Wisconsin Biohealth

Industry Landscape and Economic Impact Report

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Prepared for: BioForward Wisconsin

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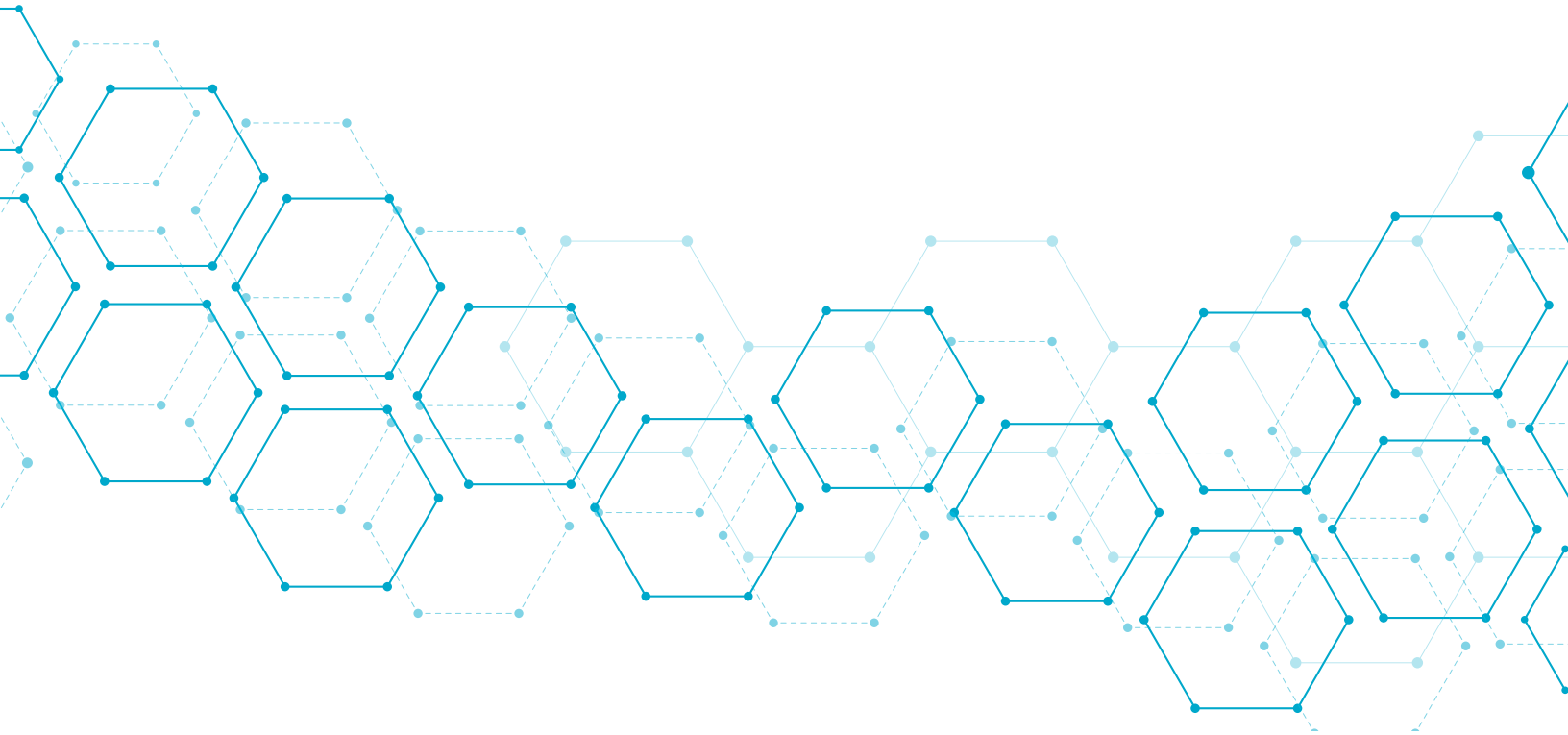


Executive Summary

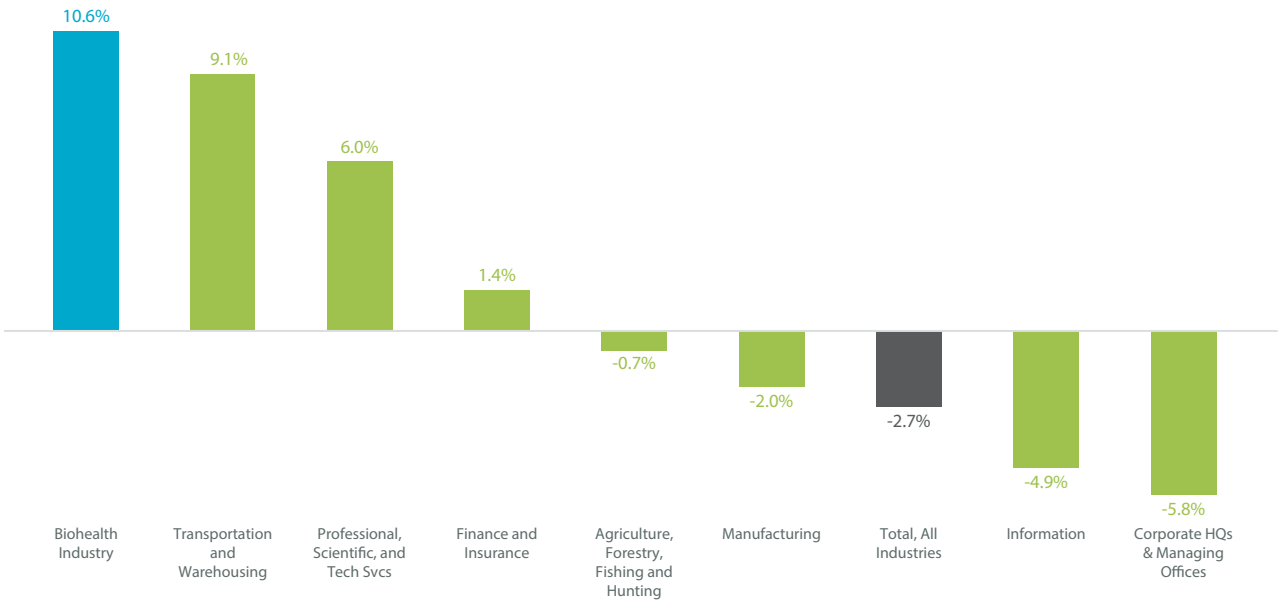
Wisconsin's biohealth industry is leading the state out of the economic challenges of the pandemic years, outpacing other major state industries with strong, double-digit, and high-wage job growth that is generating significant economic impacts throughout the state.

Biohealth is a Growth Leader and High-Quality Job Generator for Wisconsin

- The industry is large and diverse in Wisconsin—with nearly 52,000 employees earning average annual wages approaching $96,000 in 2021, 70% greater than the state's private sector average.
- While Wisconsin's private sector *declined* by 2.7% from 2018 through 2021, the biohealth industry *grew* by 10.6% (Figure ES-1).
- Wisconsin is matching the overall growth rates in the national biohealth industry and has outpaced the nation in two major subsectors seeing rapid expansion—research, testing, and medical labs and drugs and pharmaceuticals. In addition, the state continues to have a highly specialized strength in medical device manufacturing.
- The industry's expansion in Wisconsin is exciting and generally broad-based. Underlying the top-line industry and subsector growth has been a host of both corporate expansions and investments in Wisconsin facilities and capabilities.

This strong growth, high wages, and impressive innovation are just what Wisconsin needs amidst current economic challenges and headwinds.

Figure ES-1: Employment Trends in Wisconsin's Biohealth and Other Major Traded Sectors, 2018-21



Source: TEConomy Partners' analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2022.3).

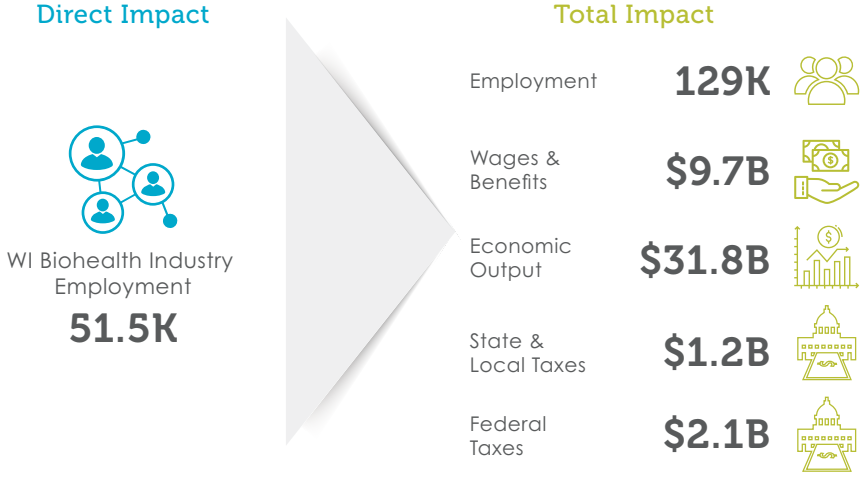
Biohealth's Growth, Innovation, and High Wages Generate $32B in Statewide Impacts

Key findings from the Wisconsin biohealth industry economic impact analysis include:

- In 2021, Wisconsin's biohealth industry is estimated to have generated more than $19 billion in direct economic output and nearly $32 billion in total economic impact (output) from direct, indirect, and induced sources (Figure ES-2).
- The industry's economic activities create major employment impacts—the biohealth industry supports nearly 129,000 jobs throughout the State of Wisconsin.

The industry has an employment "multiplier" of 2.5—meaning every Wisconsin biohealth industry job generates and supports an additional 1.5 state jobs. This is a greater impact than for many major WI industries and on par with the leaders in generating impacts.

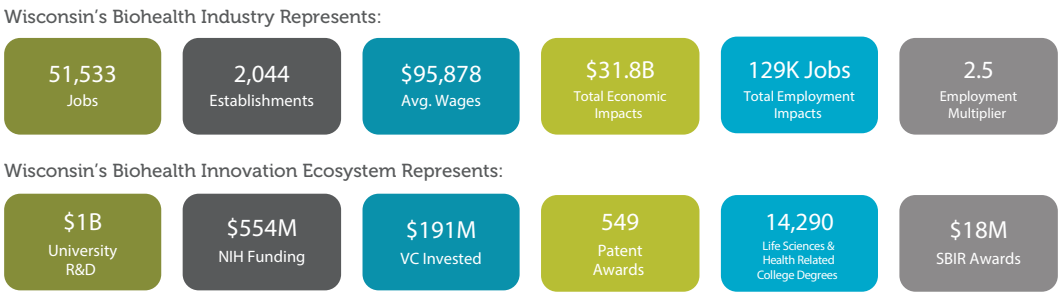
Figure ES-2: Economic Impacts of Wisconsin's Biohealth Industry, 2021



Source: TEConomy Partners' analysis using employment data developed by TEConomy and IMPLAN State of Wisconsin model.

Considering the entirety of the biohealth industry and its ecosystem, Wisconsin is advancing with progress across every measure from 2018 and seeing strong levels of activity (Figure ES-3).

Figure ES-3: Summary Economic Metrics for Wisconsin's Biohealth Industry (Not Including Health Services), 2021



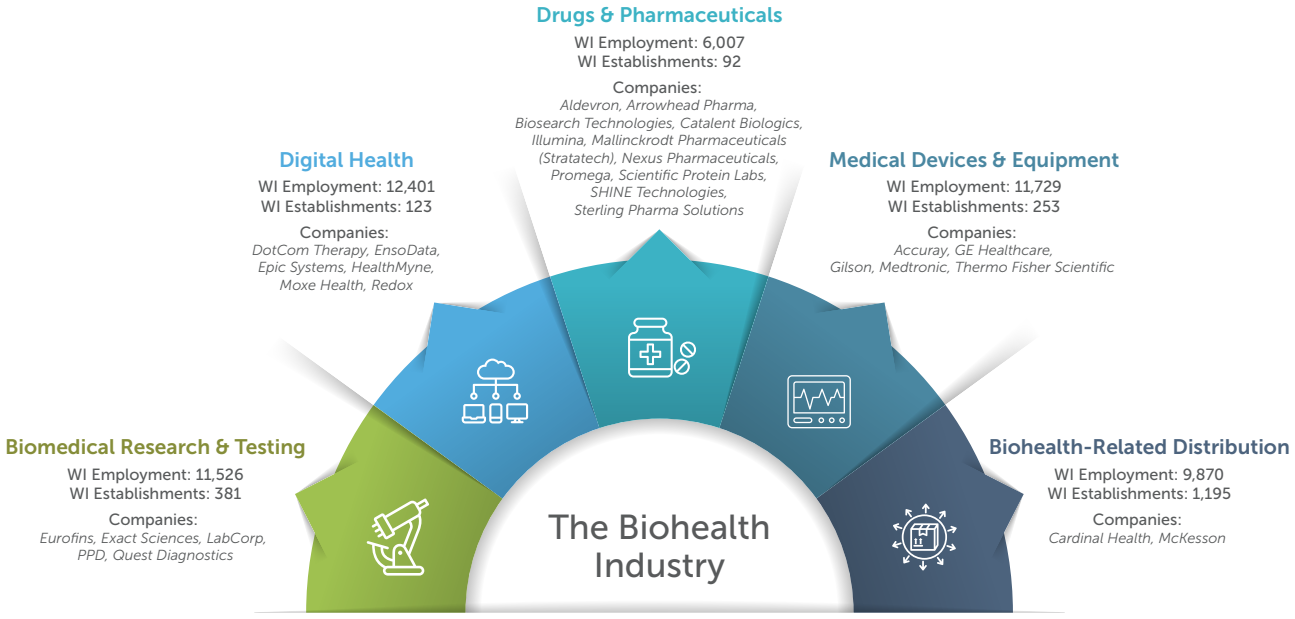
The growth opportunity for Wisconsin in biohealth is immense, particularly in the broader national and federal context of increasing emphasis on bolstering domestic production and supply chains as strategic priorities for critical sectors such as biopharmaceuticals and semiconductors. Wisconsin has both historical and current strengths in medical device, biopharmaceutical, and other manufacturing and this moment represents a genuine opportunity for the state to implement a "Made in Wisconsin" initiative for the biohealth industry.

Section 1: Who makes up the biohealth industry in Wisconsin?

Biohealth is not limited to just private industry manufacturing biohealth-related products, nor is it solely the health services complex of hospitals and outpatient facilities; it is instead a combination of the two that reflects the breadth and continuum of a value chain of activities. The biohealth industry can be segmented into two major components to reflect both the manufacturing, digital, and innovation activities at the center of life science and biohealth innovations and production as well as healthcare services where lifesaving and quality-of-life-improving biomedical advances are deployed for patients.

Combined, Wisconsin's biohealth economy, inclusive of both the biohealth industry and health services segments employed just over 201,000 people in more than 3,000 individual business establishments across the state. Figures 1 and 2 provide an overview of the large employment and establishment footprint across the two major component sectors of the biohealth economy as well as providing examples of who some of the key companies and sectors are within each.

Figure 1: The Biohealth Industry Overview and Example Companies Operating in Wisconsin



Note: The companies listed here are aligned with the federal NAICS industry classifications most closely associated with their primary activities in Wisconsin and assigned to the appropriate biohealth industry subsector. For a listing of detailed NAICS classifications that make up each subsector see the Appendix to this report.

