ESSENTIAL:

THE IMPACT OF THE HEALTHCARE AND LIFE SCIENCES SECTOR IN CENTRAL INDIANA

August 2021

Produced for: BioCrossroads

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TECONOMY PARTNERS LLC

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Prologue

In Indiana, we see the benefits of having a strong healthcare and life sciences sector every day. It accounts for one in every ten jobs in the state, provides an annual economic impact of over $80 billion, and is present in the substantial assets spanning the corporate, university and philanthropic sectors. Over the past year we saw many of these healthcare and life sciences companies lead the way for our state, our nation, and beyond to help manage the response to a global pandemic which took the lives of so many. Whether it was Roche Diagnostics receiving a COVID-19 PCR diagnostic test approved under Emergency Use Authorization and on the market in a matter of weeks; Eli Lilly and Company's quick partnership to develop and secure Emergency Use Authorization for a monoclonal antibody treatment, in addition to their remarkable efforts to assist the state with testing; Catalent's scale-up to manufacture the COVID-19 vaccine for Moderna and Johnson & Johnson; Covance's acceleration of COVID-19 test processing capability; and our hospital systems moving from diagnosis to treatment and vaccinating patients, Indiana companies made a difference.

The infrastructure required to activate this response were the result of decades of investment including financial, talent, and time, by all members of the healthcare and life sciences sector. From investments in facilities, equipment, research, talent, and connections through BioCrossroads, Indiana's healthcare and life sciences sector has a substantial collective impact on the vitality of Indiana. In this report, TEConomy Partners, LLC. examined the influence of these investments on Central Indiana and how they help provide benefits to Indiana's other sectors including manufacturing, technology, and retail.

The report begins with a description of the functional impacts of the sector – those non-financial benefits to the community resulting from healthcare and life sciences. They include high quality healthcare services, the contribution to innovation and economic development, education and talent development, and overall improvement to societal well-being and quality of life. More traditional economic impact measures are described next, including total wages and job numbers and contribution to gross domestic product, production, sales, and tax revenues. These infrastructure investments have built an ecosystem and value chain that goes beyond traditional research and development. It also consists of manufacturing, distribution and logistics and all that is required in-between. A deeper discussion of the ecosystem's response to COVID-19 comes next. The final section provides a summary of the information presented and underscores the importance of continued investment in the sector.

This is an important and timely report. And certainly, it is appropriate here to thank those whose efforts have made it possible: Lilly Endowment Inc. and the Richard M. Fairbanks Foundation through generous grants to the CICP Foundation on behalf of BioCrossroads, provided essential funding; the many members of the healthcare and life sciences community, including manufacturing, transportation, and logistics; leaders at our major research universities and government agencies, who contributed information and participated in interviews; my colleagues Nora Doherty and Brian Stemme, who led and supported this project for BioCrossroads; and our consultants at TEConomy Partners, who know both Indiana and the innovation sector well and drew on their substantial expertise to provide a helpful and comprehensive study.

Indiana, the nation, and the world will move past COVID-19. As we continue to navigate through its effects, healthcare and life sciences will continue to play an important role. The investments that have been made, and that continue to be made, to support this sector enabled Indiana to respond to the challenge and will help ensure that Indiana's economy remains vital for years to come.

Sincerely,

Patricia A. Martin
President and CEO, BioCrossroads
August 2021

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Executive Summary

A KEY ECONOMIC DRIVER

The healthcare and life sciences sector plays an essential role in driving the U.S. economy. As an advanced industry cluster with assured demand, robust growth prospects, and an array of employment opportunities, the opportunities in this space are critical to economic development in the 21st century. This is especially true for Central Indiana, where healthcare and life sciences represent a regional signature[1] and a sophisticated innovation ecosystem. With the healthcare and life sciences sector seeing both opportunities and challenges on the horizon, it is important to understand, protect, leverage, and help advance the world-class assets that comprise this ecosystem.

As a hub for academic medicine and health sciences research and higher education, the Central Indiana region benefits from assets such as the Indiana University (IU) School of Medicine (the largest in the U.S. as measured by number of students), IUPUI, and IU Health, a provider of advanced specialty clinical care and general clinical services. Not only is the academic and community health cluster a major employer for the region, but it offers residents access to high-quality healthcare, which plays an important role in human health, and economic development.

Healthcare and life sciences represent a regional signature for Central Indiana's economy and quality of life

- **IU School of Medicine, IU Health and specialty clinical care facilities provide access to quality healthcare** and a destination healthcare center for complex cases.
- **The healthcare sector itself is a key employer** in Indianapolis, providing an extremely wide range of secure job opportunities.
- **The life sciences industry is similarly diverse in its employment opportunities,** creating demand for work across R&D, manufacturing, warehousing, distribution, and all the business functions that support the value chain.
- **Critical location for medical product logistics** due to advantageous geography and access to a leading FedEx hub.

Several of the world's largest and most innovative life sciences companies also call the region home, such as Eli Lilly and Company, the North American headquarters of Roche Diagnostics, Cook Medical, Catalent Biologics, Covance Labs, and many others. As noted by TEConomy/BIO,[2] the Indianapolis metro area ranks second-highest in the nation among large metro areas for its employment concentration in drugs and pharmaceuticals (with employment specialization at levels five times the national average). Notably, the region is a key hub in the development, testing, production, and distribution of biopharmaceuticals, diagnostics, and advanced medical devices. Its advantageous geography and access to a leading FedEx hub also makes Central Indiana a critical location for medical product logistics, providing the ability to ship urgent and time-sensitive medical products (such as radiopharmaceuticals and vaccines) to market quickly and efficiently.

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1 TEConomy defines a "regional signature" industry as one that has a significant base of R&D and innovation activity, and which demonstrates a comparative leadership position by virtue of having a specialized location quotient (a measure of comparative concentration in an industry versus national normative levels).

2 TEConomy/BIO, "The Bioscience Economy: Propelling Life-Saving Treatments, Supporting State & Local Communities," 2020. The Biotechnology Innovation Organization (BIO) is the world's largest biotech trade association.

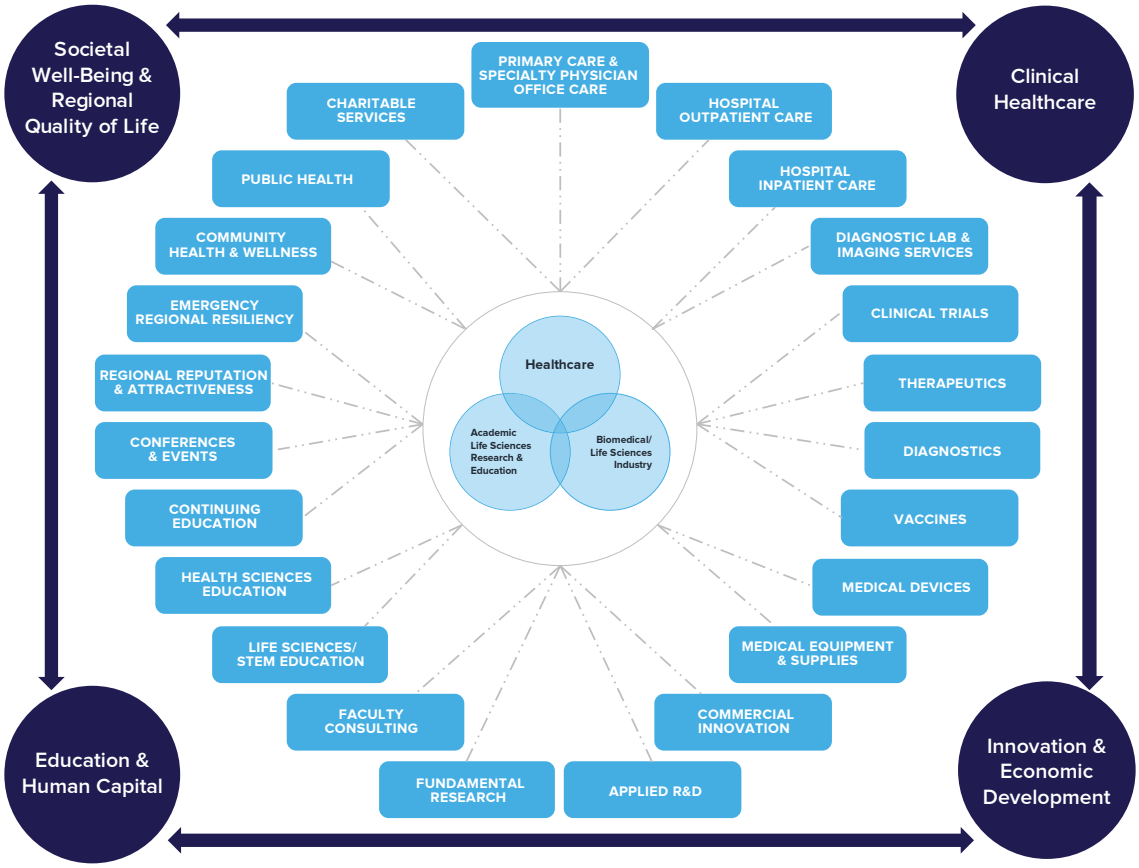
A TIME OF CHANGE

While the healthcare and life sciences sector remains vital to the success of Central Indiana and the nation at large, it is not immune to the effects of disruptive technologies and forces of change. New advancements in fields like artificial intelligence, genomics, gene editing, regenerative medicine, synthetic biology, advanced health data analytics, personalized medicine, and other emerging fields of opportunity are changing the sector's landscape. As such, it is particularly important for Central Indiana to take stock of what it has, and to build a robust understanding of the economic and societal impact of this key industry cluster. This study aims to contribute to that understanding.

FUNCTIONAL IMPACTS

This advanced industry generates a wide range of beneficial functional impacts[3], in part due to the diversity of organizations engaged in the sector (universities, hospital systems, manufacturing industries, etc.). As shown in Figure ES-1, these impacts ultimately converge around four primary domains: Clinical Healthcare, Societal Well-Being and Regional Quality of Life, Education and Human Capital, and Innovation and Economic Development.

Figure ES-1: The Functional Impacts of the Healthcare and Life Sciences Sector



Source: TEConomy Partners, LLC.

The first functional impact area relates to the provision of clinical healthcare. High-quality healthcare services positively contribute to quality of life across a variety of settings, including family practice physicians' offices; urgent care clinics; specialty clinical practices; outpatient ambulatory care practices; acute care hospitals; long-term care and rehabilitation facilities, and hospice centers. Supporting these frontline providers is a large and diverse network of supporting services in laboratory services, patient transportation, and all the supplies and ancillary services that support the clinical care ecosystem.

Second, the cluster contributes to innovation and economic development. The healthcare and life sciences R&D ecosystem creates products and services needed and valued by society which in turn generate employment, economic output, exports, and public sector revenues. Across sectors such as biopharmaceuticals, advanced diagnostics, medical devices, and medical

3 A functional impact is defined as a positive impact generated for an economy, society, or for individuals through the mission-focused activities of an organization, institution, industry, or specific project.

equipment, Central Indiana's innovation ecosystem encompasses a full spectrum of research, from fundamental research into biological processes, through applied and translational sciences, and onwards into clinical research and clinical trials activities. Healthcare and life sciences companies also make large-scale infrastructure investments to develop and support the specialized work necessary for a highly regulated industry. These infrastructure investments also provide benefits for Indiana's other sectors including manufacturing, technology, and retail.

A third functional impact area relates to education and human capital development. Central Indiana is advancing basic and applied knowledge and building the know-how and skills necessary for a high productivity healthcare and life sciences workforce. Home to IU School of Medicine, with the nation's largest enrollment, Indianapolis is a principal hub for the education of physicians and an intensive location for the education of nurses and other clinical and allied health professionals. The region's world-class colleges, universities, and academic health systems also help develop talent in life sciences, biomedical engineering, and other important disciplines.

Lastly, the cluster helps improve societal well-being and enhance quality of life. The COVID-19 pandemic highlighted the importance of a robust healthcare and life sciences ecosystem to regional resilience in the face of a fast-moving health crises. Central Indiana's healthcare and life sciences sector helps secure public health and build equitable, diverse, and resilient communities with robust livability, quality-of-place, and quality-of-life, across the entire lifespan, from conception through to elder-care care. Having quality care matters economically too, because those regions with a world-class clinical care system have a competitive advantage in attracting and retaining people and employers.

ECONOMIC IMPACTS

The presence and operations of the wide-ranging healthcare and life sciences ecosystem in Central Indiana provides a broad range of functional benefits for individuals and society. The operations of these diverse organizations and businesses within this ecosystem also generate large-scale economic impacts within the region. Consisting of an intertwined and collaborative set of actors, the sector includes industry leaders to major healthcare systems to a school of medicine and biomedical-related academic research occurring within the region. While many of these actors individually have well-known names such as Eli Lilly, Roche, and IU Health, what sets Central Indiana apart is that the whole is truly greater than the sum of its parts, driving significant impacts through the regional economy.[4]

Three components make up the Central Indiana healthcare and life sciences sector—industry, healthcare, and academe (higher education). Each component plays a different role in the region, but combined account for 164,144 employees (Table ES-1 and Appendix).

Table ES-1: Central Indiana's Healthcare and Life Sciences Components and Subsectors, 2019

Healthcare and Life Sciences Subsectors	Employment
Industry	28,711
Biomedical Manufacturing	22,506
Pharmaceutical Manufacturing	16,380
Medical Instruments, Devices, and Supplies Manufacturing	6,126
Biomedical Distribution	4,036
Biomedical Research & Development (Industry, NEC)	2,169
Healthcare	129,793
Hospitals	65,181
Private Hospitals	51,415
Public/State/Local Hospitals	10,565
Federal Hospitals (e.g., VA)	3,200
Physician and Other Health Practitioner Offices	43,524
Ambulatory Healthcare Services	11,820
Outpatient Care Centers	5,935
Medical Testing	3,333
Academic School of Medicine and Biomedical Research[5]	5,640
Total, Central Indiana Healthcare and Life Sciences	**164,144**

Note: "NEC" = Not Elsewhere Classified.
Source: TEConomy analysis of 2019 U.S. Bureau of Labor Statistics QCEW Data enhanced by IMPLAN.

4 For the purposes of this examination the Central Indiana region includes the Indianapolis MSA while also incorporating the complete corridor between Indiana University and Purdue University. This 14-County region includes the following counties: Boone, Brown, Hamilton, Hancock, Hendricks, Johnson, Madison, Marion, Monroe, Montgomery, Morgan, Putnam, Shelby, and Tippecanoe.

5 Estimate based upon IU School of Medicine fact sheet and Academic R&D in biomedical-related disciplines as reported in the National Science Foundation's 2019 Higher Education Research and Development (HERD) Survey.

The economic activity associated with Central Indiana's healthcare and life sciences sector is generated by purchases of goods and services from other businesses and from wages paid to workers, who in turn purchase other goods and services from other local companies. These successive cycles of revenues and purchases are called multiplier effects.

The results of the full economic impact analysis, shown in Table ES-2, capture the 164,144 direct healthcare and life sciences jobs within the Central Indiana economy, and how the spending of the sector's institutions and actors ripple through the regional economy. The more than $33 billion in value added to the regional economy appears as the direct effect in Table ES-2. Combined, the components and subsectors of the healthcare and life sciences sector are estimated to have generated direct output of nearly $57 billion in 2019. Importantly, considering the number of public and non-profit institutions captured within, the sector generates more than $1 billion in state and local tax revenues annually (including taxes of all types).

Table ES-2: Economic Impact of Central Indiana's Healthcare and Life Sciences Sector, 2019

Impact Type	Employment	Labor Income ($M)	Value Added ($M)	Output ($M)	State & Local Tax Revenues ($M)	Federal Tax Revenues ($M)
Direct Effect	164,144	$16,336.2	$33,203.1	$56,758.7	$1,003.1	$3,389.1
Indirect Effect	83,583	$5,580.7	$8,234.3	$14,486.3	$487.6	$999.5
Induced Effect	83,836	$3,961.4	$7,653.5	$12,724.7	$729.7	$780.1
Total Impact	331,563	$25,878.3	$49,090.8	$83,969.6	$2,220.4	$5,168.7
Multiplier	2.02	1.58	1.48	1.48		

Source: TEConomy analysis of 2019 Central Indiana Regional IMPLAN impact model.

From a total impact perspective, **the Central Indiana healthcare and life sciences sector generates and supports nearly $84 billion in total economic output—every $1 of direct output generates an additional $0.48 within the regional economy.** This economic impact also generates and supports additional employment in the region. A total of **331,563 Central Indiana jobs are supported by the sector** with the non-direct additional employment almost equally split between indirect (supplier) and induced jobs. Every job within the Central Indiana healthcare and life sciences sector supports 1.02 additional jobs in the regional economy.

While these numbers seem impressive at face value, the importance of the Central Indiana healthcare and life sciences sector to the regional economy is more fully appreciated through an analysis of its share of regional economic impact metrics.

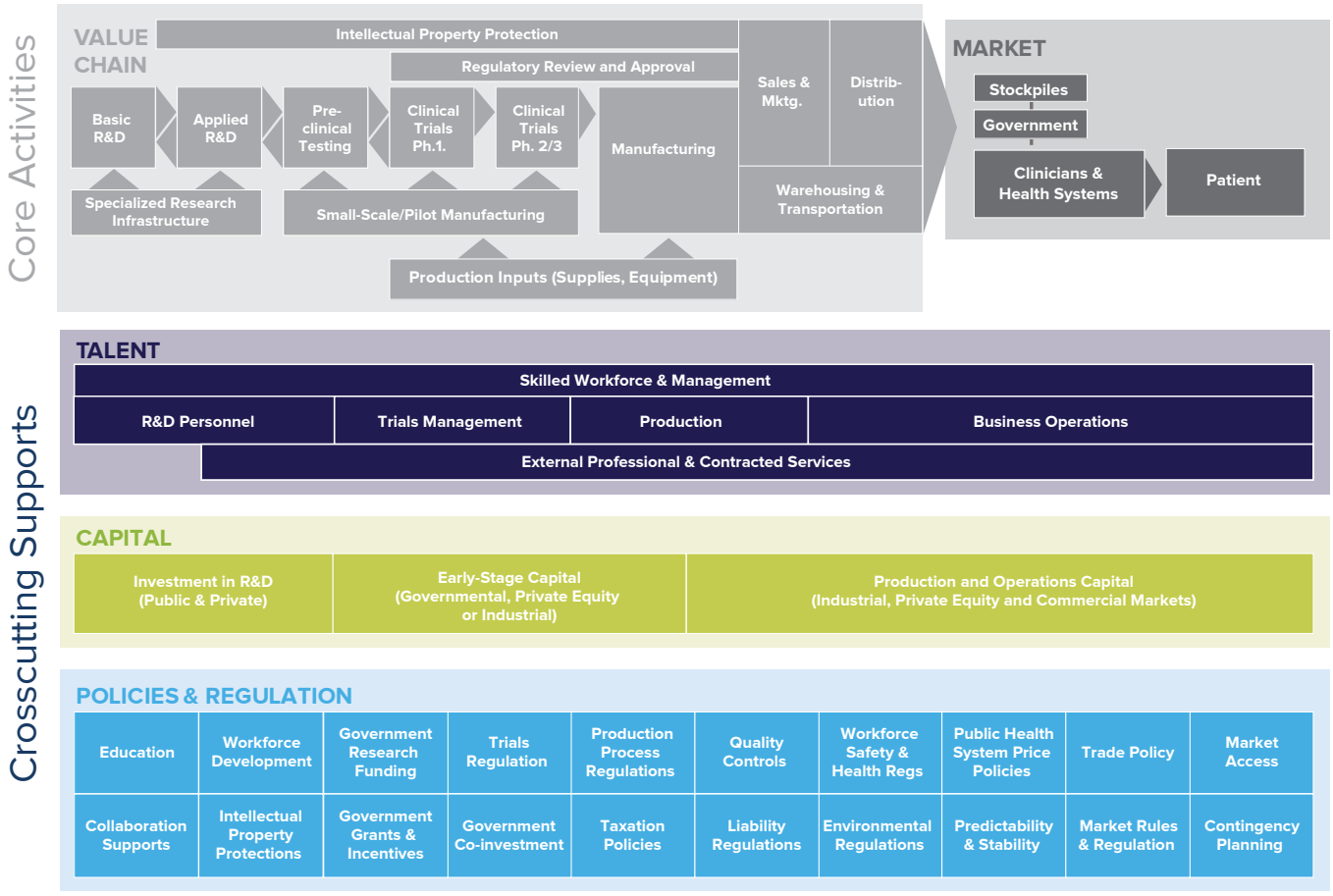
From a direct impact perspective, the healthcare and life sciences sector accounts for 10.6% of regional employment, 16.5% of regional labor income, 19.6% of regional total value added, and 18.7% of total regional output. By comparison, the entire Central Indiana manufacturing sector accounts for 7.9% of the region's employment, 11.5% of the region's labor income, 17.3% of the region's value added, and 25% of the region's total output.

More importantly, the Central Indiana healthcare and life sciences sector supports, through its total economic impacts, at least 21% of the regional economy across four major economic impact metrics: employment (21.4% of the Central Indiana Regional total), labor income (26.1%), total value added (28.9%), and output (27.7%).

