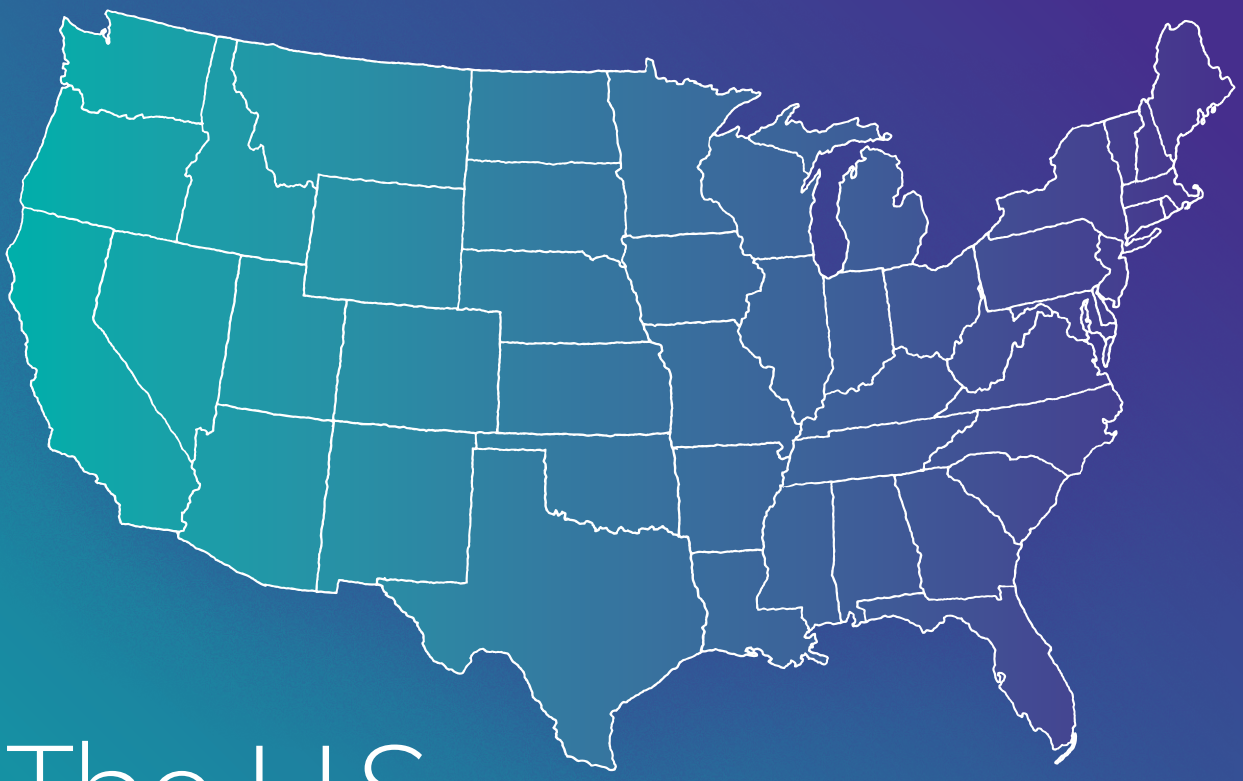
TECONOMY / BIO 2024



The U.S. Bioscience Economy:

Driving Economic Growth and Opportunity in States and Regions

TECONOMY PARTNERS LLC

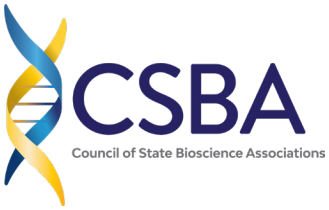
CSBA
Council of State Bioscience Associations

Bio
Biotechnology Innovation Organization

BIO is the world's largest trade association representing biotechnology companies, academic institutions, state biotechnology centers and related organizations across the United States and in more than 30 other nations. BIO members are involved in the research and development of innovative healthcare, agricultural, industrial, and environmental biotechnology products. BIO also produces the BIO International Convention, the world's largest gathering of the biotechnology industry, along with industry-leading investor and partnering meetings held around the world.

TEConomy Partners, LLC is a global leader in research, analysis and strategy for innovation-driven economic development. Today we're helping nations, states, regions, universities and industries blueprint their future and translate knowledge into prosperity. The principals of TEConomy Partners include the authors of the prior Battelle/BIO State Bioscience Development reports, published since 2004. For further information, please visit www.teconomypartners.com.

PMP Public Affairs Consulting, Inc.—PMP— is an independent consulting firm serving the public and constituent relations needs of bioscience-related companies and associations.



The Council of State Bioscience Associations (CSBA) is a confederation of state-based, non-profit trade organizations each governed by its own board of directors. The common mission of the members of the CSBA is to promote public understanding and to advocate for public policies that support the responsible development of the bioscience industry. These groups are recognized by BIO as affiliate organizations in their respective states. To learn more please visit: bio.org/csba

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Introduction, Highlights, and Key Findings

The bioscience industry sits at a unique and exciting intersection of key characteristics for societal and economic progress—generating high levels of innovation that save and improve lives through advancements in biomedical, industrial, agricultural, and environmental technology domains, while also consistently offering a growing and varied mix of high-wage employment opportunities that help drive the nation's economy.

This outsized economic vitality and health and quality-of-life dividend are further realized by individual states and regions where the biosciences represent a major targeted industry focus for economic development.

This report marks the 20th anniversary of a biennial series dating back to 2004 and provides an updated assessment of the economic progress and geographic footprint of the bioscience industry across U.S. states and regions. It details the recent performance of the bioscience industry and its supportive ecosystem for innovation, with a focus on academic research, federal funding for R&D, the innovation context via patent activities, and venture capital investments. Further, it highlights aspects of the industry's functional impacts including its value to humanity as well as the advancement of regional bioscience "Tech Hubs" that aim to enhance the nation's economic and national security.

This report, and its accompanying state profiles, continues to shine a spotlight on the activities and economic benefits realized across the U.S., as the bioscience industry has an extensive economic reach and impacts every region of the country. While this latest report finds the industry has continued to grow and advance its ecosystem, it also finds economic challenges and headwinds for the bioscience sector and its major subsectors in the form of hiring slowdowns, and even rising layoff activity. As this report has long documented, however, the industry is not only innovative, but it is also economically resilient and has historically emerged from economic challenges to drive societal and economic progress.

In 2023, the nation's bioscience industry represents:

- Nearly 2.3 million employees in almost 150,000 U.S. business establishments.
- A significant, outsized driver of expanding national economic impacts, totaling $3.2 trillion.

National Bioscience Industry Highlights

The U.S. bioscience industry has maintained its long-term growth trend; however, this growth has slowed in the last year amidst a more cautious investment and hiring environment and accelerating layoff announcements. The resilient industry, however, continues to generate high-quality, high-wage jobs that drive significant and growing economic impacts for the nation. Highlights from the latest national industry analyses include:

- In 2023, bioscience companies employed 2.29 million Americans across nearly 150,000 individual business establishments with a footprint in every U.S. state.

- The industry has maintained its long-term growth trend with employment increasing by nearly 15 percent since 2019, well outpacing the nation's overall private sector job growth during this period that includes the global pandemic and subsequent economic recovery. In 2023, industry hiring slowed, however, and the net job gain for the biosciences was just 1.2 percent.

- While all five bioscience industry subsectors have increased their employment and outpaced the nation's private sector growth rate since 2019, nearly all experienced a slower pace of hiring in 2023.

- The bioscience industry continues to employ a highly-skilled and STEM-intensive workforce that is reflected in its high-wage jobs. In 2023 the average U.S. bioscience worker earned more than $132,000 per year, which is $60,000 or 83 percent more than the nation's private sector average.

- The industry's skilled workforce continues to drive innovation and create value which is reflected through the sector's economic impacts.

    - The total economic impact of the bioscience industry on the U.S. economy, as measured by overall output, totaled more than $3.2 trillion in 2023 (Figure 1).[1]

    - The industry generated and supported $1.68 trillion in value added in 2023, accounting for 6.8 percent of U.S. private sector GDP.[2]

    - The industry's nearly 2.3 million employees and their associated economic output support nearly 8.0 million additional jobs throughout the economy through indirect and induced effects.

    - Bioscience industry impacts are growing, compared with those measured in 2021, the industry's total economic impacts have increased by $350 million, or 12 percent over the 2-year period (Figure 2).

1 The impacts developed in this report are focused solely on the economics of the production of bioscience research, manufacturing, and distribution services. These impacts do not include the immeasurable economic benefits stemming from improvements to agricultural crop and livestock production, new and sustainable industrial products, and human health and well-being derived from the work of the U.S. bioscience industry.

2 Accounts for 6.0 percent of total U.S. GDP.

Figure 1: Economic Impacts of the U.S. Bioscience Industry, 2023

DIRECT IMPACT

2.3M

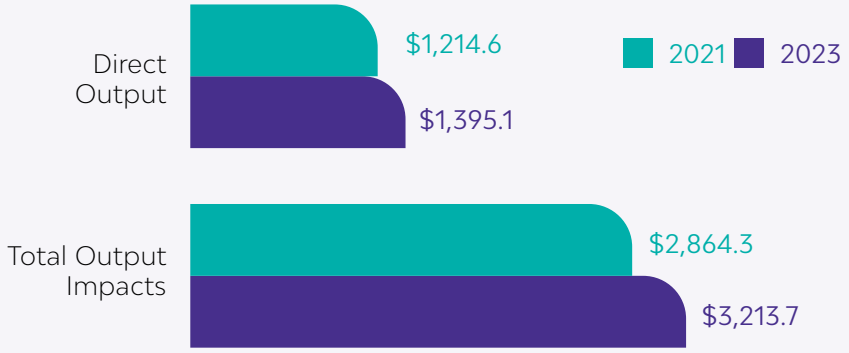
Bioscience Industry Employment

TOTAL IMPACTS

10.3M Employment	$1.7T Value Added	$882B Wages & Benefits
$3.2T Economic Output	$132B State and Local Taxes	$216B Federal Taxes

Note: For detailed definitions and a discussion of the concepts used in the economic impact analysis, see the impact section beginning on page 14 of this report as well as the Appendix.
Source: TEConomy Partners data and analysis using IMPLAN Input-Output Models.

Figure 2: Economic (Output) Impacts of the U.S. Bioscience Industry, 2021 and 2023 ($B)



Note: Direct output represents the total value of production or sales generated by the bioscience industry's operations and expenditures, it is a measure of total economic activity. For detailed definitions and a discussion of the concepts used in the economic impact analysis, see the impact section beginning on page 14 of this report as well as the Appendix.
Source: TEConomy Partners data and analysis using IMPLAN Input-Output Models.

State and Metropolitan Area Industry Highlights

The U.S. bioscience industry has a vast, well-distributed geographic footprint that extends to every state and region. The industry's breadth and diversity translate into significant market and economic development opportunities for most states; in fact, a majority of states have a "specialized" concentration in at least one of the five major bioscience industry subsectors.

- Thirty-four states and Puerto Rico have a specialization in at least one of the five bioscience subsectors in 2023.
- National industry job growth has been driven by almost every state—over the 2019 to 2023 period, 49 states, DC, and Puerto Rico experienced net job growth in the bioscience industry.

Likewise, a majority of the nation's metropolitan areas can claim a niche specialization in the biosciences—more than half (53 percent) or 203 regions, have a specialized employment concentration in at least one bioscience industry subsector or market.

Innovation Ecosystem Assessment Highlights

Somewhat similar to the industry assessment, an analysis of the bioscience industry's innovation ecosystem might be summarized as a "mixed" performance, where some elements continue to grow, though at a slower pace, and others have seen significant downward trends in recent years. Headlines and highlights from the ecosystem assessment include:

- **University Bioscience R&D Activity—Steady Growth Accelerates in Latest Year.** National academic R&D expenditures in bioscience-related fields have increased by 17 percent from 2019, with the latest 3-year average annual growth trend essentially matching that of the previous 3-year period. In 2022, however, bioscience-related academic R&D spending accelerated, rising by 8 percent, the largest annual increase recorded since 2011.
- **NIH Research Funding Grows, but at a Slower Pace in Recent Years.** NIH funding levels have increased by 23 percent since 2019, with annual growth averaging 5.3 percent during this 4-year period, a pace that has slowed from an average of 7.2 percent over the prior 4-year period.
- **Bioscience Patent Awards Level Off in 2023 After Several Years of Declines.** From 2019 through 2023, patent awards with at least one U.S. inventor or assignee in bioscience-related technology classes and categories have experienced a downward overall trend, although the total leveled-off from 2022 to 2023 with a slight gain.
- **Bioscience Venture Capital Investments See Significant Declines from All-Time Surge in 2021.** From 2019 through 2021, the U.S. bioscience industry saw a surge in investor interest in the sector that coincided with the global pandemic and other advancements in areas including genomics, personalized medicine, and digital health technologies. Since peaking at an all-time high in 2021, VC investments to the industry are down by 49 percent.