Source: TEConomy Partners' analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2022.3).

Figure 2: The Health Services Industry Overview in Wisconsin

Source: TEConomy Partners' analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2022.3).

Table 1: Wisconsin's Biohealth Economy—Business Establishments and Employment, 2021

Biohealth Economy & Major Subsectors	Establishments 2021	Employment 2021
Total, All Industries*	**188,504**	**2,798,813**
Total Biohealth Economy	**3,063**	**201,027**
Biohealth Industry	**2,044**	**51,533**
Digital Health	123	12,401
Medical Devices and Equipment	253	11,729
Biohealth-related Distribution	1,195	9,870
Biomedical Research & Testing	381	11,526
Drugs & Pharmaceuticals	92	6,007
Healthcare Services	**1,019**	**149,494**

*Total, All Industries includes both private and government establishment and employment.
Source: TEConomy Partners' analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2022.3); TEConomy's identification of digital health firms and estimated employment.

Wisconsin's Biohealth Industry Suppliers

Biohealth is intimately linked to other Wisconsin industries through intra-state purchasing of goods and services that combine to form a highly specialized network of suppliers while securing nearly 34,000 estimated jobs for the state.

Biohealth firms, like their counterparts in other advanced and manufacturing-centric industries, rely on a highly interconnected and complex network of suppliers, including a sizable cadre of intra-state connections. As will be shown in Section 4 of this report, the economic impact analysis illustrates the breadth of sectors supplying the industry and the magnitude of intra-state purchasing and sourcing by the biohealth industry. These leading supplier sectors include: business administrative and support services; wholesale manufactured inputs; facilities services; financial and insurance services; transportation and logistics services; IT and computer services; and many more.

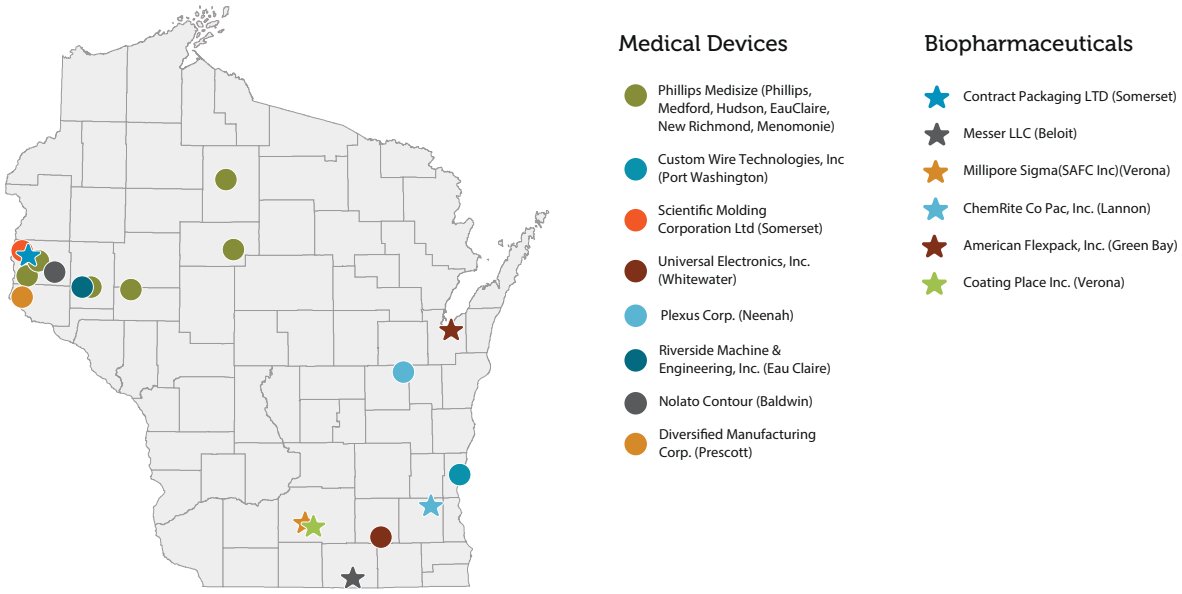
GE Healthcare, the largest individual biohealth industry employer in Wisconsin, with approximately 6,500 employees in the state, cites connections with more than 1,000 Wisconsin-based suppliers including 150 recognized by the federal government as small businesses.[1] Purchases from these Wisconsin suppliers total more than $400 million annually.[2] A recent article on the economic impacts generated by GE Healthcare in Wisconsin summarizes:

> ***"In Wisconsin specifically, GE Healthcare generates around $8 billion in direct and indirect annual economic impact, exports around $1.5 billion in goods from the state and has more than 1,000 suppliers in Wisconsin, according to the company."***[3]

Utilizing information drawn from two specialized FDA databases that track companies that have been qualified and registered by the FDA to work in the biomedical industry supply chain (one database related to medical devices, one to biopharmaceuticals)—representing a higher bar qualification for regulated supply chains and production in the industry. Figure 3 provides some varied examples of supplier firms with this FDA stamp of approval to the biohealth industry across Wisconsin.

1 See GE Works in Wisconsin at https://www.gehealthcare.com/news-center/ge-works-in-wisconsin.
2 Ibid.
3 Thomas, Arthur in BizTimes, "GE Healthcare plans to shift 1,500 jobs to West Milwaukee and Wauwatosa," September 16, 2020.

Figure 3: Examples of Supplier Firms to the Biohealth Industry Across Wisconsin Registered by the FDA*



*Note: The firms appearing in the graphic represent just some examples of firms supplying the industry, not a comprehensive set or full catalog. These firms have been registered and qualified by the FDA to supply the industry under strict regulations.
Source: U.S. Food & Drug Administration (FDA) drug and medical device establishment registration database.

With a high-level understanding of the "who?", and a primary focus on the biohealth industry component of the broader economy, the following report sections dig deeper, turning to:

- Examining how Wisconsin's biohealth industry is advancing and its innovation ecosystem evolving (Section 2)
- Assessing what makes Wisconsin's biohealth industry stand out (Section 3) and
- Calculating what is the impact of the biohealth industry on Wisconsin's economy (Section 4)

Section 2: How is Wisconsin's biohealth industry advancing and its innovation ecosystem evolving and progressing?

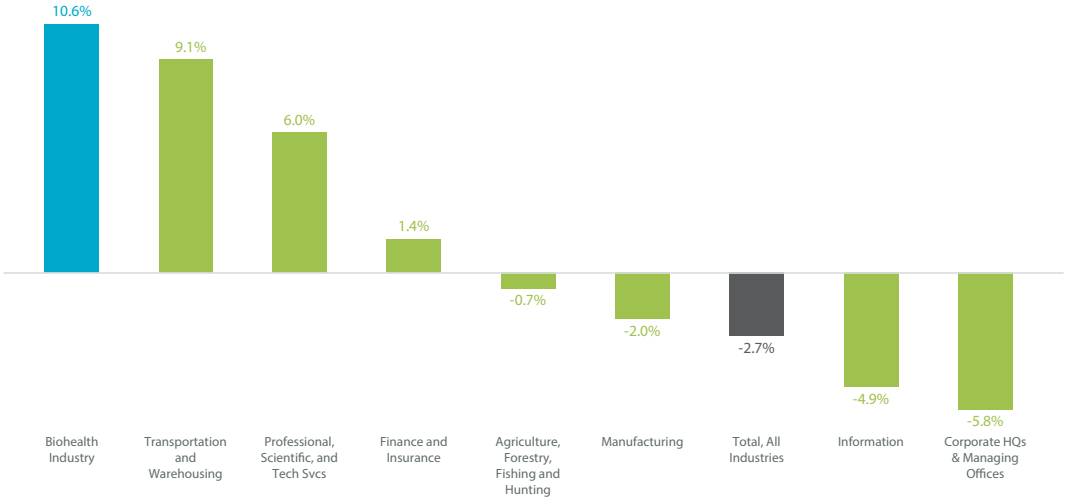
Industry Employment Growth

Wisconsin's biohealth economy is growing and serving as a critical support to the state's economy amidst overall job losses during the last few years. From 2018 through 2021, the focal period for this updated assessment, the biohealth economy *grew* by 3.7% while total Wisconsin employment (for all industries) *declined* by 2.7%.[4] Underlying these changes is the even more dramatic expansion and growth of the biohealth industry (excluding health services), which grew its employment base by 10.6% during this period and outpaced growth in other major Wisconsin industries (Figure 4). Moderating that increase is the slower, though still growing 1.5% net job gains in the health services component of the biohealth economy.

Wisconsin's biohealth industry is leading the state out of the economic challenges and job losses of recent years with strong, double-digit job growth.

The industry analysis presented herein will focus on the biohealth industry component of the overall Wisconsin biohealth economy, which excludes healthcare.

Figure 4: Employment Trends in Wisconsin's Biohealth and Other Major Traded Sectors, 2018-21



4 For this assessment comparisons made to Wisconsin's overall economy and employment are inclusive of both the private and public sectors for appropriate comparisons primarily against trends in health services, which include state and federal hospitals. For reference, the private sector change during this 3-year period was essentially the same, at a decline of 2.6% from 2018-21.

Source: TEConomy Partners' analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2022.3).

Four of the five biohealth industry subsectors have contributed to Wisconsin's double-digit growth in the biohealth industry since 2018 (Figure 5). As noted in the text box on the following page, the pandemic years saw strong gains in the largest growth sectors—biomedical research and testing, and drugs and pharmaceuticals—though both subsectors were experiencing strong job growth leading into the pandemic.

- Since 2017, **biomedical research and testing** have seen steady, strong average annual job gains in Wisconsin of an impressive 9.9%. Since that year, the subsector has added more than 3,600 state jobs to reach 11,526 in total by 2021. The vast majority of the job gains have been in the medical labs component of the industry which has grown its base by a substantial 69% just since 2018.

- In **drugs and pharmaceuticals**, average annual employment growth has risen at a 6.9% rate to just exceed 6,000 jobs in 2021. Several segments of the subsector are growing, led by the biologics manufacturing industry—one of the industry's most specialized in Wisconsin with respect to its concentration—which has grown by 29% since 2015 or nearly 600 net new jobs.

- **Biohealth-related distribution** has grown by 4.4% since 2018, with job gains and strong hiring in the medical equipment and supplies component offsetting modest job losses in other sectors.

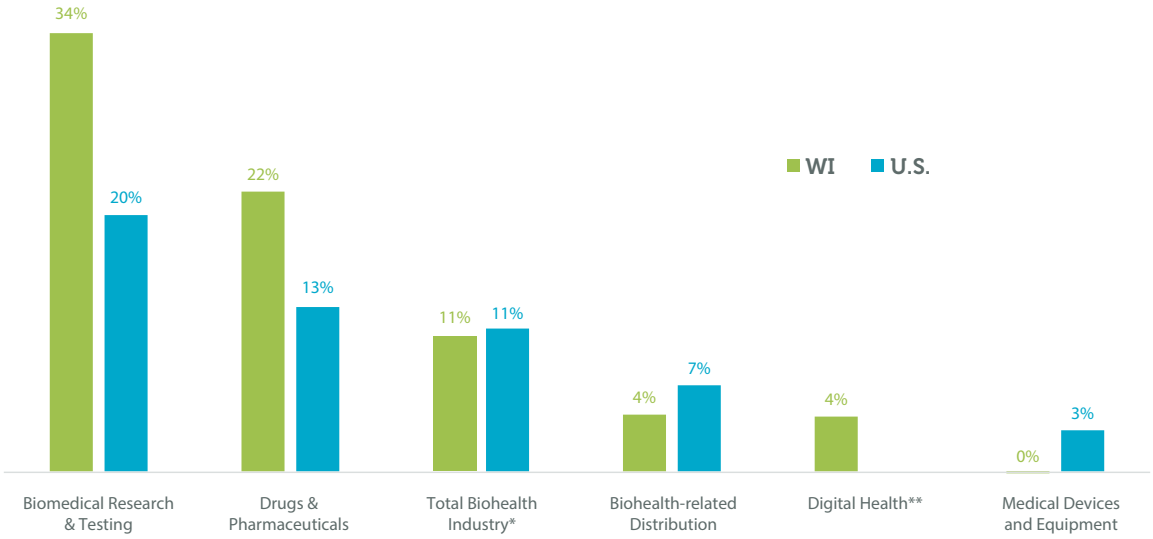
- The state's large **digital health** subsector has grown its jobs base by 4.3% since 2018, and while the customized nature of the employment estimate does not allow for detailed industry assessment, the sector's growth over the latest 3-year period is notable.

- **Medical device manufacturing** is the exception to the more widespread growth seen among other subsectors where Wisconsin employment levels have been flat overall since 2018 (-0.1%). Job losses occurred within both the electromedical and irradiation apparatus segments. These were offset by gains in other areas including dental equipment and surgical appliances and supplies. Medical device and equipment manufacturing's nearly 12,000 jobs in the state translate to a "specialized" employment concentration among the leading states nationally—the industry subsector is 34% more concentrated in Wisconsin relative to national averages. More detailed information on this specialization and specific companies are presented in Section 3.

Wisconsin is matching the growth rates seen nationally in the overall biohealth economy (Figure 5). While not fully comparable due to the inclusion in Wisconsin of the digital health subsector, the state and nation have seen the same or essentially the same growth rates in health services since 2018 (up 1.5%), and in the industrial biohealth sector (up 11%). So, while making progress in-state with strong gains relative to other sectors, Wisconsin is generally not gaining in its competitive share nationally.

From a comparative growth perspective against U.S. subsectors, the exceptions are within the biomedical research and testing and drugs and pharmaceuticals subsectors where Wisconsin's especially high growth rates are outpacing the strong growth seen across the U.S. In research and testing, the state has outpaced the nation at 34% vs. 20%; and in drugs and pharmaceuticals Wisconsin has outgained the U.S. at 22% growth compared with 13%.

Figure 5: Employment Trends for WI and U.S. Biohealth Industry and Major Subsectors, 2018-21



*Note: U.S. biohealth industry does not include the digital health subsector.
Source: TEConomy Partners' analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2022.3).

It is important to acknowledge that in addition to Wisconsin's large existing employment levels and the strong net new job creation experienced across the industry, these analyses do not take into account the current stock of job openings across the sector. At the time of writing this report there were 3,979 active and unique (non-duplicative) job postings in Wisconsin's biohealth industry.[5]

A Spotlight on Employment Trends in 2020 and 2021: The Prime Pandemic Period

The aforementioned 3-year trends are largely driven by the tumultuous labor market situation stemming from the COVID-19 pandemic and related economic shutdowns, primarily in 2020. That year, Wisconsin's total state economy shed 5.4% of its employment base amidst the resulting widespread layoffs. In 2021, state employers' hiring brought some of these jobs back with an over-the-year employment increase of 2.5%. The statewide economy continues to recover, with first quarter 2022 job growth continuing to claw back pandemic job losses.