IMPACTS ARE GENERATED AND SUSTAINED BY A HOLISTIC HEALTHCARE AND LIFE SCIENCES ECOSYSTEM

Based on a formal evaluation of lessons learned across 13 life sciences ecosystems across the globe during the COVID-19 pandemic, a recent project for Pfizer, Inc. studied the structure and characteristics of a holistic life sciences ecosystem.[6] This ecosystem framework can be used as a structure for examining the completeness of the ecosystem that has been developed in Central Indiana for the healthcare and life sciences ecosystem (Figure ES-2).

Figure ES-2: The Healthcare and Life Sciences Ecosystem



Source: TEConomy Partners, LLC. for Pfizer, Inc

The framework is divided into two principal components. First, there are the core activities of the central value chain that conducts research and development, and tests, produces, and distributes healthcare and life sciences products and services. Second, there are crosscutting ecosystem supports, which are divided into three core areas: talent, capital, and policies/regulations. Evident in this framework is the complexity of a full ecosystem. There are a great many individual elements that have to combine to provide a region with a holistic presence across the ecosystem. As seen in Table ES-3, Central Indiana is well-positioned in terms of having particularly complete coverage of key ecosystem elements.

6 Simon Tripp, David Hochman, and Mitch Horowitz. 2021. "*Response and Resilience: Lessons Learned from Global Life Sciences Ecosystems in the COVID-19 Pandemic.*" TEConomy Partners for Pfizer, Inc. Accessible online at: https://www.teconomypartners.com/wp-content/uploads/2020/11/Response-and-Resilience-Lessons-Learned-from-Life-Sciences-Ecosystems-and-COVID-19.pdf.

Table ES-3: The Healthcare and Life Sciences Ecosystem in Central Indiana – Key Metrics

CORE ACTIVITIES

Academic Healthcare and Life Sciences Research	Commercial Healthcare and Life Sciences R&D	Clinical Testing and Clinical Trials	Manufacturing	Distribution
• $604.5 million in federal R&D funding to Central Indiana higher education institutions in healthcare and life sciences. • IU School of Medicine, 95% growth in NIH funding since FY2015.	• Estimated $8.6 billion in commercial healthcare and life sciences R&D spending by regional companies in 2020.	• 2,397 ongoing clinical trials in Indiana.	• 22,506 manufacturing jobs in healthcare and life sciences products in Central Indiana (18.3% of regional manufacturing employment).	• 4,036 personnel employed in biomedical distribution in the region.

TALENT

Biosciences Graduates	Health and Clinical Sciences Graduates	Medical Students	Total Regional Employment in Healthcare and Life Sciences Sectors
• 1,617 graduates in 2020 from regional institutions with degrees in biological and biomedical sciences.	• 10,331 graduates in 2020 with an Associate's degree or higher in health and clinical sciences fields.	• 365 enrolled medical students in the class of 2024 (288 in-state students). • Largest medical school in the U.S. in total enrollment.	• 164,144 total direct jobs in Central Indiana in the healthcare and life sciences cluster.

CAPITAL

SBIR/STTR	Venture Capital	Public Companies (Valuation)	Major Capital Projects
• In 2020, there were 26 awards, within 21 companies in Indiana. Total of $12.6 million.	• In 2020, Indiana life sciences companies raised $262 million in VC.	• 12 public life sciences companies with Dec. 2020 market cap of $297.6 billion.	• Average of $455 million in major capital projects each year for five years. • 2.94 million square feet of construction for 2019-2023 5-year period. Combined capital project spending of $2.27 billion.

Source: TEConomy Partners' analysis and assembled from a variety of sources.

COMING TOGETHER TO ADDRESS COVID-19

The way in which key regional stakeholders across the public sector, industry, healthcare, and academe came together to collaborate and address the COVID-19 Pandemic in Central Indiana is particularly striking. In the face of a relatively uncoordinated and limited federal response, states and regions had to innovate and stand-up their own pandemic response. Central Indiana's ability to leverage its ecosystem and rise to the challenge is important to document and communicate.

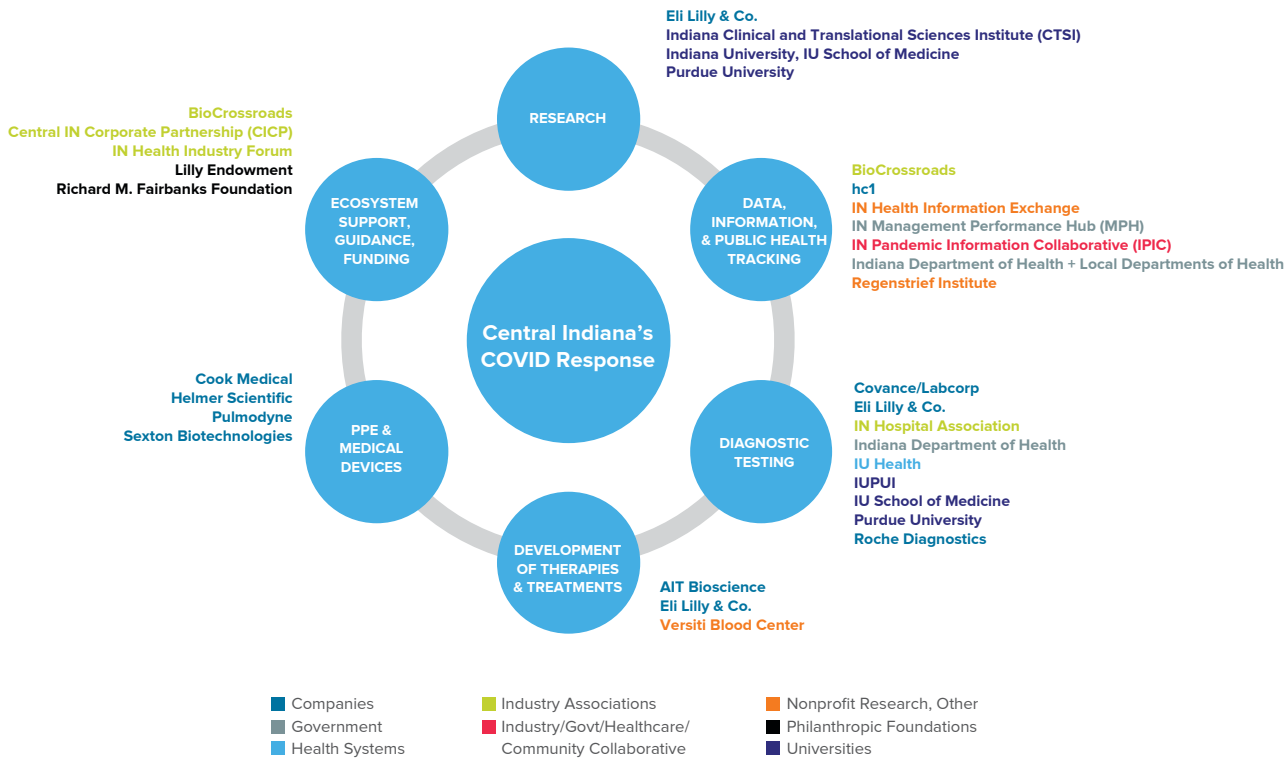
Even though Central Indiana's healthcare and life sciences ecosystem is extraordinarily complex, with many parts and moving pieces, it benefits from having in place a collaborative organization under the Central Indiana Corporate Partnership (CICP) and BioCrossroads—a meeting ground for those concerned with the successful development and operation of the ecosystem. Because this "connective tissue" already existed, the region was better able to be quick on its feet in reacting to the emerging pandemic.

Meeting weekly through a series of video-conference meetings, participants from state and local governments, universities and hospital systems, and leading private sector businesses helped coordinate a strategic approach that could leverage the ecosystem and help address the crisis. Figure ES-3 shows some of the key categories of assets that were drawn-upon in developing a coordinated response to COVID-19 in Central Indiana, and the individual organizations that stepped forward to participate in work to:

- Research the virus and biomedical approaches to diagnosing cases, combatting its transmission, and treating infections.
- Conduct data analytics, information science, and public health tracking to monitor the spread of the virus and direct resources to hotspots and points of vulnerability.
- Develop and procure diagnostic tests and provide population testing services.
- Develop novel therapeutics to combat infection, treat life-threatening symptoms, and support patient recovery.
- Rapidly improve supply and access to personal protective equipment (PPE) and important therapeutic medical equipment, such as respirators.
- Maintain business operations and protect critical workers throughout the pandemic to mitigate negative economic and social impacts.

The breadth of the healthcare and life sciences ecosystem and coordinated response to the pandemic in Indiana is illustrated by the varied actors and pandemic response categories in Figure ES-3 that span the corporate sector, government, academe, industry associations, non-profit research institutions, and philanthropy.

Figure ES-3: The Mobilization of Healthcare and Life Sciences Assets in Central Indiana to Mitigate the Negative Consequences of the COVID-19 Pandemic



Source: BioCrossroads and TEConomy Partners, LLC.

The leadership and connective tissue represented by CICP, and its affiliated cluster organizations, played an important role in helping the healthcare and life sciences ecosystem, and a broader set of community organizations, respond to the pandemic. CICP quickly mobilized and began facilitating bi-weekly teleconferences for its board members in early March 2020, offering a platform for public and private sector state leaders to coordinate efforts, receive updates, and stay informed. Outcomes and activities generated by these forums included rapid scale-up of COVID-19 testing capacities and locations throughout the state; retooling manufacturing capabilities to produce PPE for frontline healthcare professionals; developing "return-to-work playbooks" for the manufacturing, logistics and warehousing, office, and customer-facing settings; and coordinating letters of support for Governor Holcomb and Indianapolis Mayor Hogsett for mandating masks in public.[7]

CICP and BioCrossroads were able to leverage world-class talent in Indiana contained within the corporate, healthcare, academic, and public health communities to coordinate approaches to challenges as they arose in the pandemic. One early

7 Central Indiana Corporate Partnership (CICP) 2020 Annual Report.

example of this collaborative approach's effectiveness was early work to identify Indiana's resources for PCR[8] and other pieces of key scientific equipment that could pivot to applications in enabling diagnostic testing capacity to scale. Many of the techniques used are ubiquitous across biosciences (i.e., not only used in human biomedical applications, but also for basic biological sciences, veterinary medicine, agricultural research, etc.). As such, equipment, and the skilled personnel to operate the equipment existed in many locations in Indiana that were not part of the usual human diagnostics lab ecosystem. By identifying these resources and coordinating their coming-together in a collaborative consortium of sites, Indiana was able to significantly surge its capacity to conduct testing for COVID-19.

Taken together, Central Indiana's collaborative and well-coordinated response to the COVID-19 pandemic was especially impressive due to its effectiveness at mitigating the effects of the pandemic. Such a rapid and effective mobilization is representative of the robust ecosystem that has been built in the region and would not have been possible without the significant, long-term investments made over many years, if not decades. The public-private coordination in a high-functioning healthcare and life sciences ecosystem enabled Indiana to protect and inform its citizens throughout the pandemic.

CONCLUSIONS

The findings presented herein demonstrate that healthcare and life sciences represent a powerful economic engine for Central Indiana, playing a central role in providing economic and social resilience for the region on an ongoing basis and during public health emergencies. Central Indiana benefits greatly from the long-term investments that have been made by the private and public sectors in creating a complete healthcare and life sciences ecosystem—a complete range of activity from basic and translational research, through each step in the value-added development and production of products, technologies, and services, onwards into distribution and their use in the marketplace. The operations of this value-chain in Central Indiana are well supported by talent development programs and higher education programs that supply the well-educated and skilled talent needed to fill demands across the sector. Similarly, the region is attracting the capital resources needed to develop, scale, and grow the healthcare and life sciences enterprise.

The sector is expected to continue to grow, with projections noted herein for 27,000 jobs to be added in the forthcoming decade based on observable trends. This growth, however, could be higher if the ecosystem positively responds to forces of change and the opportunities presented for growth in healthcare products and services, especially those rooted in new technologies in genomics, gene editing, regenerative medicine, synthetic biology, advanced health data analytics, personalized medicine, and other emerging fields of opportunity. Ongoing investment will be needed, and attention paid, to sustaining and optimizing ecosystem conditions to continue to allow the sector to thrive.

Ultimately, it is clear that past and future investments in the infrastructure and talent that advance Indiana's life sciences and healthcare capacity represent a fundamental good for Indiana – enhancing the quality of life for Hoosiers; boosting the regional economy; making critical infrastructure investments that benefit multiple sectors including manufacturing, technology, and retail; and providing a proactive means of response in the face of public health emergencies.

8 PCR is the abbreviation for polymerase chain reaction and represents a fast technique for amplification (copying) of small segments of DNA. This amplification produces samples of DNA large enough for analysis in laboratory diagnostic processes.

I. Introduction

Within the top 100 metro areas in the U.S. more than 1 in every 10 jobs is in healthcare.[9] Add to this the number of personnel employed in industries that develop and supply products used in healthcare (medical equipment, medical devices, biopharmaceuticals, diagnostics, etc.), and the concentration of employment grows further. Add to that those engaged in academic and institutional biomedical research, and the concentration of employment grows further still. The healthcare and life sciences sectors are large-scale nationwide employers, and they represent, collectively, an essential and critically important advanced industry for the U.S. – an industry with assured demand, robust growth prospects, and providing a diversity of employment opportunities.

CENTRAL INDIANA'S EXTENSIVE AND INTENSIVE CLUSTER

For Central Indiana, healthcare and life sciences represent a distinct regional signature.[10] The region actively benefits from extensive operations in all three key components of a complete healthcare and life sciences ecosystem (Figure 1), spanning a continuum from advanced R&D in life sciences and applied biomedical sciences (in both industry and academe), through the development, manufacturing, and distribution of advanced biomedical products (including biopharmaceuticals, diagnostics, and medical devices), and onwards into the provision of high-quality, world-class, comprehensive and specialty clinical healthcare services.

Home to the IU School of Medicine (the largest in the U.S. as measured by number of students) and IUPUI, Indianapolis is a hub for academic medicine and health sciences research and higher education. In addition, IU Health is an integral element in the biomedical and health sciences research and

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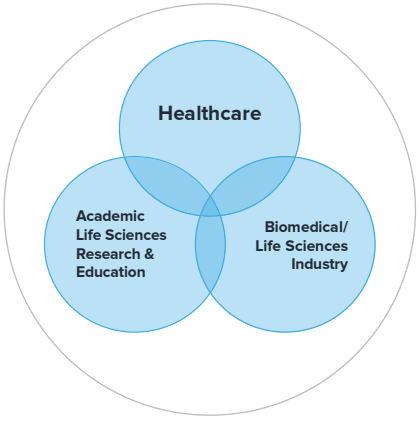
- **IU School of Medicine, IU Health and specialty clinical care facilities provide access to quality healthcare** and a destination healthcare center for complex cases.
- **The healthcare sector itself is a key employer** in Indianapolis, providing an extremely wide range of secure job opportunities.
- **The life sciences industry is similarly diverse in its employment opportunities,** creating demand for work across R&D, manufacturing, warehousing, distribution, and all the business functions that support the value chain.
- **Critical location for medical product logistics** due to advantageous geography and access to a leading FedEx hub.

Figure 1: Three Core Elements of the Healthcare and Life Sciences Sector



9 https://www.brookings.edu/wp-content/uploads/2016/06/Healthcare-Monitor-final.pdf

10 TEConomy defines a "regional signature" industry as one that has a significant base of R&D and innovation activity, and which demonstrates a comparative leadership position by virtue of having a specialized location quotient (a measure of comparative concentration in an industry versus national normative levels).

education ecosystem, and a key provider of advanced specialty clinical care and general clinical services. Together with other hospitals and health systems, the academic and community healthcare cluster is a major employer for the region.

A similar intensity of activity is found in industrial life sciences sector, with the most recent TEConomy/BIO[11] report showing the Indianapolis metro area being ranked second-highest in the nation among large metro areas for its employment concentration in drugs and pharmaceuticals (with 11,643 jobs and a highly specialized 5.2 location quotient). The region hosts some of the largest and most innovative companies in life sciences, home to Eli Lilly and Company, the North American headquarters of Roche Diagnostics, Cook Medical, Catalent Biologics, Covance, and many others. The region is one of the nation's key hubs in the development, testing, production, and distribution of biopharmaceuticals, diagnostics, and advanced medical devices. The region's central U.S. geography, and FedEx hub, makes it a favored location for medical product logistics, providing the ability to ship urgent and time-sensitive medical products (such as radiopharmaceuticals and vaccines) to market quickly and efficiently.

Large-scale infrastructure investments have been made in the region to develop and support the specialized work of the healthcare and life sciences sector. Development momentum is ongoing, with a substantial number of major healthcare and life sciences construction projects and expansions just in the last five years approaching $2.3 billion in investment. With continuous advancements being made in clinical care, and the advanced technologies that support modern healthcare, it is also a sector where significant ongoing investment is to be anticipated into the future. As a result of all the R&D, clinical, and industrial biomedical activity, there is a robust and specialized ecosystem that has developed around healthcare and life sciences in Central Indiana, an ecosystem which, as documented in this report, generates a diverse range of economic and social benefits for the region. These specialized investments in infrastructure for healthcare and life sciences also provide benefits for Indiana's other sectors including manufacturing, technology, and retail.

ECONOMIC AND SOCIETAL BENEFITS

There are multiple benefits that accrue to a region through the presence and operations of the advanced healthcare and life sciences sector. Access to quality healthcare is, of course, important to the general public, and for employers who leverage the quality of care in the region as a factor in their recruitment of personnel. The healthcare sector itself is a key employer in Indianapolis and surrounding communities, providing an extremely wide range of secure job opportunities. Employment options in the sector are available for persons across the educational and socioeconomic spectrum, from work in areas such as housekeeping and patient transport, through to highly skilled physicians and allied health professionals. The biomedical products industry is similarly diverse in its employment opportunities, creating demand for work across R&D, manufacturing, warehousing, distribution, and all the business functions that support the value chain.

In a 2020 analysis, Grand Canyon University examined metro areas across the U.S. in terms of their attraction for healthcare job seekers and ranked Indianapolis 4th in the nation.

11 The Biotechnology Innovation Organization (BIO) is the world's largest biotech trade association. TEConomy produces a joint report with BIO every two years that evaluates national and state bioscience industry metrics, for the latest report see: TEConomy/BIO, "The Bioscience Economy: Propelling Life-Saving Treatments, Supporting State & Local Communities," 2020.

A NEED TO COMMUNICATE

As is often the case with complex and multi-faceted sectors of economic activity, there can be a lack of understanding and recognition of the power and promise contained in the sector and what the full-range of economic and social benefits are that are generated for the regional economy and society. Without a current informed understanding of the size, structure, investments, and impacts generated by the cluster, state and regional decision makers may underappreciate what there is to leverage and build upon, and what needs to be protected and advanced through policy and investment decisions.

BioCrossroads has noted a need to build further recognition and understanding of the healthcare and life sciences ecosystem assets, investments, and opportunities that exist in Central Indiana—and to communicate the economic and functional benefits that accrue to the region as a result of the presence and operations of this large and dynamic cluster. BioCrossroads also recognizes that for 2020 and 2021 the COVID-19 pandemic has placed a spotlight on the importance of advanced healthcare as a fundamental regional asset able to be deployed in a public health crisis, together with the importance of the life sciences R&D sector in advancing diagnostics, therapeutics, vaccines, and medical devices to address serious health needs. With the work of the cluster becoming more prominent in regional dialog during the pandemic, there are benefits to providing stakeholders with a detailed report on the assets and impacts of the cluster and its ongoing promise for future economic and community advancement in Central Indiana. It also provides an opportunity to communicate that it takes long-term investments and commitment to build and sustain a world-class healthcare and life sciences ecosystem that is able to respond to emerging challenges and needs.

Central Indiana weathered the COVID-19 crisis better than most because the assets and expertise of the region's world-class healthcare and life sciences organizations stepped forward to work in close collaboration with regional leadership and state authorities. It is important to recognize and acknowledge this collective response, but it is equally important to recognize that the healthcare and life sciences sector in Central Indiana has a long-standing track record of contributions to society and the economy, rooted in major long-term investments.

What is evident is that the healthcare and life sciences sector in the region is very much a signature of Central Indiana. It is a sector that produces multiple benefits for the region and is contributing to regional success across all the highlighted elements of a successful region shown in the sidebar.

How would you define a successful U.S. region?

Based on TEConomy's experience in examining advanced economic development across the globe and throughout the U.S., we would classify successful U.S. regions as those that have the following characteristics:

- They are home to a significant base of advanced industries and traded sectors.
- They contain, and work to advance, distinctive core competencies in academic and industrial R&D.
- They are places that develop, attract, and retain talented, productive, and innovative people.
- They invest in education, training, and re-training, assuring people have the skills necessary to access diverse and evolving employment opportunities.
- They pay attention to equity and inclusion in employment opportunities and seek a "rising tide that lifts all ships."
- They are entrepreneurial, open to new opportunities, and able to adapt to forces of change and emerging disruptive technologies.
- They are collaborative and networked, providing ways for organizations to come together to pursue new opportunities and resolve shared challenges.
- They invest in modern infrastructure, placemaking, and community amenities.

Within Central Indiana these characteristics are readily evident in the healthcare and life sciences sector and within the region as a home for this sector's activities.

