greatest relative concentrations of drugs and pharmaceuticals suppliers and research, testing and medical laboratories.

Figure 2: Life Sciences Location Quotient Analysis



*Data reflects employment location quotient of Pennsylvania, 2016

*KPMG's analysis using Census of Employment and Wages data

Source: Bureau of Labor Statistics

In absolute terms, Pennsylvania's Life Sciences industries added fewer than 1,000 jobs on net over the 5 years spanning 2011 through 2016, but the overall trend of growth in the industry masks considerable underlying churn. Even while colleges and universities and private sector R&D organizations collectively increased Life Sciences-related employment by an estimated 3,000 jobs, much of this gain was offset by job loss among pharmaceuticals manufacturers, which shed 2,900 jobs through relocations to other states and local layoffs, a decline of almost 20.0 percent.⁶

The churn evident in Pennsylvania's Life Sciences industry has also occurred in other regions of the country, but the dynamics are different. By comparison, pharmaceutical manufacturers have shed less than 2.0 percent employment nationwide during the same period, illustrating that Pennsylvania has become less attractive for pharmaceutical manufacturers compared with other regions of the country during the last five years. Concurrently, other segments of the Life Sciences industry have managed to

⁵ A location quotient is used to measure the relative concentration of an industry in a geographic region, with a larger location quotient indicating a greater relative concentration. The location quotients included in this report are calculated based on employment from the U.S. Bureau of Labor Statistics.

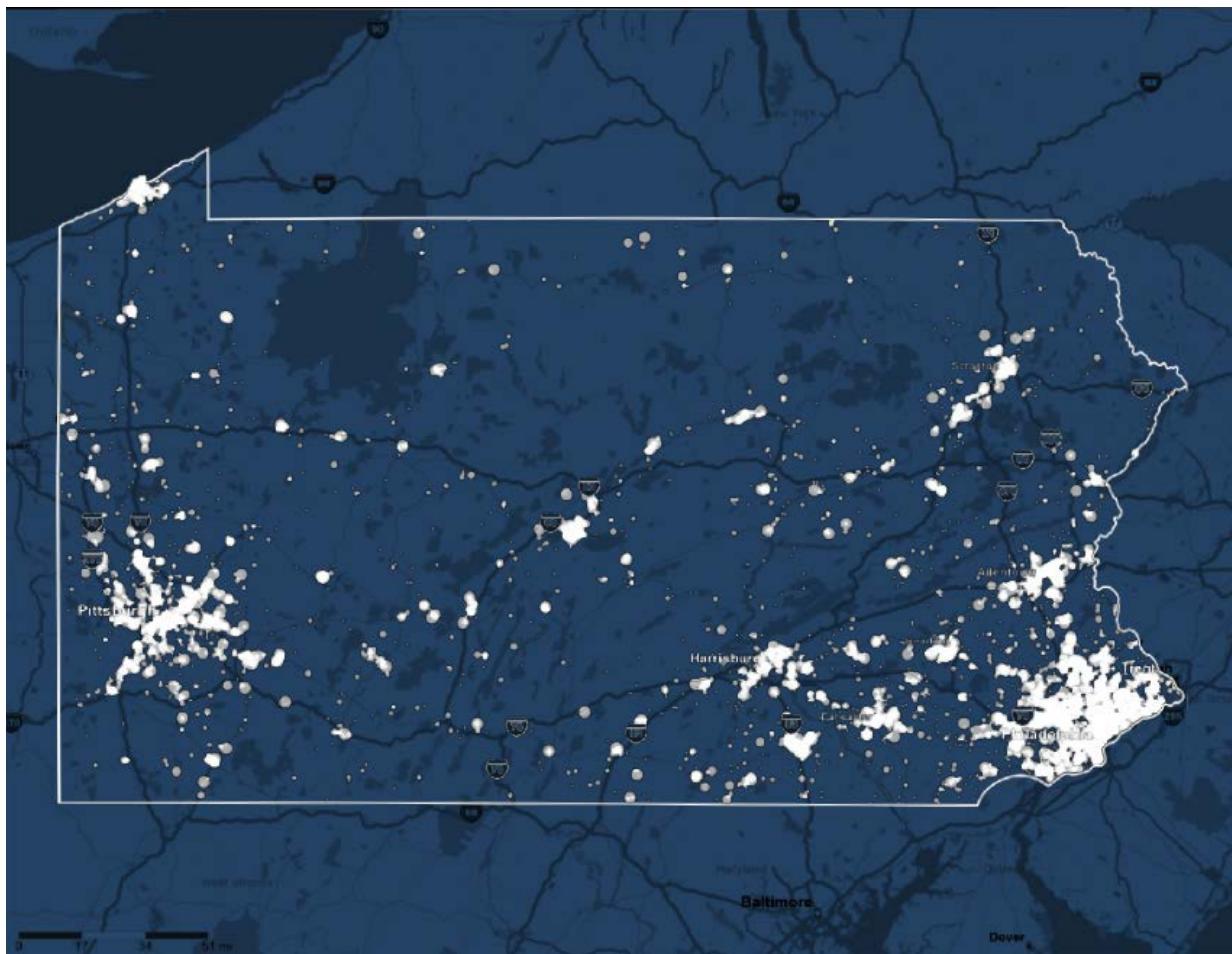
⁶ Source: Bureau of Labor Statistics.

increase their concentration in Pennsylvania. Although much smaller in size than their pharmaceutical cousins, electrotherapeutic apparatus manufacturing, testing and research laboratories, and colleges and universities are expanding in Pennsylvania faster than the national average.

Moreover, even as pharmaceutical manufacturers have downsized their local workforces, younger companies developing new therapies for treating patients with a wide variety of diseases are gradually expanding in the space vacated by shrinking pharmaceutical giants. Reflecting growth in contract research locally, employment has also increased in biotechnology R&D, testing laboratories, and other physical and biological research.

In addition to a high concentration of Life Sciences firms and establishments in the greater Philadelphia and Pittsburgh metro areas, there is a substantial industry presence across the Commonwealth as illustrated in the figure below.

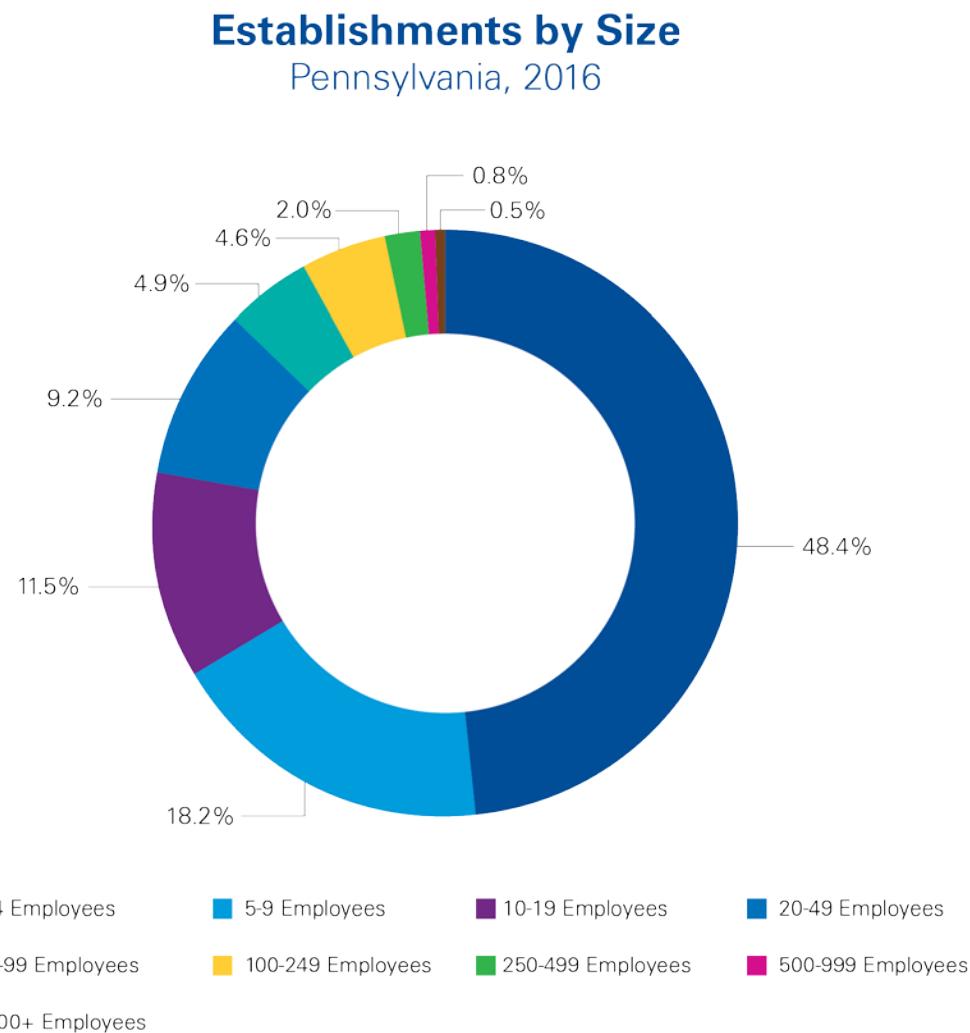
Figure 3: Distribution of Pennsylvania Life Sciences Establishments⁷



⁷ White dots indicate the geographic location of firms with NAICS codes corresponding to one of the NAICS codes used in this report to define the Life Sciences industry in Pennsylvania. Data based on Dun & Bradstreet data available as of 2017 second quarter.