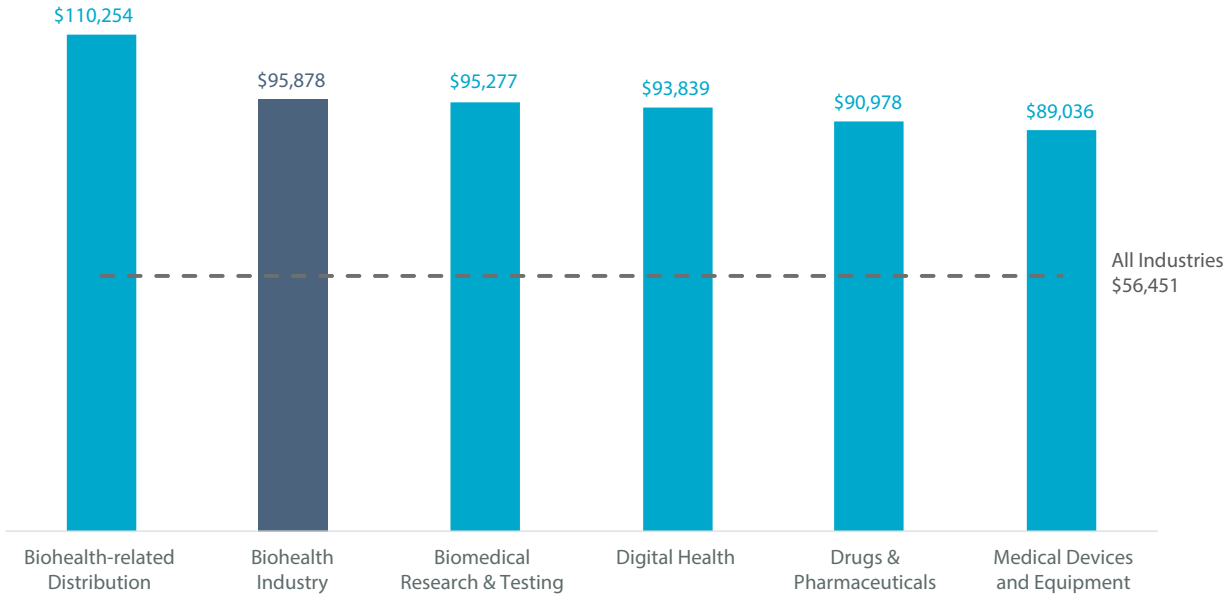
During these core pandemic years in 2020 and 2021, most of Wisconsin's biohealth industry continued to grow. Driving much of the gains was the biomedical research and testing subsector, which, not surprisingly in response to the pandemic, ramped up its employment base by an impressive 22%. Drugs and pharmaceuticals also hired at a rapid pace, with 16% job growth. Biomedical distribution rose by nearly 5%. The medical device subsector, however, ran counter to these growth trends and experienced a net employment decline of nearly 6% from where it began the pandemic. Due to the highly customized nature of estimating digital health employment at a firm-by-firm level, trends for digital health are not available for annual changes from 2019 through 2021, however the sector did grow overall from 2018 to 2021 and likely held steady or added jobs during this challenging period.

5 Based on analysis of Lightcast's Job Posting Analytics Database (release 2022.3) for the latest month available at the time of publication—August 2022.

Industry Wages

Wisconsin's biohealth industry is a high-quality job generator. Its workers earned an average of nearly $96,000 in 2021, which is more than $39,000 or 70% greater than the state's private-sector average of just over $56,000 (Figure 6). Strong wage premiums for biohealth talent reflect the industry's position as one of the most innovative advanced industries (as measured by corporate R&D) that translates into high value-adding activities. The biohealth industry deploys an especially high concentration of high-skilled STEM workforce as well as critical skilled technician and operator workforce in highly regulated advanced production environments. The strong wage context for biohealth extends to each of the major industry subsectors as well.

Figure 6: Average Annual Wages for Wisconsin's Biohealth Industry and Major Subsectors, 2021



Source: TEConomy Partners' analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2022.3).

Biohealth Industry Facility Investments, Expansions, and Acquisitions Driving Growth

The industry's expansion in Wisconsin is exciting and generally broad-based. Underlying the top-line industry and subsector growth has been a host of both expansion and investments in Wisconsin facilities and capabilities, as well as several mergers and acquisitions (M&A) affecting Wisconsin companies. Table 2 summarizes these industry developments.

From new production and R&D facilities to new headquarters operations, the companies featured here are doubling down on Wisconsin as a key location in which to thrive in the biohealth ecosystem.

Table 2: Recent Facility Investments and Expansions and M&A Activity Across the WI Biohealth Industry

Company	Description	WI Location
Expansions & Major Investments in Wisconsin Facilities, Operations:		
Aldevron	Expanded manufacturing facility in Madison to enhance production capabilities	Madison
Arrowhead Pharmaceuticals	Building a new drug manufacturing campus in the Madison area (Verona), including lab and office facilities	Verona
Catalent	Recently completed expansion at its biologics drug substance development and manufacturing facility in Madison, more than doubling its overall CGMP-scale capacity	Madison
Eurofins	Recently completed a new food lab facility in Madison to increase productivity and allow for future growth	Madison
Exact Sciences	Investing in new R&D Center of Excellence, developing more lab space, and expanding warehouse spaces at its Madison campus	Madison
GE Healthcare	Investing in a new factory in West Milwaukee, representing one of the company's largest one-time investments in a U.S. site in a generation	West Milwaukee
MilliporeSigma	Expanding its Verona manufacturing facility to increase pharmaceutical ingredient output; building a new facility in Sheboygan to facilitate lateral flow membrane production	Verona, Sheboygan
Nexus Pharmaceuticals	Completed construction of the company's first manufacturing facility in Pleasant Prairie	Pleasant Prairie
Northstar Surgical Radioisotopes	Recently completed a new facility enabling cutting-edge production and processing of radioisotopes	Beloit
Promega	Recently opened new R&D facility in Fitchburg to support core product development	Fitchburg
SHINE Technologies	Opened new headquarters and isotope production facility in Janesville	Janesville
Acquisitions:		
Aldevron	Acquired Nature Technology Corporation (NTC in Lincoln, NE)	Madison
Exact Sciences	Acquired OmicEra (Germany), proteomics and AI diagnostics; Acquired Prevention Genetics (Marshfield), DNA testing lab; Acquired Ashion Analytics (Arizona), clinical genetics testing; Acquired Thrive Earlier Detection Corp (Massachusetts), early cancer detection development	Madison, Marshfield
Sterling Pharma Solutions	Acquired the Alcami API manufacturing facility (Germantown)	Germantown
Thermo Fisher	Acquired PPD (Madison), GMP lab and clinical research services	Madison

Source: company websites, news releases, and articles collected and provided by BioForward Wisconsin.

In addition to the significant corporate investments, Wisconsin's research and innovation infrastructure continues to grow and add valuable assets. Just three recent examples include:

- **University Research Park** at the University of Wisconsin-Madison is adding to its impressive array of R&D and commercialization infrastructure with the development of **Element Labs**—a 147,000 square foot state-of-the-art lab and office space and multi-function meeting and collaboration spaces to enhance research, support emerging companies, and attract and retain talent. Element Labs will be the centerpiece of the new Element Collective district.

- **The Medical College of Wisconsin (MCW)** has just broken ground on its new cancer research building, expected to be completed in 2024 and representing an investment of $100 million. The project will centralize MCW's sizable cancer research programs spanning 700 individual researchers and 135 labs, and will introduce the only cancer-dedicated research building in Eastern Wisconsin.

- **Forward BIOLABS** is a fully equipped, shared life sciences lab facility located at Madison's University Research Park that provides office and lab space and other supportive services for biotech startups to lower the barriers for life sciences entrepreneurs launching new ventures. The initiative and facility have been so well-subscribed that space was quickly maxed out within just 7 months after its funding was secured—evidence of the high demand and growth in Wisconsin's biohealth sector. Forward BIOLABS is working to expand its facilities in response to the strong demand.

Regional Footprint of the Biohealth Industry

While primarily concentrated in Madison and Milwaukee, Wisconsin's biohealth industry is broad-based from a geographic perspective, spanning several regions across the state. The map in Figure 7 shows the regional concentrations and employment totals for six selected regions that combine to account for 84% of Wisconsin's biohealth industry jobs. Supporting data tables and charts that show the position and recent performance of the biohealth industry relative to other major sectors in each region are included in the Appendix.

Regional highlights include:

- **Madison** is recognized as a national leader in the biohealth industry for both its large employment base of nearly 25,000 regional jobs, as well as its varied specialized concentrations that include most of the major industry subsectors including biomedical research and testing; drugs and pharmaceuticals; and medical device manufacturing. Overall, Madison has 2.4 times the employment concentration in biohealth relative to the national average. The regional sector is not only large and specialized in its concentration but is rapidly growing, increasing its jobs base by 17.6% since 2018 and outpacing other major industries in the region.

- **Greater Milwaukee** is home to more than 15,000 biohealth industry jobs or three in ten state jobs in the sector. The region has two areas of specialized employment concentration—medical device manufacturing and biohealth-related distribution. Milwaukee's employment levels have remained flat overall in the sector since 2018 (-0.2%), though a particular bright spot has been double-digit job growth in drugs and pharmaceutical manufacturing which is up 12% since 2018.

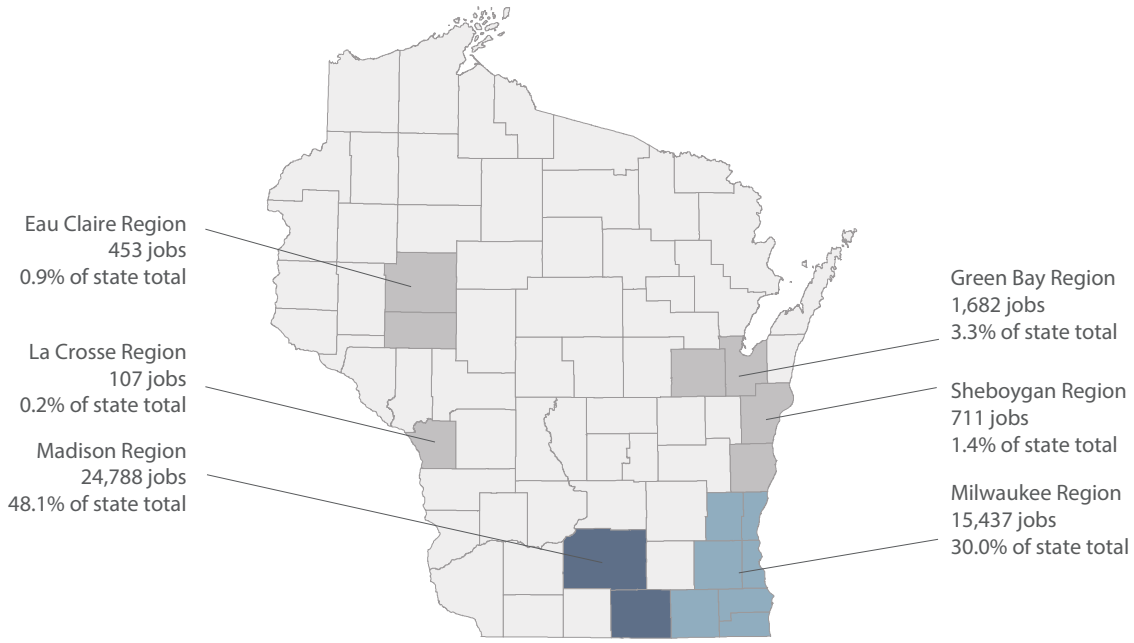
- **Green Bay's** biohealth employers account for nearly 1,700 biohealth industry jobs with three subsectors each accounting for approximately 500 to 600 jobs each—biohealth-related distribution; drugs and pharmaceuticals; and medical devices and equipment. Industry employment in the Green Bay region has increased by 3.1% since 2018.

- **Sheboygan** has more than 700 jobs in the biohealth industry after growing by 13.1% since 2018. Medical device manufacturing accounts for nearly all of these sector jobs and has driven the employment growth in the region over the last 3 years.

- **Eau Claire** is home to 453 jobs in the biohealth industry, with medical devices the largest among the major subsectors. The region has experienced a decline in employment since 2018.

- **La Crosse** has just over 100 regional biohealth industry jobs, spread across several subsectors.

Figure 7: Wisconsin's Biohealth Industry Employment by Selected Region, 2021



Source: TEConomy Partners' analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2022.3); TEConomy's identification of digital health firms and estimated employment.

The following (Figures 8, 9, 10) present detailed statewide and regional employment "bubble" charts showing the position and recent performance of the two major components of Wisconsin's biohealth economy relative to other major regional industries. The size of each bubble represents the level of employment in the state or region; the bubble's position on the horizontal axis represents recent employment gains or declines from 2018 through 2021; and its position on the vertical axis corresponds to its relative concentration as measured by the location quotient (LQ). To see bubble charts for other regions not presented here see the Appendix.

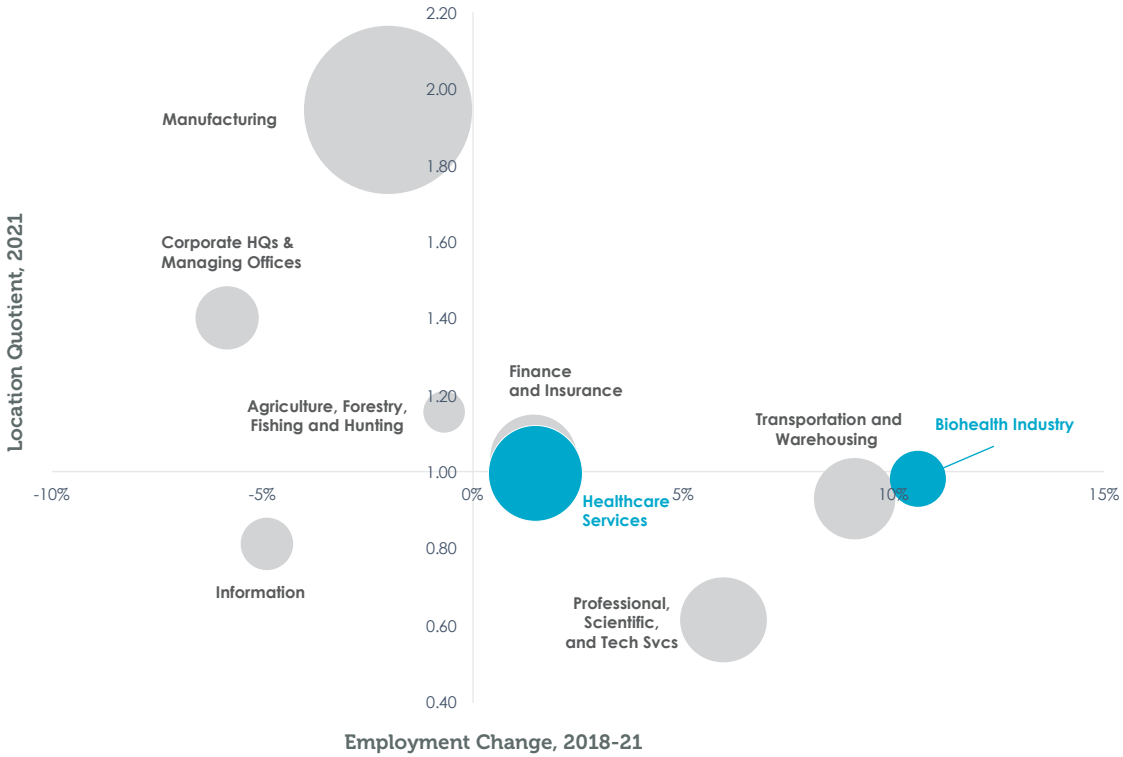
Highlights from these state and regional examinations include:

- For the state (Figure 8), the strong growth of the biohealth industry far to the right on the horizontal axis indicates its importance as an economic engine for Wisconsin.