A TIME OF CHANGE

In a recent report for BioCrossroads, TEConomy notes the following:

> *Economies, whether national or regional, are intrinsically dynamic—subject to internal and external forces of change that influence key factors such as market demand, competition, capital availability, labor supply, public policy, and technological innovation.*[12]

It is further noted that:

> *Internal forces, such as R&D and associated innovation, work to improve products and services and the efficiency of their creation and distribution. External forces, such as the emergence of new technologies, the actions of competitors, or changing market preferences, also contribute greatly to the dynamics of business sectors. The overarching theme is one of "change," and it is an ongoing challenge for businesses (and more broadly for all leaders in society concerned with the performance of the economy) to identify changes on the horizon that may represent opportunities to leverage or threats to offset.*

The healthcare and life sciences sector is certainly not immune to forces of change. Opportunities abound for advancement of new products and technologies in life sciences, some of which may be highly disruptive. New technologies in gene editing, synthetic biology, and regenerative medicine, to name just a few, provide opportunities for new products and healthcare services, but also threaten the status quo. These new technologies are speeding the development time for new products in life sciences. This has been very much in evidence in the COVID-19 crisis. The speed with which the life sciences sector reacted and accelerated the development of diagnostics, therapeutics, and vaccines (products that typically can take a decade or more to develop) has been nothing short of astonishing.

In this time of change it is particularly important for Central Indiana to take stock of what it has, and to build a robust understanding of the economic and societal impact of its key industries. With the healthcare and life sciences sector seeing both opportunities and challenges on the horizon, it is intended that this report will help inform key regional stakeholders and decision makers regarding the world-class assets that they have to celebrate, protect, leverage, and help advance.

Change appears to be accelerating rapidly as the emerging forces of convergence (the tendency for novel innovation to occur at the intersection of previously distinct business sectors), the rapid pace of disruptive technology development, and new business models individually, and in combination, shape the marketplace.

The COVID-19 crisis has vividly illustrated the critical importance of life sciences research and innovation systems and the ecosystems that support the advancement of innovations through commercial deployment to address health needs.

Simon Tripp, Mitch Horowitz, and David Hochman. 2021. "Response and Resilience: Lessons Learned from Global Life Sciences Ecosystems in the COVID-19 Pandemic." TEConomy Partners for Pfizer, Inc.

12 Simon Tripp and Ryan Helwig. 2018. "*Clusters and Disruptors: Envisioning Central Indiana's Economic Future in a Time of Change*." TEConomy Partners, LLC. for the Central Indiana Corporate Partnership.

II. Functional Impacts of the Healthcare and Life Sciences Sector

Every institution, organization, and business exists to fulfill a mission – to provide knowledge, products, services, or other elements of value to meet the needs of society, individuals, and the economy. The healthcare and life sciences sector, has the noble mission to advance the health and well-being of humanity and, in the United States, it has been highly successful in fulfilling that mission (see sidebar).

In pursuing this mission, the healthcare and life sciences sector, writ large, undertakes a wide range of activities and generates a broad variety of **functional impacts**.[13] The production of these impacts is the *raison d'etre* for the operations of sector organizations. Because of the diversity of organizations engaged in the sector (universities, hospital systems, manufacturing industries, etc.), the individual functional impacts generated are diverse (Figure 2), but they ultimately can be seen to converge around four primary functional benefit domains:

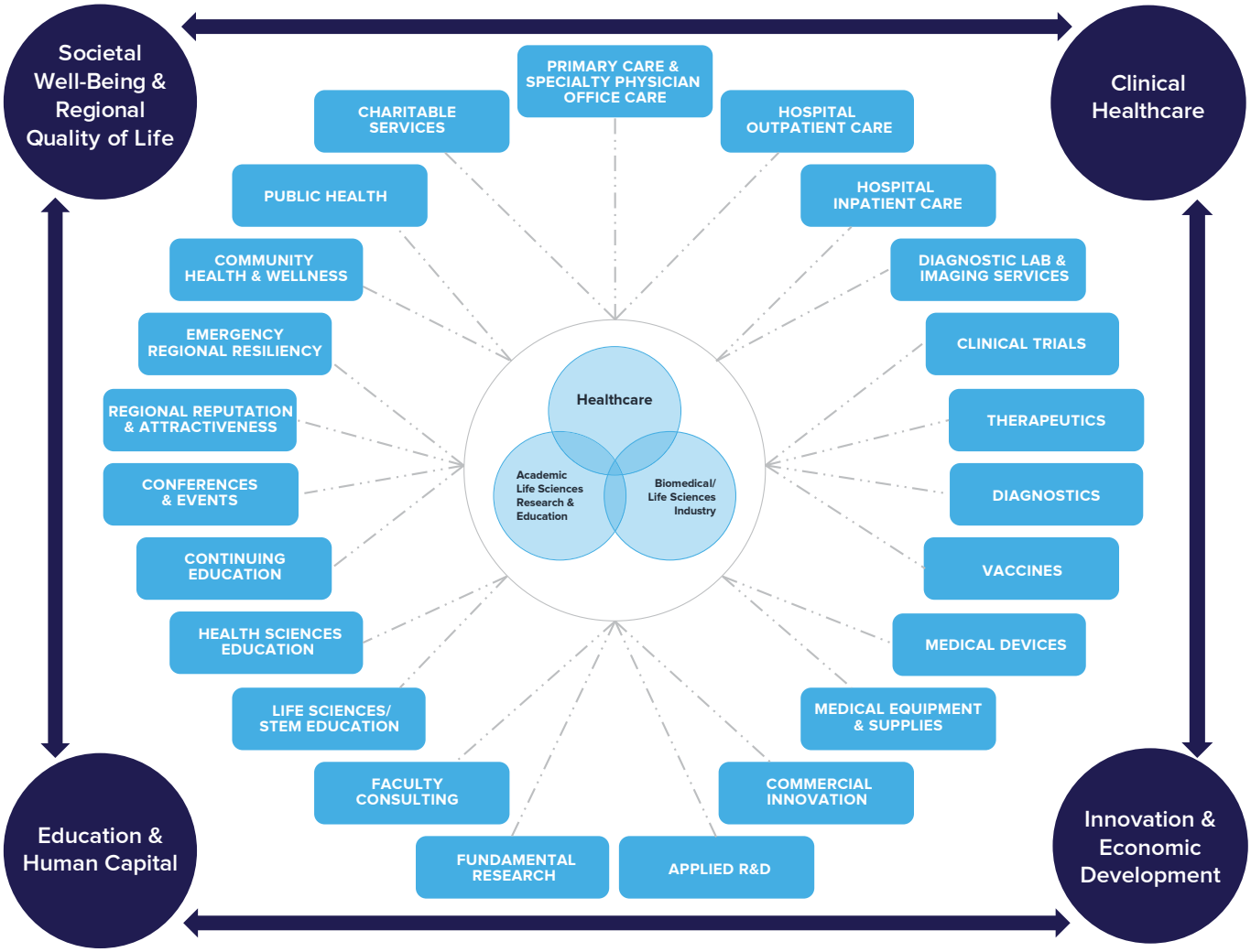
Scientific research produces many benefits and returns for society, but perhaps none are as important to us as the preservation and extension of human life itself. Modern life sciences and associated advancements in biopharmaceuticals, diagnostics, medical devices, and in healthcare services have enabled unprecedented improvements in human health and longevity. Today, the average life expectancy for a newborn female and male in the U.S. is 81.4 years and 76.3 years, respectively. In 1950, those same metrics were 71.1 and 65.6 years. We have seen our average lifespans expand by more than a decade in less than two generations through advancements in health, hygiene, and safety.

Simon Tripp and Marty Grueber. 2021. "*The Economic Impact and Functional Applications of Human Genetics and Genomics.*" TEConomy Partners and the American Society of Human Genetics.

- **Provision of Clinical Healthcare** – Working to sustain the physical health of populations served.
- **Innovation and Economic Development** – Producing products and services needed and valued by society which in turn generate employment, economic output, exports, and public sector revenues.
- **Education and Human Capital Development** – Advancing basic and applied knowledge and building the know-how and skills necessary within the healthcare and life sciences workforce.
- **Societal Well-being and Quality-of-life** – Securing public health and building equitable, diverse, and resilient communities with robust livability, quality-of-place and quality-of-life.

13 A functional impact is defined as a positive impact generated for an economy, society, or for individuals through the mission-focused activities of an organization, institution, industry, or specific project.

Figure 2: The Functional Impacts of the Healthcare and Life Sciences Sector



Source: TEConomy Partners, LLC.

PROVISION OF CLINICAL HEALTHCARE

High-quality healthcare services are important for us individually and collectively. Clinical care is provided in a variety of settings, including: family practice physicians' offices; urgent care clinics; specialty clinical practices; outpatient ambulatory care practices; acute care hospitals; long-term care and rehabilitation facilities, and hospice centers. Supporting these frontline providers is a large and diverse network of supporting services in laboratory services, patient transportation, and all the supplies and ancillary services that support the clinical care ecosystem.

CASE STUDY:

IU Health

IU Health has the largest network of physicians in Indiana and is a key partner in the education and training of physicians and other health professionals with the IU School of Medicine. Spanning the gamut of medicine from family practice to advanced specialty care practices, IU Health has more than 1,500 board certified/eligible physicians and operates across 200 locations statewide. With $7 billion in 2020 revenues, IU Health has a significant economic footprint in Indiana, with the majority of its operations located in the Central Indiana region.

IU Health – By the Numbers

- >30,000 personnel
- >1,500 physicians
- 1,174 residents and fellows
- 2,708 beds
- 118,019 admissions
- 110,445 surgery cases
- 1,569 research studies

IU Health has been significantly expanding and upgrading its facilities and infrastructure in recent years. Key projects have included:

- **Riley Hospital for Children** – The Maternity and Newborn Health facilities, with new and remodeled facilities comprised a $142 million project. Able to accommodate more than 3,800 annual deliveries, the development provides the largest neonatal intensive care unit in the state.
- **IU Health West Hospital Expansion** – Presently under construction, the project comprises an $83 million expansion, adding 48 inpatient beds, two new operating rooms, new catheterization labs, and additional support services space.
- **IU Health North Hospital** – The Joe and Shelly Schwarz Cancer Center. This new cancer center opened in January 2020 and represents a $55 million investment. Comprising an 88,000 square foot facility, it includes radiation oncology, medical oncology, surgical oncology, patient navigation, genetic counseling, pharmacy, laboratory, and other services into one state-of-the-art facility.
- **IU Health Bloomington Regional Academic Health Center (RAHC)** – The new RAHC comprises a $389 million, 720,000 square foot construction project, including a new hospital. It also includes a 115,000 square foot IU Academic Health Sciences Building, serving to consolidate most of the academic health sciences programs on the IU Bloomington campus.

IU Health is also planning a major long-term project that is anticipated to involve investment of over $1.6 billion. The project will consolidate three IU Health hospitals at the current Methodist Hospital campus, which has good land availability and site characteristics to facilitate expansion. While it is not anticipated that the consolidation of hospitals to the central site will expand the number of beds, a key component of the project will be to provide state-of-the-art facilities for advanced new clinical care models. Among the advancements are design considerations that consider lessons-learned during COVID-19 in terms of building rooms suited to patient care in isolated negative air pressure rooms, designing space to be readily reconfigured in the case of events creating surges in patients, and having an expanded intensive care unit (ICU) capability during special events. The facility is thus being developed with a specific eye on enhancing regional healthcare resiliency in the face of the continued threat of emerging pandemics and other potential large-scale health events.

IU Health is also working to secure regional healthcare resiliency across Indiana by developing several small hospitals and niche “critical access hospitals” in key strategic locations across the state. Examples include the $30 million investment by IU Health in a small hospital in Frankfort, Indiana, and expansion of capabilities and facilitates at Ball Memorial in Muncie. Between three and five critical access hospitals are planned – forming important points in a hub and spoke model, where significant local care can be delivered with more serious or complex cases transferred to the central IU Health core in Indianapolis.

CASE STUDY:

Hospitals and Health Systems Investing in Central Indiana Communities

Community Health Network
Community Health has been investing heavily in advanced clinical facilities to serve Central Indiana. Begun in 2016, Community has invested $175 million in developing the new Community Hospital East in Indianapolis. The new facility consolidated into a new build footprint of 500,000 square feet, including a new 155-bed hospital tower. The development has also doubled the hospital’s emergency room capacity.

Franciscan Health
Serving Carmel, Indianapolis, Plainfield, and south-central Indiana, Franciscan Health Indianapolis is part of a network of 14 hospital campuses in Indiana and Illinois owned and operated by Franciscan Health. A major new investment in the region by Franciscan is the new Franciscan Health Orthopedic Center of Excellence in Carmel, comprising a specialty orthopedic hospital and medical office building complex totaling 255,000 square feet and representing a $130 million investment.

INNOVATION AND ECONOMIC DEVELOPMENT

The healthcare and life sciences sector is also among the most intensive performers of research and development (R&D) among all national sectors – as well as within the state of Indiana, and the Central Indiana region. R&D is performed in a range of settings, including with research universities, academic medical centers, independent health sciences research institutes, and in private industry. The complexity of human biology and the very wide range of diseases and health disorders (there are more than 7,000 rare diseases alone, in addition to hundreds of more common and chronic conditions[14]) provide a rich demand space for novel products to meet unmet needs or improve upon current products and practices. The healthcare and life sciences R&D ecosystem in Central Indiana works across the spectrum of research, from fundamental research into biological processes, through applied and translational sciences, and onwards into clinical research and clinical trials activities. The sector represents an innovation engine for the region, performing research and development work in biopharmaceuticals, advanced diagnostics, medical devices, and medical equipment. Through this R&D and innovation activity, Central Indiana is able to enhance existing products and services and innovate new products and services to expand its market penetration. Economic development is generated through the growth of new businesses, the expansion of existing businesses and ecosystem organizations, and the attraction of new businesses to the region.

EDUCATION AND HUMAN CAPITAL DEVELOPMENT

As noted previously, the IU School of Medicine is the largest in the nation in terms of its medical school enrollment. Indianapolis is thus a principal hub for the education of physicians, but it is also an intensive location for the education of nurses and other clinical and allied health professionals. Other regional colleges and higher education institutions are also engaged in training the nursing and allied healthcare workforce. The world-class research university systems are hubs for development of undergraduate talent through to advanced doctoral students in life sciences, biomedical engineering, and other disciplines that supply talent into the R&D ecosystem. The academic healthcare system in Indianapolis also provides continuing education services in support of maintaining professional credentials and keeping the regional clinical workforce up to date.

The Leading Industry for R&D

- The life sciences industry in the U.S. invests 21% of its sales in R&D and accounts for 23% of all U.S. business R&D (more than any other sector).
- The life sciences invests in R&D at a rate that is 10x higher than the average for all manufacturing industries.
- In the Strategy&/PWC "Global Innovation 1000" study, 8 of the top 25 most innovative companies are pharmaceutical companies.
- The NSF reports that for 2019 almost 53% of all R&D performed at U.S. universities was focused in the sector. Biological and biomedical sciences ($15.4 billion), health sciences ($27.3 billion), and bioengineering and biomedical engineering ($1.5 billion).
- The NSF notes that for 2019, almost 48% of all academic publications were in health and biological and biomedical sciences.

A Regional Specialization in Health, Biomedical, and Biological Sciences Degrees

- In 2020, regional postsecondary institutions graduated 10,331 students with an Associate's degree or higher in health and clinical sciences fields. Graduate output has increased 20% since 2015.
- In 2020, 1,617 students graduated with degrees in biological and biomedical sciences from regional institutions, up 7% since 2015.
- The IU School of Medicine is the largest in the nation with 365 students enrolled in the Class of 2024, 288 (79%) are in-state students.

14 Zhichao Liu, Liyaun Zhu, Ruth Roberts, and Weida Tong. 2019. "Toward Clinical Implementation of Next-Generation Sequencing-Based Genetic testing in Rare Diseases: Where Are We?" *Trends in Genetics*. November 2019, Vol. 35, No. 11.

SOCIETAL WELL-BEING AND QUALITY-OF-LIFE

With an aging U.S. population, there is increasing attention paid by individuals to the quality and range of clinical care services available within a region. Quality care matters across the entire life-span, from conception through to elder-care, and those regions with a world-class clinical care system have a competitive advantage in attracting and retaining talent. The COVID-19 pandemic has very much highlighted the importance of the operations of efficient and responsive public health services and the collaborative clinical care networks that are needed to respond to emerging issues. The pandemic has shown that having a robust healthcare and life sciences ecosystem is critical to regional resilience in the face of a fast-moving health crisis. The need for public healthcare and for individually accessing quality healthcare services is something we all share and having these is at the core of being a world-class region – one that is livable and able to sustain a high quality-of-life for the regional population.

III. Economic Impacts Generated in Central Indiana by the Healthcare and Life Sciences Sector

As discussed, the presence and operations of the wide-ranging healthcare and life sciences ecosystem in Central Indiana provides a broad-range of functional benefits for individuals and society. The operations of the diverse organizations and businesses within this ecosystem also generate large scale economic impacts within the region.

The Central Indiana healthcare and life sciences sector consists of an intertwined and collaborative set of actors spanning the space from industry leaders to major healthcare systems to a school of medicine and biomedical-related academic research occurring within the region. While many of these actors individually have well-known names such as Eli Lilly, Roche, and IU Health, what sets Central Indiana apart is that the whole is truly greater than the sum of its parts, driving significant impacts through the regional economy.[15]

CHARACTERIZING THE SECTOR

Three components make up the Central Indiana healthcare and life sciences sector—industry, healthcare, and academe (higher education). Each component plays a different role in the region, but combined account for 164,144 employees (Table 1 and Appendix).

15 For the purposes of this examination the Central Indiana region includes the Indianapolis MSA while also incorporating the complete corridor between Indiana University and Purdue University. This 14-County region includes the following counties: Boone, Brown, Hamilton, Hancock, Hendricks, Johnson, Madison, Marion, Monroe, Montgomery, Morgan, Putnam, Shelby, and Tippecanoe.

Table 1: Central Indiana's Healthcare and Life Sciences Components and Subsectors, 2019

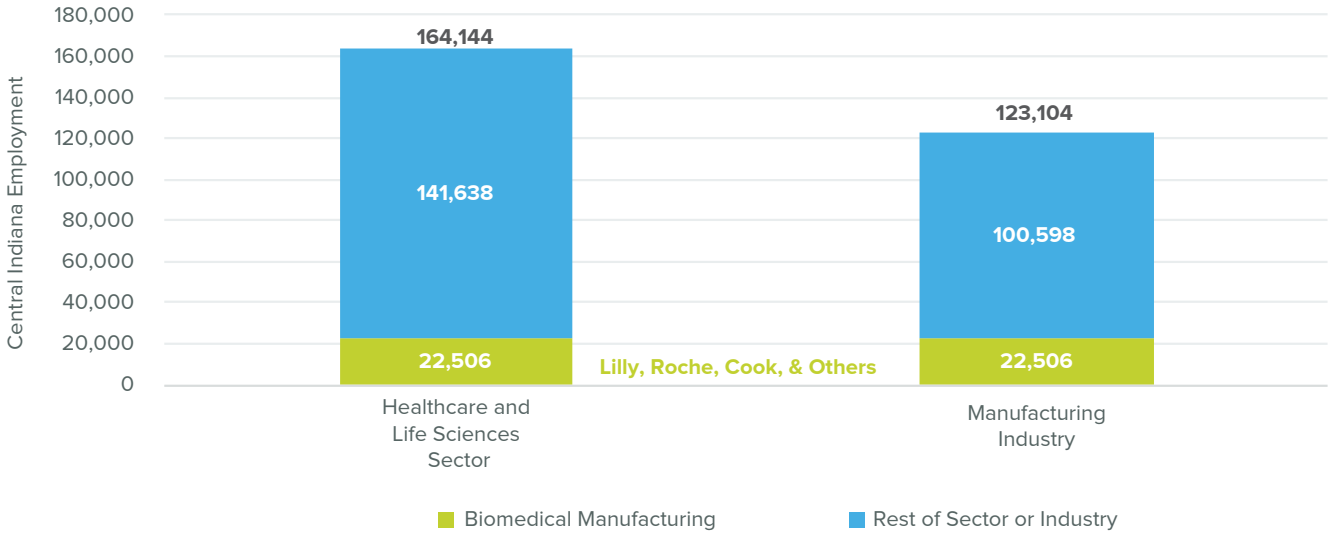
Healthcare and Life Sciences Subsectors	Employment
Industry	28,711
Biomedical Manufacturing	22,506
Pharmaceutical Manufacturing	16,380
Medical Instruments, Devices, and Supplies Manufacturing	6,126
Biomedical Distribution	4,036
Biomedical Research & Development (Industry, NEC)	2,169
Healthcare	129,793
Hospitals	65,181
Private Hospitals	51,415
Public/State/Local Hospitals	10,565
Federal Hospitals (e.g., VA)	3,200
Physician and Other Health Practitioner Offices	43,524
Ambulatory Healthcare Services	11,820
Outpatient Care Centers	5,935
Medical Testing	3,333
Academic School of Medicine and Biomedical Research[16]	5,640
Total, Central Indiana Healthcare and Life Sciences	**164,144**

Note: "NEC" = Not Elsewhere Classified.
Source: TEConomy analysis of 2019 U.S. Bureau of Labor Statistics QCEW Data enhanced by IMPLAN.

Industry accounts for nearly 29,000 Central Indiana jobs in 2019, growing by 5.5% since 2015. Considering the significant corporate presence of Lilly and Roche, pharmaceutical manufacturing accounts for nearly 16,400 jobs. Medical instrument manufacturing, including firms like Cook, accounts for an additional 6,100 jobs. This employment, core to the region's healthcare and life sciences industry, is also a key driving component of the region's overall manufacturing sector (Figure 3).