The U.S. Bioscience Industry Maintains its Long-Term Growth Trend, though with a Slower Pace of Hiring in 2023 Amidst Rising Layoff Announcements

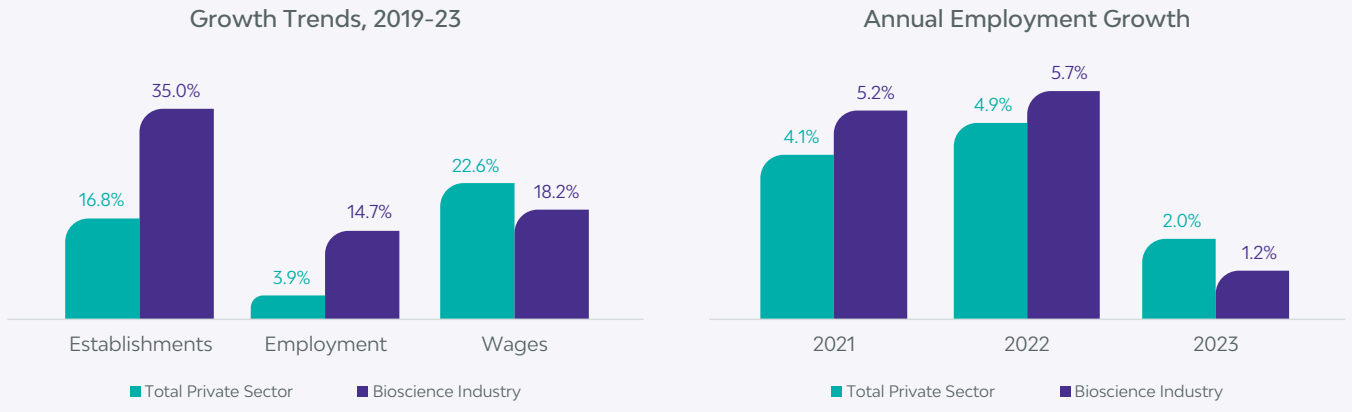
The U.S. bioscience industry has maintained its long-term growth trend with employment increasing by nearly 15 percent since 2019, well outpacing the nation's overall private sector job growth during this period that includes the global pandemic and subsequent economic recovery.

In 2023, industry hiring slowed, however, and the net job gain for the biosciences was just 1.2 percent (Figure 3). After posting strong gains in 2021 and 2022, bioscience employers have moderated their hiring.

By 2023, bioscience companies employed 2.29 million Americans across nearly 150,000 individual business establishments and with a footprint in every U.S. state. Bioscience industry establishments and average wages have, similar to employment, grown at double-digit rates since 2019 as the industry continues to generate high-quality jobs and expand its physical footprint. Annual industry wages reached more than $132,000, on average, far exceeding the overall private sector average and contributing to the bioscience industry's large and outsized national economic impacts.

The biosciences have long represented a steady economic engine for the U.S. economy, with the industry demonstrating its resiliency during recent recessions

Figure 3: Employment, Establishment, and Wage Trends for the U.S. Bioscience Industry, 2019-2023



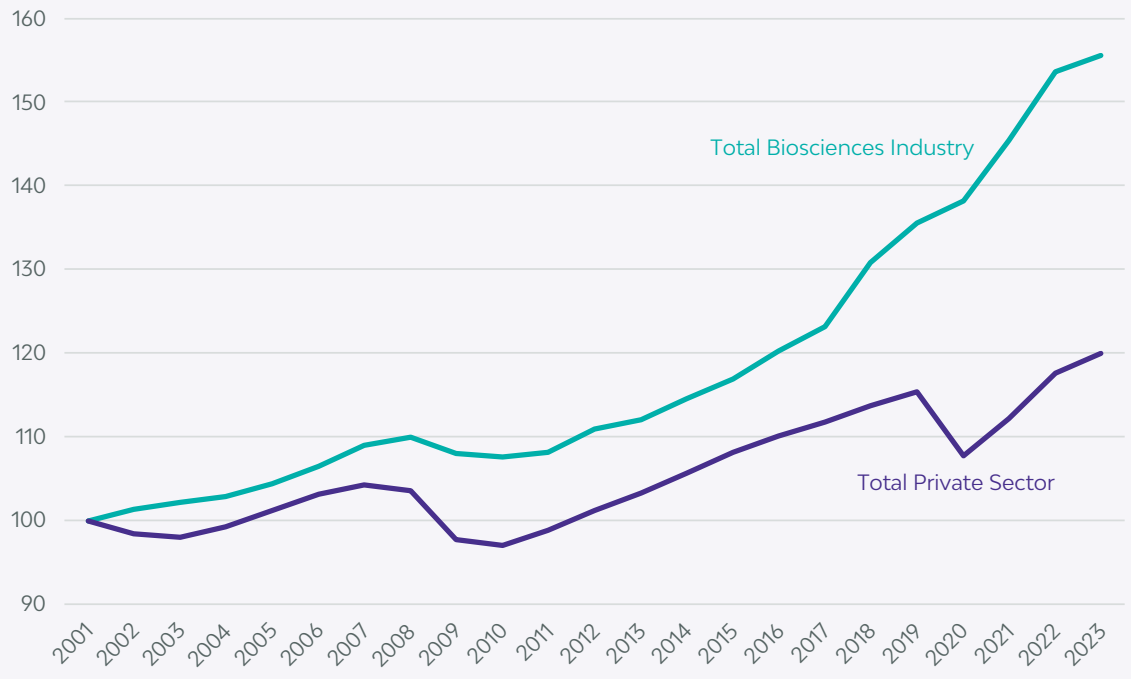
Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

and through the COVID-19 pandemic (Figure 4). Likewise, the bioscience industry has typically outpaced job growth in other leading advanced industries and has done so significantly during this latest 4-year period (Figure 5).

The recent slowdown in biosciences job growth in 2023, however, is concerning, and ongoing. The slower growth follows a period of rapid hiring and industry expansion coming out of the pandemic, which coincided with surging venture capital investments, rapid advancements in bioscience and biotech innovations in vaccines, diagnostics, and therapeutics, and increasing investments in new areas of expertise, including AI and other advanced digital health and MedTech technologies. In 2022, the economic landscape shifted with rising inflation, rising interest rates, and downturns in public markets, and companies and investors turned significantly more cautious. As 2023 arrived, hiring continued in some parts of the industry, however there were notable increases in layoff announcements. Fierce Biotech has been actively tracking layoffs in biopharmaceuticals and cites 187 workforce reduction announcements in 2023, a 57 percent rise compared with the prior year.[3] While some industry leaders pointed to a market correction following the strong hiring and investment peaks of 2021 and 2022, the continuation of layoff actions into 2024 is concerning and announcements are on pace to exceed those seen in 2023.[4] Going forward, the long-term outlook for the industry remains positive, but the industry continues to face a challenging operating environment and slower growth.

A key characteristic of the bioscience industry, and a driver of the industry's wide-reaching innovation and societal impacts, is its varied makeup of companies

Figure 4: Employment Growth Trends for the U.S. Bioscience Industry and Private Sector, 2001-23, Employment Index (2001 = 100)

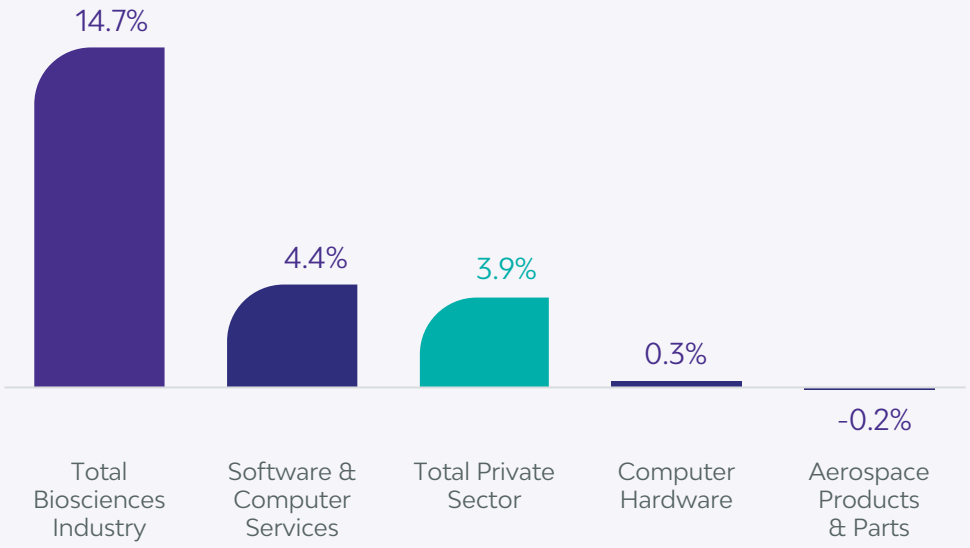


Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

3 Fierce Biotech, see: https://www.fiercebiotech.com/biotech/every-bad-signal-theres-good-sign-not-far-behind-biopharma-layoffs-rise-57-yoy-hope-2024.

4 Fierce Biotech, see: https://www.fiercebiotech.com/biotech/2024s-layoff-woes-continue-q2-fierce-biotech-analysis.

Figure 5: Employment Growth Trends—Biosciences vs. Other Technology Industries, 2019-2023



Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

delivering a wide range of market and product solutions. From seeds to alternative jet fuels and from wearable electronic medical devices to vaccines and innovative therapeutics, the biosciences are far from monolithic. TEConomy and BIO define the industry to span five major subsectors (see "Defining the Bioscience Industry"), and just as the industry advances distinct products and markets, each has its own economic and business dynamics.

Since 2019, all five subsectors have increased their employment and outpaced the nation's private sector growth rate (see Figure 6 and Table 1). Three of the five have increased employment at double-digit growth rates during this period, however most all experienced slower hiring in 2023. Highlights for each subsector and their respective performance include:

- **Research, testing, and medical laboratories** is the largest employer among the five subsectors, accounting for just over one in three U.S. bioscience jobs (35 percent). In 2023 subsector companies employed just over 790,000 in more than 60,000 individual business establishments. The subsector has grown its employment base by nearly 24 percent since 2019—the fastest growth rate among the five subsectors and particularly impressive recognizing it has the largest total employment level. The subsector has helped to drive growth since 2019, averag-

While growth has been robust for the biosciences over the latest 4-year period overall, the slower growth experienced in the biosciences has played out at the subsector level, with four of the five seeing markedly slower growth in 2023.

ing 5.5 percent job growth annually; but, like the overall bioscience industry, employment growth slowed substantially in 2023, increasing just 1.9 percent. Seventy percent of the subsector jobs are in biotechnology and other commercial life sciences R&D and testing labs, with the remainder in medical labs. Both major components of the subsector have grown significantly since 2019, increasing employment by 29 percent and 14 percent, respectively.

- **The pharmaceutical manufacturing subsector** has also experienced strong job growth since 2019, increasing employment by nearly 13 percent to just over 360,000 in 2023. The subsector accounts for 16 percent of total bioscience jobs and operates across 7,420 establishments nationwide. All four detailed industry components within the subsector have grown since 2019, led by 31 percent job growth in medicinal and botanicals production and by 25 percent growth in the fast-growing biologics manufacturing sector. Subsector job growth has averaged 3.1 percent annually since 2019 but saw its growth slow in 2023 to just 0.7 percent. Pharmaceutical manufacturing is closely tied to the upstream commercial R&D, including biotechnology R&D, and activities captured within the research, testing, and medical labs subsector.

- **Medical device and equipment manufacturers** employed nearly 416,000 in 2023 or almost one in five U.S. bioscience workers. Employers in the subsector have grown their payrolls by 6 percent since 2019, averaging 1.5 percent growth annually. Medical device companies, however, saw a modest net employment decline of 1.1 percent in 2023, the only job decline among the bioscience subsectors over the year. Most of the component industries within the subsector have contributed to the overall

Defining the Bioscience Industry

Defining the biosciences is challenging due to its diverse mix of technologies, products and markets, R&D focus, and companies themselves. The industry includes companies engaged in advanced manufacturing, research activities, and technology services but has a common thread in their application of knowledge in the life sciences and how living organisms function. At a practical level, federal industry classifications do not provide for one over-arching industry code that encompasses the biosciences. Instead, two dozen detailed industries must be combined and grouped to best organize and track the industry in its primary activities.

The TEConomy/BIO biennial reports have developed an evolving set of major aggregated subsectors that group the bioscience industry into five key components, including:

Agricultural feedstock and industrial biosciences—Firms engaged in agricultural research and development, processing, organic chemical manufacturing, and fertilizer manufacturing. The subsector includes industry activity in the production of ethanol and other biofuels.

Bioscience-related distribution—Firms that coordinate the delivery of bioscience-related products spanning pharmaceuticals, medical devices, and ag biotech. Distribution in the biosciences is unique in its deployment of specialized technologies including cold storage, highly regulated monitoring and tracking, and automated drug distribution systems.

Medical devices and equipment—Firms that develop and manufacture surgical and medical instruments and supplies, laboratory equipment, electromedical apparatus including MRI and ultrasound equipment, and dental equipment and supplies.

Pharmaceuticals—Firms that develop and produce biological and medicinal products and manufacture pharmaceuticals and diagnostic substances.