- For Madison (Figure 9), the strong regional employment growth combined with the highly concentrated and specialized location quotients position the two biohealth economy sectors firmly in the quadrant of regional "stars"—sectors that are both fast-growing and highly specialized.

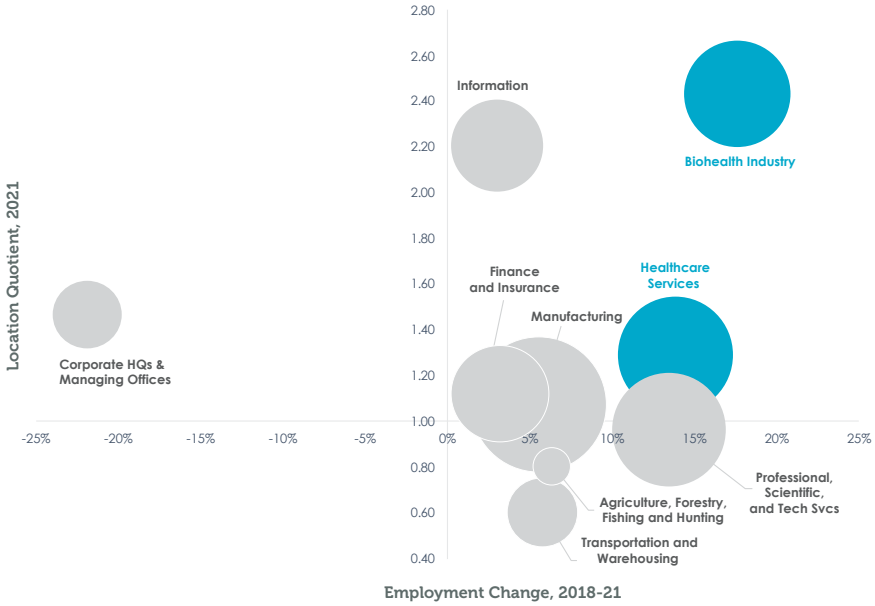
- For the Milwaukee region (Figure 10), the size of the regional healthcare services component stands out as well as its growth context in recent years.

Figure 8: Employment Size (Size of bubble), Concentration (LQ), and Employment Growth for Wisconsin's (Statewide) Biohealth Economy vs. Other Major Regional Industries



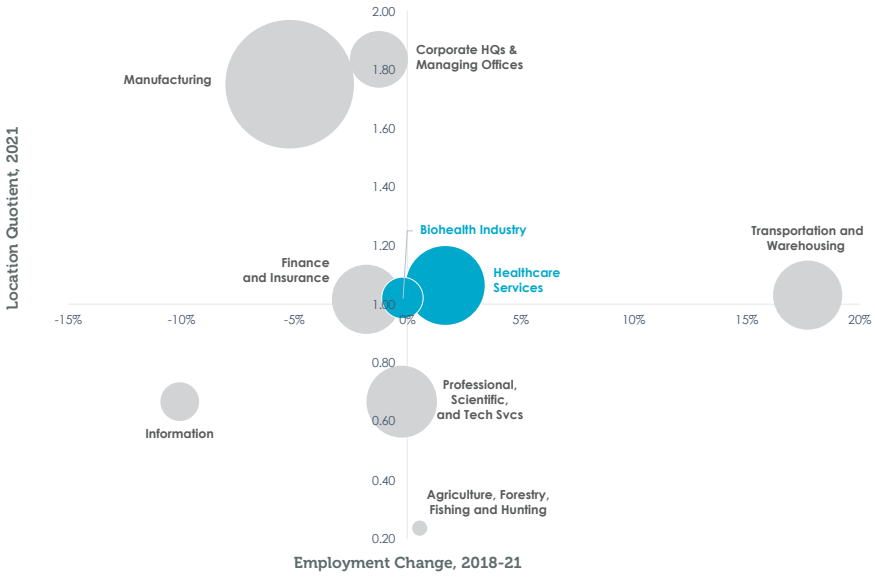
Source: TEConomy Partners' analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2022.3).

Figure 9: Employment Size (Size of bubble), Concentration (LQ), and Employment Growth for the Madison Region's Biohealth Economy vs. Other Major Regional Industries



Source: TEConomy Partners' analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2022.3).

Figure 10: Employment Size (Size of bubble), Concentration (LQ), and Employment Growth for the Milwaukee Region's Biohealth Economy vs. Other Major Regional Industries



Source: TEConomy Partners' analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2022.3).

The Evolving Biohealth Ecosystem

A robust and thriving biohealth industry cluster includes not only high-profile, well-established and emerging companies, but a whole host of ecosystem role players advancing scientific innovation, investing in emerging companies, nurturing startups, and developing the next generation of talent. Wisconsin's biohealth industry and its broader innovation ecosystem is inclusive of all of these individual players and collaborative organizations that contribute to the greater whole.

The primary elements of a robust innovation ecosystem for biohealth industry development are listed in the sidebar. The biohealth industry has especially unique development requirements within this framework as the industry operates in a highly regulated environment, with especially expensive, risky, and lengthy development lead times for commercialization; requires close connections with universities as a science-driven industry; traverses the "valley of death" between discovery and viable commercial products; and has distinct and varied workforce and talent demands.

Elements of a Robust Innovation Ecosystem for Biohealth Development

- Research & Development
- National Institutes of Health (NIH) Funding
- Innovation & Risk Capital: VC Investments and Federal SBIR/STTR Awards
- Patent Innovations
- Workforce & Talent Development

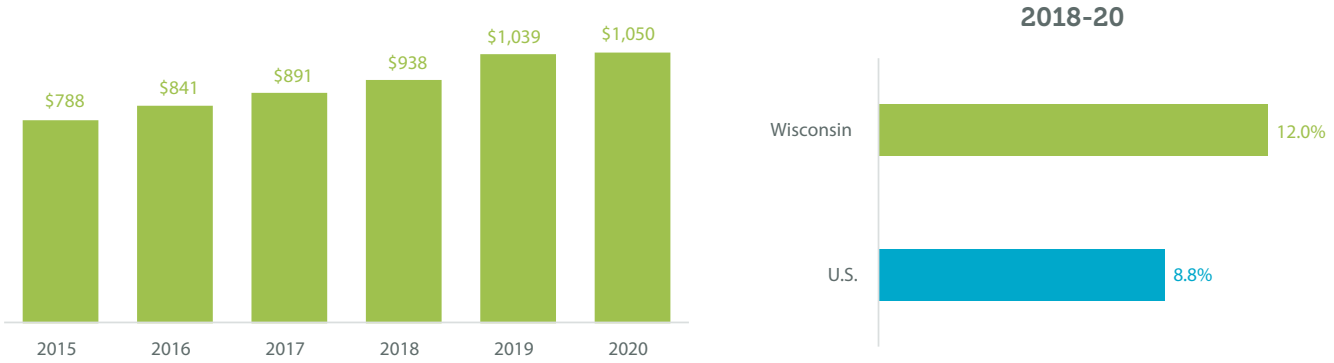
In Wisconsin, numerous organizations and institutions play key roles across these elements, just some of which are highlighted here, along with key performance trends for Wisconsin relative to the nation.

Biohealth Research & Development

In the life sciences and biohealth, universities play an especially important role given the close connections between scientific discovery and industry commercialization. **Wisconsin benefits by having an especially large and leading university R&D engine fueling biohealth discovery and innovation, which in 2019 and 2020 surpassed $1 billion in annual expenditures** (Figure 11). Biohealth-related R&D in Wisconsin has outpaced the U.S. in growth since 2018.

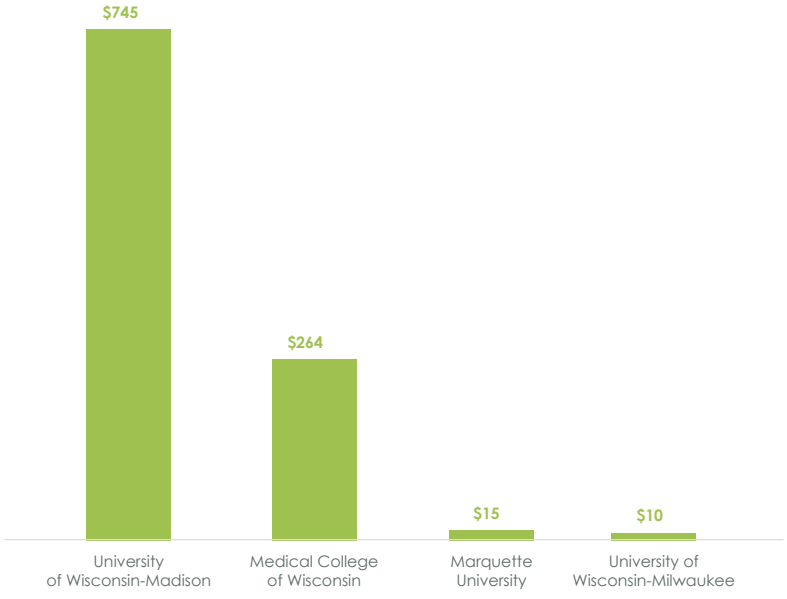
The leading state institutions in terms of biohealth-related R&D expenditures are shown in Figure 12, with the University of Wisconsin-Madison the leading institution accounting for nearly three-quarters of all R&D activity and the Medical College of Wisconsin second-largest—both institutions have medical schools driving biohealth research.

Figure 11: University Biohealth R&D Expenditures in Wisconsin, Levels and Growth Trends, 2018-20 ($ in Millions)



Source: National Science Foundation, Higher Education Research and Development Survey and TEConomy Partners calculations.

Figure 12: Leading Wisconsin Colleges and Universities in Biohealth-related R&D Expenditures, 2020 ($ in Millions)

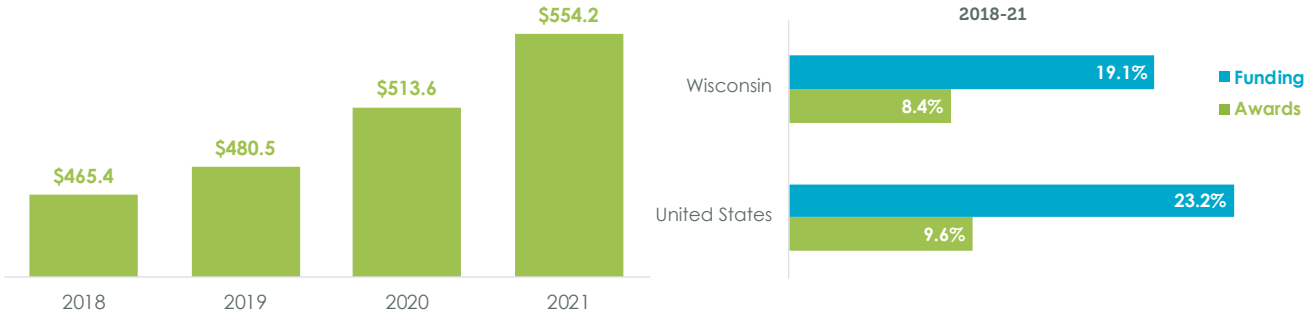


Source: National Science Foundation, Higher Education Research and Development Survey and TEConomy Partners calculations.

National Institutes of Health (NIH) Funding

University R&D funding originates from and is driven by several key sources including the federal government. The majority of vital biohealth-related federal research funding is allocated through the Department of Health and Human Services (HHS), and within that, originates from the National Institutes of Health (NIH). Wisconsin-based institutions and organizations received $554 million in NIH funding in 2021 (Figure 13). Since 2018, Wisconsin institutions have seen steady increases in award funding, rising 19%, just behind the growth in overall national funding (23%).

Figure 13: NIH Funding to Wisconsin Institutions, Levels and Growth Trends vs. U.S., 2018-21 ($ in Millions)



Source: NIH RePORT database, and TEConomy Partners calculations.

Innovation & Risk Capital: VC Investments and Federal SBIR/STTR Awards

VC and angel investments in Wisconsin biohealth companies reached a new high in 2021 of $191 million, an increase of 49% from the average levels of investment seen in the prior three years (Figure 14). The state has not, however, experienced the type of growth seen nationally, where VC funding took off in 2020 and 2021 with aggressive, record-breaking investment activity. For the U.S. biohealth industry, the volume of VC and angel funding in 2021 doubled the average of the prior three years, rising 102%.

Wisconsin incentivizes and supports critical investments in early-stage, high-growth potential companies through its Qualified New Business Venture (QNBV) program, which has been in place for nearly two decades. The QNBV provides tax incentives—specifically tax credits equal to 25% of the amount of an equity investment—to angel investors/

Wisconsin-Based Organizations Investing in Wisconsin Biohealth Companies

The following Wisconsin-based investors and organizations have participated in numerous VC and/or Angel investment deals in state biohealth companies since 2015:

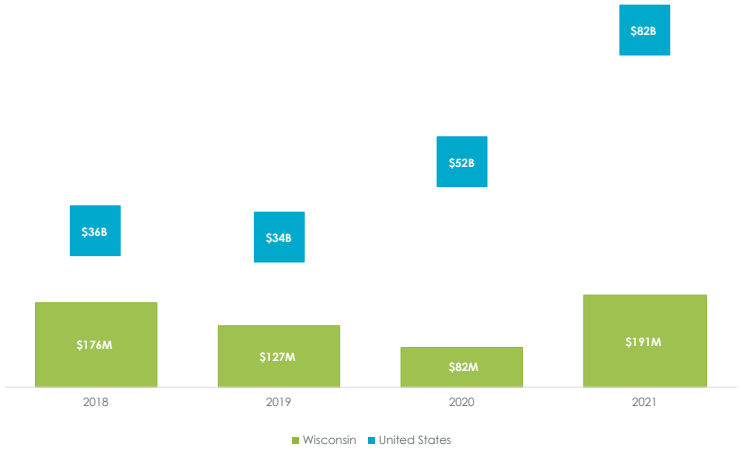
- Wisconsin Economic Development Corporation
- Wisconsin Investment Partners
- BrightStar Wisconsin Foundation
- Wisconsin Alumni Research Foundation
- gBETA
- HealthX Ventures
- Venture Investors
- TitletownTech

Source: PitchBook.

networks or Qualified Venture Funds (QVF) that invest in early-stage firms developing innovative products, processes, or services with a focus on advancing technology.[6]

While pre-seed through early-stage investments account for the majority of Wisconsin VC and angel investments in the latest 4-year period, and have certainly been impacted by incentives such as the QNBV, Wisconsin's deal activity from 2018 through 2021 has been more concentrated relative to the country in the later stages of company development with 40% of all VC deals in later-stage companies compared with 26% nationally.

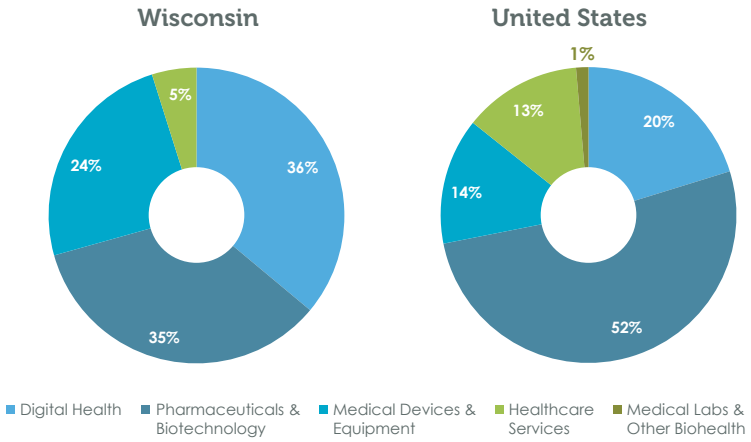
Figure 14: Biohealth VC and Angel Investment Trends, Wisconsin and U.S., 2018-21



Source: TEConomy Partners analysis of PitchBook data.