Interestingly, more than half of the Life Sciences industry establishments operating in Pennsylvania in 2016 are comprised of fewer than 10 employees. Conversely, fewer than 1.0 percent in the Pennsylvania Life Sciences industry employ more than 1,000 individuals as captured in the figure below.

Figure 4: Establishments by Size



*Data reflects total number of establishments in life sciences by size in Pennsylvania as of the first Quarter of 2017

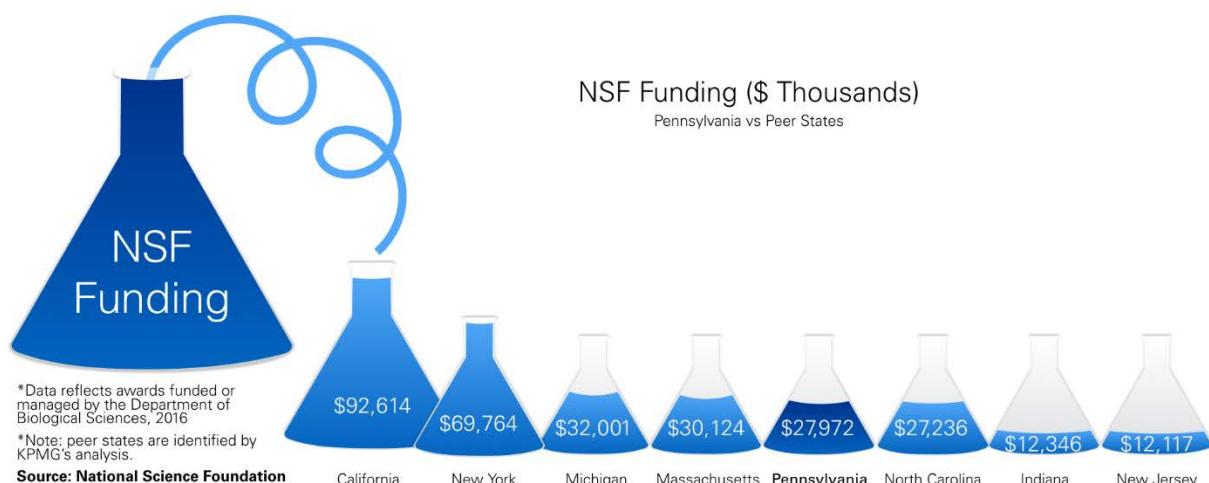
*KPMG's analysis using Dun & Bradstreet data

Source: Dun & Bradstreet

Research excellence

Pennsylvania is a national Life Sciences research leader and one of the most prominent states active in the industry.

Figure 5: NSF Funding, by State

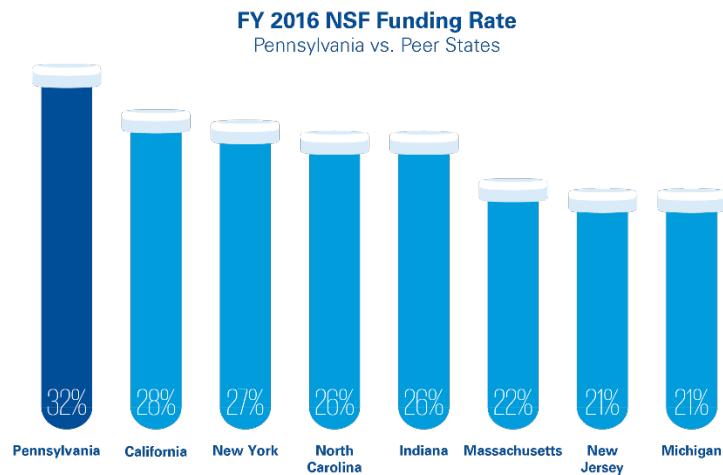


In 2016 Pennsylvania businesses, universities, and establishments received \$27.9 million in funding from the National Science Foundation (NSF). This makes Pennsylvania one of the highest NSF funded states in the nation. In addition, Pennsylvania had the highest 2016 NSF funding rate⁸ in comparison to peer states. Although states like California and New York received considerably more NSF funding,

⁸ The funding rate, sometimes referred to as “success rate”, is calculated by the number of competitive awards made during a year divided by the number of total proposals competitively reviewed.

Pennsylvania's approximately 32.0 percent funding rate (meaning 32.0 percent of total NSF proposals receive an award) exceeded that of its peers.

Figure 6: NSF Funding Rate, by State



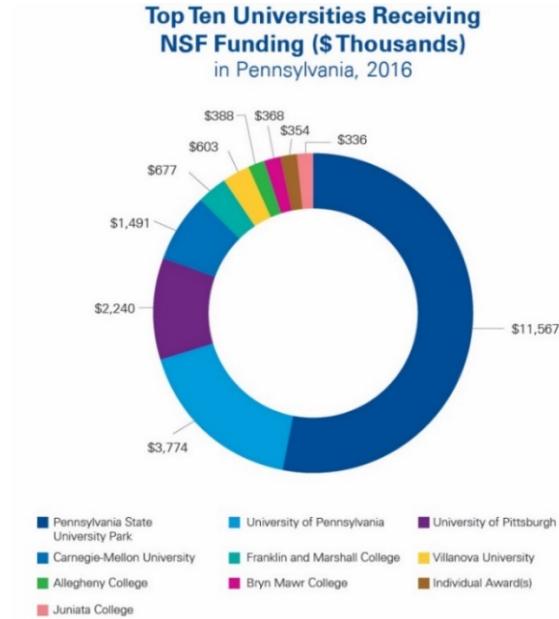
*Data reflects funding rate from the Department of Biological Sciences, 2016. Funding rate is calculated by dividing the number of awards by the number of awards and declines

*Note: peer states are identified by KPMG's analysis.

Source: National Science Foundation

Similar to other states, much of Pennsylvania's NSF funding can be attributed to universities, with Penn State responsible for about 50.0 percent, or about \$11.6 million of the total university NSF funding of \$23.2 million in Pennsylvania in 2016.

Figure 7: Top Ten University Rankings (Life Sciences)

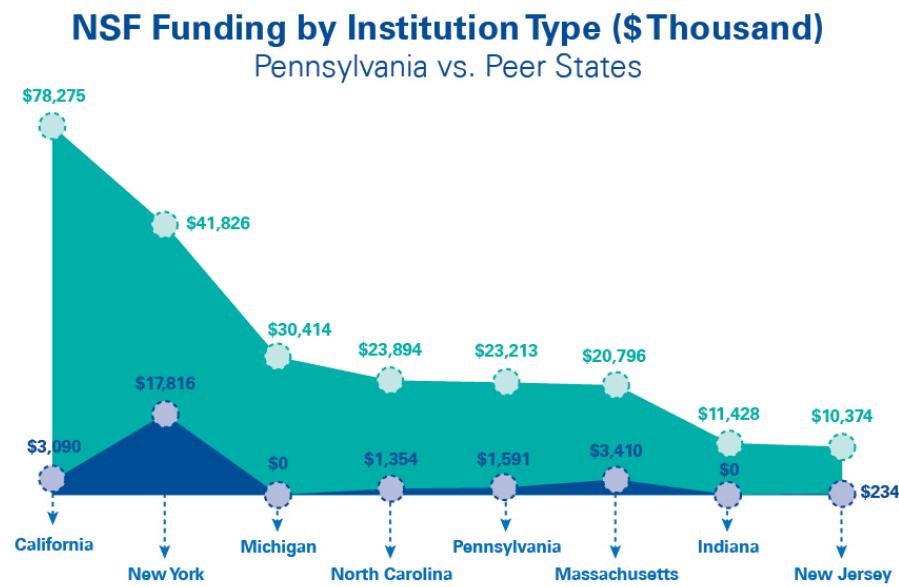


*Data reflects awards funded and managed by the Department of Biological Science, 2016
Source: National Science Foundation

Pennsylvania establishments also receive significant National Institute of Health (NIH) funding relative to other states. In 2016 Pennsylvania received \$1.6 billion in NIH funding. Pennsylvania's NIH funding is

especially significant when viewed on a per capita basis to account for the Commonwealth's relative size.

Figure 8: NSF Funding



*Data reflects awards funded and managed by the Department of Biological Sciences, 2016

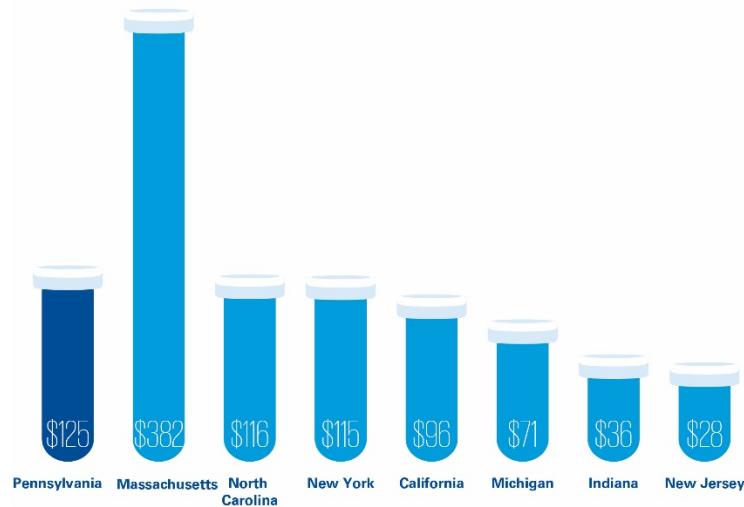
*Non-University includes federal, industry, small business and other.