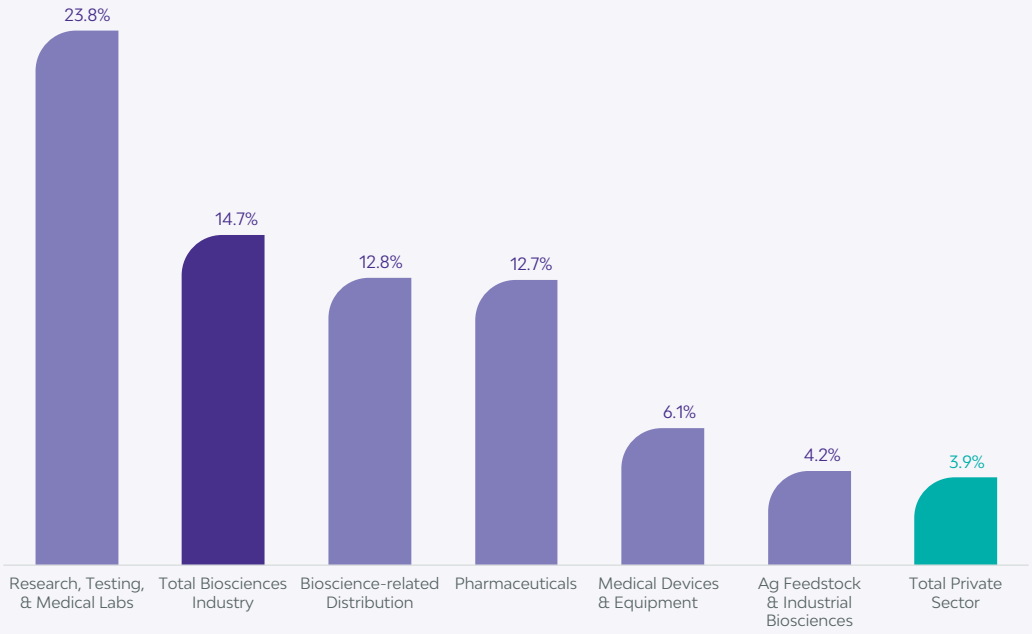
Research, testing, and medical laboratories—Firms engaged in research and development in biotechnology and other life sciences, life science testing laboratories, and medical laboratories. Includes contract and clinical R&D organizations.

growth since 2019, led by 17 percent growth in analytical lab instruments and 8 percent growth in surgical and medical instruments. The only industry to see a net decline since 2019 has been irradiation apparatus manufacturing (down 5 percent). Medical device companies operate just over 12,000 business establishments, a footprint which has increased by 32 percent since 2019.

- **Agricultural feedstock and industrial biosciences** has experienced a 4.2 percent increase in jobs since 2019 to reach 71,510 in 2023 across nearly 2,100 U.S. business establishments. Subsector companies accelerated their hiring in 2023, increasing employment by 2.3 percent in this latest year and running counter to the slower growth seen in the other bioscience subsectors. Within the subsector, hiring trends have been mixed, though overall there has been growth in both agricultural feedstock and in the agricultural chemicals manufacturing component.
- **Bioscience-related distribution** operations employ more than 649,000 in important activities across the industry value chain, accounting for a sizable 28 percent of bioscience industry jobs. The subsector has increased employment by nearly 13 percent since 2019 with contributions from each of the three component industries, including from its largest—medical, dental, and hospital equipment, which has grown by an impressive, 20 percent rate since 2019. Similar to most other major bioscience subsectors, the distribution sector saw slower growth in 2023.

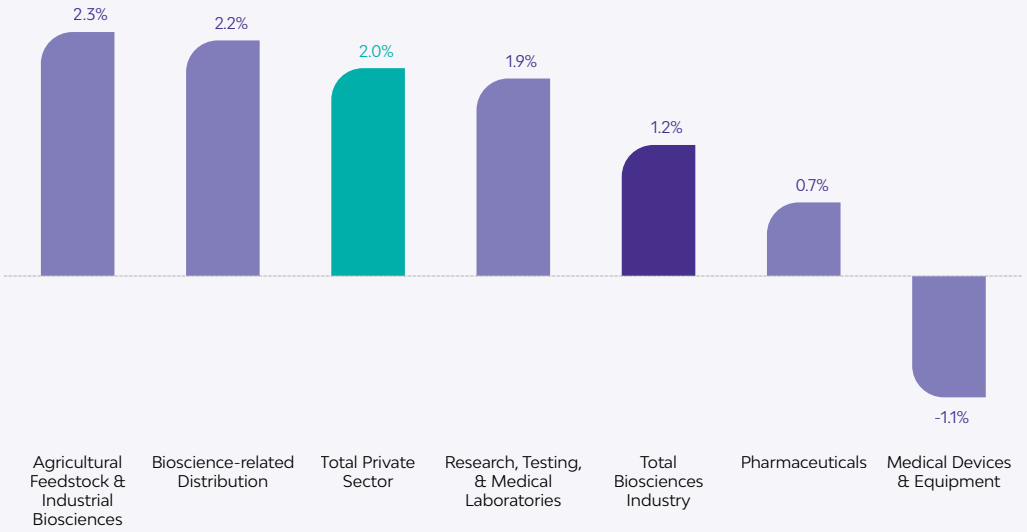
While growth has been robust for the biosciences over the latest 4-year period overall, the slower growth experienced in the industry has played out at the subsector level, with four of the five seeing markedly slower growth in 2023 (Figure 7).

Figure 6: Employment Growth Trends, Bioscience Industry and Major Subsectors, 2019-23



Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Figure 7: Employment Growth Trends, Bioscience Industry and Major Subsectors, 2022-23



Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Table 1: U.S. Bioscience Establishment and Employment Summary, 2023 and Recent Trends

Bioscience Industry & Major Subsectors	Establishments		Employment	
	Count, 2023	Change, 2019-23	Count, 2023	Change, 2019-23
Agricultural Feedstock & Industrial Biosciences	2,087	14.4%	71,510	4.2%
Bioscience-related Distribution	67,759	17.6%	649,328	12.8%
Medical Devices & Equipment	12,055	32.1%	415,818	6.1%
Pharmaceuticals	7,420	52.7%	360,345	12.7%
Research, Testing, & Medical Laboratories	60,424	61.4%	790,268	23.8%
Total Biosciences	**149,744**	**35.0%**	**2,287,268**	**14.7%**

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

The Bioscience Industry's Value to Humanity: Unlocking the Power of Life

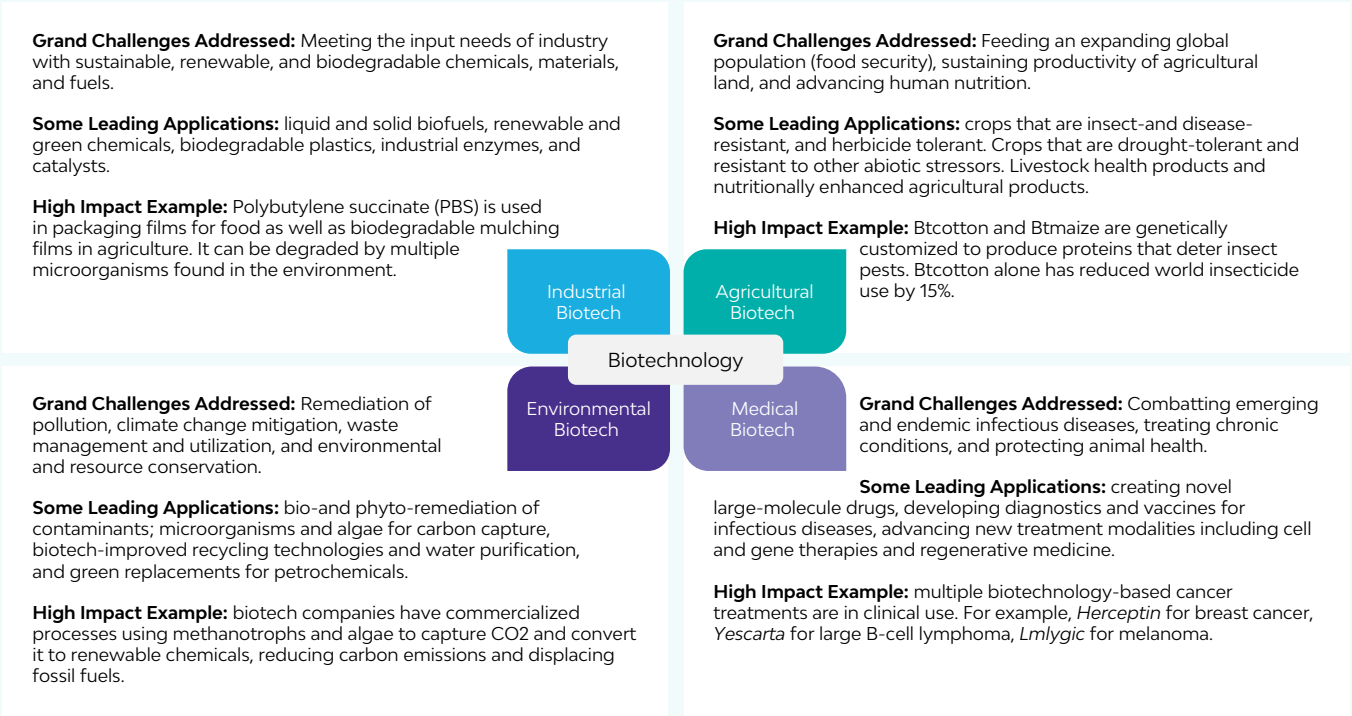
The bioscience industry, and biotechnology, is at the forefront of innovation, combining biological systems and advanced technologies to enhance our lives, protect the environment, and grow our economy. This vital field offers solutions that tackle critical needs and challenges in human and animal health, food security, environmental resiliency, sustainable development, and more.

Biotechnology is working toward a world where diseases (in humans and animals) are effectively treated, crops are highly productive and resilient, food production is more abundant and safer, industrial materials and chemicals are green and sustainable, and the environment and natural resources protected. Modern biotechnology makes this possible through a range of high-impact scientific discoveries and technological innovations, such as:

- CRISPR Gene Editing – precision tools for customizing genetic code.
- Advanced Fermentation – efficiently producing valuable biomolecules.
- Bioreactors – scaling up biological processes for widespread industrial use.
- High-Tech Analytical and Process Tools – analyzing and purifying biological materials with high precision.

Biotechnology is at the forefront in shaping a healthier, more sustainable future, while its innovations are the basis for dynamic new industry sectors with high paying jobs. Figure 8 illustrates how biotechnology, with its innovative approaches and practical solutions, is actively addressing major global challenges, transforming industries, and improving lives every day through a diverse range of applications.

Figure 8: Illustration of Leading Biotechnology Domains and Impact Areas



Source: TEConomy Partners, LLC.

A High Value Industry

The $1.4 trillion U.S. bioscience industry harnesses biological systems and organisms to develop innovative products and technologies that address critical challenges in healthcare, food production, agriculture, industry, and environmental sustainability. These innovations help propel new economic growth and job creation rooted in U.S. investment in life science research and associated technology leadership. With products providing life-saving medical treatments, enhancing food security, and creating valuable bio-based inputs for industry, biotechnology addresses global market needs and opportunities valued in the trillions of dollars.

By driving innovation and offering solutions to pressing global issues like climate mitigation, heath, and food security, biotechnology plays a crucial role in advancing human health, improving quality of life, and fostering economic growth across multiple sectors of the economy. Additionally, the economic footprint of the sector, as shown in this report, positively impacts every U.S. state.

Bioscience Industry Wage Premiums Reflect Innovation Activities, Outsized Demand for Highly Skilled STEM Talent

The economic importance and impacts of the bioscience industry are reflected in the wage levels paid to its workforce. Employees in the biosciences earn wages well above their counterparts in other major U.S. industries, a reflection of the innovations advanced by the industry and its strong value-adding activities, as well as the high-skilled, STEM-intensive nature of its jobs.

In 2023, the average U.S. bioscience worker earned more than $132,000 per year, which is $60,000 or 83 percent more than the nation's private sector average (Table 2). Average wages for each of the industry's five major subsectors now exceed $100,000 and are significantly higher than those in the private sector and most other major U.S. industries.

Findings from the latest biennial assessment of bioscience/life sciences workforce trends by TEConomy and the Coalition of State Bioscience Institutes (CSBI) affirm the industry's role as an outsized employer of STEM-related roles and skills[5]:

> *"The U.S. life sciences industry has an outsized concentration and demand for skilled STEM talent with postsecondary education and training credentials. As a highly innovative, science- and discovery-driven sector, the life sciences have a more-than-five-times greater concentration of individuals employed in STEM occupations compared with the overall private sector economy—fully one-third (34%) of all life science industry jobs fall within a STEM role.*
>
> *At the same time, 82% of all life science industry roles have minimum typical entry-level requirements that can be classified as either middle- or high-skilled occupations. High-skilled jobs most often require a bachelor's or higher degree for entry, whereas middle-skill jobs most typically require education and/or training beyond a high school diploma, but less than a bachelor's degree."*

Table 2: Average Annual Wages for the Bioscience Industry and Other Major U.S. Industries, 2023

Biosciences & Other Major U.S. Industries	Average Annual Wages, 2023
Information	$154,924
Research, Testing, & Medical Laboratories	**$151,006**
Finance and Insurance	$135,760
Bioscience-related Distribution	**$133,088**
Total Biosciences	**$132,314**
Pharmaceuticals	**$131,562**
Professional, Scientific, and Technical Services	$121,257
Agricultural Feedstock & Industrial Biosciences	**$101,825**
Medical Devices & Equipment	**$101,478**
Manufacturing	$82,582
Construction	$77,185
Real Estate and Rental and Leasing	$74,495
Total Private Sector	**$72,384**
Transportation and Warehousing	$63,980
Health Care and Social Assistance	$62,850
Retail Trade	$41,136

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

5 TEConomy Partners, LLC and CSBI, "2023 Life Sciences Workforce Trends Report: A Rapidly Evolving Industry and its Impact on Talent Dynamics," June 2023.