Digital health stands out in Wisconsin as a lead investment area representing just over one of every three dollars invested in biohealth (Figure 15). The subsector has received $208 million since 2018. Pharmaceutical and biotechnology companies are just behind digital health with 35% of all dollars invested since 2018 ($199 million).

Figure 15: VC and Angel Investments by Biohealth Industry Subsector, WI and U.S., 2018-21



Source: TEConomy Partners analysis of PitchBook data.

6 The QNBV program is administered by the Wisconsin Economic Development Corporation (WEDC), for more information visit: https://wedc.org/programs-and-resources/qualified-new-business-venture/#:~:text=Wisconsin's%20Qualified%20New%20Business%20Venture,investors%2C%20businesses%20and%20Wisconsin's%20economy.

Leading Wisconsin companies receiving VC and angel investments during the 2018-21 period ($15M or more cumulatively) include:

- SHINE Medical Technologies (Janesville, Pharmaceuticals & Biotech)
- Redox (Madison, Digital Health)
- Elephas (Madison, Medical Devices)
- Propeller Health (Madison, Medical Devices)
- FluGen (Madison, Pharmaceuticals & Biotech)
- Moxe (Madison, Digital Health)
- Zurex Pharma (Middleton, Medical Devices)
- HealthMyne (Madison, Digital Health)

Support and Development Resources for Wisconsin's Biohealth Entrepreneurs, Broader Technology Commercialization

Forward BIOLABS
Forward BIOLABS is a shared lab facility at the University Research Park that provides office and lab space and other supportive services for biotech startups. Its aim is to lower the barriers for entrepreneurs in launching new ventures.

Early outcomes at Forward BIOLABS are promising—young companies that have taken space and even "graduated" from Forward BIOLABS have far exceeded projections, demonstrating the necessity of Forward BIOLABS in meeting the entrepreneurial demand for shared lab space and key services.

WARF Therapeutics
The Wisconsin Alumni Research Foundation partners with UW-Madison and Morgridge Institute for Research Principal Investigators to facilitate a translational research path designed to improve the value proposition of new drugs.

Isthmus Project
Isthmus Project is an innovation hub within UW Health. The program is designed to aid potential entrepreneurs in understanding the innovation ecosystem, validating and testing ideas, and identifying commercialization pathways.

Federal SBIR/STTR Awards to Wisconsin Biohealth Companies

For innovative, emerging biohealth startups and smaller firms, access to capital is critical to advance toward commercialization. Access to seed- and early-stage capital is especially important for biohealth companies developing products and in some cases conducting and meeting rigorous pre-clinical and clinical testing requirements. In addition to privately-funded risk capital, federal Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) awards represent a key source of non-dilutive innovation capital.

SBIR/STTR Award Levels to WI Firms in Biohealth technologies and markets:

- $10.57M in 2018
- $18.76M in 2019
- $17.45M in 2020

SBIR funding from the HHS in the biomedical space totaled $17.45 million for Wisconsin companies in 2020. This figure declined by 7% from 2019 award levels compared with flat growth for the nation.

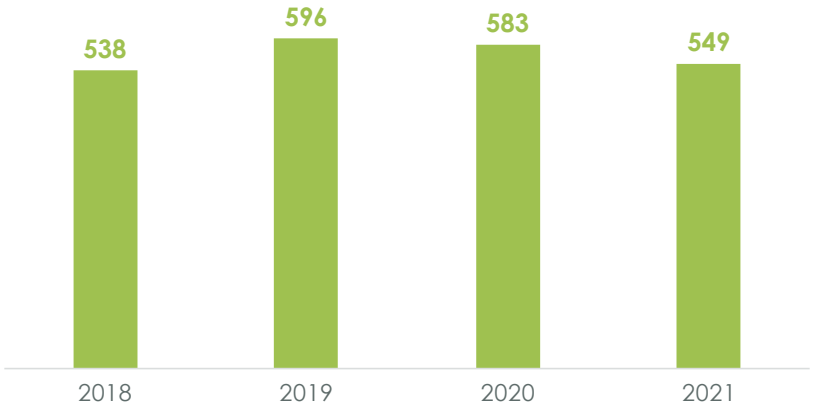
The State of Wisconsin, through WEDC and in partnership with the Center for Technology Commercialization at the University of Wisconsin, works to both support small, innovative state firms in applying for SBIR/STTR awards, as well as to enhance outcomes for SBIR award winners through a matching grant program. The program, known as SBIR Advance, targets both Phase I and Phase II award winners for matching grants aimed at accelerating business development and reaching commercialization milestones. In addition, the program includes entrepreneurial support and training in Lean Startup, regulatory plans, commercialization plans, funding strategies, etc. based on the business need.

Patent Innovations

The extensive biohealth-related R&D activity across Wisconsin's academic institutions and its corporate community is translating into tangible innovations. Patent awards offer a lens into the outcomes of often years of rigorous scientific research and commercialization pursuits; and represent a critical legal framework for protecting valuable intellectual property (IP). In the biohealth industry in particular, IP can represent significant time and resources invested in developing a novel therapeutic, medical device, or other idea or product rooted in leading-edge science and engineering.

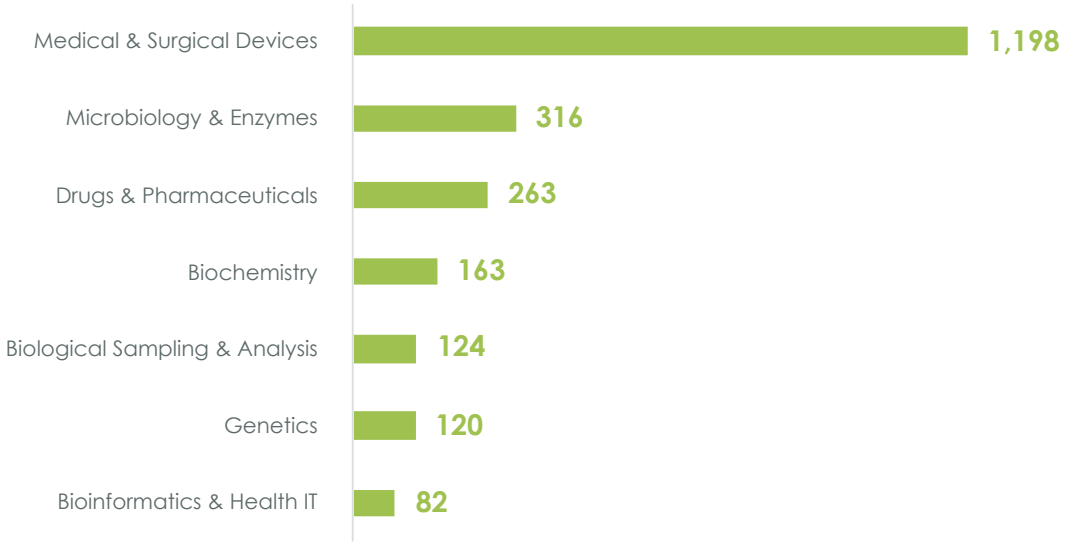
Patent awards associated with at least one Wisconsin-based inventor or assignee in a biohealth-related patent class totaled 2,266 over the full 2018 through 2021 period. Though 2021 saw a dip in patent awards for Wisconsin, the totals have remained relatively steady in recent years (Figure 16). Nationally, biohealth-related patent awards rose from 2018 through 2021 by 8.5% compared with a slower 2.0% gain for Wisconsin. Wisconsin's biohealth patent awards are especially concentrated in medical device technologies (Figure 17).

Figure 16: Biohealth-Related Patent Awards with a Wisconsin Inventor or Assignee, 2018-21



Source: TEConomy Partners' analysis of U.S. Patent & Trademark Office data from Clarivate Analytics' Derwent Innovation patent analysis database.

Figure 17: Biohealth-Related Patent Awards with a Wisconsin Inventor or Assignee, by Major Grouping, 2018-21



Source: TEConomy Partners' analysis of U.S. Patent & Trademark Office data from Clarivate Analytics' Derwent Innovation patent analysis database.

Workforce and Talent Development

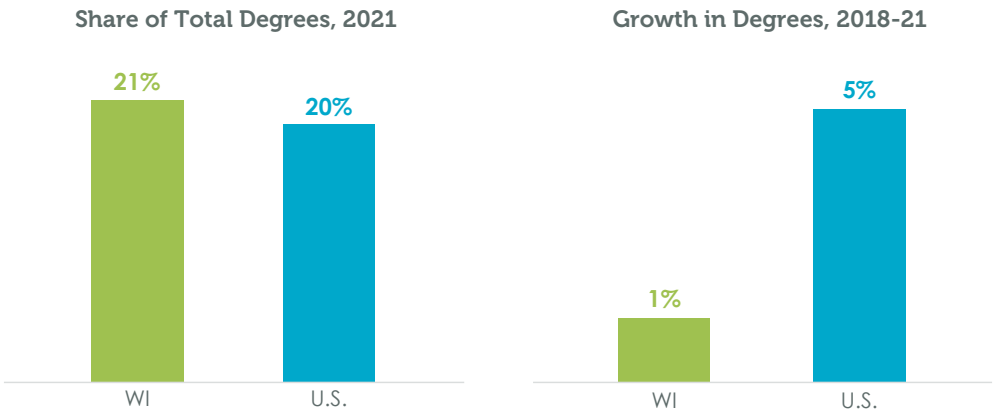
For a high-growth advanced industry with strong demands for skilled talent, particularly in STEM-related fields, postsecondary graduates represent an extremely important element for maintaining the biohealth growth trajectory. Wisconsin's colleges and universities have a strong concentration in health and life science degree fields at the Associate's level and above, with just over one in five degrees conferred in one of these fields (Figure 18). This 21% share essentially matches that of the U.S. (20%). What is concerning is the lack of recent growth in degree graduates as Wisconsin institutions have only grown this base by 1% since 2018, behind the growth rate seen nationally.

Across Wisconsin, postsecondary institutions play key roles in developing and advancing this health and life sciences talent pipeline. Figure 19 highlights the leading institutions in numbers of graduates, and shows the complementary roles across academia spanning the state's technical colleges focused at the associate's level up through the UW system, Marquette University, and others generating high-skilled talent at the Bachelor's through Doctorate and Professional levels.

> Arguably the most critical ingredient to a thriving biohealth ecosystem is a statewide talent base equipped with the myriad blend of education, expertise, and hard skills required to advance scientific inquiry and R&D; translate discoveries into commercially-viable products; and ultimately produce, sell, and distribute biohealth-related products and services.

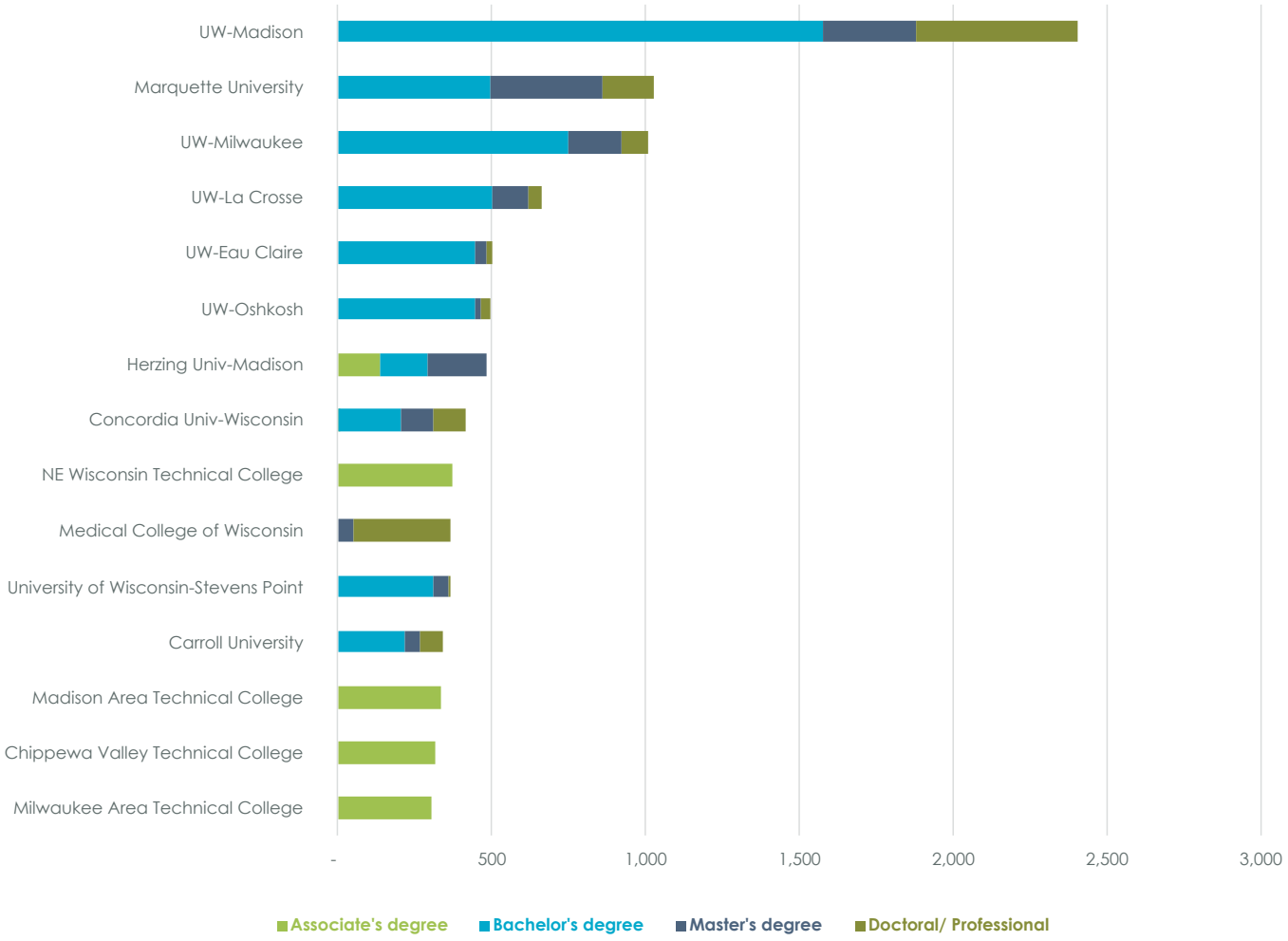
It is critical to point out, however, that while health and life sciences degrees are critical to the core talent demanded by the biohealth industry, there is substantial demand for talent spanning other STEM fields such as data sciences, quality control and assurance, engineering, as well as production, technician, and key business functions. In addition, there also is a critical base of talent required throughout the industry in positions requiring Associate's degrees, certifications, and even entry-level personnel with high school diplomas combined with on-the-job training, which employers report is often challenging to find.