*Peer states are identified by KPMG's analysis.

Source: National Science Foundation

University
Non-University

NSF & NIH Funding Per Capita
Pennsylvania vs. Peer States



*Data reflects NSF and NIH funding per capita in 2016

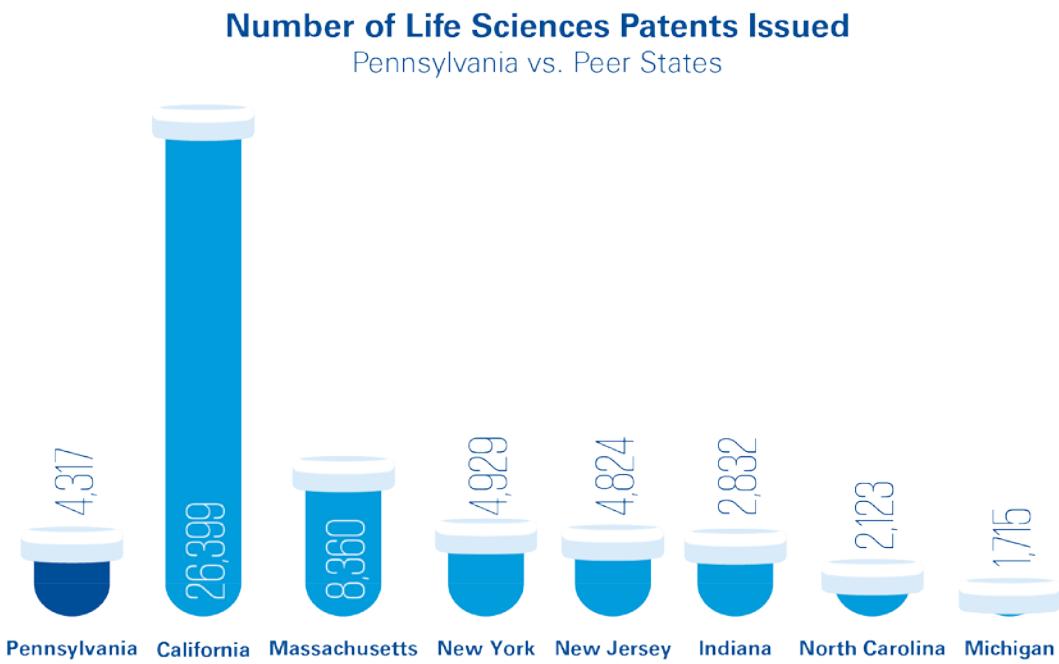
*Note: peer states are identified by KPMG's analysis.

Source: National Institute of Health, National Science Foundation and U.S. Census Bureau

Just as Pennsylvania receives significant NSF and NIH funding, Pennsylvania establishments have issued a substantial number of Life Sciences related patents. From 2011 to 2015, Pennsylvania establishments

have issued 4,317 Life Sciences patents. In 2015, Life Sciences patents in Pennsylvania were issued at a rate of 7.6 patents per 100,000 people, an increase of about 44.0 percent in rate since 2011. While this rate change from 2011 to 2015 was higher than many of its peers, Pennsylvania's rate of Life Sciences patent issuance in 2015 did not stand out amongst its peers.

Figure 9: Life Sciences Patents



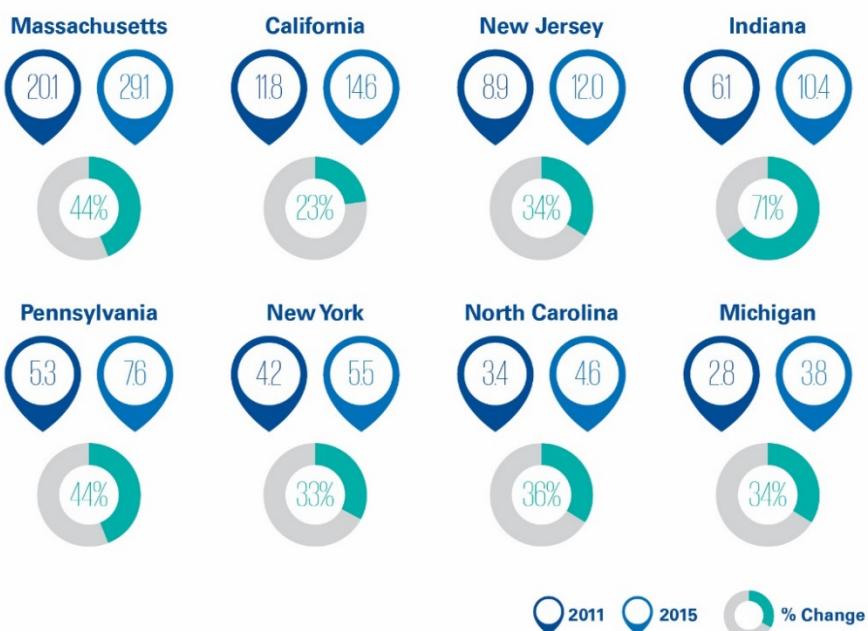
*Data reflects total number of utility patents issued from Calendar Year 2011-2015

*KPMG's analysis using Calendar Year General Patent Statistics Reports

Note: peer states are identified by KPMG's analysis.

Source: U.S. Patent and Trademark Office

Life Science Patents per 100,000 Population Pennsylvania vs. Peer States



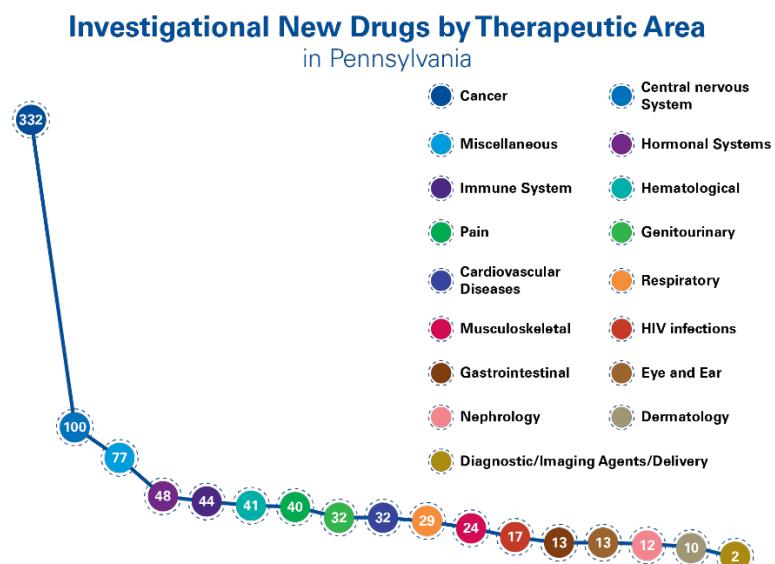
*Data reflects life sciences patents per 100,000 population in 2011 and 2015 and the 5-year growth rate from 2011 to 2015

*KPMG's analysis using Calendar Year General Patent Statistics Reports and annual estimate of residential population

Source: U.S Patent and Trademark Office, U.S. Census Bureau

Much of the Life Sciences research in Pennsylvania centers on the development and investigation of new drugs. As of July 2017, roughly one third of all drugs investigated in Pennsylvania are related to cancer treatments, with central nervous system drugs being the second most investigated.

Figure 10: Investigational New Drugs by Therapeutic Area



*Data reflects IND studies through early clinical trial phases (early phase 1, phase 1, phase 1/phase 2, phase 2, phase 2/phase 3) and Phase 3, active as of 2017.

"Miscellaneous" drugs are those that fall into more than one therapeutic area based on possible indications treated.

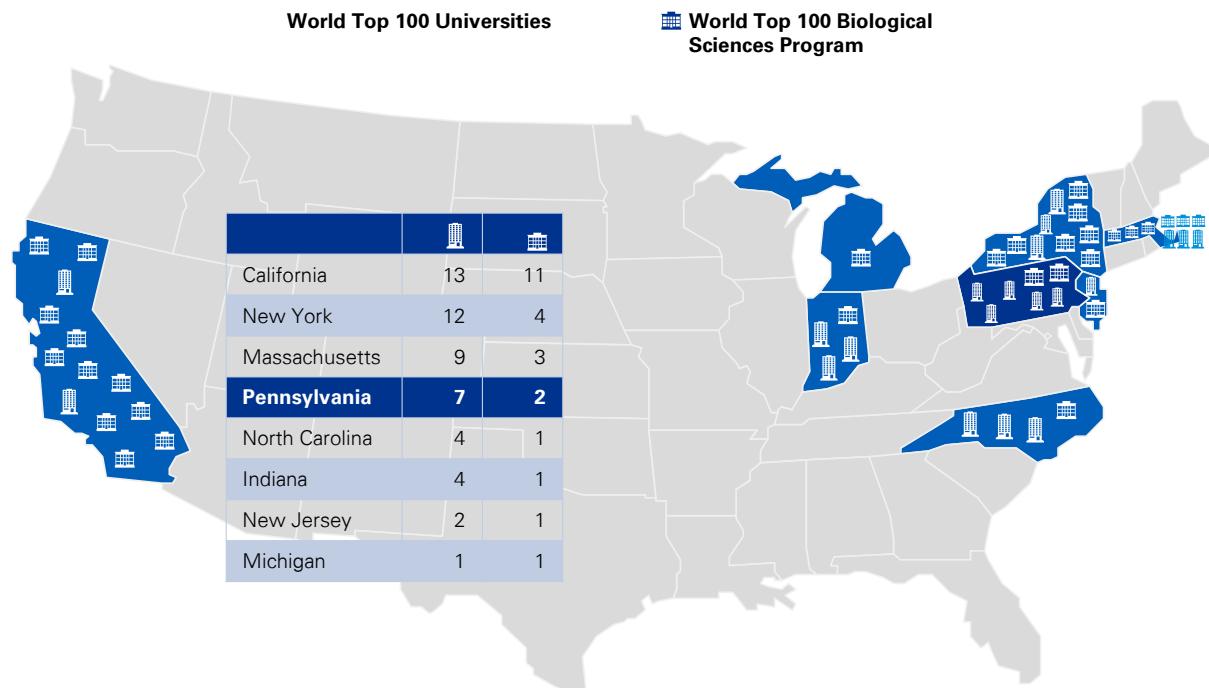
Source: BioPharm Insight

Academic contribution

Pennsylvania has a longstanding tradition of academic excellence, which serves as an engine for research and innovation for the Life Sciences industry.