Bioscience Industry Economic Impacts: A $3.2 Trillion Contribution to the U.S. Economy

The nearly 2.3 million U.S. bioscience industry workers are employed across every U.S. state, the District of Columbia, and Puerto Rico and together create and support a significant national economic impact. The bioscience industry has a broad and often interdependent supply chain for its research, production, and distribution activities, including supplier relationships among the bioscience sectors themselves. The industry both supports and depends upon other sectors to supply everything from utilities, such as water and electricity, to legal and other business services to production machinery and commodity inputs. In addition, industry employees who earn high average wages generate demand for goods and services through their own personal spending. As a result, the bioscience industry has a national economic impact that supports and multiplies well beyond the industry's direct employment.

Key Findings from the Economic Impact Analysis of the Bioscience Industry Include:

- The bioscience industry's total economic impact on the U.S. economy totaled more than $3.21 trillion dollars in 2023.
- The industry generated and supported $1.68 trillion in value added in 2023, accounting for 6.8 percent of U.S. private sector GDP.
- The industry's nearly 2.3 million employees and their associated economic output support nearly 8.0 million additional jobs throughout the economy through indirect and induced effects.

Economic impact analysis measures these types of impacts and effects described, including:

- *Direct effects:* the direct employment and other economic activity generated by the bioscience industry's operations and expenditures;
- *Indirect effects:* the economic activity generated by supplier firms to the bioscience industry; and
- *Induced effects:* the additional economic activity generated by the personal spending of the direct bioscience employees and the employees of the supplier firms in the overall economy.

The sum of these three effects is referred to as the total economic impact. TEConomy estimated the total economic impact of the U.S. bioscience industry in 2023 based on employment values for each detailed industry sector within the biosciences and evaluated the impacts across several key economic measures:

- *Employment.* The total number of full- and part-time jobs in all industries;
- *Personal Income.* The wages and salaries, including benefits, earned by the workers and proprietors holding the created and supported jobs;
- *Value-Added.* The difference between an industry's total output and the cost of its labor and other inputs; also considered to be the industry's contribution to gross state or gross domestic product (GSP or GDP); and
- *Output.* The total value of production or sales in all industries; a measure of total economic activity.[6]

6 The total output impacts are commonly referred to as the "economic impact" of an industry, project, or investment.

Additionally, the model allows for a high-level estimation of tax revenues generated by the economic activity at the local/county, state, and at a federal level. These tax revenues include estimates of a variety of corporate and personal tax payments, including both the employer and employee portions of social insurance taxes.

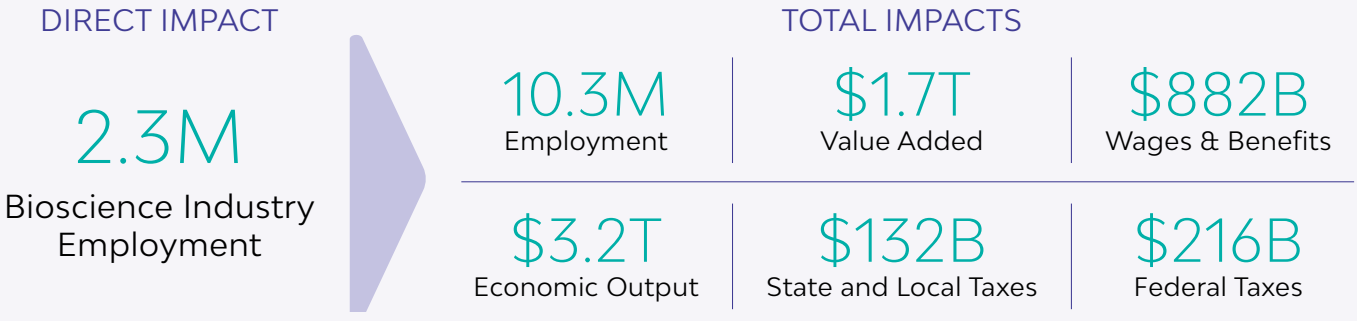
The total economic impact of the bioscience industry on the U.S. economy, as measured by overall output, totaled $3.21 trillion dollars in 2023 (Figure 9 and Table 3). This impact is generated by the direct industry output ($1.40 trillion) combined with the indirect and induced impacts, which total an additional $1.82 trillion for an industry output "multiplier" of 2.30. This means that for every $1 in industry output, an additional $1.30 in output is generated throughout the rest of the national economy.

A key economic indicator of the importance of the bioscience industry to the U.S. economy is estimated via the industry's value added. With the bioscience industry generating a direct value added of $683.3 billion and supporting a total value added of $1,675.1 billion in 2023, the industry accounted for 2.8 percent and 6.8 percent of U.S. private sector GDP, respectively.

The 2.29 million bioscience employees, and their associated economic output, support nearly 8.0 million additional jobs throughout the entire U.S. economy through both indirect and induced effects. These additional jobs span numerous other industries including key purchased product inputs, real estate, production machinery and research instruments, legal services, transportation, information technology, and utilities. The industry's employment multiplier is 4.48, which means that for every one bioscience job an additional 3.48 jobs are supported throughout the rest of the national economy.

Contributions to local/county, state, and federal tax revenues are an additional economic impact of the nation's bioscience industry. Through the corporate, personal income, and other taxes paid by bioscience firms, their suppliers, and their workers, the bioscience industry generates substantial tax revenue. These total taxes, through combined direct and multiplier effects, are estimated to have contributed $50 billion to local/county governments, $82 billion to state governments and $216 billion to the federal government in 2023.

Figure 9: Economic Impacts of the U.S. Bioscience Industry, 2023



Source: TEConomy Partners data and analysis using IMPLAN Input-Output Models.

Table 3: Economic Impacts of the U.S. Bioscience Industry, 2023 ($ in Billions)

Impact Type	Employ-ment	$ in Billions					
		Labor Income	Value Added	Output	Local/ County Tax Revenue	State Tax Revenue	Federal Tax Revenue
Direct Effect	2,287,268	$308.1	$683.3	$1,395.1	$16.4	$30.0	$82.7
Indirect Effect	3,619,382	$293.8	$483.8	$922.7	$12.6	$21.8	$67.5
Induced Effect	4,345,785	$279.9	$507.9	$895.9	$21.3	$29.8	$65.8
Total Effect	**10,252,436**	**$881.9**	**$1,675.1**	**$3,213.7**	**$50.3**	**$81.6**	**$216.0**
Multiplier	4.48	2.86	2.45	2.30			

Source: TEConomy Partners data and analysis using IMPLAN Input-Output Models.

U.S. Regions Aim to Enhance Bioscience Strengths, Deepen Innovation, and Fund Collaborative Cluster Projects via Highly Competitive Federal "Tech Hubs" Program

Recognizing the outsized economic development impacts and broader value to humanity of bioscience industry development and innovations, numerous states and regions have identified the industry as a "targeted" cluster for development that leverages their unique portfolio of industry and broader ecosystem strengths and partner organizations. A major new federal funding opportunity aligns with these efforts via a significant programmatic initiative aimed at enhancing U.S. competitiveness and national security in future-focused technologies and industries, including the biosciences.

Background on the Tech Hubs Program

The U.S. Regional Innovation and Technology Hubs Program ("Tech Hubs") was authorized by the CHIPS and Science Act in 2022 with the aim of bolstering the nation's economic and national security by investing in regions with the assets to be globally competitive in future-focused technologies and industries. The program, overseen by the Economic Development Administration (EDA) and authorized with $10 billion for a 5-year period, invests directly in those regions with the capacities and potential to develop as global leaders and serve as innovation centers in approximately 10 years. At the same time, the Tech Hubs Program aims to create high-quality jobs for U.S. workers across skill levels and with an intentional focus on equitable and inclusive growth. To meet these goals, the program requires regions to bring together a diverse group of entities spanning public, private, and academic partners as a consortium for highly collaborative project efforts.

The program has been broken down into two distinct phases:

- In late 2023, President Biden announced the designation of 31 Tech Hubs in addition to 29 awardees of Tech Hubs Strategy Development Grants (SDG) to further develop their regional strategies (Phase 1). These 31 Phase 1 designees were selected from more than 370 total applicants.

- Designated Tech Hubs were then able to apply for a Phase 2 designation and in the Summer of 2024, EDA announced the competitive awarding of $504 million to 12 Tech Hubs, with each Hub receiving between approximately $19 million and $51 million, depending upon the number of distinct proposed projects within each Hub.

The technology and market focus of Tech Hubs are wide ranging, and not solely focused on bioscience-related technologies or industries. Among the two-phased rollout, however, are a significant number of Tech Hub and Strategy Development Grant recipients with a primary focus in a bioscience-related area—16 have been identified by TEConomy and BIO, including 14 Tech Hubs across both phases and 2 SDG recipients. Among the 16 bioscience-related Tech Hubs are 5 large grant recipients under Phase 2. These are summarized under broad categories in Figure 10 and highlighted on the map in Figure 11.

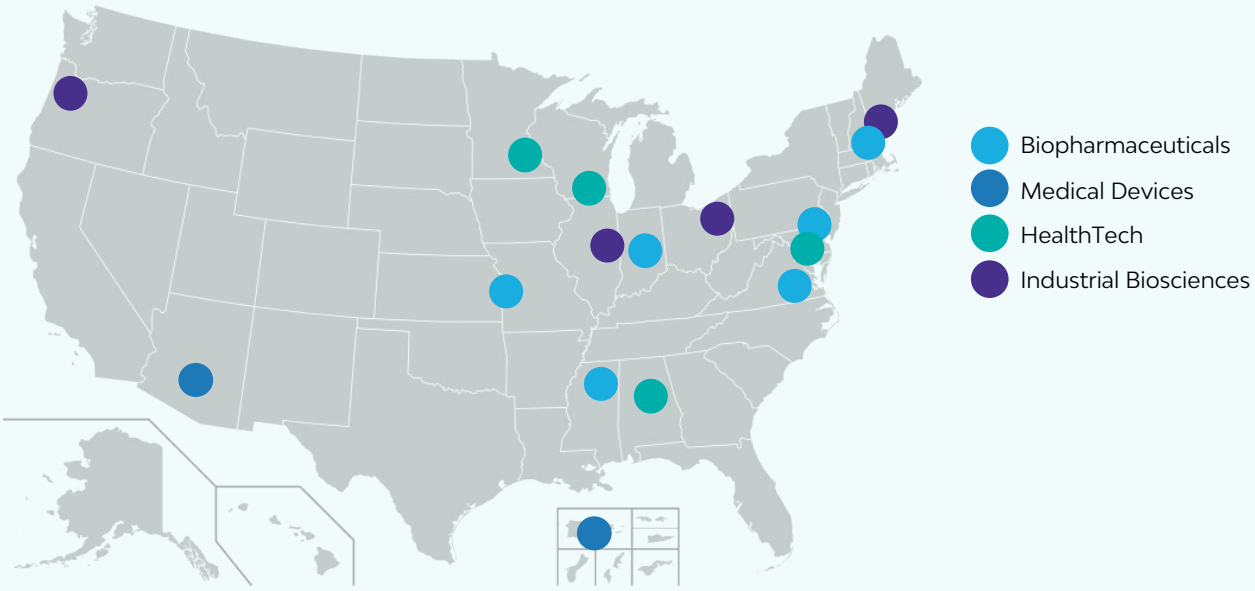
Many of the efforts have been organized and convened by state and regional bioscience industry associations, including CSBA members, who are often in a unique position to play such a role. In the biosciences, the regional Tech Hubs aim to advance numerous critical biomedical and industrial technology areas and solutions key to ensuring U.S. competitiveness and national security into the future, including:

- **Biopharmaceutical-related technologies, including**: biofabrication (for regenerative therapies), biomanufacturing, pharmaceutical ingredients, precision fermentation, precision medicine, vaccine-related biologics.
- **Health Tech, including**: AI biotechnology, personalized medicine, predictive healthcare, smart medical technologies.
- **Industrial Biosciences, including**: mass timber manufacturing, sustainable polymers, and wood biomass polymers.
- **Medical Devices, including**: smart medical device manufacturing.

Figure 10: Bioscience-Related EDA Regional Tech Hubs and Strategy Development Grant Recipients—Tech Hubs in Bold Represent 5 Large Grant Recipients from Phase 2

*Denotes consortiums awarded Strategy Development Grants.

Figure 11: Bioscience-Related EDA Regional Tech Hubs and Strategy Development Grant Recipients



The Bioscience Industry in U.S. States and Metropolitan Areas: Key Findings and Highlights

The U.S. bioscience industry has a vast, well-distributed geographic footprint—extending to every state and region. The industry's breadth and diversity translate into significant market and economic development opportunities for most states; in fact, a majority of states have a "specialized" concentration in at least one of the five major bioscience industry subsectors. Similarly, the industry represents an important economic engine for the nation's metro regions.

Highlights of State Industry Performance

- Thirty-four states and Puerto Rico have a specialization in at least one of the five bioscience subsectors in 2023 (see Table 4). These include:
  - 16 states specialized in Agricultural Feedstock & Industrial Biosciences
  - 10 states and Puerto Rico specialized in Bioscience-related Distribution
  - 12 states and Puerto Rico specialized in Pharmaceuticals
  - 14 states and Puerto Rico specialized in Medical Devices & Equipment
  - 8 states and Puerto Rico specialized in Research, Testing & Medical Laboratories
- Puerto Rico is the only territory that is specialized in four of the five bioscience subsectors. While nine states have a specialization in three subsectors (see callout below), no state has a specialization in all five subsectors.
- National industry job growth has been driven by almost every state—over the 2019 to 2023 period, 49 states, DC, and Puerto Rico experienced net job growth in the bioscience industry.