Figure 18: Health and Life Science Degree Graduates— Share of Total Degrees and Growth Trends (Associate's and Higher), 2018-21



Note: major degree categories include: Biological and Biomedical Sciences; Health Professions and Related Clinical Sciences.
Source: TEConomy Partners analysis of National Center for Education Statistics, IPEDs Database.

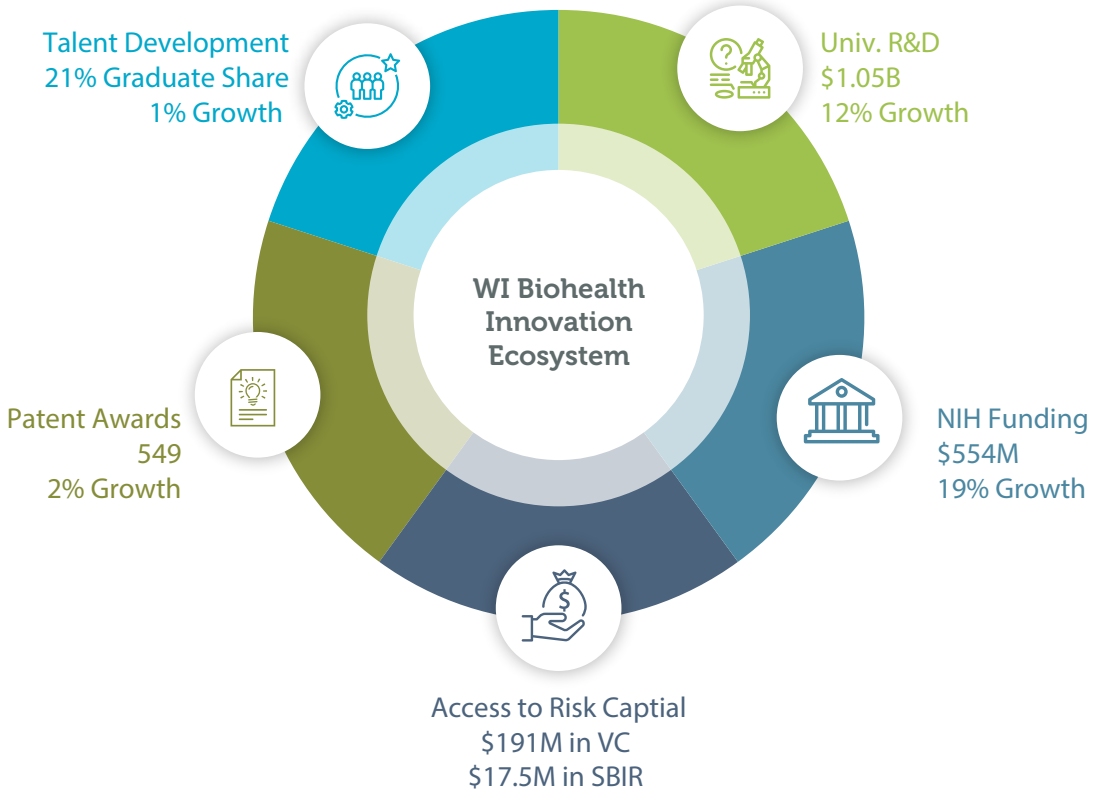
Figure 19: Leading Health and Life Sciences Institutions by Degree Counts (Associate's and Higher), 2021



Note: major degree categories include: Biological and Biomedical Sciences; Health Professions and Related Clinical Sciences.
Source: TEConomy Partners analysis of National Center for Education Statistics, IPEDs Database.

Considered altogether, Wisconsin's biohealth innovation ecosystem elements are all demonstrating progress, though in most cases the state is lagging behind national growth trends (Figure 20). University R&D is the exception, where state institutions are outpacing their counterparts nationally, but in other areas the slower pace of growth is concerning.

Figure 20: Summary Performance Across Wisconsin's Biohealth Innovation Ecosystem, 2021 (or latest) Levels and Growth Trends Since 2018



Source: TEConomy Partners' analysis.

Section 3: What makes Wisconsin's biohealth industry stand out?

With the size and growth of Wisconsin's biohealth industry and its major subsectors established, more detailed examination of biohealth markets, products, technologies, and companies with a significant and outsized concentration in the state reveals both established and emerging strengths that make Wisconsin stand out.

Industry Strengths

Wisconsin's established industry strengths are varied, but primarily concentrated in three areas:

- Medical device manufacturing, with a primary focus in medical imaging technologies;
- Biopharmaceuticals, with several areas of focus related to biomanufacturing; and
- An exciting, emerging area of radiation/nuclear medicine that spans both the device and biopharmaceutical subsectors.

These strengths are identified, assessed, and characterized by examining several metrics and summarized in Figures 21 and 22. Metrics and other considerations include:

- Outsized and "specialized" employment concentrations in the state within detailed industry classifications below the subsector level and measured using industry-specific location quotients ("LQs", see sidebar) where Wisconsin has a significantly above-average economic concentration relative to national averages.
- Substantial concentrations and/or especially large presence of leading companies and their shared product and market focus.
- Significant presence of innovation activities and investments across key ecosystem metrics.

Medical device and equipment manufacturing's nearly 12,000 jobs in the state translate to a "*specialized*" employment concentration among the leading states nationally—the industry subsector is 34% more concentrated in Wisconsin relative to national averages (LQ is 1.34).

Measuring Industry Concentration & "Specialization" Using Location Quotients

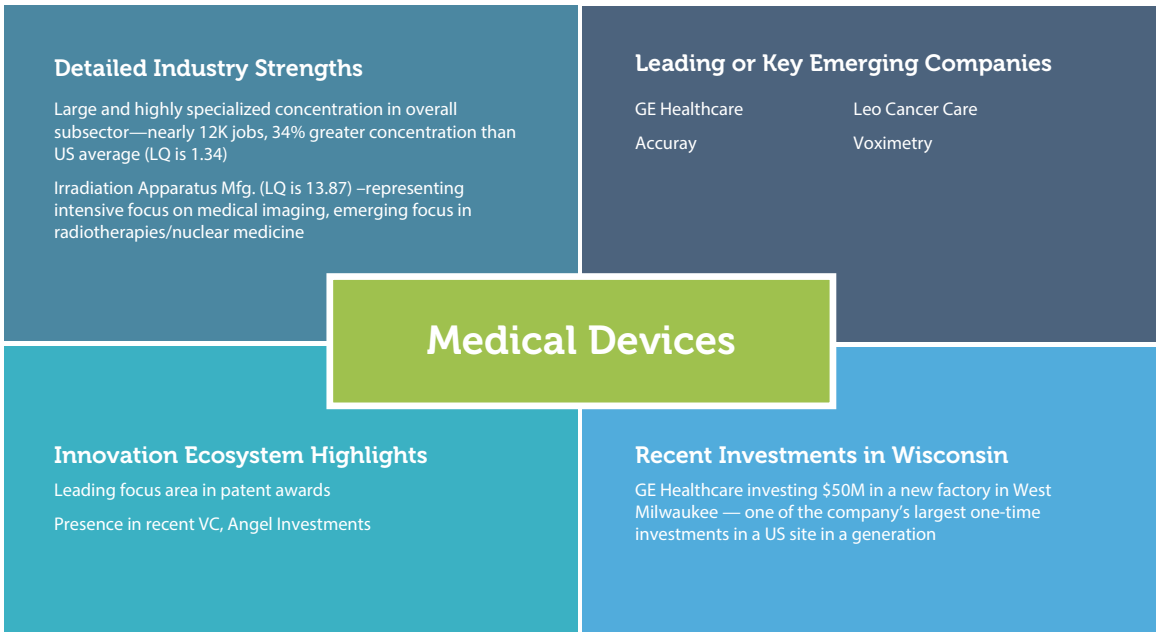
Employment concentration is a useful way to gauge the relative importance of an industry to a state or regional economy.

State location quotients (LQs) measure the degree of job concentration within the state relative to the national average. States or regions with an LQ greater than 1.0 are said to have a concentration in the sector. When the LQ is significantly above average, 1.20 or greater, the state is said to have a "*specialization*" in the industry.

GE Healthcare's large and leading footprint in the production of medical imaging equipment—including magnetic resonance (MRI), computed tomography (CT), positron emission tomography (PET), radiography (X-ray), ultrasound—as well as software and IT, patient monitoring, and performance improvement solutions. With approximately 6,000 employees in Wisconsin, the state continues to be an important hub for GE Healthcare, serving as the global headquarters of its imaging and clinical care solutions businesses, supporting a major hub for repair/recycling of devices, and demonstrating advanced manufacturing technologies. As a result of GE's presence in Wisconsin, the state has a concentration in "Irradiation Apparatus Manufacturing" *nearly 14 times* that for the nation.

An additional and relatively new cluster of emerging firms and activities is advancing in Wisconsin around the development of medical isotopes or radioisotopes with associated development, applications, and production of medical imaging technologies and nuclear medicine/radiation therapies that leverage this high-value resource. **The state via the research and educational expertise of UW-Madison is building a core competency and exciting presence in radiotherapeutic technologies.** And while these companies and competencies span both areas of strength in terms of medical devices and equipment, for example, Accuray's manufacturing of its "Cyberknife" robotic radiotherapy treatment in Madison; and drugs and pharmaceuticals, for example, SHINE Technologies' development of radioisotopes—the emerging concentration and cluster of companies can be thought of as more unified. So, some of the companies are therefore split across the graphics in this section that summarize Wisconsin's unique biohealth industry strengths.

Figure 21: Summary of Wisconsin Biohealth Strengths in Medical Device Manufacturing



Within the drugs and pharmaceuticals subsector, Wisconsin has a highly specialized, diverse, and growing presence in what can broadly be referred to as "biomanufacturing". The state has a specialized employment concentration exceeding three times the national average in biological products manufacturing (LQ is 3.30). The Wisconsin sector has grown by 29% since 2018, well outpacing strong national growth (14%).

Wisconsin's concentration of companies and exciting set of substantial corporate and ecosystem investments combine to form a unique and strong cluster of innovation and production in biologics manufacturing, cell and tissue engineering and manufacturing, research tools and instrumentation, as well as other high-value aspects of the biopharmaceuticals industry and research infrastructure including active pharmaceutical ingredients (API) and contract research organizations (CROs).

In addition are the aforementioned companies within the radiation medicine concentration that are producing medical radioisotopes and are therefore technically classified within the drugs and pharmaceuticals subsector, including SHINE Technologies and Northstar Medical Radioisotopes.

The 22% increase in drugs and pharmaceuticals subsector employment since 2018 has been propelled by numerous manufacturing facility expansions as well as new lab buildouts, investments in office space, and enhanced R&D facilities and capabilities. Figure 23 highlights examples of companies in the biopharmaceutical sector and the concentrations across key themes.

Figure 22: Summary of Wisconsin Biohealth Strengths in Drugs & Pharmaceuticals, Biomanufacturing

Figure 23: **Examples of Biopharmaceutical Companies and Strength Areas for Wisconsin**

Emerging Strengths

Additional notable, high-growth areas in the biohealth sector are emerging in Wisconsin with a sizable presence and state growth rates outpacing the national sector, and important to monitor:

- **Medical laboratories**—within the biomedical research and testing subsector, the state has seen strong and steady emergence in recent years, and while there is no doubt that establishments were added during the pandemic, the growth has been ongoing and steady since well before. Since 2018, the sector has added more than 2,200 jobs in Wisconsin, growing its base by 69% and crossing the threshold for a "specialized" concentration with a 1.26 LQ.

- **Medical equipment and supplies wholesalers**—within the broader distribution subsector, state medical equipment and supplies wholesalers are steadily growing employment (up 13% since 2018) and with more than 5,800 state jobs the industry sector is 11% more concentrated in Wisconsin than the national average (LQ is 1.11).

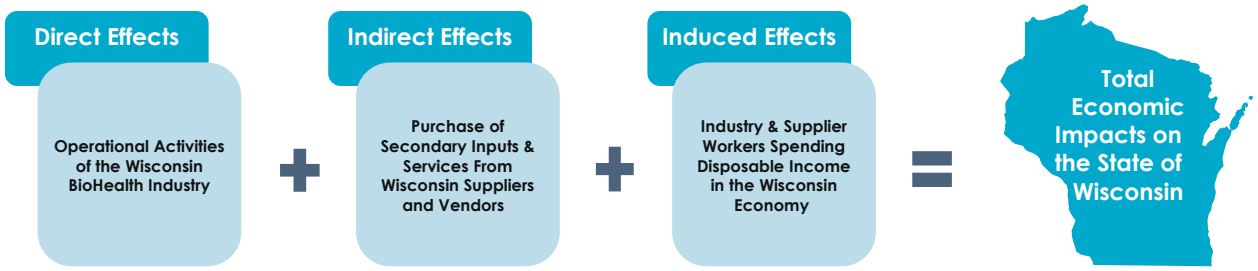
Section 4: What is the impact of the biohealth industry on Wisconsin's economy?

The biohealth industry's substantial size, strong employment and facilities growth, varied strengths, high value adding activities and resulting wage premiums all translate into significant economic impacts for Wisconsin's statewide economy.

With more than 51,500 employees, Wisconsin's large employment base and high average wages in the biohealth industry leads to outsized economic impacts for the state. This section defines, describes, and details these impacts.

The impact analysis is focused solely here on the biohealth industry segment of the broader biohealth economy—consisting of the manufacturers, digital health, and distribution subsectors as defined in Section 1. The premise is that every dollar these firms spend within the state's economy (the direct impact) is spent and re-spent on the purchase of inputs and additional goods or services by suppliers and workers generating additional economic activity and impact in the state as depicted in Figure 24.

Figure 24: Components of the Wisconsin Biohealth Industry Impacts



The total economic impact, or more precisely the revenue and expenditure impacts, of Wisconsin's biohealth industry can be measured using the well-established regional economic analysis technique of input-output (I-O) analysis. I-O analysis tracks the production activities of a sector and the related economic activity of its in-state suppliers and the suppliers' personnel.

The impact analysis captures and reports the following impact metrics, with detailed values reported in Table 3.

Employment and Compensation

As described in Section 1, the economic activities of the Wisconsin biohealth industry directly employ more than 51,500 (workers and owners). In turn, through industry purchases of goods and services from in-state supplier firms an additional 33,850 workers are supported by the industry (indirect effects). Finally, as the industry and its supplier firms' employees spend their wages within the Wisconsin economy, an additional 43,150 employees are supported (induced effects). **In total the Wisconsin biohealth industry supports more than 128,700 Wisconsin jobs, for an employment multiplier of 2.50—for every direct job in the Wisconsin biohealth industry, an additional 1.50 Wisconsin jobs are supported.**

Strong biohealth job growth and its significantly higher wages are generating impressive, broad-based employment impacts for Wisconsin via "multiplier" effects:

- Biohealth has an employment multiplier of 2.50—for every direct job in the Wisconsin biohealth industry, an additional 1.50 Wisconsin jobs are supported. This is a greater impact than for other major industries such as Professional and Technical Services; Corporate Headquarters; Transportation & Warehousing; and Agriculture; and it is on par with total Manufacturing and the Finance & Insurance Industries.