Pennsylvania has seven universities listed on the World Top 100 Universities according to the Shanghai Index and two universities on the World Top 100 Biological Sciences Program according to the QS 2016 University Ranking by Subject. In 2015, institutions in the Commonwealth awarded 578 doctoral degrees in the Life Sciences discipline, which ranks amongst the highest states in the nation.

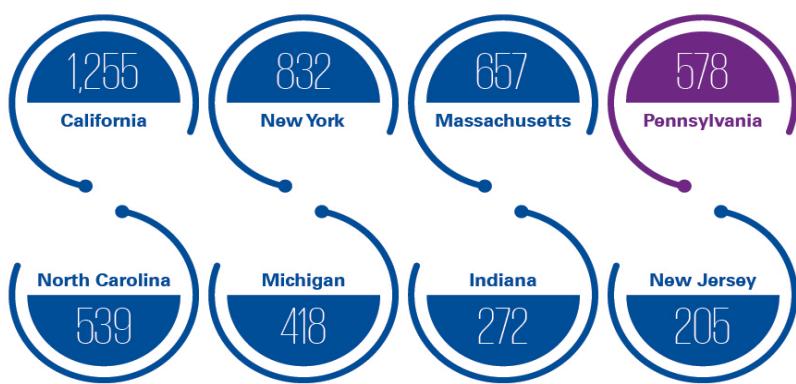
Figure 11: Top 100 Universities



Source: Shanghai Index, 2016 rankings; QS World University Ranking by subject

Doctorate Recipients in the Life Sciences Discipline

Pennsylvania vs. Peer States



*Data reflects doctoral recipients in the life sciences fields of study in 2015.

*Life Sciences Disciplines includes agricultural sciences and natural resources, biological and biomedical sciences and health sciences based on NSF's definition.

Note: Peer states are identified by KPMG's analysis.

Source: National Science Foundation, National Center for Science and Engineering Statistics, Survey of Earned Doctorates, 2015

It is difficult to overstate the role of the university in the formation of regional economies driven by technical and scientific activities. Pennsylvania's world-class research universities are some of its most important assets not only because they confer a comparative advantage in promising gene and cell therapeutic areas, but also because of their role in supporting the Commonwealth's innovation ecosystem through models of collaboration that enable researchers, entrepreneurs, angel investors, and venture capitalists to translate new ideas into marketable goods and services.

University Commercialization

Pennsylvania's research universities engage in two broad forms of commercialization:

1. Licensing – Licensing or sale of intellectual property, typically in return for royalties; and
2. Spinoffs/Start-Ups – Ventures created by the university, or that use technologies owned by the university, or those that are managed or financed by the university. The terms Spinoffs and Start-Ups are sometimes used interchangeably but some definitions distinguish a Spinoff from a Start-Up based on the latter's typically greater reliance on capital or management supplied by an entity other than the university.

is a movement towards the "innovation center" model. Through this model universities invest heavily in programs designed to form linkages with businesses pursuing research, connect entrepreneurs with researchers, and accelerate business development.

The commercialization activities⁹ occurring at Pennsylvania's major research institutions are closely aligned with the Life Sciences industry, which at several large institutions accounts for between half and three-quarters of the commercialization activities taking place. Universities in Pennsylvania are increasingly working with corporations to conduct corporate-sponsored research in promising niche areas such as digital health, cellular immunotherapy, novel medical devices, and health-related information technology. Pennsylvania's universities take an active role in connecting researchers with entrepreneurs, venture capitalists and angel investors to promote an active start-up environment. The clear trend across the Commonwealth's universities

⁹ See "University Commercialization" text box. Source: CEO Council for Growth, "Technology Transfer and Commercialization in Greater Philadelphia".

The latest signs suggest the pace of commercialization activity is accelerating. For example, from 2013 to 2016 the University of Pennsylvania's Penn Center for Innovation (PCI) has seen the share of research and development expenditures from all corporate sponsorships double¹⁰, with much of the increase tied to Life Sciences. Similarly, the University of Pittsburgh's Innovation Institute has recorded a sharp increase in both the number of patents issued and start-up companies formed (both university-led and student-run), indicating research activities are increasingly translating into new ventures¹¹.

One limiting factor for even greater university-led commercialization efforts is a dearth of both experienced entrepreneurial and venture capital in Pennsylvania. Although difficult to measure directly, anecdotal evidence based on discussions with leading university commercialization offices suggests greater levels of commercialization could occur with the support of more local entrepreneurs having experience in Life Sciences ventures and larger inflows of venture capital.¹²

¹⁰Source: Penn Center for Innovation, University of Pennsylvania. PCI Metrics Dashboard, "[% Total Penn R&D Expenditures from Corporate Sponsorships](#)"., as accessed on August 23, 2017.

¹¹ Source: [Innovation Institute](#), University of Pittsburgh. Annual Reports for 2013-2016, as accessed on August 23, 2017.

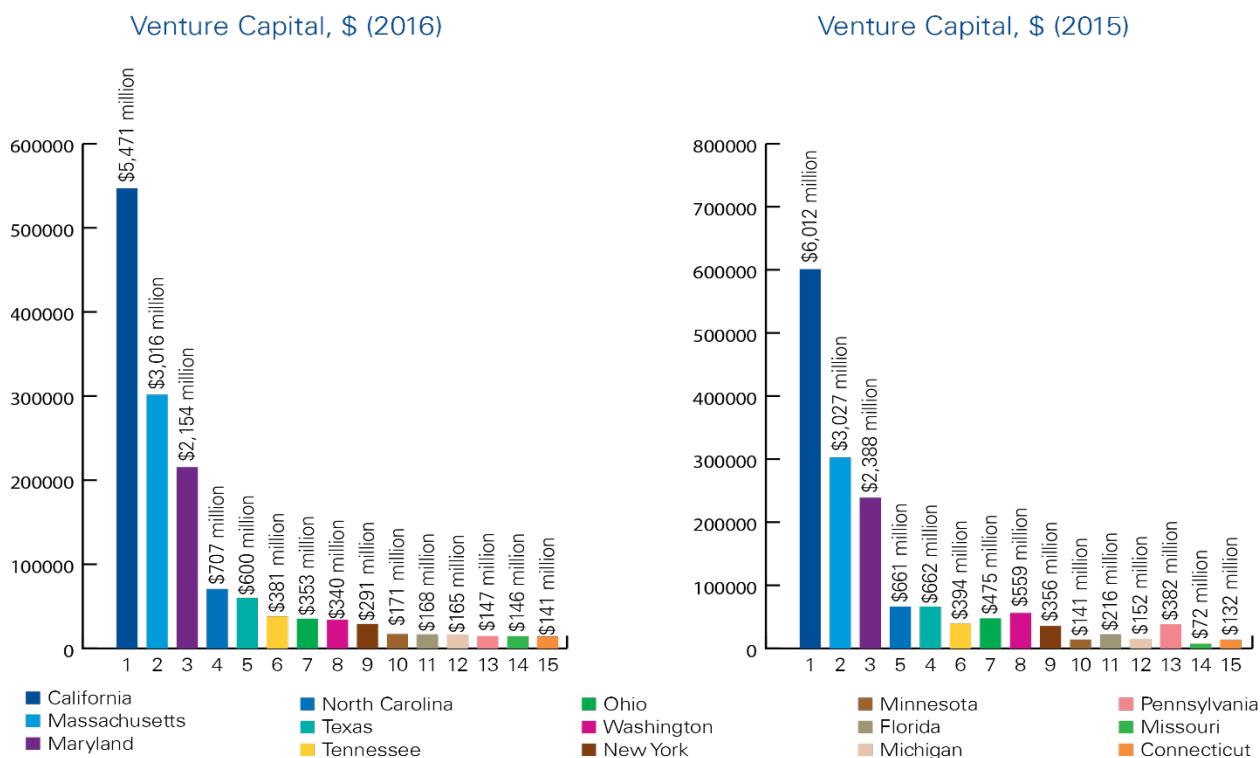
¹² Information based on a series of informational interviews conducted with technology transfer program coordinators of several major Pennsylvania universities.