Measuring Industry Concentration and State/ Regional "Specialization"

Employment concentration is a useful and valuable way in which to gauge the relative importance of an industry like the biosciences 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.

Diverse & Varied Strengths: Nine States and Puerto Rico have a Specialized Employment Concentration in Three or More Bioscience Industry Subsectors

Illinois, Indiana, Massachusetts, Minnesota, Nebraska, New Jersey, North Carolina, Puerto Rico, South Dakota, Utah

Table 4: State Specializations and Job Growth by Bioscience Subsector, 2023

State	Agricultural Feed-stock & Industrial Biosciences		Bioscience-related Distribution		Medical Devices & Equipment		Pharmaceuticals		Research, Testing, & Medical Laboratories	
	LQ	Growth	LQ	Growth	LQ	Growth	LQ	Growth	LQ	Growth
AK						●		●		●
AL	●	●		●		●		●		●
AR	●	●		●		●				●
AZ		●		●		●		●		●
CA				●	●	●			●	●
CO			●	●	●			●		●
CT				●	●	●		●		●
DC				●				●		●
DE		●		●	●			●		
FL				●		●		●		●
GA		●		●		●				●
HI		●								●
IA	●	●	●	●				●		●
ID	●	●		●						●
IL	●	●	●	●			●	●		●
IN	●	●		●	●		●	●		●
KS	●	●		●			●	●		●
KY		●		●		●		●		●
LA	●	●		●		●		●		●
MA				●	●	●	●	●	●	●
MD		●				●	●	●	●	●
ME		●		●			●	●		●
MI		●		●		●		●		●
MN	●		●	●	●	●		●		●
MO	●	●		●		●		●		●
MS				●		●		●		●
MT				●		●		●		●
NC	●	●		●		●	●	●	●	●
ND	●	●	●	●		●		●		●
NE	●	●	●	●	●			●		●
NH		●		●	●	●	●	●		●
NJ		●	●	●			●	●	●	●
NM		●				●		●		●
NV				●		●		●		●
NY				●				●		●
OH			●	●				●		●
OK	●			●		●		●		●
OR				●		●		●		●
PA		●				●	●	●	●	●

State	Agricultural Feed-stock & Industrial Biosciences		Bioscience-related Distribution		Medical Devices & Equipment		Pharmaceuticals		Research, Testing, & Medical Laboratories	
	LQ	Growth	LQ	Growth	LQ	Growth	LQ	Growth	LQ	Growth
PR		●	●	●	●	●	●	●	●	●
RI				●	●	●		●		●
SC		●		●			●	●		●
SD	●	●	●	●	●			●		
TN			●	●				●		●
TX				●		●		●		●
UT				●	●	●	●	●	●	●
VA		●		●		●				●
VT					●	●				●
WA				●				●	●	●
WI				●	●			●		●
WV		●		●						●
WY	●			●		●				●

Note: Dots represent either a "specialized" employment concentration (LQ >= 1.20) or employment growth (> 0%).
Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Highlights of Metropolitan Area Industry Performance

More than half of all U.S. metropolitan areas have a specialized employment concentration in at least one bioscience industry subsector or market. Of the nation's 382 metropolitan regions with bioscience industry employment, 203 (53 percent) can claim this distinction, further evidence of the industry's widespread footprint and development.

A Varied Set of Metros Exhibit Varied Strengths in the Biosciences Spanning all U.S. Regions

Twenty-one metro areas have an especially diverse set of bioscience industry strengths, with specializations in at least three of the five industry subsectors. These metros span all regions of the U.S., and regional sizes, and reflect the broad distribution of the industry nationally. These include (number of specializations in parenthesis):

- Boulder, CO (4)
- Madison, WI (4)
- Bloomington, IN (3)
- Boston-Cambridge-Newton, MA-NH (3)
- Durham-Chapel Hill, NC (3)
- Fargo, ND-MN (3)
- Fort Collins-Loveland, CO (3)
- Kankakee, IL (3)
- Kansas City, MO-KS (3)
- Kenosha, WI (3)
- Lafayette-West Lafayette, IN (3)
- Lebanon, PA (3)
- Logan, UT-ID (3)
- Memphis, TN-MS-AR (3)
- Morgantown, WV (3)
- Raleigh-Cary, NC (3)
- Salt Lake City-Murray, UT (3)
- San Diego-Chula Vista-Carlsbad, CA (3)
- San Francisco-Oakland-Fremont, CA (3)
- Trenton-Princeton, NJ (3)
- Worcester, MA (3)

The Innovation Ecosystem for the Biosciences: National Highlights and Leading States

At the national, state, and regional levels, the innovation-intensive bioscience industry requires a strong and supportive ecosystem with sustained nurturing and attention in which to advance.

The type of long-term growth achieved in the nation's bioscience sector is rooted in, and enabled by, basic and applied research and development activities; development of, and access to, a qualified and highly skilled workforce; investment capital allocated to innovative emerging and existing firms; and strong and enforced legal protections of intellectual property. This ecosystem and industry success cannot be taken for granted, particularly in a high-stakes, globally competitive environment.

This section of the report takes stock of the nation's overall position and performance, as well as highlighting leading states, across several key elements of the U.S. ecosystem, specifically:

- University Bioscience R&D Expenditures
- National Institutes of Health (NIH) Funding
- Bioscience-Related Patents
- Venture Capital (VC) and Angel Investments in Bioscience Companies

University Bioscience R&D Activity: Steady Growth Accelerates in Latest Year

Research universities play a central role in scientific discovery and innovation, helping to fuel the bioscience industry's innovation ecosystem. Bioscience-related research disciplines span health, biological, biomedical, and agricultural sciences, as well as biological and biomedical engineering, and have long formed an important foundation for both fundamental, basic scientific inquiry and applied or industry-facing R&D. Often, university researchers, institutes and centers form collaborative research partnerships with both emerging and established bioscience companies and entrepreneurs to translate discoveries into commercial products and services.

In 2022, the latest year of available data, national academic R&D expenditures in bioscience-related fields reached $58.2 billion. This represents a 17 percent increase from 2019 and relatively strong and steady growth in recent years (Figure 12). The latest 3-year average annual growth trend has essentially matched that of the previous 3-year period—increasing, on average, 5.5 percent annually since 2019 compared with a 5.8 percent average rate from 2016 through 2019. In 2022, however, bioscience-related academic R&D spending accelerated, rising by 8 percent, the largest annual increase recorded since 2011.

Bioscience research disciplines represent a majority of all academic R&D activity, and that share has risen over time. Combined, they account for 60 percent of all U.S. university R&D expenditures. This share has risen from 58 percent over the last decade.

Figure 12: University Bioscience R&D Expenditures, FY 2019-22 ($ in Billions)

Source: TEConomy Partners analysis of National Science Foundation (NSF), National Center for Science and Engineering Statistics, Higher Education Research and Development (HERD) Survey.

The leading states in sheer levels of academic bioscience R&D tend to be larger, with multiple research universities and sizable medical schools. Nearly all of the leading states in R&D activity exceeded $2 billion in expenditures in 2022 (Table 5), with New York and California leading and each exceeding $5 billion annually. Among the fastest-growing states are a number of smaller or mid-sized states seeing growth rates from 2019 ranging from 23 percent to nearly 50 percent. Ohio and Texas have the distinction of being among the leading states in both the size/level of R&D activities and growth rate.

Other states stand out for the intensive concentration of academic bioscience R&D activities relative to their populations and others as an outsized focus of their science and engineering research base (Table 6). Per capita expenditures in smaller states like Maryland, Connecticut, and Massachusetts lead the nation relative to their size, as well as the District of Columbia which reflects the presence of two major research institutions. For other states, biosciences comprise the vast majority of their overall R&D portfolio, which in the case of Missouri, Connecticut, and Arkansas, exceed 80 percent.

Table 5: Leading States in Academic Bioscience R&D Expenditures and Growth

Academic Bioscience R&D Expenditures, 2022	
Leading States	Total R&D Expenditures ($ Billions)
California	$7.8
New York	$5.5
Texas	$4.6
Pennsylvania	$3.6
North Carolina	$2.9
Massachusetts	$2.3
Maryland	$2.2
Ohio	$2.0
Illinois	$2.0
Michigan	$1.7

Academic Bioscience R&D Growth, 2019-22	
Leading States	Growth Rate, %
New Mexico	49.7%
Vermont	40.9%
Tennessee	37.2%
Delaware	36.6%
West Virginia	28.7%
Ohio	27.6%
Wyoming	26.7%
Minnesota	25.8%
Texas	25.1%
Missouri	23.0%

Source: TEConomy Partners analysis of National Science Foundation (NSF), National Center for Science and Engineering Statistics, Higher Education Research and Development (HERD) Survey.

Table 6: Leading States in Per Capita and Concentration of Academic Bioscience R&D Expenditures, 2022

Per Capita Expenditures	
Leading States	$ Per Capita
District of Columbia	$646
Maryland	$364
Connecticut	$356
Massachusetts	$330
New York	$281
Pennsylvania	$276
North Carolina	$270
Vermont	$247
Wisconsin	$226
Nebraska	$221

Share of Total Science & Engineering R&D	
Leading States	% Share
Missouri	83.3%
Connecticut	82.4%
Arkansas	81.3%
Kentucky	79.8%
Vermont	78.1%
Oregon	77.8%
North Carolina	77.7%
Minnesota	77.0%
Nebraska	74.6%
Tennessee	74.0%

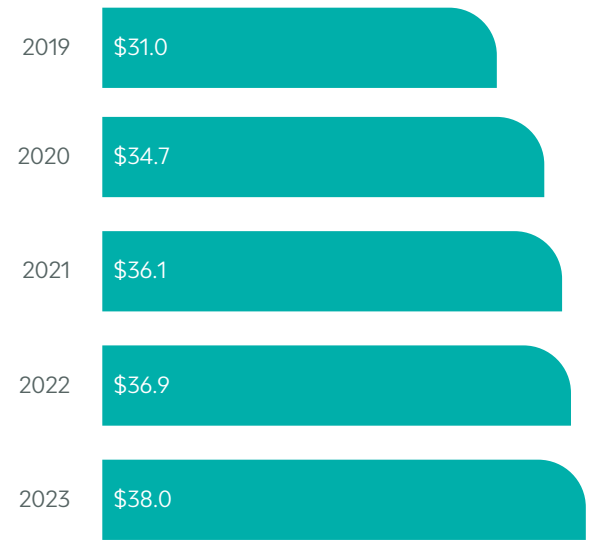
Source: TEConomy Partners analysis of National Science Foundation (NSF), National Center for Science and Engineering Statistics, Higher Education Research and Development (HERD) Survey.

NIH Research Funding Grows, but at a Slower Pace in Recent Years

Funding for university R&D originates from several key sources, including the federal government, non-profit organizations, internal institutional funds, business, state and local governments, and other sources. Among the federal bio-related funding sources, the vast majority of funding is allocated through the Department of Health and Human Services, and within that, originates from the National Institutes of Health (NIH). NIH funds biomedical research and is typically recognized as the "gold standard" for federal biomedical R&D funding.

NIH awarded $38 billion in external or "extramural" research and related funding to universities, hospitals, medical research institutions, and industry in 2023 (Figure 13). This funding level has increased by 23 percent since 2019, with annual growth averaging 5.3 percent during this 4-year period. This pace of annual growth has slowed from an average of 7.2 percent over the prior 4-year period.

Figure 13: National Institutes of Health Awards, FY 2019-23 ($ in Billions)



Source: TEConomy Partners analysis of National Institutes of Health RePORT data.

Each of the ten leading states had NIH funding totals to its institutions and researchers of at least $1 billion in 2023 (Table 7). Several of the leading states in funding totals also have a leading concentration of NIH award

Table 7: Leading States in NIH Funding, FY 2023

Total NIH Funding	
Leading States	Funding ($ Billions)
California	$5.4
New York	$3.6
Massachusetts	$3.5
Maryland	$2.8
North Carolina	$2.3
Pennsylvania	$2.2
Texas	$1.8
Washington	$1.3
Illinois	$1.2
Ohio	$1.0

Per Capita NIH Funding	
Leading States	$ Per Capita
Massachusetts	$501
Maryland	$446
District Of Columbia	$346
Rhode Island	$233
Connecticut	$213
North Carolina	$212
New York	$184
Pennsylvania	$172
Washington	$165
California	$137

NIH Funding Growth, 2019-23	
Leading States	Growth Rate
Mississippi	88.9%
Arkansas	80.9%
West Virginia	48.0%
North Carolina	45.2%
Arizona	41.1%
Maryland	38.5%
Virginia	34.8%
Texas	34.4%
Wisconsin	33.5%
Tennessee	31.5%

Source: TEConomy Partners analysis of National Institutes of Health RePORT data.

funding on a per capita basis, including smaller states such as Massachusetts and Maryland, as well as several larger states such as North Carolina, New York, Pennsylvania, Washington, and California.

A number of states far exceeded the national trend in NIH funding growth, with Mississippi and Arkansas exceeding an 80 percent growth rate. While these gains are impressive in their own right, the high percentage growth can reflect a modest initial base of funding from which it grew. This makes the outsized growth in states like North Carolina, Maryland, and Texas particularly impressive since they are both leading states as well as among the fastest growing.