Table 3: Economic Impact of the Wisconsin Biohealth Industry, 2021

Impact Type	Employment	$ in Billions					
		Labor Income	Value Added	Output	Local/County Tax Revenue	State Tax Revenue	Federal Tax Revenue
Direct Effect	51,533	$5.374	$9.829	$19.173	$0.190	$0.368	$1.198
Indirect Effect	33,856	$2.226	$3.234	$6.014	$0.083	$0.143	$0.456
Induced Effect	43,354	$2.126	$3.803	$6.645	$0.173	$0.227	$0.464
Total Effect	128,744	$9.726	$16.866	$31.833	$0.446	$0.739	$2.117
Multiplier	2.50	1.81	1.72	1.66			

Source: TEConomy Partners' analysis using employment data developed by TEConomy and IMPLAN State of Wisconsin model.

Direct labor income, consisting of the value or cost of all wages and benefits paid to employees and owners, reaches nearly $5.4 billion in 2021 or an average of over $104,000 per industry worker. Through supplier and employee purchases the indirect and induced labor income generated by the industry reaches $4.3 billion. Overall, the Wisconsin biohealth industry supports more than $9.7 billion in annual wages and benefits in the state.

Value Added

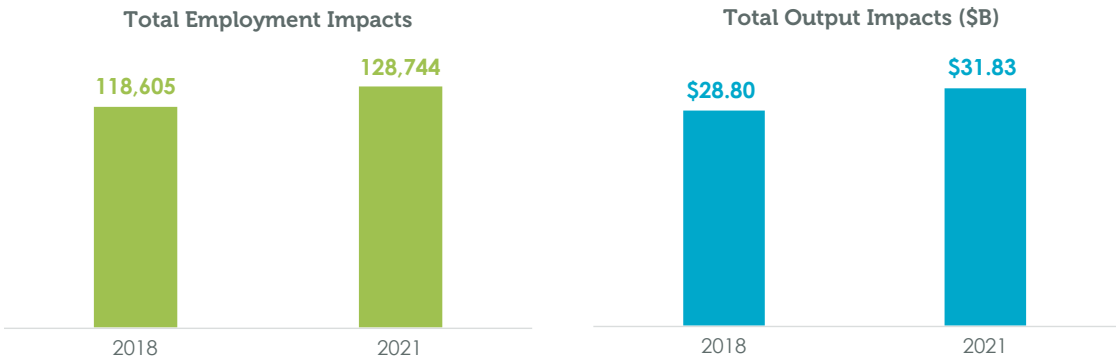
Value added, often described as an industry's contribution to gross state product (GSP; or gross domestic product if describing the industry nationally) captures the total revenue of an industry minus the costs of inputs and labor. The Wisconsin biohealth industry generated more than $9.8 billion in direct value added in 2021, or approximately 2.7 percent of total state GSP. **From a total impacts perspective, the $16.9 billion generated and supported by the state's biohealth industry accounts for 4.6% of Wisconsin's GSP.**

Output

Typically referred to as the "economic impact" metric, the Wisconsin biohealth industry is estimated to have generated and supported nearly $32 billion in total output (sales or revenue) impacts in 2021. Consisting of $19.2 billion in direct output and more than $12.6 billion in supported indirect and induced output, the industry generates an additional $0.66 of in-state revenue for every $1.00 of biohealth industry output (an output multiplier of 1.66).

When compared against the output and employment impacts calculated in the prior Landscape and Economic Impact report for 2018, Wisconsin has seen significant increases—reflective of the strong job growth generating high-wage opportunities. Total output impacts have risen by just over $3 billion or 11%, while employment impacts have increased by more than 10,000 state jobs or 9% (Figure 25).

Figure 25: Growth in Total Output and Employment Impacts, 2018 vs. 2021



Note: Output impacts for 2018 are not inflation-adjusted, though inflation did not rapidly accelerate in 2021.
Source: TEConomy Partners' analysis using employment data developed by TEConomy and IMPLAN State of Wisconsin model.

Taxes

The biohealth industry in Wisconsin is estimated to have paid nearly $560 million in state and local taxes, consisting of $190 million in local/county taxes and nearly $370 million in state taxes. **Including suppliers and worker income and spending the industry generated and supported nearly $1.2 billion in total local/county and state taxes.** From a federal tax perspective, the industry generated and supported more than $2.1 billion in total federal tax revenues in 2021.

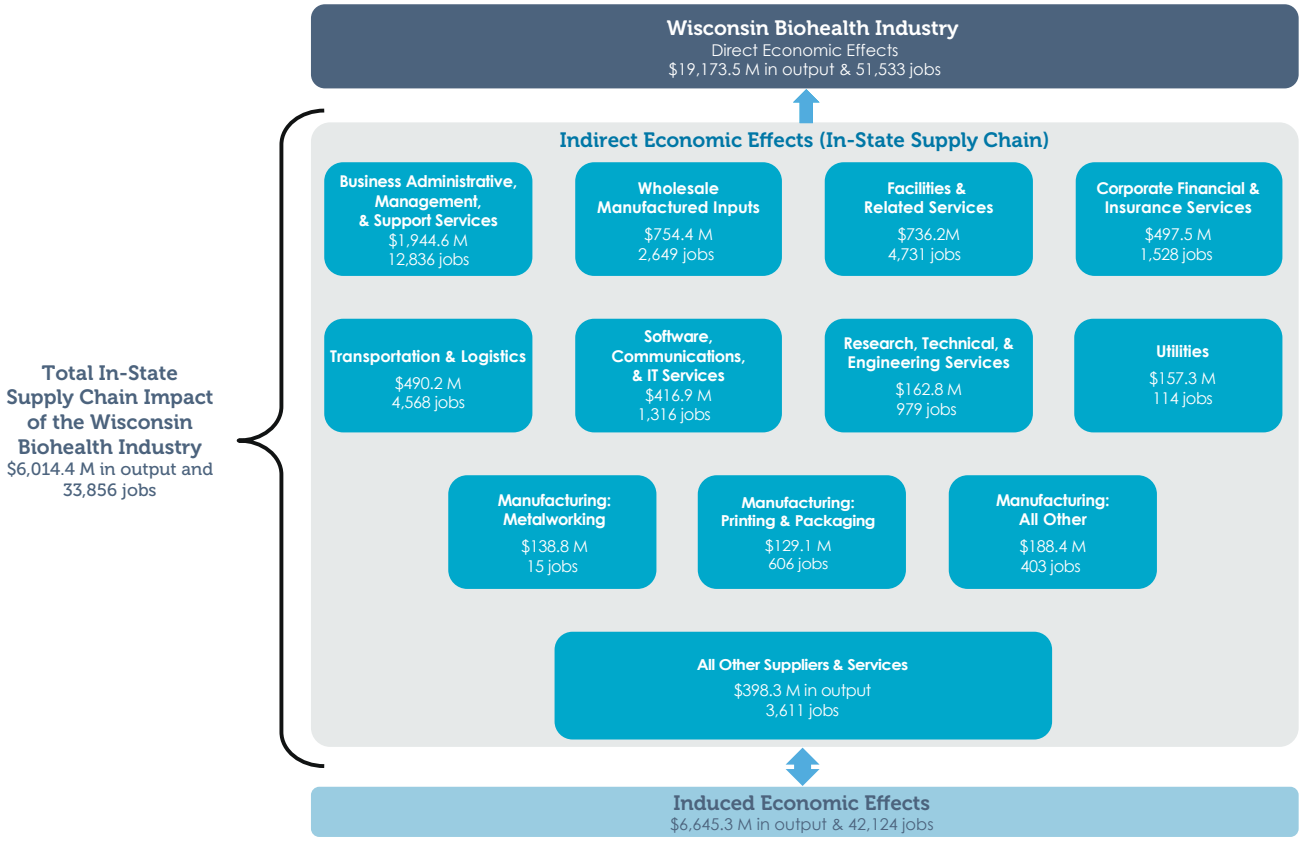
The Biohealth Manufacturing Supply Chain

Within the analysis of the economic impacts of the biohealth industry, some insights can be gleaned into the size and involvement of other sectors of the Wisconsin economy in supplying the more than $6.0 billion in products and services to the state's biohealth industry. Figure 26 provides a visual perspective on the overall economic impact analysis and the important role played by key in-state supplier input sectors to the Wisconsin biohealth industry.

Output

The 12 "supply chain" sectors shown in Figure 26 represent the breadth of in-state inputs to the industry reaching a total of $6,104.4 million in 2021. As with most industries the largest in-state input sector to Wisconsin's Biohealth industry is ***business administrative, management, & support services*** (which includes administrative and service support functions provided by corporate headquarters, regional, sales, or other corporate offices, legal, accounting, and management consulting services, employment, and other administrative service businesses). Together these administrative-related services accounted for 32 percent ($1,945 million) of the total in-state supplier value in 2021. Likewise, the second largest sector, ***wholesale manufactured inputs*** (materials, components, and parts purchased from wholesale distributors) accounted for $754 million or 13 percent. ***Facilities & related services*** accounted for $736 million, while both ***financial & insurance services*** and ***transportation & logistics*** each accounted for just under $500 million. ***Software, communications, and IT services*** represented $417 million in inputs—not including the significant software and IT presence within the digital health sector captured in the direct industry totals. Combined, the manufacturing supply chain sectors (***metalworking; printing & packaging; all other manufacturing***), account for $456 million, or 8 percent of total in-state supply chain value.

Figure 26: **Key In-State Supplier Sectors to Wisconsin's Biohealth Industry**



Source: TEConomy Partners' analysis using employment data developed by TEConomy and IMPLAN State of Wisconsin model.

Employment

The 33,857 jobs among Wisconsin's suppliers to the biohealth industry are spread across the Wisconsin economy in a somewhat different distribution than output impacts. Business administrative, management, & support services, parallel to its output effects, is the largest employer among the supply chain sectors accounting for more than 12,800 jobs or 38 percent of all in-state supplier workers. The second-largest supply chain sector in terms of employment is facilities & related services capturing the more than 4,700 workers involved in the leasing, maintenance, and repair of facilities and equipment used by the biohealth industry. Supporting the state's biohealth industry with more than 4,550 workers, transportation & logistics is the third-largest supply chain sector, in terms of employment.

Conclusion

The updated assessment finds the biohealth industry advancing in Wisconsin by matching the strong, double-digit job growth seen nationally during the last few years and acting as a critical bolster against the economic shocks of the global pandemic. Through growth and extensive exciting private facilities investments, Wisconsin is solidifying its identity as a leader in biomanufacturing and other biopharmaceuticals and maintaining its historical position as a leading hub for medical device production, particularly with respect to advanced biomedical imaging technologies. At the same time, Wisconsin is advancing with an emerging cluster of innovation and production in radiation/nuclear medicine.

This growth period has been followed, however, by national and global economic headwinds of inflation, supply chain constraints, tightening labor market dynamics, and slower overall growth in 2022. There are clearly ongoing economic challenges facing the industry today and into the future. Of additional concern for Wisconsin is the slower growth in its biohealth innovation ecosystem elements. The ecosystem is advancing with at least some growth across every element, though among most, Wisconsin is lagging behind the U.S. Support for the industry is especially critical with respect to meeting the talent challenge, through enhanced education and training programs to meet its high-growth and sizable job openings demands. This ecosystem is critical to supporting and maintaining the industry's hard-earned gains.

The biohealth industry is critical to the Wisconsin economy, and the state needs this industry now more than ever—not only to contribute its significantly high wages and outsized economic impacts, but also to solve intra-state and broader global health and quality of life challenges.

The growth opportunity for Wisconsin in biohealth is immense, particularly in the broader national and federal context of increasing emphasis on bolstering domestic production and supply chains as strategic priorities for critical sectors such as biopharmaceuticals and semiconductors. Wisconsin has both historical and current strengths in medical device, biopharmaceutical, and other manufacturing and this moment represents a genuine opportunity for the state to implement a "Made in Wisconsin" initiative for the biohealth industry.

Appendix: Industry Definitions and Methodology

Defining the Biohealth Economy in Wisconsin for Industry Analyses

TEConomy worked closely with BioForward to define the biohealth economy in Wisconsin, building up industry subsectors from individual detailed North American Industry Classification System ("NAICS") codes. Some industries are adjusted in this analysis by TEConomy to include only the share of these industries directly involved in life science-related activities—they are designated by an asterisk in Table A-1 below.

Measuring the Digital Health Subsector

Unlike the majority of the biohealth industry which can be delineated and defined by federal NAICS classifications, isolating companies engaged in digital health requires building up a firm-level database with employment estimates derived from several sources. Because of this unique approach applied to Wisconsin, comparisons with the U.S. on any digital health metrics are not available in this report.

Digital health companies are embedded largely within broader software and computer services industry classifications. Therefore, to identify and address this key component of Wisconsin's biohealth industry, TEConomy's project team worked to identify individual companies and to build a firm-level database. The project team used a variety of sources to construct the database of digital health companies. These sources included the company inventory used in the 2020 "Wisconsin's Biohealth Industry" Economic Impact report; the PitchBook database of venture capital and private equity; the BioForward Wisconsin and Wisconsin Technology Council membership lists; data from the Business Dynamics Research Consortium (BDRC); Infogroup's ReferenceUSA database; the proprietary Dun & Bradstreet Hoovers database; the HealthTechMKE directory of firms; LinkedIn; and individual company websites. A company was retained in the list if its business model has a clear and predominant focus in healthcare or biomedical software, information technologies, or other digital services or products. Employment values were derived from the same sources, with efforts undertaken to verify accuracy where possible. BioForward Wisconsin assisted in vetting the database.

Table A-1: Defining the Biohealth Economy, NAICS-Based Definition

Biohealth Economy Subsectors	NAICS Code	NAICS Title
Biohealth-Related Distribution	423450*	Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers
	423460	Ophthalmic Goods Merchant Wholesalers
	424210*	Drugs and Druggists' Sundries Merchant Wholesalers
	532283	Home Health Equipment Rental
Biomedical Research & Testing	541713*	Research and Development in Nanotechnology
	541714	Research and Development in Biotechnology (except Nanobiotechnology)
	541715*	Research and Development in the Physical, Engineering, and Life Sciences (except Nanotechnology and Biotechnology)
	621511	Medical Laboratories
Digital Health**	N/A	N/A
Drugs & Pharmaceuticals	325411	Medicinal and Botanical Manufacturing
	325412	Pharmaceutical Preparation Manufacturing
	325413	In-Vitro Diagnostic Substance Manufacturing
	325414	Biological Product (except Diagnostic) Manufacturing
Medical Devices and Equipment	334510	Electromedical and Electrotherapeutic Apparatus Manufacturing
	334516	Analytical Laboratory Instrument Manufacturing
	334517	Irradiation Apparatus Manufacturing
	339112	Surgical and Medical Instrument Manufacturing
	339113	Surgical Appliance and Supplies Manufacturing
	339114	Dental Equipment and Supplies Manufacturing
	339115	Ophthalmic Goods Manufacturing
	339116	Dental Laboratories
Healthcare Services	621410	Family Planning Centers
	621420	Outpatient Mental Health and Substance Abuse Centers
	621491	HMO Medical Centers
	621492	Kidney Dialysis Centers
	621493	Freestanding Ambulatory Surgical and Emergency Centers
	621498	All Other Outpatient Care Centers
	621512	Diagnostic Imaging Centers
	621991	Blood and Organ Banks
	621999	All Other Miscellaneous Ambulatory Health Care Services
	622110	General Medical and Surgical Hospitals
	622210	Psychiatric and Substance Abuse Hospitals
	622310	Specialty (except Psychiatric and Substance Abuse) Hospitals

*Note: Includes only the portion of these industries engaged in relevant biohealth, life sciences activities.
**Note: Digital health subsector analysis developed through a firm-level database as these activities cannot be isolated within the existing NAICS industry structure.