Attracting capital

There are several ways in which early-stage Life Sciences companies can acquire funding. The method most commonly utilized by early-stage companies involves securing commitments from venture capitalists or angel investors. In Pennsylvania, the amount of venture capital commitments falls far below national leaders like California and Massachusetts. A lack of venture capital may serve as a limiting factor for the Life Sciences industry in Pennsylvania, as companies that are unable to secure sufficient funding early in their lifecycle may be unable to stage significant expansions necessary to become dominant in their industries.

Figure 12: Life Sciences Venture Capital

Venture Capital: Life Sciences



Source: PwC/CB Money Tree Report, data for 2015 and 2016 available as of Q2 2017.

Another method of acquiring funding is through an initial public offering (IPO). IPOs occur most frequently among late-stage start-up companies that may require access to a larger pool of potential investors than may be acquired through venture capital alone. In 2016, fourteen Pennsylvania Life Sciences companies either announced or closed on an IPO with a total transaction value of \$992 million.

Similarly, companies can acquire funding through private placements by issuing securities directly to private investors. In 2016, there were 26 instances of Pennsylvania Life Sciences companies acquiring funding through private placement activities. In total, Pennsylvania Life Sciences companies acquired \$537 million in funding through private placements in 2016.

Figure 13: Investment Activities in Life Sciences¹³

| 2016 Pennsylvania investment activities | | |
|---|-------|---------------------------------------|
| Transaction activities | Count | Total transaction value (in millions) |
| IPO ¹⁴ | 14 | \$992 |
| Private Placement | 26 | \$537 |

Mergers and acquisitions (M&A) within the Life Sciences industry are sometimes a signal of consolidation but often serve as mechanisms for expansion and reducing risk. As the Life Sciences industry continues to grow, larger companies have begun to enhance their new product portfolios through M&A rather than investing in traditional R&D. While the Pennsylvania Life Sciences industry recorded only one acquisition in 2016, two such activities occurred in 2015, and five M&A transactions occurred in 2014.

¹³ Source: S&P Capital IQ database (2017).

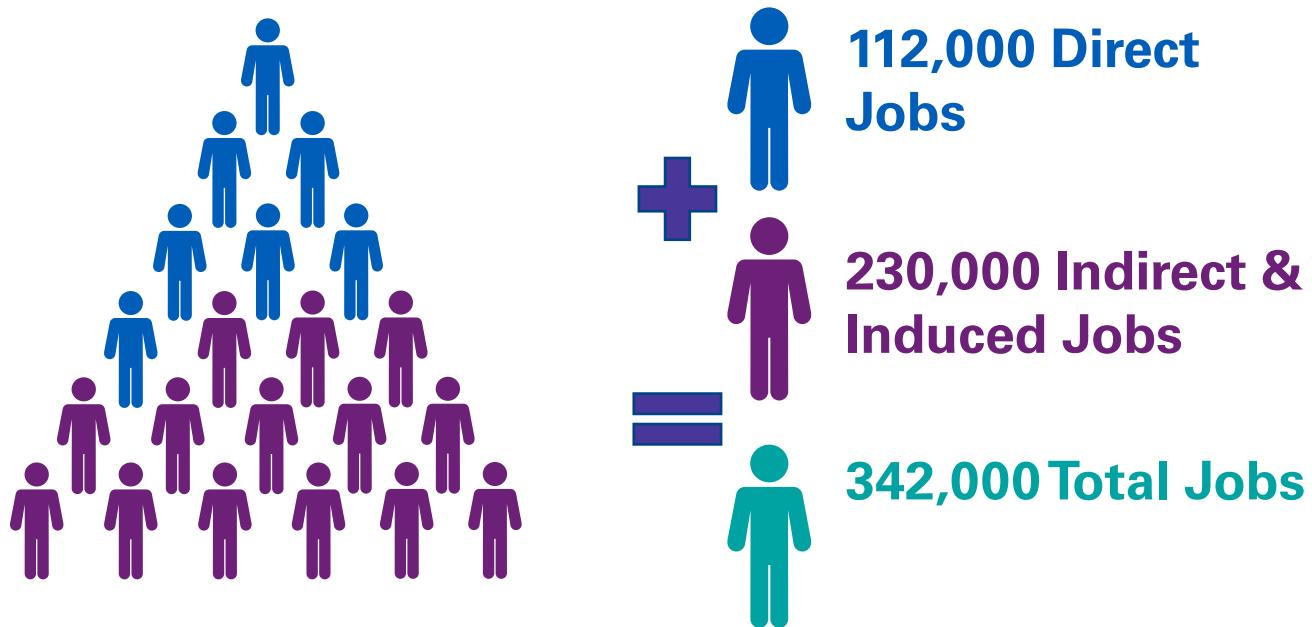
¹⁴ Includes both announced and closed transactions

Economic contribution

In addition to its role in the issuance of patents, development of innovative drugs, and integration with world-class academic institutions, the Life Sciences industry is an integral component of the Pennsylvania economy. This section provides estimates of the economic impact that the Life Sciences industry brings to the Commonwealth.

Economic impact analysis quantifies the direct and indirect economic impacts of companies' or industry presence as measured by economic output, employment, labor income, and taxes of spending associated with an activity/event/project on a local, state or national economy. Economic impact analysis recognizes the interdependence among different sectors of the economy. Operating expenses incurred, compensation paid, taxes paid, and capital invested by an industry help stimulate business activity, personal consumption, and social development throughout the economy. The presence and impact of a particular industry generates total economic impact that is substantially larger than its own activities.

The Life Sciences industry directly employs over 112,000 individuals in Pennsylvania and supports over 340,000 total jobs in the Commonwealth. The additional indirect and induced jobs are generated by firms in the supply chain providing goods and services to the Life Sciences industry, as well as jobs created as a result of the spending of Life Sciences and supporting industry workers.



Employee labor income contributed to the Pennsylvania economy both directly through the Life Sciences industry and indirectly through supporting industries. Labor income, including all wages and salaries, directly attributable to the Life Sciences industry in Pennsylvania totaled \$11.0 billion in 2016. An

additional \$15.2 billion in labor income resulted from the indirect and induced contributions of the Commonwealth Life Sciences industry.



In addition, the Life Sciences industry's importance to Pennsylvania can be captured through its significant contribution to state economic output. The industry directly contributed approximately \$48.8 billion in economic output in 2016 to the Commonwealth, with an additional \$39.6 billion contributed through economic activities supporting the industry. This resulted in a total of \$88.5 billion in state economic output contributed to the Pennsylvania economy by the Life Sciences industry and supporting activities in 2016.

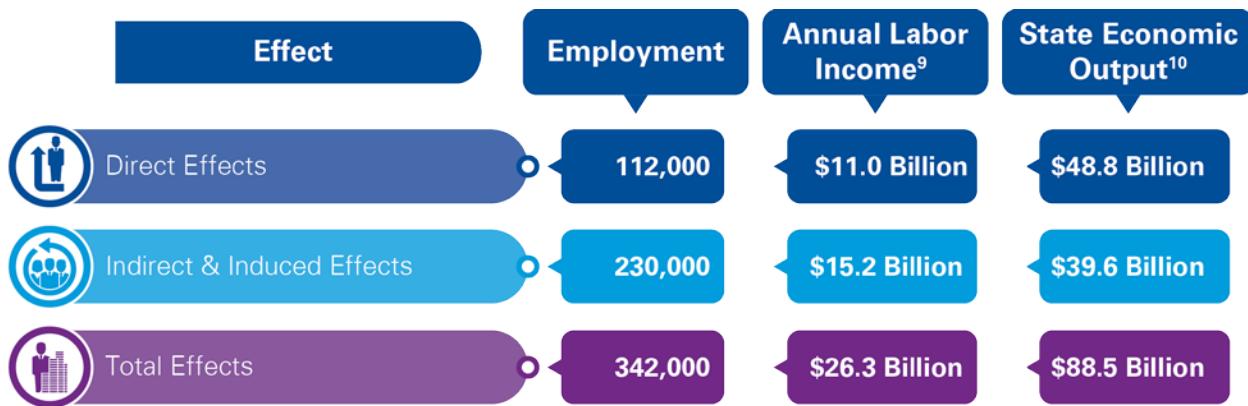
The Pennsylvania Life Sciences industry was responsible for generating approximately \$9.8 billion in federal, Commonwealth and local taxes in 2016

Figure 14: Life Sciences Economic Contribution

| Effect | Employment | Annual labor income ¹⁵ | State economic output ¹⁶ |
|----------------------------|------------|-----------------------------------|-------------------------------------|
| Direct Effects | 112,000 | \$11.0 Billion | \$48.8 Billion |
| Indirect & Induced Effects | 230,000 | \$15.2 Billion | \$39.6 Billion |
| Total Effects | 342,000 | \$26.3 Billion | \$88.5 Billion |

¹⁵ Labor Income refers to the sum of all wages and salaries (including employee benefits) paid to those directly and indirectly impacted by the Life Sciences industry. Labor Income is a component of Economic Output, and hence is not an additive economic impact to Economic Output.

¹⁶ State Economic Output represents the value of goods and services produced in the state economy due to certain economic activity, measured in gross product (revenues) generated.