16 Estimate based upon IU School of Medicine fact sheet and Academic R&D in biomedical-related disciplines as reported in the National Science Foundation's 2019 Higher Education Research and Development (HERD) Survey.

Figure 3: Comparison Between Central Indiana's Healthcare and Life Sciences Manufacturing Subsector and Total Regional Manufacturing, 2019



Source: TEConomy analysis of 2019 U.S. Bureau of Labor Statistics QCEW Data enhanced by IMPLAN and 2019 Central Indiana Regional IMPLAN impact model.

The size of the biomedical distribution subsector reflects both the overall industrial presence in the region, but also the region's central locale to the overall U.S. distribution network. Finally, industrial biomedical research and development consists of corporate facilities as well as emerging biomedical/biotech companies that are able to thrive in the region's life sciences ecosystem.

Not surprisingly, healthcare operations, ranging from hospitals and outpatient clinics to doctors and medical laboratories, constitute a significant presence in the region and within the healthcare and life sciences sector with these essential personnel numbering nearly 130,000 in 2019. Overall, healthcare grew by 13.9% (2.8% annually) over the 2015 - 2019 period. Private, public, and federal hospitals (e.g., Roudebush VA Medical Center) employ nearly 65,200 healthcare workers in the Central Indiana region.[17] It is important to note that the Central Indiana hospital infrastructure is 25% more concentrated in the region, indicating that while these hospitals provide services to the Central Indiana region, they additionally support the healthcare needs from around the state and beyond. Physicians and other health practitioners make up an additional 43,500 healthcare employees, with outpatient care centers and medical testing nearly 9,300 jobs, combined.

Finally, biomedical-related faculty, staff, and researcher employment within Indiana University and its School of Medicine, Purdue University, and the Indiana University-Purdue University, Indianapolis campus performed a combined $604.48 million in biomedical research in 2019 and employed an estimated 5,640 academic life sciences research-oriented positions (e.g., researchers, faculty, post docs, support staff, etc.).[18]

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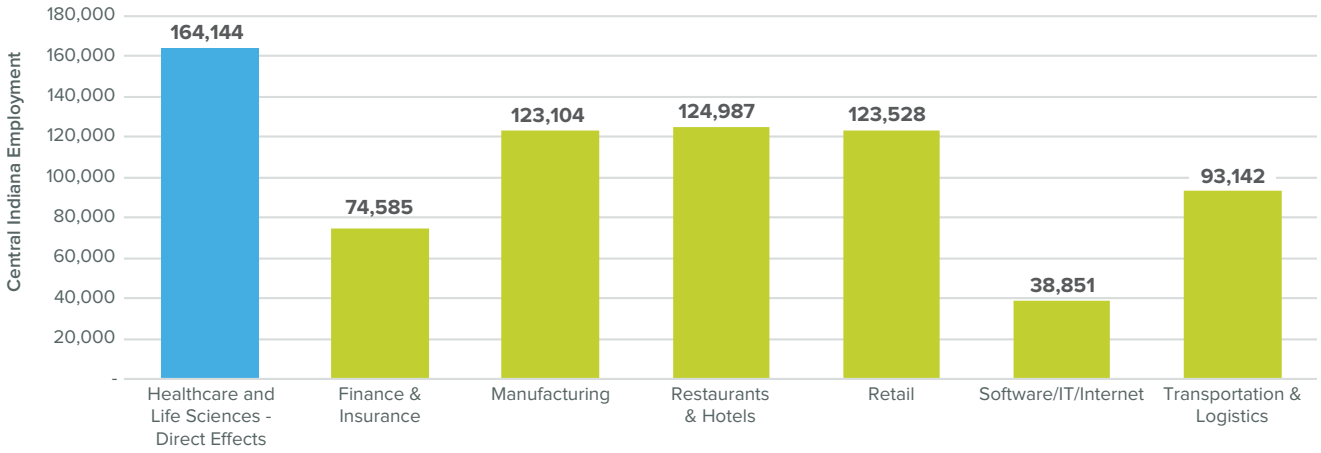
17 As measured by the subsector's location quotient (LQ) which compares a regional sector's share of total employment to the national sector's share of total U.S. employment. The LQ for hospital employment is 1.25.

18 For this assessment, TEConomy combined data from the IU School of Medicine (IUSOM) fact sheet and the 2019 IMPLAN model representing the 14-County region, to estimate the combined faculty, staff, and biomedical research-oriented employment generated by the IUSOM and the total of $604.48 million in medical science R&D performed by the region's higher education institutions. The IMPLAN (Economic IMpact for PLANning) model is a widely used input-output-based model used to estimate the economic impact of a project, program, or industry. The IMPLAN model's data track, within a specified region—in this instance the 14-County Central Indiana region—the flow of commodities to industries from producers and institutional consumers and the consumption activities by workers, owners of capital, and imports. The inter-industry trade flows built into the model then permit estimating the impacts of one sector on all other sectors with which it interacts within the specified region.

While Figure 3 compared the sector's and the manufacturing subsectors' employment to overall manufacturing, Figure 4 depicts the Central Indiana healthcare and life sciences sector to key and important regional industries. From this perspective the relative employment size of the region's healthcare and life sciences sector become even more apparent and noteworthy. The next section describes and highlights the importance to the region's overall economy.

Figure 4: Central Indiana's Healthcare and Life Sciences Employment Compared to Other Industries, 2019



Source: TEConomy analysis of 2019 Central Indiana Regional IMPLAN impact model.

ECONOMIC IMPORTANCE AND IMPACT OF SECTOR

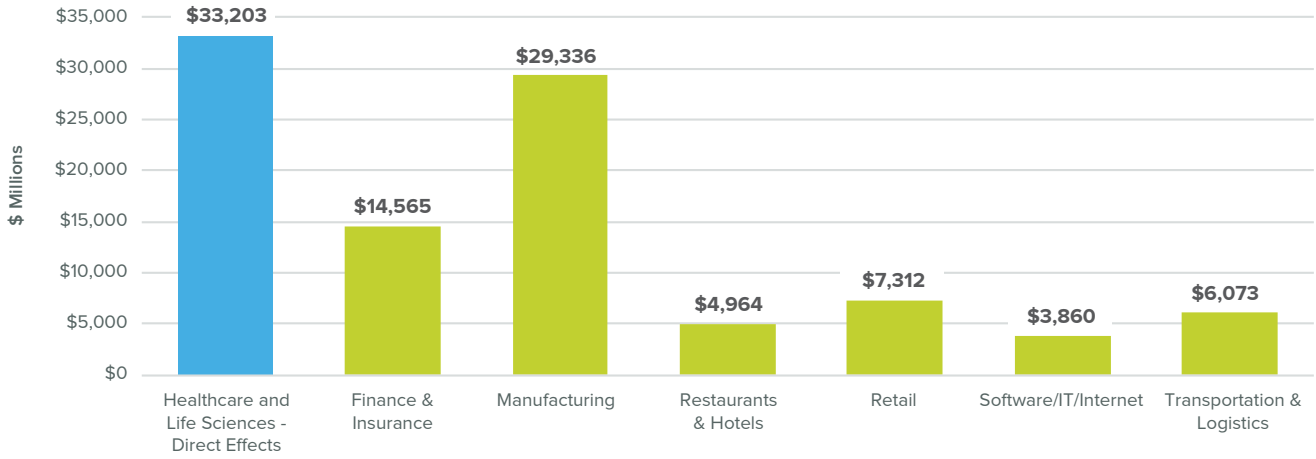
To estimate the economic importance of Central Indiana's healthcare and life sciences sector a 2019 IMPLAN economic impact model representing the 14-County region was developed and used for this analysis. The sector's 164,144 employees (direct effect) are used to drive the various sectors of the model to estimate additional direct, indirect, and induced effects and total impacts. The economic impact model (based upon input-output analysis) estimates the flow of goods and services between sectors and between inputs and final demand (indirect effects). Additionally, the spending of wages within the regional economy by the employees of these sectors are also captured (induced effects). This spending and re-spending of dollars within the economy is described as the "ripple effect" and when combined across all three types of effects provides an estimate of the total impacts. Impact effects are estimated for employment, labor income, value added, output, and tax revenues (federal and state/local estimated separately, see text box for the definitions of each of these).

The economic impact model is first used to estimate and further explore the relative importance of the healthcare and life sciences sector to the Central Indiana regional economy. Figure 5 shows a comparison to other key and important regional industries, similar to Figure 4, but reflecting the contributions of each to the Central Indiana Regional GDP (Total Value Added).

Economic Impact Measures

- **Employment** or the total number of jobs analyzed and estimated; includes the direct jobs captured as part of the healthcare and life sciences sector and indirect/induced jobs generated and supported through purchases and expenditures.
- **Labor Income**, also known as total compensation, is the total amount of income—including salaries, wages, and benefits (individual and company payments)—received by employees, proprietors, and other supplier and supported workers in the economy.
- **Value Added** captures the difference between an industry's total output and the cost of its intermediate inputs; sometimes referred to as the industry or sector's "contribution to GDP."
- **Output**, also known as production, sales, or business volume, is the total value of goods and services produced by the healthcare and life sciences sector in the economy along with the value of goods and services produced throughout the regional economy due to the ripple effects of sector spending. For public/non-profit entities, such as universities and hospitals, expenditures, rather than revenue, are often the truest measure of this economic activity. The total output impacts are often referred to as the total economic impact.
- **State/Local and Federal Government Tax Revenues** includes the estimated revenues to federal and state/local governments from all sources as a result of the direct, indirect, and induced impacts estimated.

Figure 5: Central Indiana's Healthcare and Life Sciences Contribution to Regional GDP Compared to Other Industries, 2019



Source: TEConomy analysis of 2019 Central Indiana Regional IMPLAN impact model.

An additional, and often overlooked, consideration for estimating the impacts of the healthcare and life sciences sector are the significant levels of facility/campus development and new construction that are occurring within the sector. At the time of this assessment, organizations within the Central Indiana healthcare and life sciences sector have announced and are in the process of developing nearly $2.1 billion of facility and campus improvements—ranging from hospital expansions to corporate headquarter and production facility development, to campus redevelopment. To estimate the additional impacts stemming from these development and construction activities, the total value of each project was spread evenly on an annual basis over the reported duration of the project, and the values reflecting only 2019 share of activities were incorporated into the impact model for estimation purposes. This value equaled $385.5 million.[19]

19 Note: the construction impacts stem from the "purchases of construction services" by the institutions within the healthcare and life sciences sector and hence, other than the direct expenditure, are captured as indirect (supplier) effects.

The results of the full economic impact analysis, shown in Table 2, capture the 164,144 direct healthcare and life sciences jobs within the Central Indiana economy, and how the spending of the sector's institutions and actors ripple through the regional economy. The more than $33 billion in value added to the regional economy, as discussed with Figure 5, appears as the direct effect in Table 2. Combined, the components and subsectors of the healthcare and life sciences sector are estimated to generate direct output of nearly $57 billion in 2019. Importantly, considering the number of public and non-profit institutions captured within, the sector generates more than $1 billion in state and local tax revenues annually (including taxes of all types).

From a total impact perspective, **the Central Indiana healthcare and life sciences sector generates and supports nearly $84 billion—every $1 of direct output generates an additional $0.48 within the regional economy**. This economic impact also generates and supports additional employment in the region. A total of **331,563 Central Indiana jobs are supported by the sector** with the non-direct additional employment almost equally split between indirect (supplier) and induced jobs. Every job within the Central Indiana healthcare and life sciences sector supports 1.02 additional jobs in the regional economy.

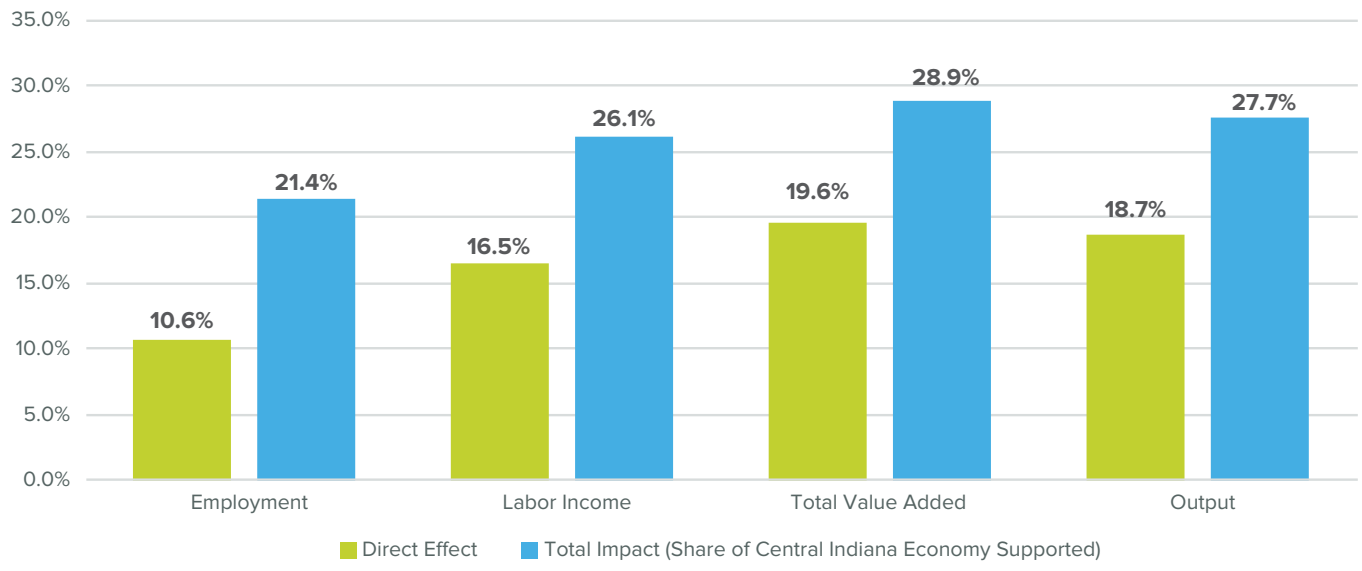
Table 2: Economic Impact of Central Indiana's Healthcare and Life Sciences Sector, 2019

Impact Type	Employment	Labor Income ($M)	Value Added ($M)	Output ($M)	State & Local Tax Revenues ($M)	Federal Tax Revenues ($M)
Direct Effect	164,144	$16,336.2	$33,203.1	$56,758.7	$1,003.1	$3,389.1
Indirect Effect	83,583	$5,580.7	$8,234.3	$14,486.3	$487.6	$999.5
Induced Effect	83,836	$3,961.4	$7,653.5	$12,724.7	$729.7	$780.1
Total Impact	**331,563**	**$25,878.3**	**$49,090.8**	**$83,969.6**	**$2,220.4**	**$5,168.7**
Multiplier	**2.02**	**1.58**	**1.48**	**1.48**		

Source: TEConomy analysis of 2019 Central Indiana Regional IMPLAN impact model.

While these numbers seem impressive at face value, the importance of the Central Indiana healthcare and life sciences sector to the regional economy is more fully appreciated through the metrics in Figure 6. As shown in the figure, **the sector supports at least 21% of the regional economy across the four major impact metrics.**

Figure 6: Healthcare and Life Sciences Sector Impact-Based Share of Total Central Indiana Regional Economy



Source: TEConomy analysis of 2019 Central Indiana Regional IMPLAN impact model.

IV. The Life Sciences Industry Ecosystem and Value-Chain

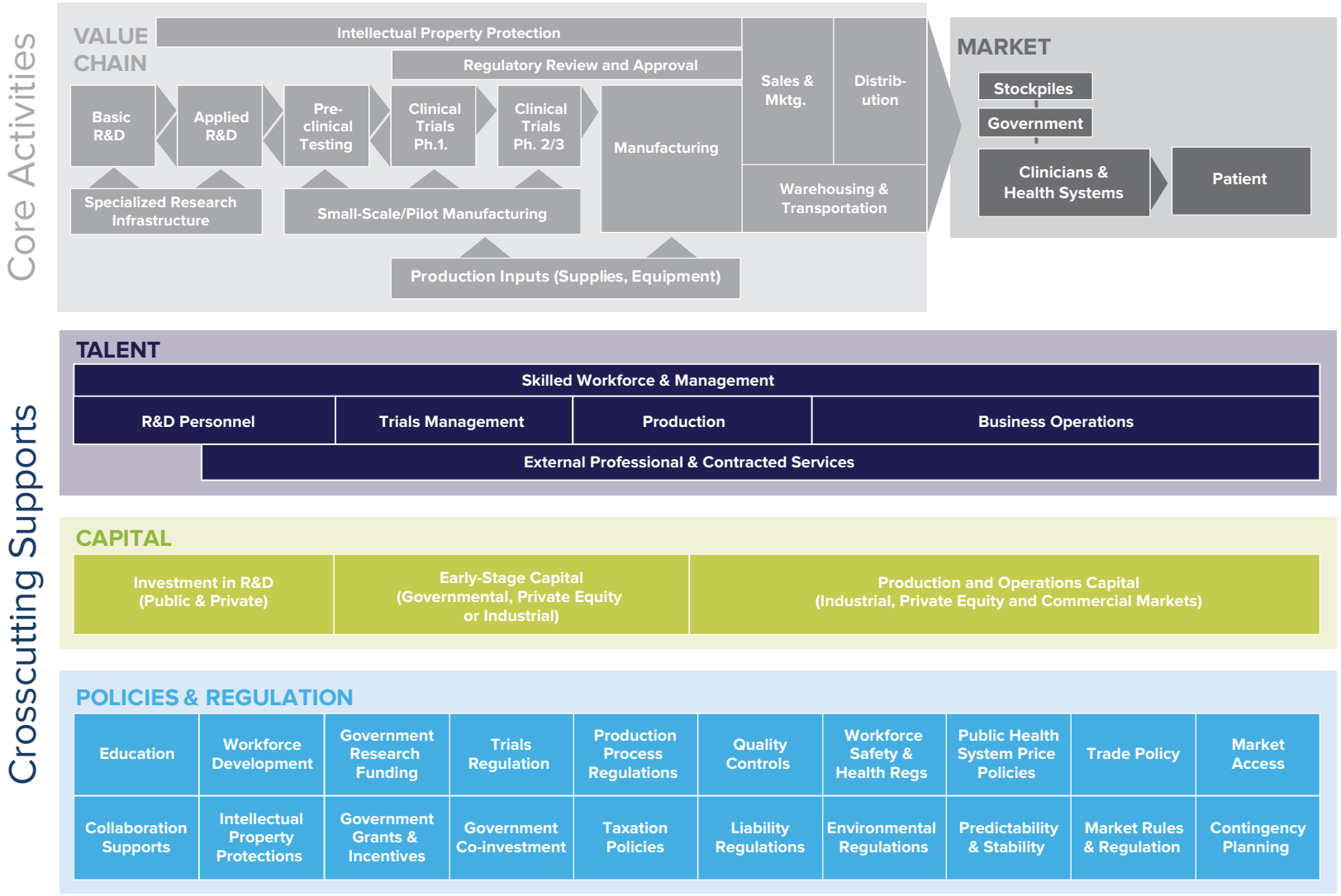
The economic and functional impacts generated by the healthcare and life sciences sector in Central Indiana are not the result of serendipity. They stem from the long-term strategic investments made by the clinical health, academic, and industrial communities which have built a holistic life sciences economic development ecosystem in the region. Certainly, the ecosystem has been built through the individual decisions and strategies of individual institutions and companies, but there has also been concerted collaboration and attention to "ecosystem completeness" evident in the work of the Central Indiana Corporate Partnership and the dedicated sector-focused BioCrossroads organization. Because healthcare and life sciences are highly regulated, the infrastructure investments are necessarily large and must meet a high bar. These investments benefit not only the healthcare and life sciences sector, but also other significant sectors such as manufacturing, finance, and retail.

A recent project for Pfizer, Inc. studied the structure and characteristics of a holistic life sciences ecosystem.[20] Figure 7 shows the ecosystem framework that TEConomy developed for Pfizer, which was recently deployed in a formal evaluation of lessons learned across 13 life sciences ecosystems across the globe during the COVID-19 pandemic. This ecosystem framework can be used as a structure for examining the completeness of the ecosystem that has been developed in Central Indiana for the healthcare and life sciences ecosystem.

The framework is divided into two principal components: 1) the core activities of the central value chain that conducts research and develops, trials, produces, and distributes healthcare and life sciences products and services, and 2) crosscutting ecosystem supports (divided into three core areas – talent, capital, and policies/regulations). Evident in this framework is the complexity of a full ecosystem. There are a great many individual elements that have to be combined to provide a region with a holistic presence across the ecosystem. As we will see, Central Indiana is well-positioned in terms of having particularly complete coverage of key ecosystem elements.

20 Simon Tripp, David Hochman, and Mitch Horowitz. 2021. "*Response and Resilience: Lessons Learned from Global Life Sciences Ecosystems in the COVID-19 Pandemic.*" TEConomy Partners for Pfizer, Inc. Accessible online at: https://www.teconomypartners.com/wp-content/uploads/2020/11/Response-and-Resilience-Lessons-Learned-from-Life-Sciences-Ecosystems-and-COVID-19.pdf.

Figure 7: The Healthcare and Life Sciences Ecosystem



Source: TEConomy Partners, LLC. for Pfizer, Inc.