Regional Biohealth Employment Data

The following present detailed employment data tables and regional "bubble" charts showing the position and recent performance of the biohealth economy and its major components relative to other major regional industries, all for a set of selected regions representing more than 80% of state biohealth industry employment.

Table A-2: Summary Employment Metrics for Selected WI Regions, 2021 [Continued on next page]

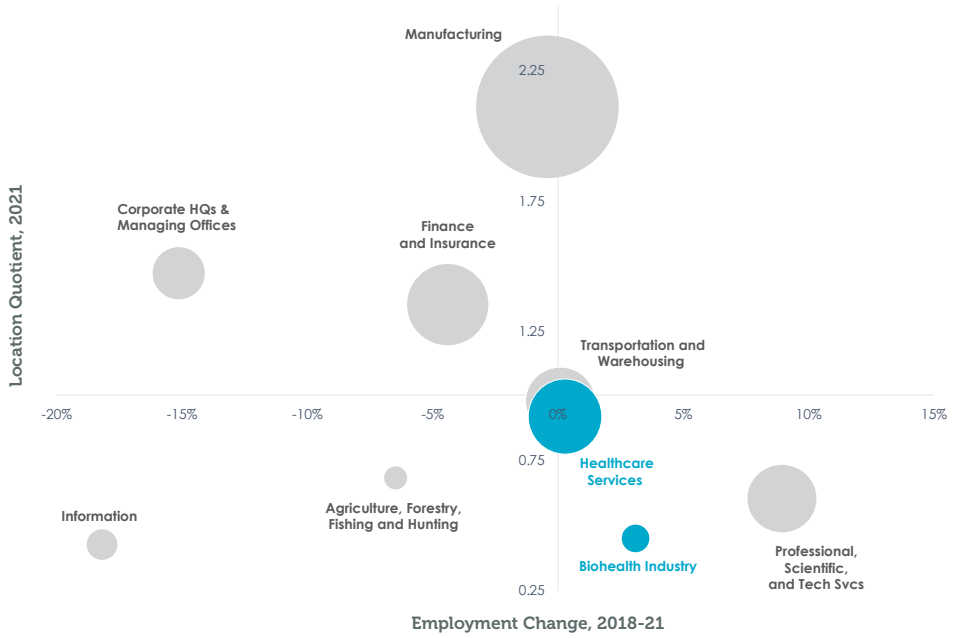
Region	Biohealth Industry & Major Subsectors	Employment 2021	Empl. Change 2018-21	Location Quotient 2021
Milwaukee Region	**Total, All Industries***	**972,704**	**-4.40%**	**1**
	Total Biohealth**	**70,995**	**1.20%**	**1.06**
	Industrial Biohealth**	15,437	-0.20%	1.02
	Biohealth-related Distribution	4,752	3.00%	1.26
	Digital Health	1,339	5.40%	n/a
	Drugs & Pharmaceuticals	1,805	12.30%	0.8
	Medical Devices and Equipment	6,214	-7.40%	2.04
	Biomedical Research & Testing	1,327	4.70%	0.28
	Healthcare Services	55,558	1.60%	1.06
Madison Region	**Total, All Industries***	**401,247**	**-0.50%**	**1**
	Total Biohealth**	**52,577**	**15.60%**	**1.53**
	Industrial Biohealth**	24,788	17.60%	2.43
	Biohealth-related Distribution	855	-26.80%	0.55
	Digital Health	10,916	3.90%	n/a
	Drugs & Pharmaceuticals	3,099	41.20%	3.34
	Medical Devices and Equipment	2,204	8.70%	1.75
	Biomedical Research & Testing	7,714	48.70%	3.93
	Healthcare Services	27,789	13.80%	1.29
Green Bay Region	**Total, All Industries***	**256,597**	**-4.00%**	**1**
	Total Biohealth**	**14,352**	**0.60%**	**0.82**
	Industrial Biohealth**	1,682	3.10%	0.45
	Biohealth-related Distribution	612	4.80%	0.62
	Digital Health	34	142.90%	n/a
	Drugs & Pharmaceuticals	506	8.10%	0.85
	Medical Devices and Equipment	496	18.40%	0.62
	Biomedical Research & Testing	35	-76.40%	0.03
	Healthcare Services	12,669	0.30%	0.92
La Crosse Region	**Total, All Industries***	**67,407**	**-3.50%**	**1**
	Total Biohealth**	**8,203**	**-1.30%**	**1.79**
	Industrial Biohealth**	107	-21.40%	0.11
	Biohealth-related Distribution	56	-45.90%	0.22
	Digital Health	-	-	n/a
	Drugs & Pharmaceuticals	21	2307.70%	0.13
	Medical Devices and Equipment	22	-13.60%	0.1
	Biomedical Research & Testing	7	43.30%	0.02
	Healthcare Services	8,096	-1.00%	2.24

Region	Biohealth Industry & Major Subsectors	Employment 2021	Empl. Change 2018-21	Location Quotient 2021
Eau Claire Region	**Total, All Industries***	**81,326**	**-1.90%**	**1**
	Total Biohealth**	**5,314**	**-5.30%**	**0.96**
	Industrial Biohealth**	453	-25.60%	0.38
	Biohealth-related Distribution	72	-30.90%	0.23
	Digital Health	20	100.00%	n/a
	Drugs & Pharmaceuticals	88	-55.00%	0.47
	Medical Devices and Equipment	252	-1.60%	0.99
	Biomedical Research & Testing	21	-50.90%	0.05
	Healthcare Services	4,861	-2.80%	1.11
Sheboygan Region	**Total, All Industries***	**91,266**	**-3.90%**	**1**
	Total Biohealth**	**3,440**	**4.40%**	**0.56**
	Industrial Biohealth**	711	13.10%	0.55
	Biohealth-related Distribution	52	42.40%	0.15
	Digital Health	-	-	-
	Drugs & Pharmaceuticals	-	-	-
	Medical Devices and Equipment	598	16.00%	2.09
	Biomedical Research & Testing	61	-10.20%	0.14
	Healthcare Services	2,729	2.30%	0.56

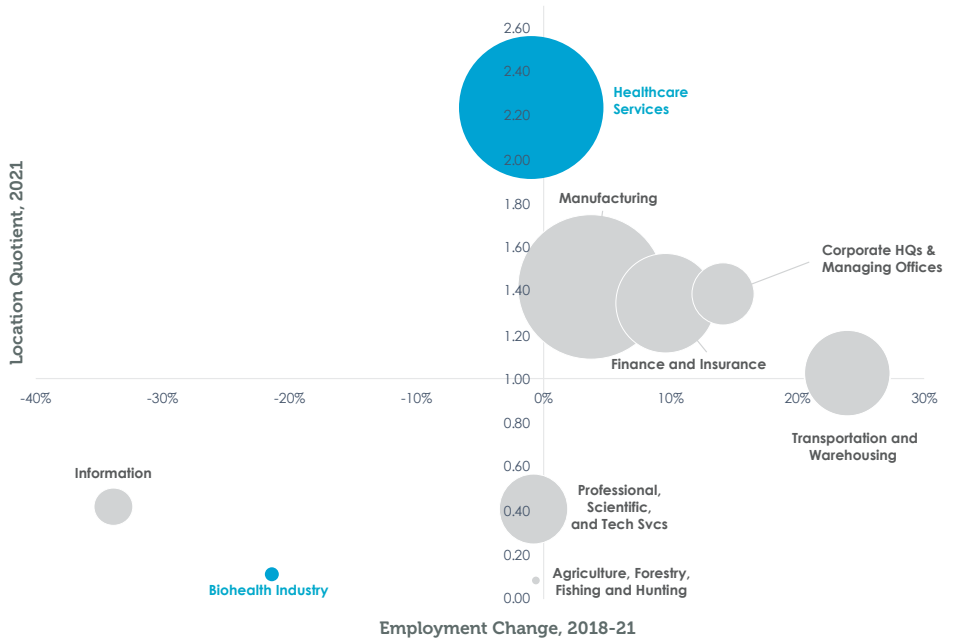
*Total, All Industries row includes both private and government establishment and employment.
**Total Biohealth and Industrial Biohealth LQs do not include Digital Health.
Source: TEConomy Partners LLC analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2022.3).

Figure A-1: Employment Size (Size of bubble), Concentration (LQ), and Employment Growth for Regional Biohealth Economy vs. Other Major Regional Industries

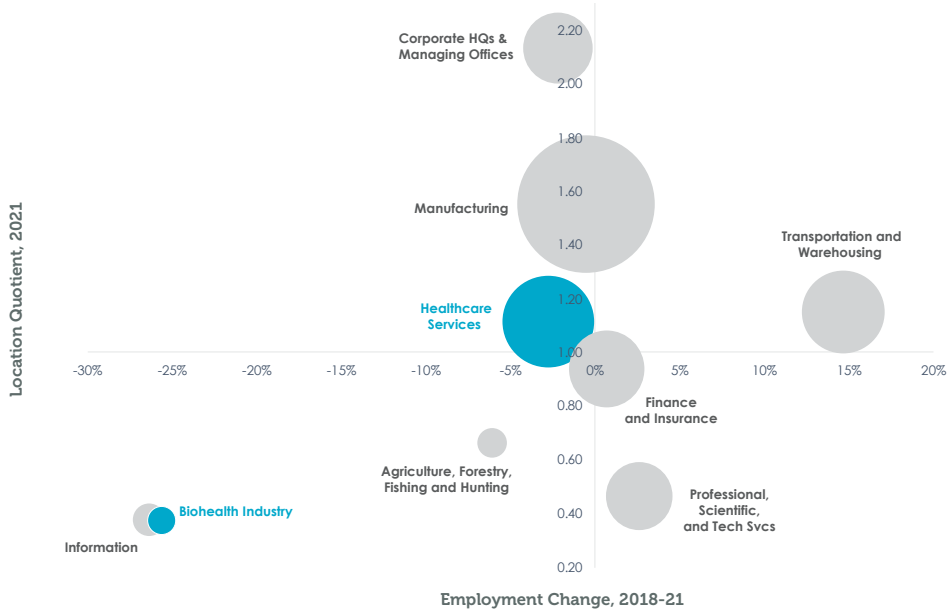
Green Bay Region



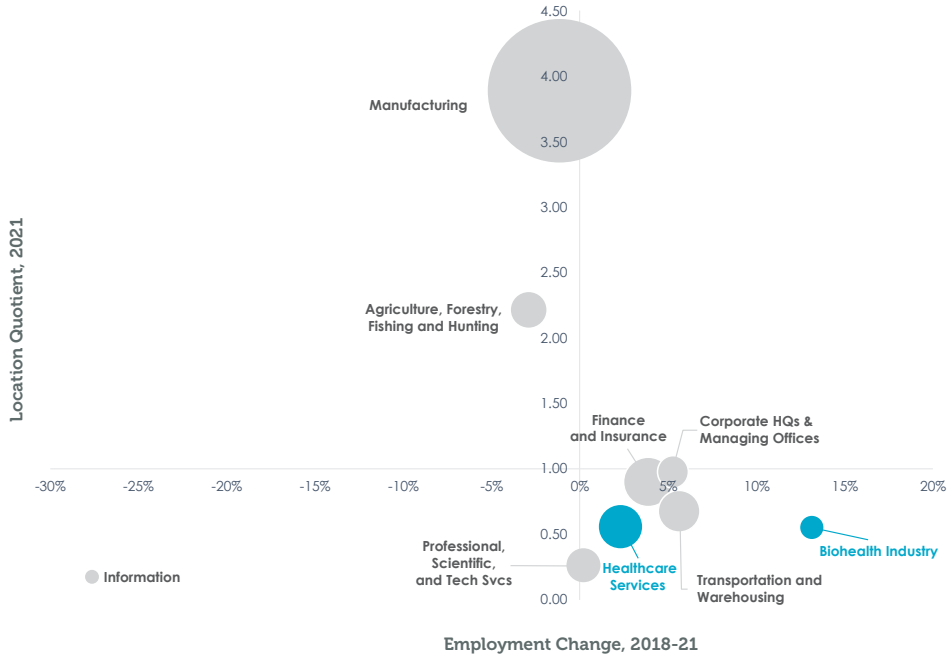
La Crosse Region



Eau Claire Region



Sheboygan Region



Source: TEConomy Partners LLC analysis of Bureau of Labor Statistics, QCEW data from Lightcast (Datarun 2022.3).

Broader Measures of Economic Impacts

Tables A-3 through A-5 detail additional and broader measures of the Biohealth Economy's economic impacts for the State of Wisconsin.

Table A-3: Economic Impacts of the "Extended" Biohealth Economy in Wisconsin, 2021

Impact Type	Employment	$ in Billions					
		Labor Income	Value Added	Output	Local/County Tax Revenue	State Tax Revenue	Federal Tax Revenue
Direct Effect	201,027	$17.157	$23.569	$45.698	$0.326	$0.838	$3.544
Indirect Effect	110,389	$6.448	$10.006	$18.727	$0.246	$0.412	$1.245
Induced Effect	132,826	$6.573	$11.737	$20.506	$0.525	$0.691	$1.409
Total Effect	444,242	$30.178	$45.312	$84.931	$1.096	$1.941	$6.198
Multiplier	2.21	1.76	1.92	1.86			

Source: TEConomy Partners analysis using employment data developed by TEConomy and IMPLAN State of Wisconsin model.
Extended Biohealth Economy includes Biohealth Industry and Healthcare Services.

Table A-4: Economic Impact of Wisconsin's University Biohealth Research

Impact Type	Employment	$ in Billions					
		Labor Income	Value Added	Output	Local/County Tax Revenue	State Tax Revenue	Federal Tax Revenue
Direct Effect	4,754	$0.374	$0.522	$1.050	$0.000	$0.010	$0.072
Indirect Effect	3,221	$0.195	$0.299	$0.570	$0.007	$0.012	$0.040
Induced Effect	3,194	$0.158	$0.282	$0.493	$0.013	$0.017	$0.034
Total Effect	11,169	$0.728	$1.103	$2.113	$0.019	$0.040	$0.146
Multiplier	2.35	1.94	2.11	2.01			

Source: TEConomy Partners analysis using 2020 higher education research and development expenditures
from NSF (most recent available) and IMPLAN State of Wisconsin model.

Table A-5: Estimated Economic Impact of the Broadest Measure of the Wisconsin Biohealth Economy, 2021

Impact Type	Employment	$ in Billions					
		Labor Income	Value Added	Output	Local/County Tax Revenue	State Tax Revenue	Federal Tax Revenue
Direct Effect	205,781	$17.532	$24.091	$46.748	$0.326	$0.848	$3.615
Indirect Effect	113,610	$6.644	$10.304	$19.297	$0.253	$0.425	$1.285
Induced Effect	136,021	$6.731	$12.020	$20.999	$0.537	$0.708	$1.443
Total Effect	455,412	$30.906	$46.415	$87.044	$1.116	$1.981	$6.344
Multiplier	2.21	1.76	1.93	1.86			

Source: TEConomy Partners analysis using data developed by TEConomy and IMPLAN State of Wisconsin model.
Broadest measure combines Biohealth Industry, Healthcare Services, and University Biohealth Research.

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