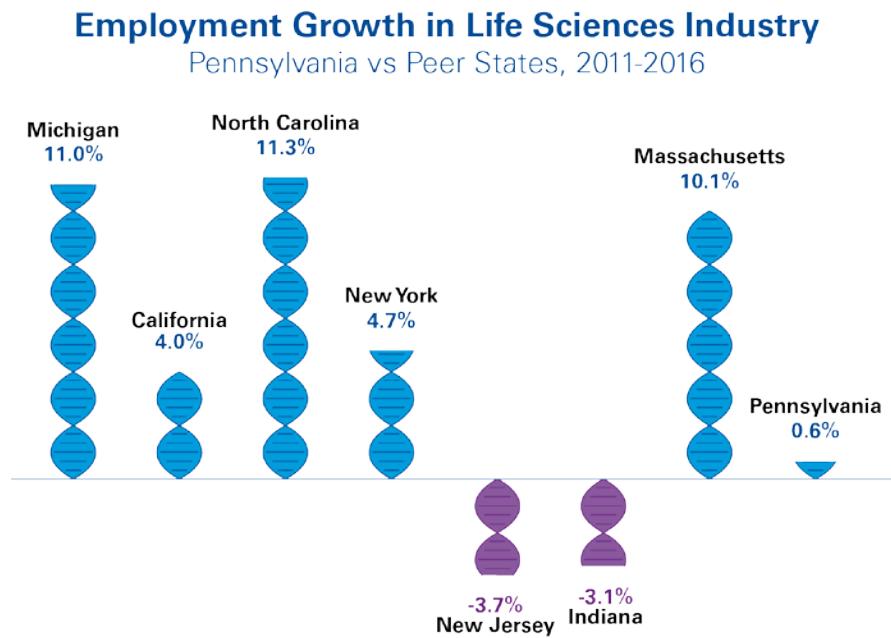
The following sectors are most prominently impacted by the contributions of the Life Sciences industry in Pennsylvania. Many of these sectors, such as colleges, universities, and professional schools, scientific research and development services, and pharmaceutical preparation manufacturing are primarily the result of direct employment in the Life Sciences industry. Other industries, such as wholesale trade, management of companies and enterprises, and real estate are the result of significant indirect and induced employment in support of the Life Sciences industry.

Figure 15: Employment Impact Detail, Top 10 Sectors



Pennsylvania has experienced modest employment growth of 0.6 percent from 2011 to 2016 in the Life Sciences industry relative to its peer states. While two peer states, New Jersey and Indiana, experienced a decline in Life Sciences industry employment over this period, all other peer states grew more rapidly than Pennsylvania. Three states, North Carolina, Michigan, and Massachusetts, experienced double-digit employment growth over this period of 11.0 percent, 11.3 percent, and 10.1 percent respectively.

Figure 16: Employment Growth



*Data reflects 5-year employment growth rate from 2011-2016

Commonwealth support

The Commonwealth of Pennsylvania offers several supportive incentive programs across various industries which are often utilized by companies in the Life Sciences industry including: Research and Development Tax Credit, Keystone Opportunity Zone, and Job Creation Tax Credit. In addition, the Commonwealth has specific appropriations in its budget specifically focused on Life Sciences and other high-tech industries including the Life Sciences Greenhouse Incentive and the Ben Franklin Technology Development Authority Fund. The Commonwealth also offers additional support in the form of a dedicated agency focused on supporting companies in the Life Sciences agency (Department of Community and Economic Development). The following table provides additional detail on Pennsylvania incentive programs, recipients, and proposed costs.

Figure 17: Illustrative Commonwealth Support for Life Sciences

| Program name ¹⁷ | Program description | Beneficiaries | Proposed budget (\$ in millions) |
|---|--|--|----------------------------------|
| R&D Tax Credit | A statutory credit in the amount of 10.0 percent of increase in qualified research expenditures | 765 companies, annually | \$55.0¹⁸ |
| Life Sciences Greenhouse Initiative | A special appropriation fund to promote early-stage risk capital and catalyst development and creation of new Life Sciences related products and companies | 38 life sciences companies in 2016 ¹⁹ | \$3.0 |
| Ben Franklin Technology Development Authority Fund | A special appropriation fund to promote entrepreneurial business environment, advance technology innovation, and create technology ready workforce | Not Available | \$14.5 |
| Keystone Innovation Zones | A statutory tax credit offered to targeted industries (including Life Sciences) in an amount derived in the zone over the previous 2 years, subject to limitations | 59 Life Sciences companies, annually | \$15.0⁸ |
| Job Creation Tax Credit | Provides non-refundable income tax credits to companies that create a minimum of 25 new jobs | Not Available | \$10.1⁸ |

¹⁷ The table identifies the key business support programs included in the Commonwealth of Pennsylvania's proposed budget for 2017-2018.

¹⁸ Amounts are included in the proposed revenue bill, however the bill has not been passed other numbers per general bill.

¹⁹ During 2016, Pittsburgh Life Sciences Greenhouse invested a total of \$1.4 million into 14 companies. BioAdvance invested in 12 companies. Life Sciences Greenhouse of Central Pennsylvania (LSGPA) invested in 12 companies.

| | | | |
|-----------------|---|---------------|---------------|
| | or increase employment by 2.0 percent within three years from a negotiated start date | | |
| PA First | A discretionary cash grant awarded to promote job creation and capital investment in the Commonwealth | Not Available | \$15.0 |

California, New York, Massachusetts, and New Jersey are often evaluated in conjunction with Pennsylvania due to their large Life Sciences industry presence. Similar to Pennsylvania, each of these states have R&D tax credits which are often utilized by Life Sciences companies. Massachusetts has a similar approach to Pennsylvania as they both provide strong support in the form of a dedicated agency and a legislative act to appropriate funding support in the form of incentives at the discretion of the governor's budget. New York, New Jersey, and California utilize a different approach to support companies in this industry. These states have designated incentive programs in the form of grants, tax credits, etc. which may be enhanced if the company is in the Life Sciences industry. While both approaches may result in significant incentive benefits for a company in the Life Sciences industry, Pennsylvania's focus on the Life Sciences industry is evident.

Life sciences: Key trends

Life Sciences is evolving at a rapid rate, driven by changes in technology, research, policy, and the allocation of capital. The following section analyzes the trends shaping the national Life Sciences industry and how those trends have manifested themselves in Pennsylvania. These trends include:

- Supply trends: How the industry is responding to volatility in input prices and supply levels, the increase in supply chain complexity, the consolidation of existing industries, and the emergence of new value-generating ventures;
- Demand trends: Expanding demand for the products and services produced in the Life Sciences industry, entry into new markets, new revenue mechanisms and risk-sharing arrangements, the shift from volume-based to value-based models, and the changing definition of the consumer;
- External factors: The changing regulatory and risk environment and its impact on the Life Sciences industry, changing economic environment and its impact on the Life Sciences industry growth; and,
- Disruption: Scientific breakthroughs, the growing need for digital and analytics capabilities to gain both operational efficiencies and greater consumer engagement, new forms of competition.

Supply trends

Consolidation in the industry²⁰

In many healthcare-related segments of the Life Sciences industry in the US, consolidation is occurring, leading to a further concentration in the healthcare market. Technology regulation, market disruption, the drive to gain access to clinical research, patent expirations, and increased movement of private and government payers are forcing companies to review their operating models. Life sciences is currently a leading industry in merger and acquisition activity.

Pennsylvania in Focus

In the last quarter of 2016, M&A activities in the healthcare industry accounted for 22% of total M&A deals in Central Pennsylvania. In the Philadelphia metro area, M&A activities in the healthcare industry accounted for 17% of all deals – third most of any industry. One of the largest healthcare deals in late 2016 was the acquisition of Koltan Pharmaceuticals by Celdex Therapeutic, with a total transaction value of over \$230 million.

²⁰ Sources: [KPMG 2016 M&A Survey findings: U.S. executives on M&A: full speed ahead in 2016](#), 2016, KPMG, as accessed on August 3, 2017; [Central Pennsylvania regional M&A update: Q4-2016 Baker Tilly Capital](#), as accessed on August 29, 2017; [Philadelphia Regional M&A Update: Q4-2016. Baker Tilly Capital](#), as accessed on August 29, 2017.

Demand trends

Downward Pressure on Pricing²¹

Governments and payers are exerting pressure to drive prices down in many of the industries in healthcare and pharmaceuticals. The movement of payers towards value-based methodologies is having significant follow-on effects for suppliers, especially in the pharmaceuticals industry. Companies are working increasingly towards developing value-based contracts, marking a decisive shift away from the volume-based models that prevailed in the past. Value-based pricing comes with its own set of risks and challenges, but it also has large potential to benefit multiple healthcare stakeholders if implemented properly.

Pennsylvania in Focus

- The University of Pittsburgh Medical Center (UPMC) Health Plan has established the Center for Value-Based Purchasing for Pharmaceuticals. The center is dedicated to studying existing payment models, developing new payment methodologies, and evaluating health outcomes. UPMC hopes the center will "fundamentally change the way medications are paid for in the U.S."
- Teva Pharmaceuticals, whose North American headquarters is based in North Wales, PA, intends to close 15 plants and lay off 7,000 employees over the next two years. Much of the firm's financial troubles stem from increased approval of generic drugs leading to price erosion.