Table 3: The Healthcare and Life Sciences Ecosystem in Central Indiana – Key Assets and Activities

CORE ACTIVITIES

Academic Healthcare and Life Sciences Research	Commercial Healthcare and Life Sciences R&D	Clinical Testing and Clinical Trials	Manufacturing	Distribution
$604.5 million in federal R&D funding to Central Indiana higher education institutions in healthcare and life sciences. IU School of Medicine, 95% growth in NIH funding since FY2015.	Estimated $8.6 billion in commercial healthcare and life sciences R&D spending by regional companies in 2020.	2,397 ongoing clinical trials in Indiana.	22,506 manufacturing jobs in healthcare and life sciences products in Central Indiana (18.3% of regional manufacturing employment).	4,036 personnel employed in biomedical distribution in the region.

TALENT

Biosciences Graduates	Healthcare and Clinical Sciences Graduates	Medical Students	Total Regional Employment in Healthcare and Life Sciences Sectors
1,617 graduates in 2020 from regional institutions with degrees in biological and biomedical sciences.	10,331 graduates in 2020 with an Associate's degree or higher in healthcare and clinical sciences fields.	365 enrolled medical students in the class of 2024 (288 in-state students). Largest medical school in the U.S. in total enrollment.	164,144 total direct jobs in Central Indiana in the healthcare and life sciences cluster.

CAPITAL

SBIR/STTR	Venture Capital	Public Companies (Valuation)	Major Capital Projects
In 2020, there were 26 awards, within 21 companies in Indiana. Total of $12.6 million.	In 2020, Indiana life sciences companies raised $262 million in VC.	12 public life sciences companies with Dec. 2020 market cap of $297.6 billion.	Average of $455 million in major capital projects each year for five years. 2.94 million square feet of construction for 2019-2023 5-year period. Combined capital project spending of $2.27 billion.

Source: TEConomy Partners' analysis and assembled from a variety of sources.

BASIC AND APPLIED/TRANSLATIONAL LIFE SCIENCES RESEARCH IN CENTRAL INDIANA

Academic research is a major component of the research continuum, and Indiana performs well in terms of attracting funding from major federal R&D funding agencies. In 2020, Indiana institutions were awarded $281.5 million in funding by the National Institutes of Health (NIH), with the major recipients being the IU School of Medicine (recorded under IUPUI in the NIH database) and IU Bloomington. Purdue University and the Indiana Department of Health also received significant NIH funding.

The National Science Foundation (NSF) reports R&D across fields of research, by institution, with the most recent complete dataset being for 2019. For Central Indiana, in healthcare and associated life sciences disciplines, total federal funding across all agencies totaled $604.5 million, distributed as shown on Table 4.

Table 4: Federal Healthcare and Life Sciences Funding to Central Indiana Universities

Fields	IUPUI	IU Bloomington*	Purdue University	Total
Biological and Biomedical Sciences	$5,449,000	$116,176,000	$25,238,000	$146,863,000
Health Sciences	$14,273,000	$341,217,000	$73,660,000	$429,150,000
Bioengineering and Biomedical Engineering	$1,832,000	$678,000	$25,957,000	$28,467,000
Total	**$21,554,000**	**$458,071,000**	**$124,855,000**	**$604,480,000**

** Includes IU School of Medicine.*

Source: NSF, Higher Education Research and Development Survey (HERD).

Indiana University and the Indiana University School of Medicine

Indiana University operates a system of seven campuses, with the "flagship campus" located in Bloomington, and the IU School of Medicine located in Indianapolis, together with IUPUI. IU is Indiana's oldest research university, just having celebrated its bicentennial in 2020. As would be expected given a university with over 43,000 students, IU provides a very broad coverage of academic disciplines and operates a large-scale research enterprise. While the campus in Bloomington is certainly active in life sciences research (with centers such as the Center for Genomics and Bioinformatics, and the Center for the Business of Life Sciences), the majority of the University's healthcare and life sciences-oriented research, education, and training programs are focused on the extensive academic medical center complex in central Indianapolis.

The IU School of Medicine is the largest in the U.S. in terms of student enrollment, and its faculty are also intensively engaged in research spanning the spectrum from fundamental science through to translational clinical research. The research enterprise is large in scale, and has been substantially increasing its volume of research funding, with the School of Medicine noting that:

> *"IU School of Medicine physicians and scientists were awarded approximately $408 million in research grants and awards in fiscal year 2020 to study the underlying causes of disease, the development of new therapeutics and how to improve the delivery of care. This marks a nearly 36% increase in six years and demonstrates the school's growing national reputation as an institution that conducts high-impact, patient-centered research. Funding to IU School of Medicine specifically from the National Institutes of Health—the gold standard in medical research—totaled about $213 million in federal fiscal year 2020."* [21]

The IU School of Medicine's growth in research has now propelled the institution into the top quintile of medical schools in terms of NIH funding. While research is understandably diverse across such a large enterprise, multiple key areas of research strength and core competency have been identified by the School of Medicine as being in:[22]

- **Musculoskeletal Health.** "Recently awarded a five-year NIH grant for a Comprehensive Musculoskeletal Training Program, IU School of Medicine trains new scientists in studying musculoskeletal disorders to improve treatment. The new Indiana Center for Musculoskeletal Health leverages the expertise of research groups at IU School of Medicine, in conjunction with IUPUI, to boost the population of doctors and scientists who study and specialize in musculoskeletal disorders."
- **Alzheimer's Disease.** "Indiana University School of Medicine recruits top global researchers studying Alzheimer's disease, and these investigators receive generous grant awards and international support to advance their studies. Through advanced research facilities and clinical care service centers, IU School of Medicine is committed to ending the suffering of Alzheimer's disease and other dementias."
- **Global Health.** "IU School of Medicine is training the next generation of physicians who will improve the health of people in Indiana and throughout the world. IU School of Medicine's Global Health program includes work opportunities in Kenya, Honduras, Mexico for student clerkships and electives."
- **Traumatic Brain Injury.** "IU School of Medicine is a leader in the research, diagnosis, treatment and rehabilitation of traumatic brain injury and mild traumatic brain injury, known also as concussion. With the Rehabilitation Hospital of Indiana, IU School of Medicine is a designated Traumatic Brain Injury Model Systems Site, one of just 16 such centers in the nation. The work of this partnership focuses on the long-term treatment and rehabilitation of people with traumatic brain injury (TBI) as well as critical research to fill knowledge gaps related to TBI and concussion."
- **Precision Health.** "IU School of Medicine's Precision Health Initiative, selected as the winner of the IU Grand Challenges Program, will transform biomedical research, healthcare innovations and the delivery of health interventions in Indiana. The goal of this initiative is to position IU School of Medicine and its partner institutions among the leading universities in understanding and optimizing the prevention, onset, treatment, progression, and health outcomes of human diseases through a more precise definition of the genetic, developmental, behavioral and environmental factors that contribute to an individual's health."

21 https://medicine.iu.edu/
22 https://medicine.iu.edu/expertise

Purdue University

From an economic development perspective, Purdue University is a very interesting institution. While certainly a world-class and highly ranked university from a traditional academic standpoint, Purdue is also among the most progressive universities in terms of working to proactively translate its research expertise to benefit the economy and society. Purdue's commitment to applied and translational research, to entrepreneurship, and to collaborative projects with industry may be viewed as sustaining a powerful commitment to the original mission of Purdue as a public Land-grant university – a mission focused on pragmatic research and education to help sustain and grow major U.S. industries (such as manufacturing and agriculture). Purdue has not lost sight of the important role that research, higher education, and university outreach play in sustaining robust economic growth and the opportunities that presents for societal advancement.

One of the physical investments at Purdue that embodies this commitment is the development of Discovery Park, a 40-acre interdisciplinary research environment open to university research teams, industry, and other stakeholders seeking to collaborate on complex challenges and opportunities. Purdue notes that the "Lilly Endowment provided generous initial funding for the centers and programs in **Discovery Park,** recognizing the potential of Purdue's commitment to advancing its interdisciplinary research and translational capabilities to a new level of excellence and impact."[23] Biosciences feature heavily in the investments made at Discovery Park. Examples of infrastructure, facilities, and programs focused on life sciences at the Park include:

- **Bindley Bioscience Center** – a $15 million, 30,000 assignable square foot, collaborative life sciences research center, opened in 2005. The center includes 20,000 square feet of lab space, and houses core equipment needed for modern life sciences, together with space for research collaborations. Core research capabilities include: "biological mass spectrometry with metabolomic and proteomic applications; computational life sciences and informatics; biophysical analysis; biomolecular screening and drug discovery core; flow cytometry and cell sorting; bioscience imaging; translational pharmacology and bionanotechnology."[24]

- **Drug Discovery Facility** – opened in 2014, the Drug Discovery Facility at Discovery Park was a $28 million investment, developing 32,000 assignable square feet, including 24,000 square feet for labs, offices, conferences, and meetings. The facility has been developed to "promote the discovery, design and development of new drugs through an innovative architecture that encourages collaborations in chemistry, medicinal chemistry and biology."[25] The facility houses the Purdue Institute for Drug Discovery and accommodates more than 100 multidisciplinary researchers. Designed to advance drugs through discovery and on into development, Purdue notes that "more than 30 drug compounds developed by Purdue researchers, often in collaboration with pharmaceutical companies or federal agencies, are undergoing preclinical development and 13 molecules are in human clinical trials."[26]

Discovery Park also houses the **Burton D. Morgan Center for Entrepreneurship**, a $7 million, 16,000 square foot facility that opened in 2004. The Center houses many of Purdue's innovation, entrepreneurship, commercialization, and partnership programs and is a central hub for entrepreneurship training and networking events on campus.

Expanding to Become the Discovery Park District

Building on the impetus established with Discovery Park, Purdue University has substantially expanded its already significant commitment to commercial research advancement, industry partnerships, and associated economic development through establishing the Discovery Park District. Ten times larger than the original Discovery Park, at 400-acres the Discovery Park District is designed to be "a launch pad where businesses of all sizes can access a business-minded University, global talent pipelines, and advanced R&D facilities to solve … pressing business problems."[27] The development follows an innovation district model, developing a master-planned, mixed-use development comprising university research operations, industry facilities, and residential development in combination with amenities and greenspace for a true live-work-play environment. The District is being developed as a collaboration between the Purdue Research Foundation and Browning Investments (an Indiana-based development company). One of the key hubs for industry-university collaborations and for new ventures is the new 143,000 square foot Convergence building in the District, which is designed to serve as a central location for private industry to collaborate with Purdue faculty, students, and one another.

High Performance Innovation and Commercialization Metrics

Purdue University's commitment to economic development is readily demonstrated in its performance in terms of innovation and the commercialization. The Association of University Technology Managers (AUTM) ranked Purdue 6th in the world for university start-ups in 2018 and in 2019 announced Purdue as the winner of the Economic Prosperity Universities Award. Even in the challenging year of FY2020, Purdue recorded 180 issued U.S. patents, 148 licensing agreements, 225 individual licensed technologies, and saw 22 start-up businesses founded on Purdue technologies. In the past seven years (2014-2020) Purdue technologies have been the basis for 161 start-up business ventures.

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23 https://www.purdue.edu/discoverypark/facilities/index.php
24 https://www.purdue.edu/discoverypark/facilities/bindley.php
25 https://www.purdue.edu/discoverypark/facilities/drug-discovery.php
26 Ibid.
27 https://discoveryparkdistrict.com/about/

COMMERCIAL LIFE SCIENCES R&D

The total volume of expenditures on R&D across industry is extremely challenging to quantify. Public companies will typically provide this information in their SEC filings, but these data are generally not revealed by privately held corporations (for example Cook Medical). While academic R&D expenditures in life sciences are large, these are typically eclipsed significantly by commercial life sciences R&D (often by an order of magnitude). In the biomedical sphere, global biopharmaceutical multinationals stand among the very largest performers of R&D, and this is demonstrated in Central Indiana in terms of the publicly released data by Eli Lilly on their R&D expenditures (see sidebar). In 2020 Lilly spent over $6 billion on R&D, equivalent to $23.4 million in R&D expenditures every workday in 2020.

Economic impact analysis by TEConomy places the total direct output of the industrial healthcare and life sciences sector in Central Indiana at $34.6 billion. **Using Lilly's percent of sales spent on R&D as a proxy measure** (i.e., estimating that other companies in the industry would place a similar emphasis on R&D), **this would place R&D across industry in the healthcare and life sciences sector in Central Indiana at an estimated $8.6 billion for 2020.**

CLINICAL TESTING AND CLINICAL TRIALS

Advancing biomedical innovations that will interface with the patient into the market requires that clinical research and clinical trials be performed to prove efficacy and safety of the resulting product. Indiana's expertise in clinical research and clinical trials is evidenced in data maintained by the U.S. National Library of Medicine at the NIH which shows 2,397 ongoing clinical studies operating in Indiana, out of a total universe of such studies in the U.S. of 37,053.[29] Indiana is thus represented in 6.45% of clinical studies, a level that is more than three times its percentage of the U.S. population (which the Census Bureau shows to be 2.05%).

A wide range of Indiana organizations, companies, and institutions are engaged in clinical research and clinical trials in Indiana. Universities sponsor clinical trials for biomedical innovations stemming from their research and, of course, the IU School of Medicine and IU Health are deeply engaged in this work. The biopharmaceutical candidates, medical devices, and other regulated products developed by Indiana's commercial biosciences innovators are also major components of the clinical trials ecosystem in the state, and contract research organizations, such as Covance (see case study) provide important support and trials management services in support of clinical research.

29 https://clinicaltrials.gov/ct2/search/map/click?map.x=322&map.y=334&mapw=1559

2020 R&D at Eli Lilly & Company

- Research expenditures = $6.086 billion
- R&D as a percent of sales = 25%
- Employees engaged in R&D = 8,227

CASE STUDY:

Indiana Biosciences Research Institute

An additional catalyst for life sciences cluster development is the Indiana Biosciences Research Institute (IBRI). Established in 2012, the non-profit IBRI was designed by industry but is intended, in part, to create collaborative bridges to Indiana's research universities. The state of Indiana and its leading life sciences companies, academic research universities and medical schools, and philanthropic community saw the need for better health solutions in the local and global community and called for the creation of IBRI. The Institute leverages the depth and breadth of the varied, complementary R&D activities occurring in Indiana, and in particular, the industry and academic expertise in nutrition science, genetics and genomics, biochemistry, endocrinology, novel delivery systems, and therapeutic approaches, to deliver important answers to metabolic disease. IBRI's mission is to "become the leading industry-inspired applied research institute in the discovery and development of innovative solutions to improve health, initially targeting diabetes, metabolic disease, and poor nutrition."[28]

IBRI is intentionally designed to advance discoveries by breaking down traditional barriers to research that encourages collaboration across both industries and scientific disciplines. This includes leveraging and sharing assets and resources, utilizing a flexible business model across multiple funding sources, and attracting world-class talent. The Institute also encourages academic collaborations and talent connections by allowing a "shared" talent approach where academic researchers can have IBRI and university privileges at the same time.

IBRI is located in the new Innovation Building 1 in the developing *16 Tech Innovation District* in Indianapolis.

28 https://www.indianabiosciences.org/about

Indiana institutions and industry have also formally organized to advance translational research and clinical research activity through the formation in 2008 of the Indiana Clinical and Translational Sciences Institute (see case study).

CASE STUDY:

Covance – a Leading Provider of Contract Research Services

Owned by LabCorp, Covance is a multinational contract research organization (CRO) that provides nonclinical, preclinical, clinical, and commercialization services to drug, diagnostics, and medical device industries. The firm has over 26,000 personnel worldwide and is an established global leader in nonclinical safety assessment, clinical trial testing and clinical trial management services. LabCorp acquired Covance in 2015.

Covance has two major locations in Central Indiana. The Indianapolis location is focused on bioanalysis central lab testing, and the Greenfield location is focused on analytical testing, discovery services, nonclinical safety, and translational biomarkers.

CASE STUDY:

Indiana CTSI

Assuring that the output of advanced research is translated into tangible product development is a priority for the nation. The federal government established the Clinical and Translational Science Award (CTSA) Program to help fund the development of innovative solutions aimed at improving the "efficiency, quality, and impact of the process for turning observations in the laboratory, clinic and community into interventions that improve the health of individuals and the public."[30] Part of the CTSA program has involved support for the establishment of Clinical and Translational Sciences Institutes (CTSIs) in key locations within the U.S. In Indiana, multiple stakeholders came together under the leadership of Anantha Shekhar, MD, PhD to form the Indiana CTSI.

The Indiana Clinical and Translational Sciences Institute (CTSI) is a statewide collaboration of Indiana University, Purdue University, and the University of Notre Dame, as well as public and private partnerships, focused on the translation of scientific discoveries in the lab into clinical trials and new patient treatments in Indiana and elsewhere. The Indiana CTSI is one of 61 such Institutes formed nationally, established through an award from the NIH and supplemented by funding from the state, the three universities, and public and private partnerships.

The CTSI provides a partnering vehicle with the private sector and has brought together the research universities in collaborations with Eli Lilly and Company and Cook Group, as well as healthcare institutions such as Eskenazi Health. Among its partnership efforts is the Strategic Pharma-Academic Research Consortium Funding Program (SPARC), which the Indiana CTSI spearheaded and now leads. The consortium involves three other NIH-funded CTSAs – Ohio State University, Northwestern University, and The Washington University – and its industry partners include Eli Lilly and Co. and Takeda Pharmaceuticals International Inc. The first grants from SPARC provided over $1.9 million to advance research on autoimmune disease at several medical research universities across the Midwest. Another Indiana CTSI public-private partnership effort is with Covance for a Phase I clinical trials unit.

Indiana CTSI reports that, since 2008, it "has assisted more than 5,000 researchers and trained more than 400 future scientists across the state."[31]

30 https://ncats.nih.gov/ctsa
31 https://indianactsi.org/

MANUFACTURING BY OEMS AND CONTRACT MANUFACTURERS

Indiana is an established manufacturing hub for a broad range of manufactured products. A recent article in *Global Trade* notes that[32]:

> Manufacturing accounts for nearly 30% of the output in Indiana, where $102.59 billion was generated in 2017. Manufacturing accounts for almost 20% of the state's workforce, with 516,900 workers employed in the sector statewide—an estimated one in five workers. In fact, Indiana has the highest concentration of manufacturing jobs in America.

Indiana has strong manufacturing clusters in a range of industries (including automotive, aerospace, recreational vehicles, etc.) and it is also a key hub for the manufacturing of medical devices and biopharmaceutical products. Central Indiana is not only researching and innovating new biomedical products but is also a leading geographic location for their manufacturing. As shown on Figure 3, healthcare and life sciences products manufacturing in Central Indiana accounts for 22,506 jobs. Compared to total manufacturing jobs in the region (123,104) healthcare and life sciences products manufacturing accounts for nearly one in every five regional manufacturing jobs (18.3%).

CASE STUDY:

Medical Devices and Central Indiana

The Warsaw area in Northern Indiana is well recognized as a hub for the medical device industry, with a special concentration in orthopedic device development and manufacturing. Northern Indiana is not alone, however, in the state in terms of being home to significant medical device R&D and production capabilities and major investments. Central Indiana enjoys an important position in medical devices:

- **Cook Medical**, in Bloomington, for example, is a leading developer and manufacturer of advanced medical devices for applications such as minimally-invasive surgery. Cook provides products that are used across 41 medical specialties.
- A recent addition to the Central Indiana device ecosystem is **Abbott Cardiovascular**, which announced plans to build a 120,000 square foot, $37 million manufacturing facility in Westfield to produce cardiac devices. The new Abbott operation is anticipated to employ 477 personnel by the end of 2024.

32 Taylor Girardi-Schachter. 2019. "TOP 10 STATES FOR MANUFACTURING 2019." *Global Trade*. September 2019. https://www.globaltrademag.com/top-10-states-for-manufacturing-2019/.

CASE STUDY:

Contract Biopharmaceutical Production in Central Indiana

In addition to being the home of major OEM biopharmaceutical companies, such as Eli Lilly, Cook, and Novartis, Central Indiana is an important hub for the contract development and manufacturing of pharmaceuticals, biologics, and associated products. Some key examples of operations for this important life sciences business sector in Central Indiana include:

- **Catalent Biologics.** The company is among the world's leaders in development and contract manufacturing of biopharmaceuticals. Headquartered in New Jersey, the firm has multiple operations in North America and Europe. Indiana is a major location for Catalent, and the firm has recently undertaken several expansion projects in the state, with $150 million in investment in Bloomington since 2018. Catalent's Bloomington operations conduct manufacturing, fill, and packaging with controlled temperature storage of biological and sterile products. These capabilities in Indiana have been leveraged for a critical role in COVID-19 vaccine production under agreements with multiple vaccine developers.
- **Baxter BioPharma Solutions** is a business division of Baxter and operates a large-scale 600,000 square foot campus in Bloomington, performing contract services that span from clinical development through to commercial launch. The Bloomington facility is equipped to provide contract services including aseptic formulation, filling, and finishing services. In November 2020, Baxter BioPharma Solutions announced an expansion of its sterile fill-finish operations, including adding a 25,000 square foot warehouse, new filling lines, and a high speed automated visual inspection line. New investments expected to total $50 million, with more than 100 new jobs created.
- **INCOG Biopharma** is planning to invest $60 million in a new 60,000 square foot global headquarters operation in Fishers. The firm is focused on providing contract development and manufacturing services for the biopharmaceutical industry and anticipates creating 150 new jobs in Fishers by the end of 2024.