Bioscience Patent Awards Level Off in 2023 After Several Years of Declines

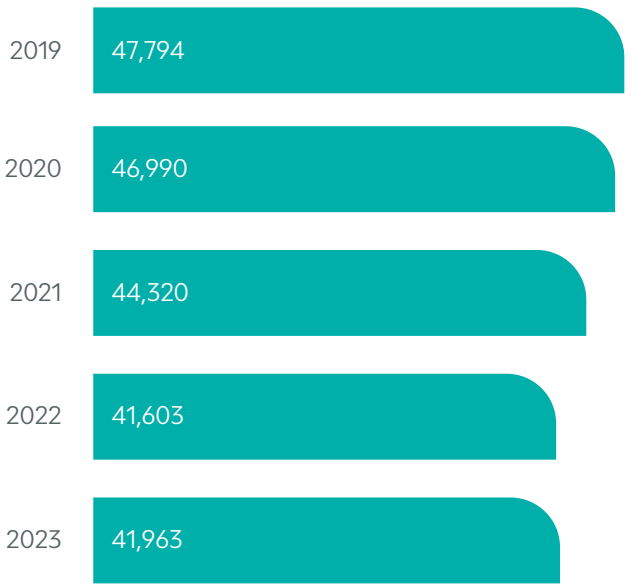
Inventing and successfully commercializing a biomedical therapy or medical device is uniquely challenging. Scientific rigor is challenging in its own right; but one must also consider the sensitive and complex nature of biomedical therapies and patient interactions with those therapies. This requires meeting and fulfilling staunch regulatory requirements for clinical trials and manufacturing that in turn require a lengthy time horizon unlike any other product category. At the end of this risky and costly process, a firm must be confident that its intellectual property (IP) will be protected.

Patents offer a legal framework for protecting valuable IP, which in the biopharmaceutical sector can represent significant time and resources invested in development of a novel therapeutic.

From 2019 through 2023, patent awards with at least one U.S. inventor or assignee in bioscience-related tech-

nology classes and categories totaled nearly 223,000 (Figure 14). In 2023, these patents totaled nearly 42,000, a figure that grew slightly from 2022, but in general reflects a downward trend in patent awards since 2019.

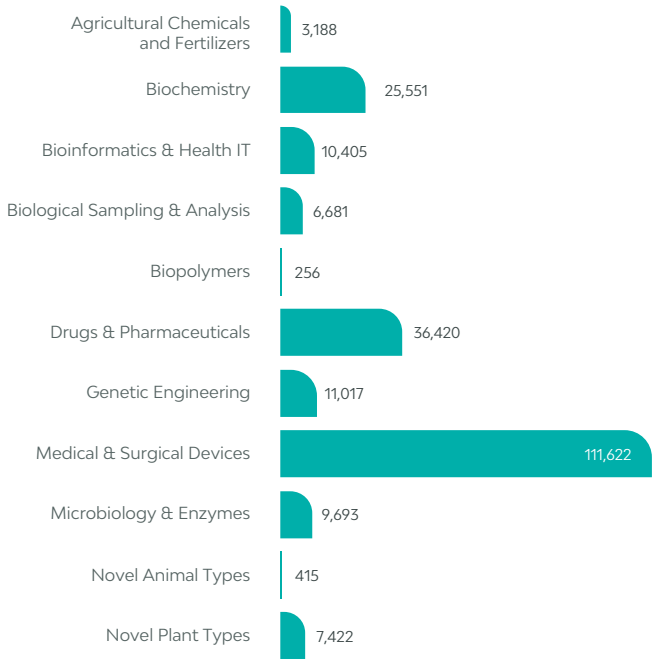
Figure 14: Bioscience-related U.S. Patents, 2019-23



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

Analysis of patent technology classes, and key groupings of classes provides a window into those areas in which major investments are concentrated and where innovation is emerging. The impressive breadth of biosciences innovation areas are illustrated by the varied patent segments in Figure 15, which shows the cumulative patent award totals for 5 years of activity. Medical and surgical devices are, by far, the leading area of patent activity, accounting for one of every two bioscience-related patents. Pharmaceuticals and biochemistry represent additional large segments. Despite the overall recent downward trend in patent awards, one area has seen significant increases—health informatics, captured within the bioinformatics and health IT segment.

Figure 15: Bioscience-related U.S. Patents by Segment, Cumulative 2019-23



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

Among states, California is and has long remained a national leader in bioscience patenting accounting for 22 percent of all patent awards during the latest 5-year period (Table 8). Massachusetts, New Jersey, and Minnesota stand out both for their overall level of patent activity as well as their high concentration on a per capita basis. Additional smaller states with a leading patent per capita concentration include Delaware, Connecticut, New Hampshire, Maryland, Rhode Island, and Colorado.

Leading states by patent classification groupings are presented in Table 9, with darker circles signifying the leading five states and open circles completing the top ten. Several states are leaders in many innovation segments, including California, Texas, New York, Massachusetts, New Jersey, Pennsylvania, and Florida. Other states have focused strengths in key areas such as: Iowa in novel plant variants, Indiana in agricultural chemicals, Maryland and North Carolina in genetic engineering, Minnesota in medical and surgical devices, and Ohio in biopolymers.

Table 8: Leading States in Bioscience-Related Patents, Cumulative 2019-23

Patent Totals, 2019-23	
Leading States	Total Patents
California	49,250
Massachusetts	21,386
New York	11,929
Pennsylvania	10,783
New Jersey	10,777
Minnesota	8,952
Florida	8,778
Ohio	8,197
Texas	7,950
Illinois	6,679

Patents Per 1M Population	
Leading States	Patents per 1M Population
Delaware	3,213
Massachusetts	3,055
Connecticut	1,639
Minnesota	1,560
California	1,264
New Hampshire	1,217
New Jersey	1,160
Maryland	951
Rhode Island	901
Colorado	866

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

Bioscience Venture Capital Investments See Significant Declines from All-Time Surge in 2021

Following a sharp surge in VC funding to the biosciences in 2021 that reached all-time highs, venture investments to the industry have declined significantly in the last two years. VC investments to the bioscience industry totaled $43 billion in 2023, representing a 4-year low (Figure 16). From 2019 through 2021, the U.S. bioscience industry saw a surge in investor interest in the sector that coincided with the global pandemic and other advancements in areas including genomics, personalized medicine, and digital health technologies including the use of AI in drug discovery and emerging wearable medical devices and was driven by significant funding rounds in biotechnology and digital health companies.

Since peaking in 2021, VC investments to the industry are down by 49 percent. The dramatic slowdown in funding began in 2022 and was influenced by global economic conditions and market corrections, including surging inflation, rising interest rates, and geopolitical tensions leading to a more cautious VC investment environment overall. The investment "recalibration" was evidenced by increased median intervals between funding rounds and a shift toward preferences for more "mature" clinical data from emerging bioscience companies.[7]

The bioscience industry's share of total U.S. VC funding has typically averaged 25 percent in recent years, however in 2020 investor interest in the sector began to significantly increase and this share reached a remarkable 30 percent of all VC investments. In 2021 and 2022, despite seeing the biosciences investments peak, that share returned to more historical norms. Interestingly, while 2023 totals are down significantly from those prior years, biosciences' share of total VC funding rose again, to 27 percent, indicating investor pullbacks in other sectors as well.

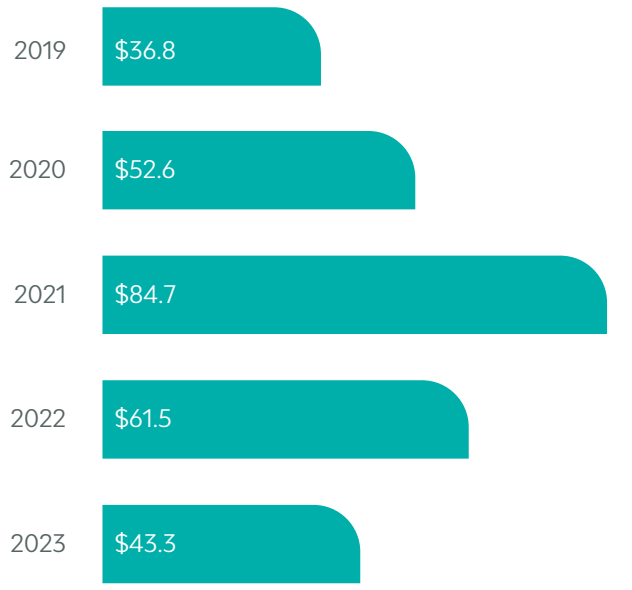
7 BioSpace, see: https://www.biospace.com/biopharma-vc-funding-dropped-21-percent-in-q4-2023-pitchbook.

Table 9: Leading States in Bioscience-related Patents by Class Group, Cumulative 2019-23

State	Total Biosciences	Agricultural Chemicals and Fertilizers	Biochemistry	Bioinformatics & Health IT	Biological Sampling & Analysis	Biopolymers	Drugs & Pharmaceuticals	Genetic Engineering	Medical & Surgical Devices	Microbiology & Enzymes	Novel Animal Types	Novel Plant Types
AZ						○						
CA	●	●	●	●	●	○	●	●	●	●	●	●
CO								○				
CT			○								●	
DE			○									
FL	○	○		○		●	○		●			○
GA												○
IL	○			●	○					○		○
IN		●	○									○
IA												●
MD			○		●		○	●		●	○	
MA	●		●	●	●	●	●	●	●	●	●	
MI						○						●
MN	○	●				●			●		○	●
MO		○						○				○
NJ	●	●	●	○	●	○	●	○	○		○	
NY	●	○	●	●	●	●	●	●	○	●	●	
NC		●		○			○	●		○		○
OH	○				○	●	○		●			
PA	●	○	●	●	○		●	○	○	●		
TN						○						
TX	○	○	○	○	○	○	○	○	○	○	●	○
WA				○	○			○		○	○	
WI								○		○	○	●

Note: a shaded circle signifies the state ranks in the top 5 and an open circle signifies a ranking in the next 5 for that particular patent class group.
Source: TEConomy Partners analysis of U.S. Patent & Trademark Office data from Clarivate Analytics' Derwent Innovation patent analysis database.

Figure 16: Bioscience-related Venture Capital Investments, 2019-23 ($ in Billions)



Source: TEConomy Partners analysis of PitchBook Data, Inc.

More modest levels of VC funding translate to lower average levels of funding per deal. While Table 10 smooths the four years of funding into a cumulative picture, two years ago this publication reported average bioscience-related investments per deal of $12.9 million and that figure has declined to $11.9 million, despite including the peak year of 2021.

In general, later-stage investments tend to be significantly larger than those at the earliest stages of company development, though deal volumes tend to be higher for earlier-stage investments as investors fund smaller rounds often across several tranches. These dynamics have held up during the 2019 through 2023 period, where pre-seed through early stage companies account for 73 percent of all VC deals, but just 42 percent of funding totals.

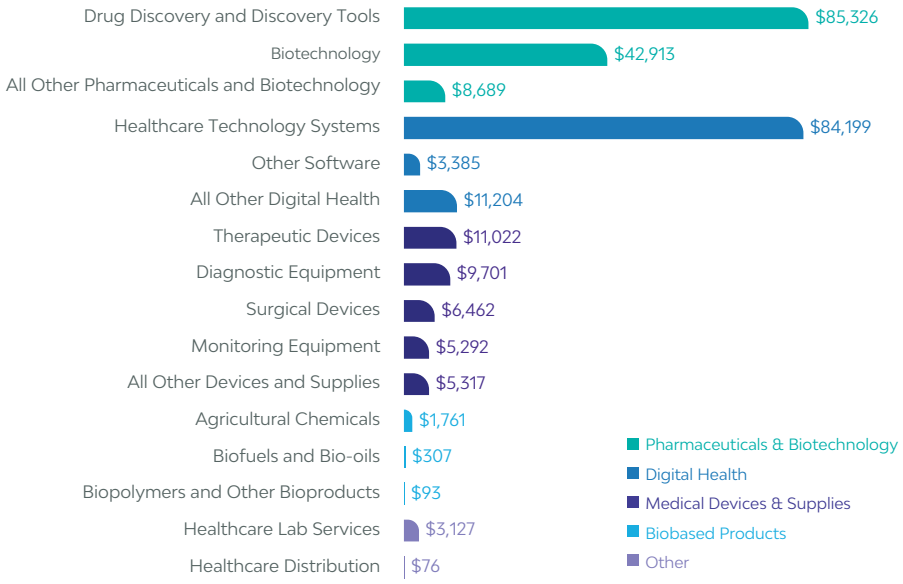
The vast majority of recent VC and Angel investments to U.S. bioscience companies have been directed to two segments—biopharmaceutical development spanning drug discovery and delivery, biotechnology, and other related areas; and digital health (Figure 17). Across the cumulative investment totals over the 5-year period, these segments account for 49 percent and 35 percent, respectively.

Table 10: U.S. Bioscience Venture Capital Investments by Stage, Cumulative 2019-23

Stage	Number of Deals	Number of Companies	Total VC Investments ($ Millions)	Average Investment per Deal ($ Millions)	Average Investment per Company ($ Millions)
Pre-Seed	5,565	3,914	$843	$0.15	$0.22
Angel	1,161	1,011	$730	$0.63	$0.72
Seed	5,177	4,088	$16,271	$3.14	$3.98
Early Stage VC	5,145	3,861	$98,919	$19.23	$25.62
Later Stage VC	6,374	4,091	$162,130	$25.44	$39.63
Total	**23,422**	**12,230**	**$278,893**	**$11.91**	**$22.80**

Source: TEConomy Partners analysis of PitchBook Data, Inc.

Figure 17: Bioscience-related Venture Capital Investments by Segment, Cumulative 2019-23 ($ in Millions)



Source: TEConomy Partners analysis of PitchBook Data, Inc.