Rising costs²²

Despite continued growth and positive prospects, Life Sciences companies continue to incur high costs, particularly on the research front. There is a high demand for innovative and more effective healthcare solutions, however research remains a high risk and high expense approach for companies. This pricing pressure is further intensified as the cost of bringing a new product to the market has been the highest ever. Industry stakeholders are intensively scrutinizing income statements in an attempt to cut costs through company right-sizing, increasing cross-functionality within the organization, and improving operational efficiency.²³

Pennsylvania in Focus

Mylan, a Pennsylvania-based pharmaceutical company, has announced its intention to restructure operations and reduce headcount in an effort to reduce costs.

²¹ Sources: KPMG Global Strategy Group report: Pharma outlook 2030: From evolution to revolution – A shift in focus, 2017, KPMG, as accessed on August 3, 2017;

[UPMC Health Plan Establishes Unprecedented Center for Value-Based Purchasing for Pharmaceuticals](#), May 31 2017, Cision PR Newswire, as accessed on August 29, 2017;

[American Pharmacists Association](#), as accessed on August 29, 2017;

[Teva to Cut 7,000 Jobs After Disappointing Quarter Results](#), August 4 2017, BizPhilly, as accessed on August 29, 2017.

²² [Mylan eyes up to 3,500 layoffs in post-M&A cost-cutting drive](#), December 2016, FiercePharma, as accessed on August 3, 2017

²³ [An evolving industry: Today's clusters creating tomorrow's breakthroughs](#), 2017, JLL Research, as accessed on August 3, 2017

External factors

Portfolio optimization through M&A

As the Life Sciences and healthcare industry in the U.S. continues to grow, biotechnology companies have started to focus on new product development through M&A activities and strategic partnerships, as it may often be more cost efficient than traditional R&D.²³ M&A activity is also seen as an opportunity, for pharmaceutical companies, to access new and innovative technologies, thereby refill their drug pipelines. This trend is expected to continue attracting top pharmaceutical players to pursue M&A opportunities further.

The healthcare and Life Sciences industry ranked as the top sector for U.S. M&A in 2016 with \$242.6 billion in transactions.²⁴ The top deal for the Life Sciences sector in 2016 was Dublin, Ireland-based Shire plc entering into an agreement to acquire Baxalta Incorporated from Baxter International Inc. and others for \$36.2 billion on January 11, 2016.

Continued wage growth for skilled labor

The high demand for skilled labor in the Life Sciences industry has had a significant impact on the labor market. This trend has resulted in sustained wage growth for employees in the Life Sciences industry. In the US, over the past five years, the average employee salary has gone up by 19.2 percent. As Life Sciences companies continue to require highly skilled labor with advanced educational qualifications, wage growth will likely continue.

In 2015, almost 60.0 percent of the jobs in the U.S. Life Sciences industry required some post-secondary education to obtain an entry level position, according the Bureau of Labor Statistics, while 45.6 percent of these positions required a Bachelor's degree or higher.²⁵

Increasing inflow of capital

The Life Sciences industry ecosystem would not have grown without the funding received from venture capital firms. This funding has enabled further product innovation through R&D. National venture capital investment volume fell in 2016 after a record year in 2015. However, while U.S. funding as a whole decreased by about 20.0 percent in 2016, Life Sciences industry funding only decreased by about 8.0 percent. The Life Sciences industry received the second highest funding in 2016, while the software industry received the highest funding.²⁶

Disruption

Increase in Partnership and Integration with Technology Businesses²⁷

The significance of technology, particularly software, has been steadily increasing across various fields, and the Life Sciences industry is no exception to this trend. Several pharmaceutical and medical devices companies are seeking opportunities to partner and integrate with technology firms. One of the recent examples is the collaboration that was announced in September 2016, between Sanofi and Verily Life

²⁴ Source: [2016 Announced US M&A Summary](#), January 2017, S&P Global Market Intelligence, as accessed on August 2, 2017

²⁵ Source: [Greater Philadelphia Region Life Sciences Report](#), 2017, Ben Franklin Technology Partners, as accessed on August 3, 2017

²⁶ Source: [An evolving industry: Today's clusters creating tomorrow's breakthroughs](#), 2017, JLL Research, as accessed on July 31, 2017

²⁷ Sources: Digital Health: Building on our Strengths Greater Philadelphia Region. Trends and Highlights, January 2008 to June 2014

<http://www.prnewswire.com/news-releases/rightcare-solutions-and-thomas-jefferson-university-hospital-announce-partnership-to-reduce-readmissions-176938761.html>

Sciences LLC, the Life Sciences business unit of Alphabet Inc. This joint venture plans to invest approximately \$500 million to develop a solution comprising devices, software and medicine.²⁸

Pennsylvania in Focus

- Digital health companies are flourishing in the Greater Philadelphia region. More than 20% of these companies develop specialized information technology or data services for pharmaceutical and clinical trials. Additionally, more than two-thirds of these companies are developing provider/payer solutions.
- In 2012, Thomas Jefferson University in Philadelphia, PA entered into a partnership with RightCare Solutions to use innovations in medical technology to improve patient care and reduce readmissions.

From Treatment to Prevention²⁹

Increased collection and monitoring of health data permits practitioners to predict the likelihood of a patient being diagnosed with a disease or health condition, marking a shift from treatment of symptoms to prevention measures. This cost-effective trend is marked by groundbreaking new therapies, advances in technology, and increased focus on consumers of healthcare products through increased data access by patients.²⁸ In addition, the collection and processing of patient-related data are paving the way for personalized treatment. Verily, in collaboration with Dexcom, is developing a miniaturized continuous glucose monitor with embedded sensors to monitor the glucose level. Leveraging real-time information, this device will help in effective control of diabetes in patients.³⁰

Pennsylvania in Focus

Ben Franklin Technology Partners, a Pennsylvania based early-stage investment firm, has invested in Instadiagnostics, Inc., a technology company that is developing a rapid, quantitative, point-of-care platform designed to allow for early diagnosis for monitoring patients more easily at their care center.

Disruption, and an increasing focus on R&D

Life sciences product pipelines are gaining strength, U.S. Food and Drug Administration (FDA) approvals have rebounded, and new products are launching in key therapeutic areas. Venture capitalists remain focused on Life Sciences start-ups. Overall growth in the contract research organization sector is picking up. Elsewhere, Pennsylvania's Life Sciences industry is distinguishing itself in terms of its ability to acquire research funds and grants available from national research centers and federal agencies.

²⁸ Source: [Pharma outlook 2030: From evolution to revolution](#), January 2017, KPMG International, as accessed on July 31, 2017

²⁹ Source: [Twelve Health Companies Creating an Impact in our Region](#), July 28, 2017, Ben Franklin Technology Partners, as accessed on August 29, 2017

³⁰ Source: [Miniaturized CHM](#), Verily website, as accessed on August 3, 2017

Methodological appendix

Employment Data

The model used to estimate the economic contribution of the Life Sciences industry on the Pennsylvania economy relied on data from a variety of sources. The direct employment impacts of the Life Sciences industry to Pennsylvania were used to inform the model and were primarily derived from the Bureau of Labor Statistics Quarterly Census of Employment and Wages (QCEW). QCEW data reports employment and wages as reported by employers and covers more than 95.0 percent of U.S. jobs at the national, state, metropolitan statistical area, and county level. Data is aggregated starting at the 6-digit NAICS industry level.

For the purposes of this study, the definition is heavily informed by the guiding principal that Life Sciences companies are involved directly or indirectly in biomedical or human health research, product development, and innovation. This definition included contributions from 23 NAICS industry codes. All of the QCEW Pennsylvania employment data was attributed to the Life Sciences industry for the following 18 industries.

| NAICS | Sector Name | Allocation |
|--------------------------------------|---|------------|
| Drugs & Pharmaceuticals | | |
| 325411 | Medicinal and Botanical Manufacturing | 100% |
| 325412 | Pharmaceutical Preparation Manufacturing | 100% |
| 325413 | In-Vitro Diagnostic Substance Manufacturing | 100% |
| 325414 | Biological Product (except Diagnostic) Manufacturing | 100% |
| Medical Devices and Equipment | | |
| 333314 | Optical Instrument and Lens Manufacturing | 100% |
| 334510 | Electromedical and Electrotherapeutic Apparatus Manufacturing | 100% |
| 334516 | Analytical Laboratory Instrument Manufacturing | 100% |
| 334517 | Irradiation Apparatus Manufacturing | 100% |
| 339112 | Surgical and Medical Instrument Manufacturing | 100% |
| 339113 | Surgical Appliance and Supplies Manufacturing | 100% |
| 339114 | Dental Equipment and Supplies Manufacturing | 100% |
| 339115 | Ophthalmic Goods Manufacturing | 100% |
| 339116 | Dental Laboratories | 100% |
| Wholesale Trade | | |
| 423450 | Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers | 100% |
| 423460 | Ophthalmic Goods Merchant Wholesalers | 100% |

| Research, Testing and Medical Laboratories | | |
|---|---|------|
| 541711 | Research and Development in Biotechnology | 100% |
| 621511 | Medical Laboratories | 100% |
| 621512 | Diagnostic Imaging Centers | 100% |

An additional five industries were classified as partially attributed to the Life Sciences industry, with less than 100.0 percent of QCEW Pennsylvania employment attributed to the Life Sciences definition.

The allocation of output for these five industry segments were calculated through a variety of measures based on data availability.