CASE STUDY:

The Broader Life Sciences Ecosystem – Elanco Chooses Indianapolis for its Global Headquarters

Elanco Animal Health Incorporated is a biopharmaceutical company focused on R&D and production of medicines and vaccinations for pets and livestock. The veterinary medical space uses much of the same science, tools, technologies, and skills as human life sciences, and is very much complementary to Central Indiana's position as an advanced life sciences hub for biopharmaceutical products.

In December 2020, Elanco announced, that after conducting a search of potential locations suited for its business, it selected Indianapolis for its global headquarters and R&D operations. The firm acquired a 45-acre campus site close to downtown, that was once home to a GM stamping plant, and will be revitalizing the site with more than $300 million in investment. In addition to consolidating over 1,000 existing employees at the new campus, Elanco has announced that it plans to add 570 additional jobs at the site over the next decade.

HEALTHCARE AND LIFE SCIENCES PRODUCTS DISTRIBUTION

Indiana's central U.S. location is itself a key strategic asset for industry. Eighty percent of the U.S. population is within a day's truck drive, and Indianapolis is home to the second-largest FedEx hub in the nation and a top ten airport for cargo. The advantages Indiana's location provides for logistics industries is a major component of why the state is often referred to as the "Crossroads of America."

For healthcare and life sciences products, having access to an efficient and cost-effective logistics environment is a critical component of a successful business ecosystem. Indiana's leading medical products, be they medical devices, pharmaceuticals, or diagnostics, have a market in every state and across the globe, and the locational advantages offered by an Indiana location help with industry competitiveness. In many cases biomedical products are also environment- (e.g., temperature) or time-sensitive (for example, see the case study on radiopharmaceuticals below, or the urgent need for rapid diagnostics test distribution under the COVID section), and the ready access to market provided by Indiana's location and logistics infrastructure are, again, highly beneficial.

CASE STUDY:

Central Indiana's Logistics Advantages Build a New Play in Time-Sensitive Biomedical Products

Multiple medical procedures employ radioisotopes in diagnostics and radiologic substances in specialized pharmaceuticals (radiopharmaceuticals). In some cases, the rapid radioactive decay (half-life) of radiologic products means that their distribution to point-of-use is exceptionally time sensitive. The Indianapolis region's central U.S. location, in combination with a FedEx hub and other logistics assets, makes Central Indiana a logical pick for such time sensitive medical industry operations. The advantages of Central Indiana for the industry are captured in two recent major investments made in the region by Advanced Accelerator Applications and POINT Biopharma:

- In late 2019, **Advanced Accelerator Applications (AAA),** a subsidiary of the global biopharmaceutical company Novartis, broke ground on a 60,000 square foot manufacturing facility located at the Purdue Research Park. The facility will produce radioligand therapeutics for cancer treatment. AAA selected Central Indiana to provide access to the R&D and training expertise in nuclear pharmacy contained within Purdue University and the distribution capabilities centered on Indianapolis International Airport. The new $70 million facility at the Research Park is expected to begin operations in 2023.

- Another win for the region in this sector comes with the decision of **POINT Biopharma** to construct its first U.S. manufacturing facility in Indianapolis. The company, which is headquartered in Canada, develops, and commercializes radioligand therapies for the treatment of cancer. Announced in May 2020, the POINT Biopharma project will comprise a 77,000 square foot production and distribution center and anticipates a $25 million investment in the operation that is expected to employ up to 100 personnel by the end of 2024.

Another example of Central Indiana being picked for a major biomedical investment based on its logistical advantages is evident in the $18 million investment being made by Virginia-based **LifeNet Health**, a company developing and producing specialized, time-sensitive products for the regenerative medicine sector. LifeNet Health selected Plainfield in Central Indiana for construction of a new 70,000 square foot biologics distribution facility, enabling efficient delivery of its therapeutic products coast to coast. The Plainfield location of LifeNet opened in September 2019 and is expected to create 127 new jobs in the region by the end of 2023.

CASE STUDY:

Central Indiana Logistics and COVID-19

A recent report by Conexus Indiana, titled "MOVING INDIANA: State of the Logistics Industry 2021," summarizes the assets and infrastructure of Indiana in the logistics sector, and highlighted some of the activities undertaken to leverage these assets and assure the flow of essential products and healthcare products during the COVID-19 crisis.[33] The report highlights that:

- On May 1, the State of Indiana established a PPE marketplace with the help of numerous Indiana logistics providers to ensure that small businesses and non-profits lacking resources could reopen safely. At the time of the program's release, 7.84M pieces of PPE had been secured with 2M already distributed by logistics suppliers to the Indiana Department of Health (IDOH).
- Langham Logistics utilized their expertise and fleet capabilities to help Indiana University Health guarantee supplies were available to 17 of the network's sites throughout the state.
- Conexus Indiana assembled a team of transportation companies that volunteered to move critical medical supplies and much-needed food throughout the state early in the pandemic. These industry partners worked with the Indiana Economic Development Corporation to ensure that the needs of Hoosiers were being met.

33 https://www.cicpindiana.com/wp-content/uploads/2021/03/CNXS_CILC-2020-Report_FINAL.pdf

INDIANA'S HEALTHCARE AND LIFE SCIENCES TALENT DEVELOPMENT

Healthcare and life sciences are inherently dependent on the skills, talent, and know-how of a well-educated workforce. Any ecosystem focused on delivering quality healthcare or life sciences innovations needs to have:

- Higher education institutions producing undergraduate and graduate level talent.
- An ability to attract talent from outside of the ecosystem to meet demand for specialized skills and to supplement the output of regional talent development programs.
- Pathways for upskilling and continuing education for the existing workforce.
- Programs designed to inform people of job opportunities within the ecosystem and build awareness and connectivity for personnel entering the job market or seeking to change jobs or careers.

In high skill, knowledge-driven sectors (which healthcare and life sciences certainly are) there is no resource more important than human capital. The facilities, infrastructure, and physical assets of the sector are only useful if there are well-educated, talented individuals able to use these assets to accomplish tangible, high-productivity activities. The demand for talent in this sector in Central Indiana is clearly significant, with the economic impact analytics showing direct employment of 164,144 in the region in the healthcare and life sciences sector for 2019. In Central Indiana, and statewide, the demand for talent in healthcare and in life sciences is projected to increase. A recent report published by Ascend and FutureWorks[34], includes the projections for employment growth shown on Table 5:

34 Ascend Indiana and FutureWorks. 2019. "*Aligning the Workforce: Labor Market Demand and the Supply of Talent in Indiana, 2019.*" Accessed online at: https://ascendindiana.com/uploads/resource-downloads/Aligning-the-Workforce_2019-Supply-and-Demand-Report_Final.pdf.

Table 5: Projection of Indiana Job Growth in Healthcare and Life Sciences Sectors

Sector	2010-2019 Percent Change	2019-2029 Projected Percent Change
Healthcare	16.68%	17.85%
Life Sciences	2.71%	6.85%
TOTAL	**14.80%**	**16.53%**

Source: Ascend Indiana and FutureWorks.

As the data on Table 5 show, employment growth within both sectors is accelerating – with the percentage change in employment projected to be higher over the forthcoming decade, versus the decade just completed.

If we apply the anticipated statewide percent change for 2019-2029 from the Ascend/FutureWorks study (16.53%) to the 2019 Central Indiana regional healthcare and life sciences employment figure from TEConomy's impact analytics (164,144), the result is a projection that **within the next decade sectoral employment demand will increase by 27,133 jobs in the region.**

The most relevant vantage for understanding the underlying deployment of talent and skills across the healthcare and life sciences industry is occupational employment. A set of "primary" industry-related occupations—those roles that are clearly and primarily healthcare and life sciences-oriented—are organized and distributed across two major groups in Table 6. While these occupational groups do not fully encompass all industry workers and functions, they represent the key job functions and expertise that develop and deploy healthcare- and life sciences-related innovations spanning products and services.

Central Indiana's clinical workforce totals nearly 124,000 and has grown by 9% over the latest five-year period (Table 6). The recent growth and relative concentration of the region's clinical employment essentially match those for the U.S. average. Several clinical occupations stand out, however, in their "specialized" concentration of regional employment (a regional location quotient greater than or equal to 1.20). These include several major groups representing the majority of the "high-skilled" clinical professions that typically require at least a bachelor's degree or higher including surgeons, therapists, physicians, and nurses. With respect to growth, the region has outpaced the nation in hiring among nurses, health technicians, and surgeons.

The specialized concentration of the industrial life sciences industry in Central Indiana translates into a rapidly growing, highly concentrated non-clinical workforce of more than 14,000. Three out of four primary life sciences occupation groups have specialized location quotients, including managers, scientists, and biomedical engineers. Each of these groups have grown their employment base since 2015, and the demand for managerial talent has been especially strong.

Table 6: Primary Healthcare and Life Sciences Occupational Employment Metrics, Central IN and U.S., 2020

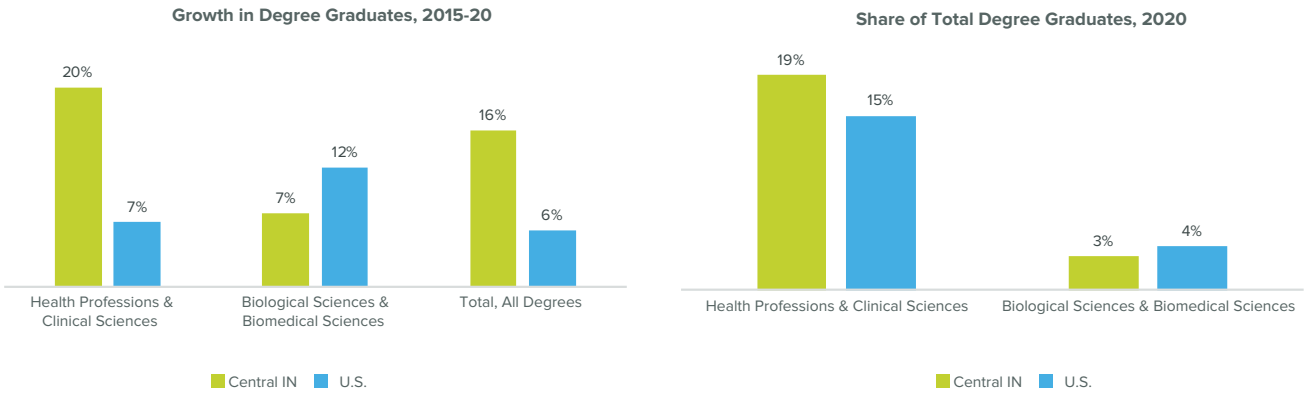
Primary Healthcare & Life Sciences Occupational Groups	Employment, 2020	Location Quotient	Central Indiana Empl. Change, 2015-20	U.S. Empl. Change, 2015-20
Total, All Occupations	**1,153,597**	**1.00**	**2.9%**	**1.3%**
Total, Clinical Workforce	**123,907**	**1.00**	**9.0%**	**10.0%**
Healthcare Assistants & Support	42,370	0.79	11.4%	12.9%
Nursing	32,087	1.21	10.5%	9.9%
Healthcare Technologists & Technicians	26,796	1.10	11.5%	6.7%
Health Diagnosing & Treating Practitioners	8,268	1.06	0.5%	7.0%
Therapists	7,352	1.28	0.8%	9.2%
Physicians	6,440	1.24	-3.9%	4.7%
Surgeons	594	1.90	79.4%	-8.1%
Total, Non-Clinical Life Sciences Workforce	**14,099**	**1.66**	**22.3%**	**15.4%**
Healthcare & Life Sciences Managers	7,397	1.87	60.2%	29.3%
Life & Biomedical Scientists	4,590	1.76	8.1%	11.4%
Life Sciences Technicians	1,810	1.01	-26.1%	-0.3%
Biomedical Engineers	302	1.91	41.8%	-11.8%

Source: TEConomy Partners' analysis of Emsi 2021.2 Data Set.

The overall high rate of growth among the clinical workforce and its varied skill levels and expertise, as well as the expected high growth in the industry, as populations age, reinforce the need for regional postsecondary clinical education and workforce training programs and initiatives to keep pace. Central Indiana colleges and universities are largely meeting that challenge, demonstrating a high comparative concentration in relevant degree programs and recent growth in health and clinical sciences degree graduates (Figure 8). In 2020, regional postsecondary institutions graduated 10,331 at the associate's level and higher, a total that represents 19% of all degrees conferred in 2020. Since 2015, the region has well outpaced the nation in the growth of these clinical degree graduates—20% versus 7%, respectively.

To meet the region's strong and growing demand for its primary, non-clinical life sciences workforce, Central Indiana colleges and universities graduated 1,617 students in 2020 in biological and biomedical sciences degree programs. This total accounts for 3% of regional degrees conferred at the associate's and higher levels, and has grown by 7% since 2015, just behind the pace for the nation (12%). While regional life sciences companies source their workforce from numerous geographies, degree programs, and experienced labor pools, these regional graduates represent a key, primary source of industry talent and raising this growth rate will be key for keeping pace with rapidly growing industry demand.

Figure 8: Healthcare and Life Sciences Degree Graduates—Share of Total Degrees Conferred and Recent Growth Trends at the Associate's Level and Higher, Central Indiana and U.S.

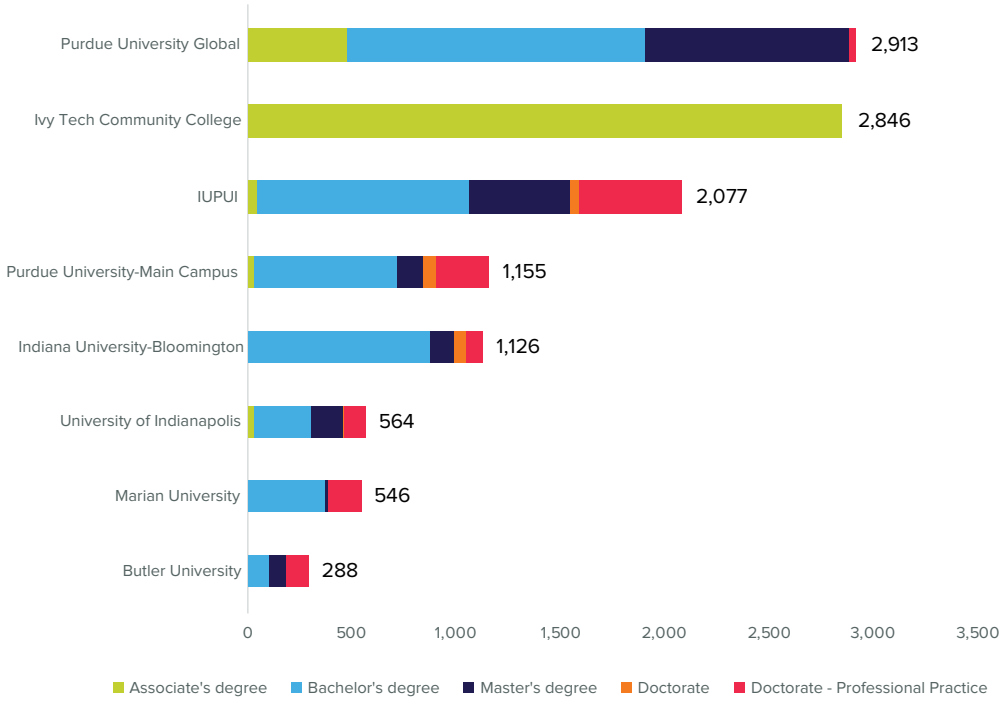


Note: Data represent degree graduates at the Associate's level and above; exclude certifications and other non-degree awards.

Source: TEConomy Partners' analysis of National Center for Education Statistics, IPEDs Database.

Central Indiana's leading colleges and universities in healthcare and life sciences graduates are shown in Figure 9. The breadth of regional postsecondary educational "assets" in the region is apparent as eight institutions have graduate totals exceeding 200 degrees granted in 2020, with several conferring more than 1,000 on an annual basis.

Figure 9: Leading Healthcare and Life Sciences Colleges and Universities in Central Indiana by Degrees Conferred (Associate's and Higher), 2020



Note: Data represent degree graduates at the Associate's level and above; exclude certifications and other non-degree awards. IUPUI data, in IPEDs database, includes IU School of Medicine, with medicine degrees falling under the "Doctorate-Professional Practice" category. Purdue and IU regional campuses outside of Central Indiana are not included in the data presented.

Source: TEConomy Partners' analysis of National Center for Education Statistics, IPEDs Database.

CASE STUDY:

Collaborations to Build the Talent Pipeline

Organizations across the healthcare and life sciences spectrum well recognize the importance of education, especially STEM education, for society and for assuring a pipeline of talent exists to meet the needs of Indiana sector operations. Many collaborations and support programs exist between Indiana organizations, with some examples including:

- Roche Diagnostics investing in the "Roche Academy" with the University of Indianapolis, a partnership to create a custom talent pipeline for biomedical equipment technicians.
- Purdue University Global partnering with Roche for further/continuing education programs.
- In Bloomington, Cook Medical has entered into an important workforce training partnership with Goodwill of Central and Southern Indiana, the Indianapolis Foundation, and the United Northeast Community Development Corporation. The partnership is working on developing the skills needed in the workforce at a planned 40,000 square foot, $7 million Cook facility for medical device production. The unique public-private partnership model will see Goodwill Commercial Services supplying workforce and building operations capabilities, and ongoing workforce training and support services.
- The Lilly Endowment has made substantial philanthropic gifts, supporting multiple Indiana institutions to advance STEM education in the state – promoting educational pathways that support the growth of the life sciences, and other key sectors. N. Clay Robbins, Lilly Endowment's chairman, president and CEO has noted that "the need for world-class engineers, technologists and other STEM leaders has never been greater as the state of Indiana and the nation prepare for the jobs of tomorrow."[35] A recent, large-scale example of the Lilly Endowment's support for STEM education is the 2019 $40 million grant to Purdue Research Foundation to help create Purdue's Engineering and Polytechnic Gateway Complex, a project designed to help meet the growing demand for STEM graduates.
- Eli Lilly and Company has been financially supporting and collaborating with The Mind Trust, an Indianapolis-based non-profit that supports evidence-based education reform to assure Indiana is on track to improve K-12 educational performance, including in STEM disciplines. The company also supports medical student education programs, and provides internships for medical students, between their first and second years, to work "alongside healthcare professionals in the pharmaceutical industry to gain scientific knowledge and experience in several areas, including preclinical research, clinical trial development, medical affairs, regulatory affairs, bio-ethics and patient safety."[36]

35 https://www.purdue.edu/newsroom/releases/2019/Q3/40-million-lilly-endowment-inc.-grant-to-impact-stem-students,-jobs.html
36 https://investor.lilly.com/news-releases/news-release-details/eli-lilly-and-company-launches-second-education-program-medical

CASE STUDY:

Ascend Indiana

Ascend, an initiative of the Central Indiana Corporate Partnership (CICP), is a dedicated non-profit organization focused on connecting talent to job opportunities in Indiana. Ascend operates programs for employers (helping to raise awareness of their job opportunities and build their connections to talent) and for job seekers (working to connect talent to Indiana employers who offer positions suited to their education, skills, interests, and ambitions).

To accomplish its mission, Ascend has developed an extensive network of partners comprising "employers, education providers, community organizations, and philanthropic entities that are committed to growing a talented workforce and thriving economy."[37] For job-seekers, the Ascend Network is a service that helps college students and recent graduates "find a job or internship in Indiana through a unique combination of one-on-one guidance and an easy-to-use website – at no cost."[38] The services provided are proactive, with Ascend working with career services at schools and colleges to promote the service, provide candidates with guidance on resume building, and Ascend assigning professionals to help the candidates refine their interview skills and identify the careers and open positions that are a fit for their education, skills and interests. The candidate's profile is hosted on the Ascend Network website and personalized job or internship recommendations are provided.

For employer partners, the Ascend Network provides a well-curated online resource of job-candidates, with information provided in a standardized and searchable format for their review. Employers are able to see a pool of qualified, interested candidates for the positions they have open. Ascend also offers strategic consulting through Ascend Services, which is designed to identify, evaluate, and secure education partners to help employers build their talent pipeline when supply is unable to meet demand or projected future talent shortfalls are anticipated.

The services provided by Ascend have proven to be highly valued by both talent and employers across the healthcare and life sciences spectrum. Ascend has supported a broad range of biomedical industry partners (including, for example, leading companies such as Lilly, Roche, Catalent, and Cook, through to smaller start-up and midsize life sciences ventures) and also helped create focused programs with regional hospitals and health systems. Overall, 60 life sciences and healthcare employer partners utilize the Network. Roche Diagnostics, alone, has brought onboard 58 employees and interns through the network. Leading colleges and universities in Central Indiana, and statewide that have higher education programs in healthcare and life sciences, are likewise partners with Ascend – including both public and private education institutions. These range from community colleges (e.g., Ivy Tech) through to the high-level graduate and professional programs of Indiana's world-class research universities and medical colleges.

One example of Ascend Services' work to address talent shortfalls in healthcare is a custom program developed with Community Health Network (a large, non-profit health system with more than 200 sites of care and affiliates throughout Central Indiana). Ascend Services has been working with Community Health Network to resolve the challenge of shortfalls in the supply of registered nurses (RNs), developing a Nursing Academy as a scalable education model operated in collaboration with the University of Indianapolis. The resulting program is providing scholarship funds, work-based experiences, and an innovative inter-professional approach to improve awareness of, and connectivity to nursing careers, and build a pipeline of students entering undergraduate and graduate level nursing programs of study. To-date, 125 students have been accepted into the program, and the Nursing Academy is currently accepting applicants for its sixth cohort of students. Ascend Services reports that Nursing Academy graduates have a first year retention rate in the profession of 90%, significantly outpacing the national average.