Maintaining long-term trends, bioscience VC investments continue to be highly concentrated in two states—California and Massachusetts, with those states exceeding $104 billion and $58 billion, respectively over the full 2019 through 2023 period. Combined, these two states account for 59 percent of national totals since 2019, a share that has declined just slightly from prior reports. Several other states stand out for their per capita concentrations in bioscience VC investments including New York, Tennessee, Delaware, Maryland, Minnesota, Washington, Colorado, and DC.

Table 11: Leading States in Bioscience Venture Capital Investments, Cumulative 2019-23

Total VC Investments, 2019-23	
Leading States	Total ($ Millions)
California	$104,601
Massachusetts	$58,711
New York	$25,483
Illinois	$11,053
Texas	$8,744
Pennsylvania	$7,064
Washington	$6,961
Colorado	$5,227
Maryland	$4,434
North Carolina	$4,416

Per Capita VC Investments	
Leading States	$ Per Capita
Massachusetts	$1,498
California	$402
New York	$184
Tennessee	$148
Delaware	$147
Maryland	$144
Minnesota	$116
Washington	$115
Colorado	$112
District of Columbia	$111

Source: TEConomy Partners analysis of PitchBook Data, Inc.

Table 12: Leading States in Bioscience Venture Capital Investments by Segment, Cumulative 2019-23

State	Pharmaceuticals and Biotechnology			Digital Health			Medical Devices and Supplies					Biobased Products			Other Biosciences	
	Drug Discovery and Discovery Tools	Biotechnology	All Other Pharmaceuticals and Biotechnology	Healthcare Technology Systems	Other Software	All Other Digital Health	Therapeutic Devices	Diagnostic Equipment	Surgical Devices	Monitoring Equipment	All Other Devices and Supplies	Agricultural Chemicals	Biofuels and Bio-oils	Biopolymers and Other Bioproducts	Healthcare Lab Services	Healthcare Distribution
CA	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
MA	●	●		●	●	●	●	●	●	●	●	●			●	
NY	●	●	●	●	●	●	●			●			●		●	●
TX				●	●		●	●	●		●		●	●	●	●
PA	●		●					●			●			●		
WA	●	●						●	●							●
IL				●		●				●						
MN					●		●		●							
CO			●							●						
GA			●											●		
NC												●			●	
CT												●				
FL																●
IA													●			
MD		●														
MI														●		
MO												●				
NE						●										
OH											●					
TN													●			

Source: TEConomy Partners analysis of PitchBook Data, Inc.

State and Metropolitan Area Performance Across the Bioscience Industry Subsectors

This section provides an in-depth examination of the employment position and recent performance trends for states across each of the five major bioscience industry subsectors.

Data were tabulated for each state, the District of Columbia, and Puerto Rico, and for every U.S. Metropolitan Statistical Area (MSA) to determine the size and relative employment concentration within each subsector. In addition, employment gains and declines were calculated to highlight recent trends.

The key metrics used in this section include:

- **Employment size** measuring the absolute level of jobs within each region.
  - To allow for meaningful comparisons, each region's share of total U.S. subsector employment was analyzed. States with more than 5 percent of national employment are designated "large"; states with more than 3 percent but less than 5 percent are referred to as "sizable."
  - For metropolitan regions, a table is included for each subsector presenting the top 25 metropolitan regions in total employment.

- **Employment concentration** is a useful way in which to gauge the concentration of a region's employment relative to the national average. While employment size reveals the largest geographic components, employment concentration can reveal the relative importance of the subsectors to a regional or state economy.
  - State and regional location quotients (LQs) measure the degree of job concentration within the region relative to the nation. States or regions with an LQ greater than 1.00 are said to have a concentration in the subsector. When the LQ is significantly above average, 1.20 or greater, the state is said to have a "specialization" in the subsector.
  - For metropolitan regions, a table is provided presenting the top 15 metropolitan areas according to LQs, based on the total employment size of the region (either small, medium, or large).

- The level of **employment growth or loss** over the 2019 to 2023 period provides a way in which to measure the performance of a state's bioscience industry. In this analysis, job growth or loss was measured by absolute employment gains or losses, as percentage changes may overstate trends in those states with a smaller subsector employment base.

Agricultural Feedstock & Industrial Biosciences

The agricultural feedstock and industrial biosciences subsector applies life sciences knowledge, biochemistry, and biotechnologies to the processing of agricultural goods, like crops, animals, and agricultural inputs, as well as organic and agricultural chemicals. The subsector also includes activities around the production of biofuels and feedstocks for biobased polymers.

Examples of Products

- Agricultural seeds improved using biotechnology
- Fertilizers, pesticides, herbicides, fungicides and agricultural microbials
- Corn and soybean oil
- Ethanol and industrial fermentation
- Organic chemicals made from renewable resources or through biological processes
- Polymers, plastics and textiles synthesized from plant-based feedstock or through biological processes
- Biobased ingredients for cosmetics, personal care products, flavors and fragrances

Examples of Companies

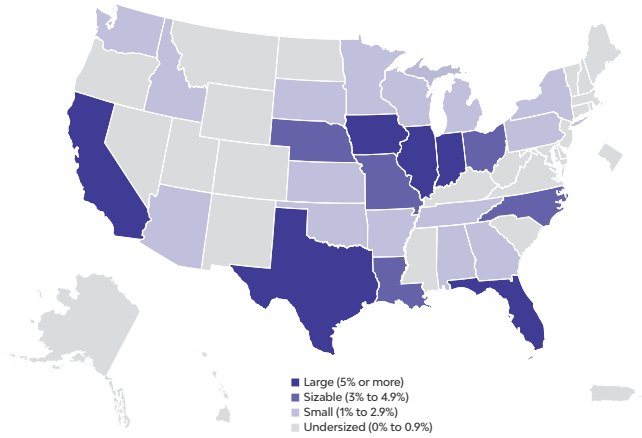
- Amyris
- BASF
- Bayer Crop Science
- Corteva Agriscience
- Evolva
- Genus
- LanzaJet
- Novonesis
- Pivot Bio
- The J.R. Simplot Company

States that are Both Large and Specialized*

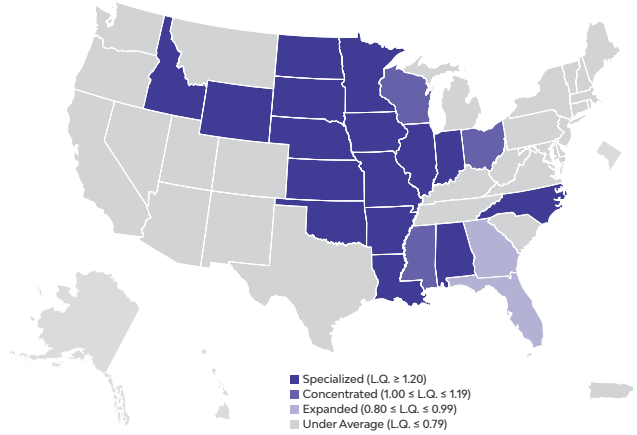
- Illinois
- Iowa
- Indiana

*States are listed in descending order by subsector employment levels.

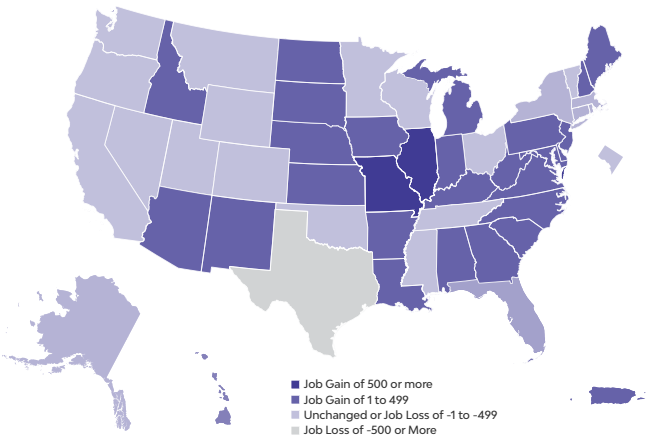
State Share of Total U.S. Employment, 2023



Employment Concentration Relative to the U.S., 2023



Employment Gains and Losses, 2019-2023



Agricultural Feedstock & Industrial Biosciences

State Leaders & Highlights

Employment Size: Employment is relatively concentrated in the top 11 states, which account for 68 percent of employment in this subsector. Those states are:

- **Large States:** Illinois, Iowa, Texas, Florida, Indiana
- **Sizable States:** California, Missouri, North Carolina, Nebraska, Louisiana, Ohio

Employment Concentration: Sixteen states have a specialized concentration of jobs in the agricultural feedstock and industrial biosciences subsector, more than for any other subsector. These concentrations are primarily in the Midwest and South.

- **Specialized States:** Iowa, Nebraska, South Dakota, Wyoming, Illinois, Louisiana, North Dakota, Idaho, Indiana, Missouri, Alabama, Kansas, Oklahoma, Arkansas, North Carolina, Minnesota
- **Concentrated States:** Wisconsin, Ohio, Mississippi

Employment Growth: Over the 2019 to 2023 time period, 28 states and Puerto Rico experienced some increase in subsector employment, with Illinois, Missouri, North Carolina, Georgia, and Alabama experiencing the largest gains.

Large and Specialized States: Three states have both large employment shares and a specialized concentration of jobs in agricultural feedstock and industrial biosciences (Table 13).

Table 14: Metropolitan Statistical Areas with the Largest Employment Levels in Agricultural Feedstock and Industrial Biosciences, 2023

Metropolitan Statistical Area	2023 Employment
Decatur, IL	5,514
Chicago-Naperville-Elgin, IL-IN	2,714
Houston-Pasadena-The Woodlands, TX	1,923
Lakeland-Winter Haven, FL	1,545
Baton Rouge, LA	1,484
Lafayette-West Lafayette, IN	1,319
New Orleans-Metairie, LA	1,195
Omaha, NE-IA	1,052
Cedar Rapids, IA	1,013
Indianapolis-Carmel-Greenwood, IN	935
Tampa-St. Petersburg-Clearwater, FL	847
Kansas City, MO-KS	844
Columbus, OH	795
Memphis, TN-MS-AR	775
Greensboro-High Point, NC	746
Dallas-Fort Worth-Arlington, TX	745
St. Louis, MO-IL	725
Des Moines-West Des Moines, IA	691
Valdosta, GA	635
New York-Newark-Jersey City, NY-NJ	627
Sioux City, IA-NE-SD	581
Fresno, CA	578
Peoria, IL	565
Madison, WI	522
Beaumont-Port Arthur, TX	511

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Table 13: States with Large and Specialized Employment in Agricultural Feedstock and Industrial Biosciences, 2023

State	Establishments, 2023	Employment, 2023	Location Quotient, 2023	Share of U.S. Employment
Illinois	105	9,350	3.30	13.1%
Iowa	126	8,432	11.87	11.8%
Indiana	70	3,762	2.51	5.3%

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Table 15: Metropolitan Statistical Areas with the Highest Location Quotients in Agricultural Feedstock and Industrial Biosciences, by Size of MSA, 2023

Metropolitan Statistical Area	Location Quotient	2023 Employment
Large MSAs (Total Private Employment Greater than 250,000)		
Baton Rouge, LA	8.34	1,484
New Orleans-Metairie, LA	5.72	1,195
Omaha, NE-IA	4.58	1,052
Greensboro-High Point, NC	4.39	746
Des Moines-West Des Moines, IA	3.67	691
Madison, WI	3.05	522
Fresno, CA	2.76	578
Memphis, TN-MS-AR	2.65	775
Indianapolis-Carmel-Greenwood, IN	1.82	935
Kansas City, MO-KS	1.67	844
Columbus, OH	1.61	795
Houston-Pasadena-The Woodlands, TX	1.27	1,923
Chicago-Naperville-Elgin, IL-IN	1.27	2,714
Tampa-St. Petersburg-Clearwater, FL	1.22	847
Louisville/Jefferson County, KY-IN	1.22	402
Medium MSAs (Total Private Employment Between 75,000 and 250,000)		
Lafayette-West Lafayette, IN	29.56	1,319
Cedar Rapids, IA	15.26	1,013
Lakeland-Winter Haven, FL	12.38	1,545
Beaumont-Port Arthur, TX	7.18	511
Peoria, IL	7.14	565
Lubbock, TX	5.89	410
Evansville, IN	4.66	305
Fayetteville, NC	3.86	194
Bellingham, WA	3.85	163
Joplin, MO-KS	3.48	142
Mobile, AL	2.99	239
Champaign-Urbana, IL	2.85	118
Sioux Falls, SD-MN	2.43	205
Fargo, ND-MN	2.32	161
Stockton-Lodi, CA	2.26	294
Small MSAs (Total Private Employment Less than 75,000)		
Decatur, IL	253.07	5,514
Valdosta, GA	27.28	635
Rocky Mount, NC	18.36	437
St. Joseph, MO-KS	16.24	401
Sioux City, IA-NE-SD	16.15	581
Mankato, MN	15.15	389
Yuma, AZ	11.93	365
Cheyenne, WY	9.38	172
Enid, OK	6.55	71
Kankakee, IL	5.60	108
Gettysburg, PA	5.49	88
Greenville, NC	4.67	140
Sandusky, OH	4.56	106
Sierra Vista-Douglas, AZ	4.17	55
Florence-Muscle Shoals, AL	4.14	101

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Pharmaceuticals

The pharmaceuticals subsector produces commercially available medicinal and diagnostic substances. The subsector is generally characterized by large multinational firms heavily engaged in R&D and manufacturing activities to bring drugs to market.