The allocation of industry employment attributable to Life Sciences for two sectors was derived using data from the U.S. Census Bureau's Economic Census. The Economic Census is a five-year measure of U.S. businesses and establishments aggregated at the NAICS industry level. The allocation for the following two sectors was calculated as the share of Life Sciences related establishments, as identified by the most disaggregated available NAICS code, relative to all establishments included in the 6-digit NAICS code. The allocation was performed using data from the 2012 Economic Census, the most recent available data at the time of this report.

| NAICS | Sector Name | Allocation |
|---|---|------------|
| Wholesale Trade | | |
| 424210 | Drugs and Druggists' Sundries Merchant Wholesalers | 63% |
| Research, Testing and Medical Laboratories | | |
| 541712 | Research and Development in the Physical, Engineering, and Life Sciences (except Biotechnology) | 53% |

In the case of one NAICS industry sector, 541380 – Testing Laboratories, sufficiently disaggregated detailed Economic Census data was not available for Pennsylvania. In this case, the allocation of industry employment attributable to Life Sciences was based on the average of this sector's allocation derived in a selection of Life Science industry studies for other states.

| NAICS | Sector Name | Allocation |
|---|----------------------|------------|
| Research, Testing and Medical Laboratories | | |
| 541380 | Testing Laboratories | 18% |

Additionally, in the case of one NAICS industry sector, 325220 – Artificial and Synthetic Fibers and Filaments Manufacturing, sufficiently disaggregated detailed Economic Census data was not available for Pennsylvania nor was data available from comparable studies. In this case, the allocation of industry employment attributable to Life Sciences was based on the average of NAICS industry sectors attributable to Life Sciences derived from Economic Census data.

| NAICS | Sector Name | Allocation |
|--------------------------------------|---|------------|
| Medical Devices and Equipment | | |
| 325220 | Artificial and Synthetic Fibers and Filaments Manufacturing | 45% |

Finally, the allocation for NAICS industry sector 611310, Colleges, Universities, and Professional Schools attributable to the Life Sciences industry was derived using data from the U.S. Department of Education's National Center for Education Statistics. The allocation was calculated as the share of Life Sciences related undergraduate and graduate degrees conferred in Pennsylvania using 2014-2015 data.

| NAICS | Sector Name | Allocation |
|---|--|------------|
| Research, Testing and Medical Laboratories | | |
| 611310 | Colleges, Universities, and Professional Schools | 18% |

IMPLAN³¹ Model Description

The IMPLAN model is a microcomputer-based program that allows construction of regional Input-Output models for areas as small as a county and aggregation of individual county databases for multi-county analysis. IMPLAN was originally developed for the U.S. Department of Agriculture and is maintained and supported by the Minnesota IMPLAN Group, Inc., Stillwater, Minnesota.

The components of the IMPLAN database form the economic accounts of an individual county, several counties, or an entire state. These accounts show the flow of commodities to industries and institutional consumers in 536 separate industries in agriculture, mining, construction, manufacturing, wholesale and retail trade, utilities, finance, insurance and real estate, and consumer and business services. Each industry is described in terms of its purchases from and sales to all other industries in the local economy. Values for all activities are in producers' prices and do not include transportation costs or other additional transaction costs associated with delivering outputs from each industry to other intermediate users.

Final demands are goods and services purchased for their ultimate use by an end user. They include personal consumption expenditures (payments by individuals or households to industries for goods and services for personal consumption); federal government purchases (military and nonmilitary) and sales; state and local government purchases (public education and non-education) and sales; inventory purchases (unsold annual output) and sales (where inventory reduction exceeds additions from production); capital formation (expenditures to obtain capital equipment); and foreign exports. Final demands are allocated to producing industries, and margins are allocated to the service sectors (transportation, wholesale and retail trade, insurance, etc.) associated with providing that good to the final user.

The IMPLAN model provides the necessary information to estimate a complete set of regional economic accounts for a local area. The economic accounts are then converted to industry through the use of Input-Output accounts and a set of Leontief multipliers. The initial data set is the "use" of commodities by industry and the "make" of commodities by industry. These flows are derived for the local area from

³¹ IMPLAN Group LLC, IMPLAN System (data and software), 16905 Northcross Dr., Suite 120, Huntersville, NC 28078 www.IMPLAN.com. IMPLAN was originally developed for the U.S. Department of Agriculture and is maintained and supported by MIG, Inc. (formerly the Minnesota IMPLAN Group, Inc.).

the national Input-Output accounts. Final demands, output, and employment are derived for each data set. Employment numbers are also derived for each industry in the local area.

To create a regional Input-Output model for the local area, the regional data are combined with the 1992 national structural matrices produced by the Bureau of Economic Analysis, U.S. Department of Commerce. This operation produces regional structural matrices and eliminates industries that do not exist in the region. Imports are then estimated via the calculation of regional purchase coefficients ("RPC"s). An RPC represents the proportion of the total locally produced supply of a good or service required to meet a particular industry's intermediate and final demands; RPCs range between 0 and 1. In the IMPLAN model, RPCs are derived from the 1977 Multi-Regional Input-Output Accounts, a cross-sectional database of Input-Output regional accounts linked with consistent interstate trade flows. Imports are calculated by using the minimum of the RPC or the supply/demand pool. The regional final demands and the use matrix are then multiplied by the resulting RPC coefficients, which creates a set of matrices and final demands that are free of imports. Domestic exports are the residual of regional production not locally consumed. The result is a balanced set of regional economic accounts.

The Input-Output accounts are then developed. The regional use matrix and final demands are converted from a commodity basis to an industry basis by using the market share hypothesis. The subsequent inversion of the Input-Output accounts provides an import-free Leontief matrix of multipliers.

The notion of a multiplier or ripple effect rests on the difference between the initial effect of a change in demand and the total effect of that change. Total effects can be calculated either as direct and indirect effects or as direct, indirect, and induced effects. Direct effects are production changes associated with the immediate effects or final demand changes. Indirect effects are production changes in backward-linked industries caused by the changing input needs of directly affected industries, that is, additional purchases to produce additional output. Induced effects are changes in regional household spending patterns caused by changes in household income generated by the direct and indirect effects.

IMPLAN estimates four sets of multipliers, corresponding to four measures of regional economic activity: total industry output, personal income, total income, and employment. These multipliers are used to estimate the impact of changes in expenditures in an industry that provides inputs to a particular existing or new activity.

The table below presents a comparison of the NAICS codes selected for the definition of Life Sciences in this report and those selected for definitions of life sciences and biosciences industries in a sample of similar reports completed during the five years preceding the publication of this report.

| Industry Code (NAICS 2012) | Industry Description | CLSA ³² | GPRL ³³ | TEconomy \BIO ³⁴ | Life Sci. MD ³⁵ | Battelle ³⁶ | Bio Ohio ³⁷ | Rutgers ³⁸ |
|----------------------------|---|--------------------|--------------------|-----------------------------|----------------------------|------------------------|------------------------|-----------------------|
| 325220 | Artificial and Synthetic Fibers and Filaments Manufacturing | | | | | | ● | |
| 325411 | Medicinal and Botanical Manufacturing | ● | ● | ● | ● | ● | ● | ● |
| 325412 | Pharmaceutical Preparation Manufacturing | ● | ● | ● | ● | ● | ● | ● |
| 325413 | In-Vitro Diagnostic Substance Manufacturing | ● | ● | ● | ● | ● | ● | ● |
| 325414 | Biological Product (except Diagnostic) Manufacturing | ● | ● | ● | ● | ● | ● | ● |
| 333314 | Optical Instrument and Lens Manufacturing | | ● | | | | ● | |
| 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 | ● | ● | ● | | ● | ● | ● |
| 339115 | Ophthalmic Goods Manufacturing | ● | ● | | | ● | ● | |
| 339116 | Dental Laboratories | ● | ● | | | ● | ● | |
| 423450 | Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers | ● | | ● | | ● | ● | |
| 423460 | Ophthalmic Goods Merchant Wholesalers | ● | | | | | ● | |
| 424210 | Drugs and Druggists' Sundries Merchant Wholesalers | ● | | ● | | ● | ● | |

³² California Life Sciences Association. *California Life Sciences Industry: 2016 Report*.

³³ Ben Franklin Technology Partners of Southeastern PA, et al. *Greater Philadelphia Region Life Sciences Report: Trends and Highlights. January 2011 to June 2016*.

³⁴ TEconomy/BIO. *The Value of Bioscience Innovation in Growing Jobs and Improving Quality of Life: 2016*.

³⁵ Maryland Department of Business & Economic Development. *Life Sciences Maryland: Jobs Analysis & Economic Impact Report 2011*.

³⁶ Battelle/Bio. *State Bioscience Industry Development: 2012*.

³⁷ BioOhio. *Ohio Bioscience Growth Report: 2017*.

³⁸ Seneca, Joseph J.; Michael L. Lahr, and Will Irving. Rutgers Edward J. Bloughstein School of Planning and Public Policy. *Contribution of the Life Sciences Industry to the New Jersey Economy*.

| | | | | | | | | |
|--------|---|---|---|---|---|---|---|--|
| 541380 | Testing Laboratories | ● | ● | ● | ● | ● | ● | |
| 541711 | Research and Development in Biotechnology | ● | ● | ● | ● | ● | ● | |
| 541712 | Research and Development in the Physical, Engineering, and Life Sciences (except Biotechnology) | ● | ● | ● | ● | ● | ● | |
| 611310 | Colleges, Universities, and Professional Schools | ● | | | | | | |
| 621511 | Medical Laboratories | ● | ● | ● | ● | ● | ● | |
| 621512 | Diagnostic Imaging Centers | | ● | | ● | ● | ● | |