37 https://ascendindiana.com/about/partners
38 https://ascendindiana.com/talent

CAPITAL INVESTMENT IN HEALTHCARE AND LIFE SCIENCES IN CENTRAL INDIANA

The development, production, and use of products that are used on humans to impact their health is highly regulated. The U.S. Food and Drug Administration (FDA) has strict regulations that govern the steps required in the performance of clinical research that is required to prove efficacy and safety in biomedical products. Progressing through these steps to move a biomedical product (especially, but not only, a drug) from discovery to market is typically a long and very expensive process. Many in-development products fail to meet performance or acceptable safety parameters during pre-clinical and clinical research phases, meaning that the expenditures accumulated up to the point of failure can comprise a significant cost of doing business. In addition, human biology is complex, and it is no small task to build the research infrastructure required to innovate and pilot new biopharmaceutical molecules and biomedical products. For all these reasons, and more, biomedical products are among the most capital-consuming products to bring to market. A 2020 study by Wouters, McKee, and Luyten, published in the Journal of the American Medical Association (JAMA), confirms the high cost of R&D investment alone required to bring a new medicine to market – finding that the median cost for doing so is $985 million and the average cost is $1.3 billion.[39] As these data indicate, whether a firm is a large multi-national biopharmaceutical company or a new biotech venture pursuing development of a novel product, very large amounts of capital need to be accessible to perform research, progress product development, and advance a potential product through the clinical trials process. Thus, for a healthcare and life sciences business ecosystem to flourish, it must have ready access to significant capital resources.

The capital for biomedical ventures derives from multiple sources, but the leading categories include:

- Federal SBIR/STTR funds
- Pre-seed funding (from multiple sources such as angel investors, dedicated university funds, friends and family, state pre-seed funds, etc.)
- Venture capital and private equity funding
- Initial public offerings and public capital markets
- Mergers and acquisitions
- Reinvestment of revenues by established companies

A recent study by BioCrossroads examined capital investment In Indiana's life sciences sector.[40] The study looks broader than just biomedical life sciences products (including investment in the full life sciences categories incorporated in the BIO/TEConomy national study definition which also includes agricultural and industrial biotech products, for example), but the findings are very much relevant to assessing access to capital within the Indiana healthcare and life sciences ecosystem. The BioCrossroads/IBRC study finds that:

> *For 2020, Indiana's life sciences companies accessed over $9.0 billion in capital to grow and support innovation from the following sources:*
>
> - *$12.6 million SBIR awarded to 21 companies (26 total awards)*
> - *$262 million in Venture Capital invested in 44 companies*
> - *$141.8 million accessed through public markets by three companies*
> - *$8.6 billion+ spent to acquire innovation representing nine transactions*

The study further found that "Indiana had 44 life sciences companies raise $262 million in 2020 through VC. Investments ranged from a low of $20,000 to a high of nearly $61 million"[41] and reports that "Indiana's strong life sciences sector is anchored by a

39 Olivier J. Wouters, Martin McKee, and Jeroen Luyten. 2020. "Estimated Research and Development Investment Needed to Bring a New Medicine to Market, 2009-2018." *JAMA.* 2020 Mar 3; 323(9): 844–853.

40 BioCrossroads. "*INDIANA LIFE SCIENCES CAPITAL: A summary of 2020 investments.*" Accessed online at: https://biocrossroads.com/wp-content/uploads/2021/04/BioCrossroads-Capital-Report-2020.pdf

41 Ibid.

significant base of public companies" with analysis of Pitchbook finding "12 life sciences public companies representing $297.6 billion in market cap as of December 31, 2020."[42]

As these data illustrate, Indiana's life sciences sector is able to attract funding across the full-continuum of capital. That does not mean, however, that attracting risk capital to novel biomedical product company development is easy – it almost never is – but it does mean that the ecosystem in Central Indiana is in place to support access to specialized capital that funds healthcare and life sciences product ventures.

MAJOR CAPITAL PROJECTS: INVESTMENTS IN FACILITIES AND INFRASTRUCTURE

Maintaining and operating a world class healthcare and life sciences ecosystem requires building, maintaining, expanding, and upgrading a large base of physical infrastructure and capital equipment. In reviewing major investments made in recent years within Central Indiana it is readily evident that industry, healthcare systems, and universities have been making a significant commitment to enhancing and expanding operations. Recent major projects constructed since 2019, or underway and planned for completion by the close of 2023 (a five-year period) are shown on Table 7. They comprise almost three million square feet of construction with a total investment of just under $2.3 billion (for an average of $455 million per year for the five-year period assessed).

Table 7: Examples of Recent Major Capital Investment Projects in the Healthcare and Life Sciences Ecosystem (and Supportive Fields) in Central Indiana

Organization/Project	Size	$ Investment	Completion Year
Community Hospital East – new hospital construction	500,000 sq. ft.	$175 million	2020
IU Health, Riley Hospital for Children – new Maternity and Newborn Health Department facilities	53,000 sq. ft.	$142 million	2021
Franciscan Health – Orthopedic Center of Excellence	255,000 sq. ft.	$130 million	2022
Butler University – Science Buildings	57,000 sq. ft.	$100 million	2023
IU Health, West Hospital expansion		$83 million	2021
IU Health, North Hospital – Joe and Shelly Schwarz Cancer Center	88,000 sq. ft.	$55 million	2020
IU Health, Bloomington Regional Academic Health Center	720,000 sq. ft.	$389 million	2021
16 Tech, Phase I – Advanced Research and Innovation Building 1	120,000 sq. ft.	$30 million	2020
IUPUI – Innovation Hall	100,000 sq. ft.	$44 million	2020
Elanco Animal Health	45 acre campus	$300 million	Starting 2021
Catalent Biologics— new developments at two sites	15,000 sq. ft. and 79,000 sq. ft.	$150 million	2021
Abbott Cardiovascular – Westfield manufacturing center	120,000 sq. ft.	$37 million	2021

42 Ibid.

Organization/Project	Size	$ Investment	Completion Year
INCOG Biopharma – Global HQ development in Fishers	60,000 sq. ft.	$60 million	2023
LifeNet Health – Plainfield biologics logistics and distribution center	70,000 sq. ft.	$18 million	2019
POINT Biopharma – Indianapolis manufacturing facility	77,000 sq. ft.	$25 million	2021
Eli Lilly and Company – Indianapolis campus expansion and redevelopment (multiple projects)	130,000 sq. ft. lab/research building + 352,000 sq. ft. Building 358 + 16,300 sq. ft. manufacturing building addition	$400 million[43]	2022
Novartis – Purdue Research Park manufacturing facility	60,000 sq. ft.	$70 million	2023
Cook Medical – Indianapolis assembly plant	40,000 sq. ft.	$7 million	2021
Baxter BioPharma Solutions – expansion of sterile fill/finish facilities	>25,000 sq. ft.	$50 million	2022
TOTALS FOR ABOVE PROJECT EXAMPLES	**2,937,300 sq. ft.[44]**	**$2,265 million**	

Source: TEConomy Partners analysis of data developed and provided by BioCrossroads and additional web research.

Evident in Table 7 are investments being made across all three key components of the ecosystem – in terms of industry, healthcare, and academic life sciences investments. Table 8 summarizes the totals for these three macro categories:

Table 8: Classification of Major Infrastructure and Facilities Investments (2019-2023)

Sector	Square Feet	$ Investment
Healthcare	1,616,000	$974 million
Academic or Institutional	277,000	$174 million
Industrial	1,044,300	$1,117 million

Source: TEConomy Partners analysis of data developed and provided by BioCrossroads and additional web research.

The above situational assessment of the healthcare and life sciences assets in Central Indiana readily demonstrates that the region has developed a highly robust institutional and industry ecosystem. The region has operations across the complete value chain, from basic and translational R&D through to the distribution and application of products in the healthcare marketplace. It supports these operations with programs designed to assure a good flow of well-educated and qualified talent, together with capital flows to sustain growth and business expansion. As a fast moving and expanding sector, positioned to add more than 27,000 jobs over the next decade, it is important that all stakeholders (public and private) pay attention to ecosystem conditions and assure that key assets are maintained and reinforced across the ecosystem to sustain growth and help sector organizations respond to forces of change and the opportunities they present.

43 Note: Eli Lilly reports having invested $4.5 billion in Indianapolis campus facilities since 2012.
44 Note: excludes Elanco (not able to identify total square footage anticipated, and IU Health West).

V. Collaborating to Combat COVID-19 – The Ecosystem in Action

The COVID-19 pandemic has shone a spotlight on the importance of healthcare systems and the innovative life sciences companies that support the delivery of healthcare. The novel virus, SARS-CoV-2, and the disease associated with it (COVID-19), has dramatically illustrated the importance of having:

- Public health systems able to respond to fast moving needs and challenges;
- A healthcare system able to respond to the challenges associated with a fast-spreading, highly contagious disease—equipped with surge capacity and supplies for protecting healthcare personnel and delivering needed care for patients;
- Diagnostics availability and testing capacity;
- Biomedical life sciences capabilities for rapid R&D, innovation, and commercialization of specialized diagnostics, therapeutics, and vaccines to address a novel infectious disease;
- Flexible manufacturing networks able to pivot to the production of high demand medical equipment and supplies;
- Adaptability and responsiveness in regulatory agencies that influence the delivery of healthcare and healthcare products; and,
- Coordinated communications between public health agencies, healthcare providers, industry, and the public regarding actions and pandemic response.

The experience with the pandemic shows that there has been great variability in terms of capacity to respond and the quality of response execution across various geographies.

INDIANA'S EXPERIENCE

In Indiana, the first confirmed case of COVID-19 was announced on March 6, 2020, and the Governor issued a public health emergency declaration that day. On March 16, the Governor ordered bars, restaurants, and nightclubs to close to in-house customers. The first stay-at-home order from the state came on March 23. Despite those actions, the pandemic continued to claim lives across the state. As of May 12, 2021, the State of Indiana reported 732,692 confirmed cases of COVID-19 and 13,033 lives lost to the disease.[45]

State government, of course, is not the only entity that needed to respond to the pandemic. Indiana's hospitals and healthcare systems had to adjust and adapt. Employers had to make challenging decisions regarding whether to temporarily close operations, move personnel to virtual working environments, put in place social distancing procedures and adapt work schedules

45 https://www.coronavirus.in.gov/2393.htm Accessed 5/13/2021.

and shifts, etc. From K-12 students through to Indiana's senior citizens, all have been impacted in some form by the changes to daily life imposed by the pandemic.

CENTRAL INDIANA RISES TO THE CHALLENGE

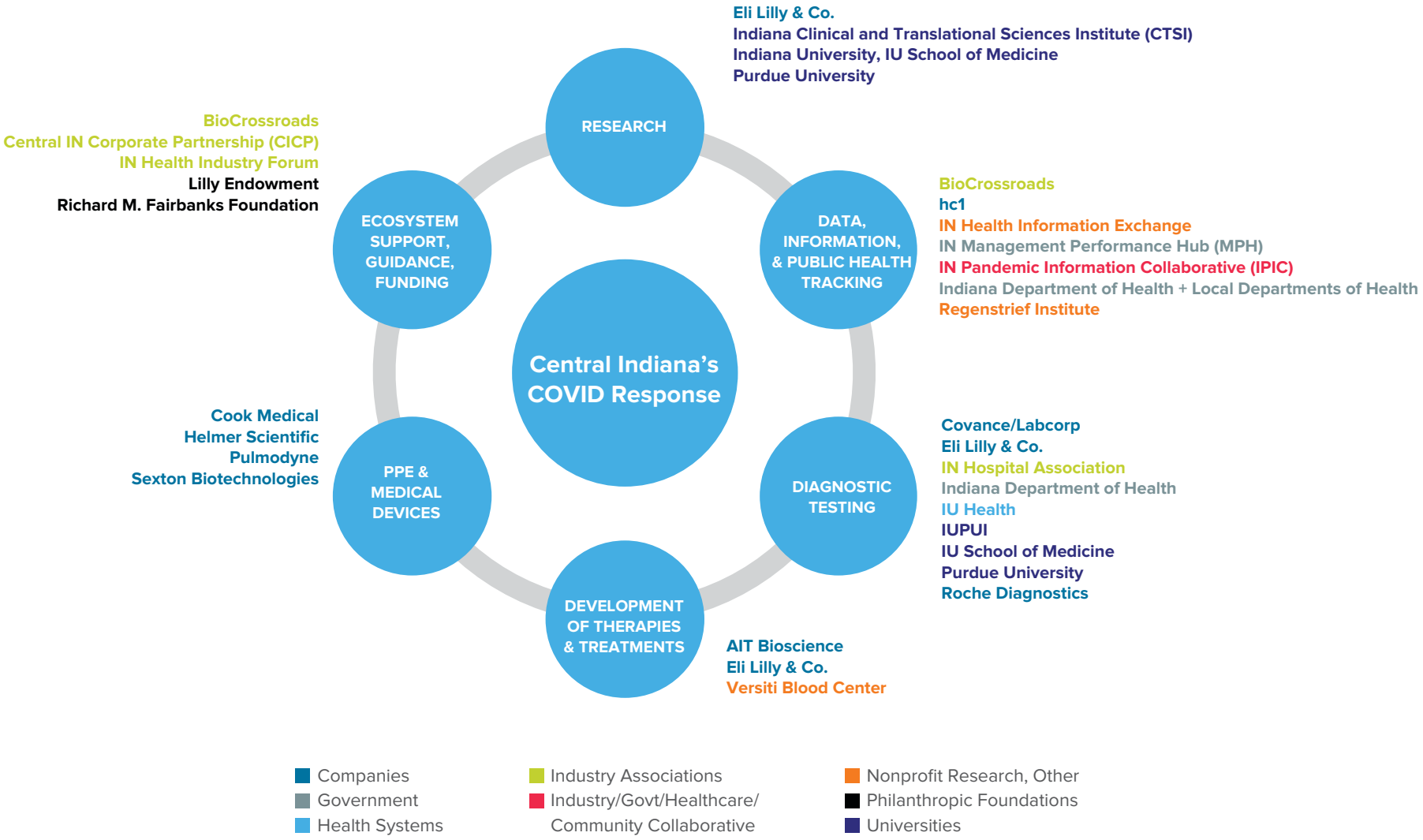
What is particularly impressive in Central Indiana is how key regional stakeholders across the public sector, industry, healthcare, and academe came together to collaborate to address the crisis. In the face of a relatively uncoordinated and limited federal response, individual states and regions had to innovate and stand-up their own pandemic response. The story of how Central Indiana rose to that challenge is important to document and communicate.

As we have seen, Central Indiana benefits from having a particularly complete and robust healthcare and life sciences ecosystem. The ecosystem is complex, and has a lot of parts and moving pieces, but it benefits from having in-place an overarching collaborative organization under CICP and BioCrossroads that is a meeting ground for all concerned with the successful development and operation of the ecosystem. Because this "connective tissue" already existed, the region was able to be quick on its feet in reacting to the emerging pandemic. What emerged was a series of weekly video-conference meetings – with participants from state government, local government, universities, hospital systems, and leading private sector businesses – meetings that led to a coordinated approach that would leverage the ecosystem to address the crisis. Figure 10 shows some of the key categories of assets that were drawn-upon in developing a coordinated response to COVID-19 in Central Indiana, and the individual organizations that stepped forward to participate in work to:

- Research the virus and biomedical approaches to diagnosing cases, combatting its transmission, and treating infections.
- Conduct data analytics, information science, and public health tracking to monitor the spread of the virus and direct resources to hotspots and points of vulnerability.
- Develop and procure diagnostic tests and provide population testing services.
- Develop novel therapeutics to combat infection, treat life-threatening symptoms, and support patient recovery.
- Rapidly improve supply and access to personal protective equipment (PPE) and important therapeutic medical equipment, such as respirators.
- Maintain business operations and protect critical workers throughout the pandemic to mitigate negative economic and social impacts.

The breadth of the healthcare and life sciences ecosystem and coordinated response to the pandemic in Indiana is illustrated by the varied actors and pandemic response categories in Figure 10 that span the corporate sector, government, academe, industry associations, non-profit research institutions, and philanthropy.

Figure 10: The Mobilization of Healthcare and Life Sciences Assets in Central Indiana to Mitigate the Negative Consequences of the COVID-19 Pandemic



Source: BioCrossroads and TEConomy Partners, LLC.

The following highlights just some of the significant contributions of individual organizations throughout Central Indiana mobilizing to respond to the pandemic.

DIAGNOSTIC TESTING

As one of the world's leading companies pioneering, developing, and producing medical diagnostic tests and supplies, **Roche Diagnostics** has been a critically important contributor to the fight against COVID-19 globally, and regionally. The pandemic required that Roche respond operationally to assure continued supply of its many products that are of central importance to healthcare nationally. The firm responded to supply chain challenges by expanding shifts in its manufacturing facilities (adding evening and weekend shifts) and added lines to its manufacturing facilities. As a result of the demand for diagnostics during the pandemic, Roche added over 1,000 jobs in the U.S.

For Indiana, Roche Diagnostics stepped forward to be an integral component of meeting the COVID challenge. A key was Roche's participation as a core member of the Indiana Public Health Testing network, which engaged Roche together with IU Health, Parkview Health, and Mid America Clinical Laboratories, in partnership with the Indiana Department of Health to create a COVID-19 testing network. Roche supplied critical PCR test capabilities for the network.

As with other leading healthcare and life sciences stakeholders in Central Indiana, **IU Health** played several critically important roles in helping Indiana respond effectively to the crisis. IU Health became a major provider of surged COVID-19 testing capacity for Indiana and rolled-out testing clinics across the state.

Internally, IU Health made a key decision to sustain all their personnel, even though the vast majority of elective clinical procedures were curtailed due to the pandemic threat. Instead of laying-off personnel, IU Health created a "resource command pool," and worked to allocate staff to jobs on the frontlines that fell within the limits of individual personnel licensure. As frontline staff became more and more pressured in the fight against the coronavirus, IU Health set-up daycare centers to care for staff's children, and even entered into agreements with local hotels and school dormitories to accommodate self-isolating physicians and other frontline workers who may have been exposed to COVID-positive patients.

DEVELOPMENT OF THERAPIES & TREATMENTS

Central Indiana life sciences companies have been engaged in the development of therapies and treatments for COVID-19, most notably and extensively **Eli Lilly and Company** (see box).

AIT Bioscience, a Nexilis company headquartered in Indianapolis, operates as a bioanalytical contract research lab with a state-of-the-art "smart" electronic lab providing numerous assessment services and capabilities for both large and small molecule therapeutics in pre-clinical and clinical trials. In 2020, AIT partnered with Karyopharm Therapeutics to provide bioanalytical analysis of Karyopharm's existing protein inhibitor, Selinexor, in clinical trial samples to explore its effectiveness in treating patients with severe COVID-19.

Early in the pandemic, **Versiti Blood Center of Indiana** in Indianapolis, began collecting plasma from recovered COVID-19 patients for potentially life-saving antibody treatments. The non-profit blood bank established a hotline to register donors and provided the plasma to its hospital partners in Indiana to treat the most severe cases.

CASE STUDY:

Eli Lilly Contributions to the Global and Regional Challenges of COVID-19

Perhaps not surprisingly, the life sciences expertise and infrastructure sustained by Lilly in Central Indiana proved critically important to enabling the region and the state to combat the COVID-19 pandemic. The company has been highly proactive in working regionally to provide expertise, equipment, and resources to address the pandemic – working in close cooperation with regional stakeholders, state government, and BioCrossroads.

Lilly Surges Testing

The high demand for testing exceeded the capacity of the state's public health labs and required other in-state stakeholders to pivot any resources they had that could help. Eli Lilly, as one of the world's leading drug companies, had a deep bench of expertise and scientific infrastructure that it philanthropically positioned to help. Lilly's PCR equipment was swung into action as a diagnostics platform, to such an extent that Lilly effectively became the state's largest reference lab, performing 6,000 tests a day on behalf of the state.

Analysis showed that with a 6.7 million person state population, Indiana was going to have to find a way to surge testing capacity. Epidemiologists calculated that 30,000 tests per day were going to be needed across Indiana (when, at that point, capacity stood at just 3,000 per day). However, by bringing in the resources of Lilly and other stakeholders with lab resources (e.g., IU, IU Health, Purdue University) by November 2020 Indiana was covering 40,000 tests per day. Lilly was in the thick of this response, providing scientific talent to help across the state, and transporting and operating diagnostic lab equipment on-site where needed.

Lilly Innovates COVID-19 Therapeutics

While Lilly's science and testing infrastructure was being pivoted to address COVID-19 testing demand in the state, the company's R&D teams drove forward research to develop therapeutics to treat infected patients. As a viral disease, antibiotics would not be effective, and physicians treating the expanding base of infections had extremely limited options for treating the disease and preventing it advancing from a moderate case to one requiring hospitalization. Lilly's expertise in R&D with monoclonal antibodies suggested that development of neutralizing antibodies may be an effective treatment approach. Working in collaboration with AbCellera, a Canadian biotechnology firm specializing in human antibodies, and the NIAID, by June 2020, Eli Lilly was able to launch the world's first research trials into the use of an antibody treatment against COVID-19. The antibody treatment LY-CoV555 (bamlanivimab) achieved positive results in non-human primate model testing, enabling rapid progression into human studies. The Lilly "Blocking Viral Attachment and Cell Entry with SARS-CoV-2 Neutralizing Antibodies" (BLAZE-1) trial was launched, with a focus on the use of bamlanivimab as a treatment for mild-to-moderate COVID-19 in adults (and certain pediatric patients), with a particular focus on persons with positive results of direct SARS-CoV-2 viral testing with at-risk conditions for progression to more serve forms of the disease that may require hospitalization. The BLAZE trials progressed, with Lilly collecting safety and efficacy data in more than 4,000 participants treated with the neutralizing antibodies, either bamlanivimab alone or bamlanivimab and a co-developed monoclonal antibody (etesevimab) together.

In conducting the BLAZE trials, Lilly had to also be innovative in bringing the trials to the participant (instead of the normal process of trial participants traveling to a trial site, which obviously was not an ideal process in a pandemic). Particularly focusing on at-risk nursing home residents, Lilly took the innovative approach of purchasing existing recreational vehicles (RVs) from an Indiana manufacturer (and then contracted for a more optimal custom design with Forest River in Indiana) so that they could take their trials to trial participants – typically the residents and workers in elder care facilities and nursing homes. Taking this approach, Lilly was able to deploy 18 mobile clinical trial units and build trial relationships with nursing homes and other sites that had not been engaged in previous clinical trial programs.

The combination of expertise at Lilly in drug R&D, in trials management, and in biopharmaceutical manufacturing and distribution (together with expedited regulatory procedures at the FDA), meant that the company was able to accelerate from concept to first FDA Emergency Use Authorization (EUA) in just 10 months on Lilly's recombinant therapeutic products – an extraordinarily fast pace given that biopharmaceuticals often take up to a decade to move from idea to clinical use approvals.

By January 2021, Lilly was able to report that "new data show treatment with Lilly's neutralizing antibodies bamlanivimab (LY-CoV555) and etesevimab (LY-CoV016) together reduced risk of COVID-19 hospitalizations and death by 70%" (January 26, 2021). In an interview with Lilly, TEConomy was informed that more than 400,000 patients have now been treated with the Lilly antibody treatments.

Lilly as a Site for Vaccinations

Lilly's expertise in health sciences procedures also meant that the firm was able to become an important site for administering vaccinations. Twelve of the largest employers in Central Indiana, for example (Toyota, Cummins, Cook, etc.) were able to have their workers who wanted the vaccine, inoculated at Lilly.

MANUFACTURING AND DISTRIBUTING PERSONAL PROTECTIVE EQUIPMENT (PPE), MEDICAL DEVICES AND EQUIPMENT

Pulmodyne, on Indianapolis' west side, manufactures airway and respiratory devices including masks used with ventilators. Early in the pandemic, the company saw a huge spike in sales as COVID began to spread across the globe. Its devices are designed to avoid intubation and were seen as critical in treating patients with severe cases. Pulmodyne expanded its operations and rapidly ramped up hiring to meet the intense demand, doubling its output in a month.

Helmer Scientific, headquartered in Noblesville, designs and manufactures medical and lab equipment for clinical organizations and life sciences companies with a focus in medical-grade, temperature-controlled storage products for pharmacies, blood banks, labs, and research institutions. Helmer is working closely with government partners and others to ensure "priority access" to its cold storage and processing equipment for COVID-19 related sample storage and processing as well as medication and vaccine storage.

DATA, INFORMATION, AND PUBLIC HEALTH TRACKING

Regenstrief Institute, founded in 1969 in Indianapolis, has long supported healthcare innovation and scientific inquiry both in Indiana and globally and has been recognized for innovations in global health information technology standards enabling the use and interoperability of electronic health records. The Institute has stepped in to play key roles in tracking the pandemic in Indiana, including establishing the Regenstrief COVID-19 Dashboard, an extremely detailed tracking of COVID cases, hospitalizations, emergency department visits, ICU admissions, and lab testing on a statewide and county-by-county basis, aiming to provide "the most complete picture of the COVID-19 pandemic in our state."[46] The Dashboard leverages the expertise of Regenstrief and unique capabilities it and others have established in Indiana as home to the nation's largest "inter-organizational clinical data repository." Further, the Institute contributed to the global fight against COVID early in the pandemic by partnering with SNOMED International, also a global health standards organization, to code and track COVID-19 cases through structured clinical information.

> "Indiana is home to the nation's largest inter-organizational clinical data repository. The public and private sector data presented [in the Dashboard] — on emergency department visits, inpatient admissions and laboratory testing — aims to provide the most complete picture of the COVID-19 pandemic in our state."
>
> **-Regenstrief COVID-19 Dashboard https://www.regenstrief.org/covid-dashboard/**

The Indiana Health Information Exchange (IHIE) has been coordinating with Regenstrief, the Indiana Department of Health (IDOH), and healthcare providers in Indiana to mitigate the pandemic's effects in the state and to meet its mission of improving healthcare through electronic information exchange. The well-established work of IHIE to test, code, and process healthcare data has paved the way for the IDOH's real-time updates of COVID-19 test results communicated to the public. IHIE has defined new tracking codes and alerts through its Notifiable Condition Detector tool, sending daily alerts to IDOH and public health departments.

A consortium of Indiana-based public and private organizations have come together as the **Indiana Pandemic Information Collaborative (IPIC)** to "ensure that relevant data, information and knowledge-related activities focused on beating the COVID-19 pandemic, particularly as it affects Indiana residents, are shared and coordinated across our state."[47] IPIC set out to leverage the complementary expertise across varied organizations, coordinate and avoid duplication across similar activities, enhance communication, enable decision-making, inform best practices, and to improve health through "optimal use of information." IPIC has taken on a series of initiatives spanning data modeling, data visualization (including dashboards), and data interchange.

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46 Regenstrief COVID-19 Dashboard, see: https://www.regenstrief.org/covid-dashboard/.
47 Indiana Pandemic Information Collaborative, see: https://www.pandemiccollaborative.org/about.html.

The Collaborative includes leading organizations and institutions spanning state government, health systems, academic organizations, life sciences industry, health data organizations, and community-facing organizations.

RESEARCH

In addition to private sector R&D related to COVID-19, Central Indiana's research universities have actively advanced research to detect, manage, and treat the disease, as well as to inform and gauge the broader impacts and ripple effects of a global pandemic on society.

Faculty at **Indiana University and the IU School of Medicine** have led or co-led research into numerous areas related to COVID-19, including :[48]

- Researching the persistent symptoms reported by COVID patients known as "long-haulers."
- Pursuing a COVID-19 vaccine for young children based on well-established vaccine technologies for the common childhood rotavirus illness.
- Exploring links between gut microbes and viral infections, including COVID.
- Studying vaccine hesitancy among parents regarding vaccinating their children.
- Alleviating loneliness associated with remote work during the pandemic.

Likewise, individual faculty researchers as well as collaborative research centers and institutes at **Purdue University** are contributing to better understanding COVID-19 and its impacts, particularly related to areas of deep expertise for the University, including[49]:

- Leveraging and rapidly pivoting capabilities through its College of Veterinary Medicine's Indiana Animal Disease Diagnostic Laboratory for increasing Indiana's COVID-19 testing capacity.
- Contributing to research and informing the public regarding the nation's food supply and related production and distribution chains amidst the pandemic from forward-looking strategic resiliency with respect to farming, agriculture, and the food supply.
- Leveraging research strengths in data sciences and related tools to monitor and understand the impacts of human mobility, and the effectiveness of sheltering in place and lockdowns on virus transmission.
- Understanding impacts of COVID-19 on the travel industry and related sustainability impacts.
- Examining water quality after extended periods of pandemic-induced shutdowns, for example in school buildings.
- Assessing the disproportionate impacts on female faculty and caretakers due to COVID-19.

ECOSYSTEM SUPPORT, GUIDANCE, AND FUNDING

Effectively mobilizing the healthcare and life sciences ecosystem and a broader set of community organizations and leaders in Indiana would not have happened without the leadership and connective tissue represented by **CICP and its affiliated cluster organizations**. In response to the pandemic, CICP quickly mobilized and began facilitating biweekly teleconferences for its board members in early March. These discussions served as a platform for public and private sector state leaders to coordinate efforts, receive updates, and stay informed. Outcomes and activities generated by these forums included: rapid scale-up of COVID-19 testing capacities and locations throughout the state, retooling manufacturing capabilities to produce PPE for frontline healthcare professionals, developing "return-to-work playbooks" for the manufacturing, logistics and warehousing, office, and customer-facing settings, and coordinating letters of support for Governor Holcomb and Indianapolis Mayor Hogsett for mandating masks in public.[50]

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48 For a summary of COVID-related research conducted by IU and the IUSOM, see: https://research.impact.iu.edu/our-strengths/coronavirus/index.html.
49 For a summary of COVID-related research conducted by Purdue University, see: https://www.purdue.edu/discoverypark/environment/for-researchers/covid-19.php.
50 Central Indiana Corporate Partnership (CICP) 2020 Annual Report.

CICP and BioCrossroads were able to leverage world-class talent in Indiana contained within the corporate, healthcare, academic, and public health communities to coordinate approaches to challenges as they arose in the pandemic. An early example of the effectiveness of this collaborative approach was to identify where in the state there were resources in terms of PCR[51] and other pieces of key scientific equipment that could be pivoted to applications in enabling diagnostic testing capacity to scale. Many of the techniques used are ubiquitous across biosciences (i.e., not only used in human biomedical applications, but also for basic biological science, veterinary medicine, agricultural research, etc.) – as such, equipment, and the skilled personnel to operate the equipment existed in many locations in Indiana that were not part of the usual human diagnostics lab ecosystem. By identifying these resources and coordinating their coming-together in a collaborative consortium of sites, Indiana was able to significantly surge its capacity to conduct testing for COVID-19.

Taken together, Central Indiana's response to the COVID-19 pandemic was especially impressive—well coordinated, collaborative, and effective at mitigating the effects of the pandemic. Such a rapid and effective mobilization is representative of the robust ecosystem that has been built in the region and would not have been possible without the significant, long-term investments made over many years, if not decades. The public-private coordination in a high-functioning healthcare and life sciences ecosystem enabled Indiana to protect and inform its citizens throughout the pandemic.

"Collectively and collaboratively, Indiana's life sciences community rose to the challenges of COVID-19 in numerous ways, and their commitment and dedication to working faster, harder and smarter – together - has helped people in Indiana and all around the globe."

-Patricia Martin, President and CEO, BioCrossroads

Inside Indiana Business, "Indiana's Life Sciences Industry Rises to the Challenge."

51 PCR is the abbreviation for polymerase chain reaction and represents a fast technique for amplification (copying) of small segments of DNA. This amplification produces samples of DNA large enough for analysis in laboratory diagnostic processes.

VI. Conclusions and Recommendations

This study readily demonstrates that healthcare and life sciences represent a powerful economic engine for Central Indiana; moreover, they also play a central role in providing economic and social resilience for the region on an ongoing basis and during public health emergencies. Central Indiana benefits greatly from the long-term investments that have been made by the private and public sectors in creating a complete healthcare and life sciences ecosystem – an ecosystem that spans a complete range of activity from basic and translational research, through each step in the value-added development and production of products, technologies, and services onwards into distribution and their use in the marketplace. The operations of this value-chain in Central Indiana are well supported by talent development programs and higher education programs that supply the well-educated and skilled talent needed to fill demands across the sector. Similarly, the region is attracting the capital resources needed to develop, scale, and grow healthcare and life sciences enterprise.

The sector is expected to continue to grow, with projections noted herein for 27,000 jobs to be added in the forthcoming decade based on observable trends. This growth, however, could be higher still, depending on how the ecosystem responds to forces of change and the opportunities presented for growth in healthcare products and services rooted in new technologies in genomics, gene editing, regenerative medicine, synthetic biology, advanced health data analytics, personalized medicine, and other emerging fields of opportunity. Ongoing investment will be needed, and attention paid to sustaining and optimizing ecosystem conditions to continue to allow the sector to thrive.

Information presented within the report leads to the following key conclusions:

- Healthcare and life sciences represent a core advanced industry for Central Indiana's economy.
  - The sector directly employs 164,144 in the region and supports a further 167,419 regional jobs through its indirect and induced expenditure impacts.
  - The direct jobs supported demonstrate high average compensation levels (wages and benefits) per job of $99,524.

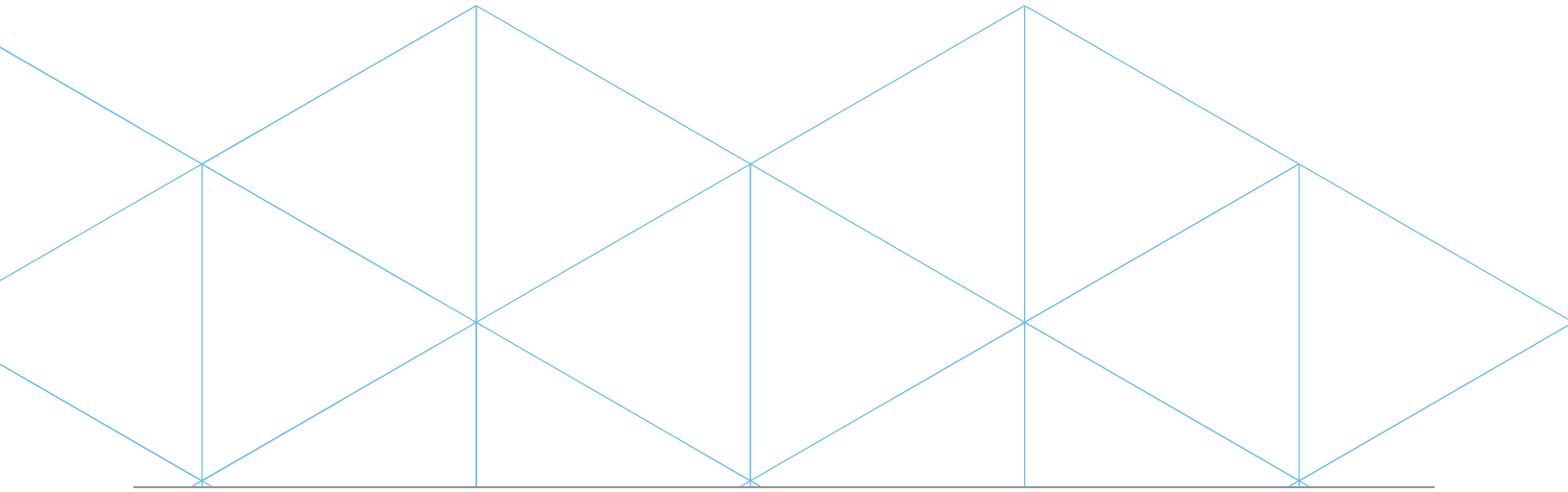
- These impacts are generated by a sector that is particularly well-rounded and diverse in Central Indiana. There are significant strengths in the three central components of clinical healthcare, life sciences education, and biomedical industry activity. Furthermore, in terms of the life sciences industry in the region, Central Indiana is one of only a handful of regions across the U.S. with a powerful presence in the large product categories of biopharmaceuticals, diagnostics, and medical devices. This diversity helps to promote resiliency in the sector and opens up multiple pathways to innovation and growth.

- These investments in infrastructure by healthcare and life sciences organizations also benefit Indiana's other major sectors including manufacturing, technology, and retail.

- The sector is providing wide-ranging functional impacts that collectively provide access to high-quality clinical healthcare, an innovation pipeline leading to economic development, opportunities for individual advancement through STEM education and high-quality jobs and sustaining a high regional quality of life.

- The sector has also proven itself to be essential to enabling resiliency during a public health emergency. The response of multiple ecosystem actors to the COVID-19 crisis was well coordinated, collaborative, and creative – bringing regional assets in healthcare and life sciences together with public and private leadership to coordinate an effective regional response to an acute national crisis.

It is clear that past and future Investments in the infrastructure and talent that advance Indiana's life sciences and healthcare capacity represent a fundamental good for Indiana—enhancing the quality of life for Hoosiers, boosting the regional economy, and providing a proactive means of response in the face of public health emergencies.



Appendix

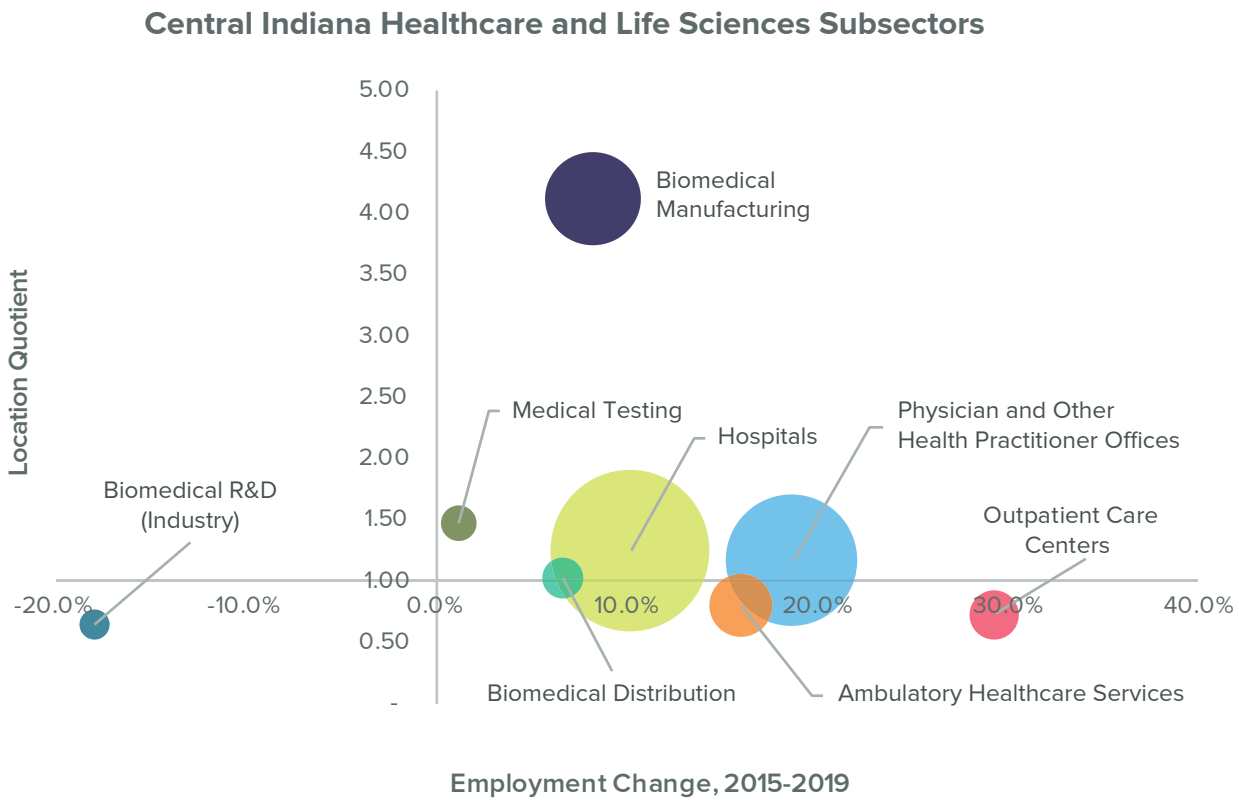
SUPPORTING DATA REGARDING CENTRAL INDIANA'S HEALTHCARE AND LIFE SCIENCES INDUSTRY

Table A-1: Central Indiana's Healthcare and Life Sciences Industry—Regional Metrics, 2019

Healthcare and Life Sciences Subsectors	Establishments	Employment	Location Quotient	Average Wages
Industry	**614**	**28,711**	**1.93**	**$129,595**
Biomedical Manufacturing	103	22,506	4.12	$138,365
Pharmaceutical Mfg.	32	16,380	6.71	$167,057
Medical Instruments, Devices, and Supplies Mfg.	71	6,126	2.03	$61,651
Biomedical Distribution	349	4,036	1.03	$101,445
Biomedical Research & Development (Industry)	162	2,169	0.40	$90,970
Healthcare	**3,596**	**129,793**	**1.13**	**$65,645**
Hospitals Total	104	65,181	1.25	$59,311
Private Hospitals	91	51,415	1.26	$58,547
Public/State/Local Hospitals	11	10,565	1.24	$56,470
Federal Hospitals (e.g., VA)	2	3,200	1.13	$80,967
Physician and Other Health Practitioner Offices	2,802	43,524	1.17	$83,631
Ambulatory Healthcare Services	286	11,820	0.80	$37,227
Outpatient Care Centers	294	5,935	0.72	$58,979
Medical Testing	110	3,333	1.47	$67,298
Academic School of Medicine and Biomedical Research	**N/A**	**5,640**	**N/A**	**N/A**
Central Indiana Biomedical and Healthcare Workforce	**4,211**	**164,144**	**1.22**	**$77,229**

Source: TEConomy Partners estimates and analysis of 2019 U.S. Bureau of Labor Statistics QCEW Data enhanced by IMPLAN.

Figure A-1: Central Indiana's Healthcare and Life Sciences Industry—Employment Size, Concentration (Location Quotient), and Recent Trends, 2019



Note: Figure does not include Academic School of Medicine and Biomedical Research metrics due to data availability.

Source: TEConomy Partners analysis of 2019 U.S. Bureau of Labor Statistics QCEW Data enhanced by IMPLAN.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