Examples of Products

- Biopharmaceuticals
- Vaccines
- Targeted disease therapeutics
- Tissue and cell culture media
- Dermatological/topical treatments
- Diagnostic substances
- Animal vaccines and therapeutics

Examples of Companies

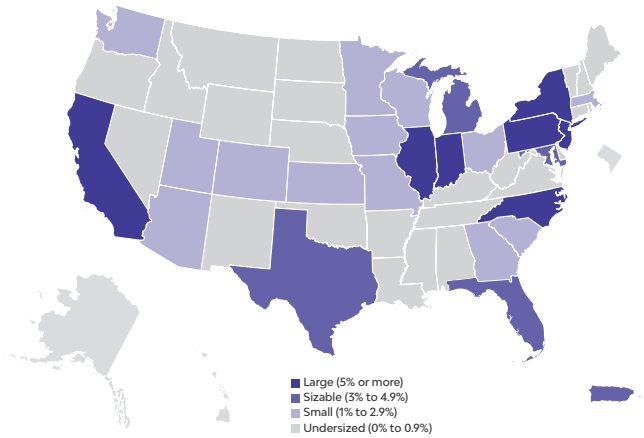
- Alkermes
- Alnylam Pharmaceuticals
- Amgen
- Bayer
- Biogen
- Eli Lilly and Company
- GlaxoSmithKline
- Johnson & Johnson
- Novo Nordisk
- Pfizer
- Roche Group-Genentech
- Sangamo Therapeutics
- Vertex Pharmaceuticals

States that are Both Large and Specialized*

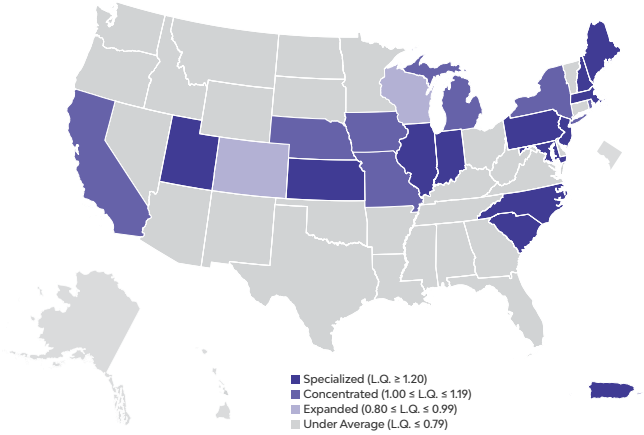
- New Jersey
- North Carolina
- Illinois
- Indiana
- Pennsylvania

*States are listed in descending order by subsector employment levels.

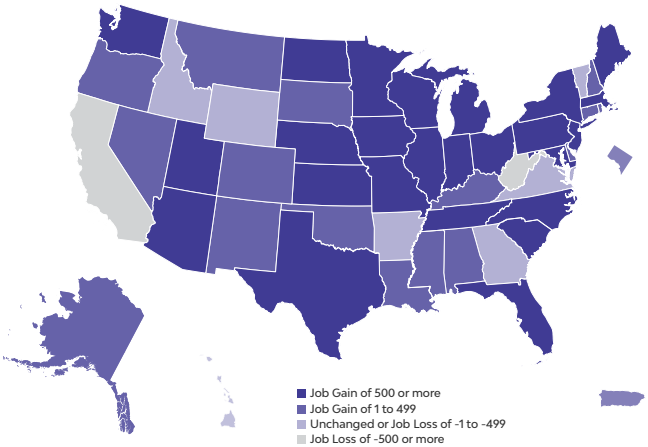
State Share of Total U.S. Employment, 2023



Employment Concentration Relative to the U.S., 2023



Employment Gains and Losses, 2019-2023



Pharmaceuticals

State Leaders & Highlights

Employment Size: Pharmaceutical manufacturing has a relatively high concentration among the leading states. The six largest employer states in this subsector account for nearly half of U.S. employment.

- **Large States:** California, New Jersey, North Carolina, New York, Illinois, Indiana, Pennsylvania
- **Sizable States:** Texas, Puerto Rico, Florida, Michigan, Maryland

Employment Concentration: Twelve states and Puerto Rico have a specialized concentration of jobs in the pharmaceuticals subsector.

- **Specialized States:** Puerto Rico, Indiana, New Jersey, North Carolina, Maine, Utah, Maryland, Illinois, Pennsylvania, Kansas, South Carolina, New Hampshire, Massachusetts
- **Concentrated States:** Iowa, Rhode Island, New York, Nebraska, Michigan, Missouri, California

Employment Growth: Over the 2019 to 2023 time period, 41 states, DC, and Puerto Rico experienced some increase in subsector employment. Of those states, New Jersey, Indiana, North Carolina, Florida, and New York experienced substantial job increases.

Large and Specialized States: Five states have both a large employment share and a specialized concentration of jobs in pharmaceuticals (Table 16).

Table 17: Metropolitan Statistical Areas with the Largest Employment Levels in Pharmaceuticals, 2023

Metropolitan Statistical Area	2023 Employment
New York-Newark-Jersey City, NY-NJ	37,621
Chicago-Naperville-Elgin, IL-IN	21,275
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	16,353
Indianapolis-Carmel-Greenwood, IN	16,346
San Francisco-Oakland-Fremont, CA	14,219
Los Angeles-Long Beach-Anaheim, CA	11,951
Boston-Cambridge-Newton, MA-NH	9,041
San Diego-Chula Vista-Carlsbad, CA	8,180
Washington-Arlington-Alexandria, DC-VA-MD-WV	7,780
Durham-Chapel Hill, NC	6,646
Dallas-Fort Worth-Arlington, TX	4,964
Phoenix-Mesa-Chandler, AZ	4,941
Miami-Fort Lauderdale-West Palm Beach, FL	4,876
Minneapolis-St. Paul-Bloomington, MN-WI	4,599
Albany-Schenectady-Troy, NY	4,355
Raleigh-Cary, NC	4,205
Trenton-Princeton, NJ	4,185
St. Louis, MO-IL	3,933
Kalamazoo-Portage, MI	3,724
Tampa-St. Petersburg-Clearwater, FL	3,715
Kansas City, MO-KS	3,613
Charlotte-Concord-Gastonia, NC-SC	3,596
Houston-Pasadena-The Woodlands, TX	3,537
Madison, WI	3,430
Bloomington, IN	3,086

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Table 16: States with Large and Specialized Employment in Pharmaceuticals, 2023

State	Establishments, 2023	Employment, 2023	Location Quotient, 2023	Share of U.S. Employment
New Jersey	467	29,550	2.97	8.2%
North Carolina	151	25,448	2.25	7.1%
Illinois	386	23,415	1.64	6.5%
Indiana	109	22,639	3.00	6.3%
Pennsylvania	164	20,488	1.42	5.7%

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Table 18: Metropolitan Statistical Areas with the Highest Location Quotients in Pharmaceuticals, by Size of MSA, 2023

Metropolitan Statistical Area	Location Quotient	2023 Employment
Large MSAs (Total Private Employment Greater than 250,000)		
Durham-Chapel Hill, NC	8.82	6,646
Indianapolis-Carmel-Greenwood, IN	6.30	16,346
Albany-Schenectady-Troy, NY	4.61	4,355
Portland-South Portland, ME	4.28	2,864
Madison, WI	3.97	3,430
Worcester, MA	3.08	2,505
Provo-Orem-Lehi, UT	2.68	1,912
Greenville-Anderson-Greer, SC	2.60	2,582
Raleigh-Cary, NC	2.50	4,205
San Francisco-Oakland-Fremont, CA	2.47	14,219
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	2.38	16,353
San Diego-Chula Vista-Carlsbad, CA	2.33	8,180
Buffalo-Cheektowaga, NY	2.18	2,646
Columbia, SC	2.02	1,706
Chicago-Naperville-Elgin, IL-IN	1.98	21,275
Medium MSAs (Total Private Employment Between 75,000 and 250,000)		
Kalamazoo-Portage, MI	12.66	3,724
Trenton-Princeton, NJ	8.18	4,185
Boulder, CO	4.76	2,144
Santa Cruz-Watsonville, CA	3.94	920
Lincoln, NE	3.84	1,513
Vallejo, CA	3.69	1,176
Waco, TX	3.32	995
Ogden, UT	3.31	1,930
Hickory-Lenoir-Morganton, NC	2.98	1,078
Evansville, IN	2.52	830
Fort Collins-Loveland, CO	2.47	916
Fargo, ND-MN	1.97	688
Lexington-Fayette, KY	1.95	1,226
Lansing-East Lansing, MI	1.94	865
Gainesville, GA	1.88	457
Small MSAs (Total Private Employment Less than 75,000)		
Rocky Mount, NC	23.18	2,782
Bloomington, IN	20.52	3,086
Greenville, NC	18.57	2,814
Kankakee, IL	17.20	1,668
Iowa City, IA	7.43	1,194
St. Joseph, MO-KS	7.23	899
Lebanon, PA	6.20	750
Morgantown, WV	4.92	695
Logan, UT-ID	4.34	652
Salisbury, MD	3.79	425
Terre Haute, IN	3.75	544
Kenosha, WI	2.85	501
Ames, IA	2.22	242
Columbus, IN	1.89	229
Janesville-Beloit, WI	1.72	285

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Medical Devices & Equipment

Firms in the medical device and equipment subsector produce a variety of biomedical instruments and other healthcare products and supplies for diagnostics, surgery, patient care, and laboratories. The subsector is continually advancing the application of electronics and information technologies to improve and automate testing and patient care capabilities.

Examples of Products

- Bioimaging equipment
- Surgical supplies and instruments
- Orthopedic/prosthetic implants and devices
- Genomic sequencing equipment
- Automated external defibrillators (AEDs)
- Vascular stents and other implantable devices
- Dental instruments and orthodontics

Examples of Companies

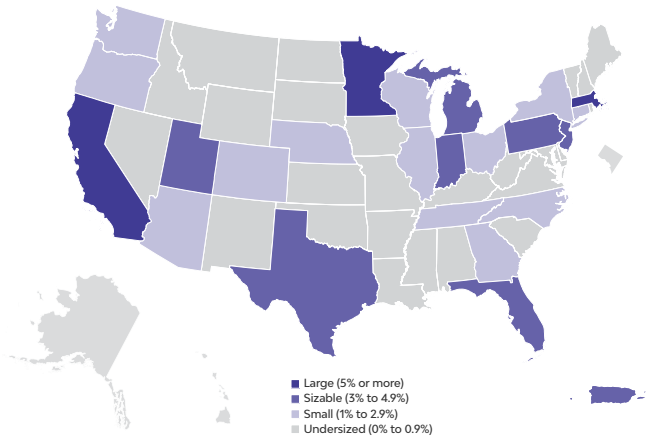
- 3M Health Care
- Baxter
- Boston Scientific Corp.
- Cook Medical
- GE HealthCare
- INSIGHTEC
- Medtronic
- Outset Medical
- REGENESIS
- Stryker
- Zimmer Biomet

States that are Both Large and Specialized*

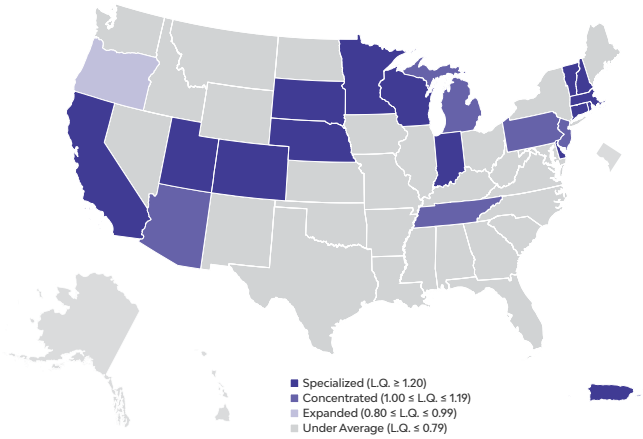
- California
- Minnesota
- Massachusetts

*States are listed in descending order by subsector employment levels.

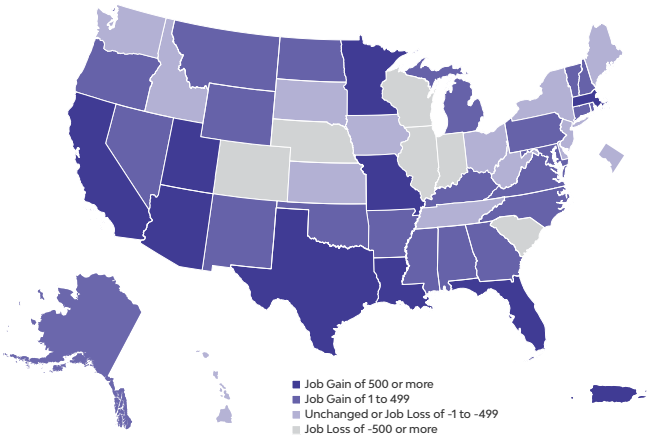
State Share of Total U.S. Employment, 2023



Employment Concentration Relative to the U.S., 2023



Employment Gains and Losses, 2019-2023



Medical Devices & Equipment

State Leaders & Highlights

Employment Size: The medical device subsector has a well-distributed geographic footprint, with large or sizable states from every region. The top ten employing states account for 61 percent of employment in this subsector.

- **Large States:** California, Minnesota, Massachusetts
- **Sizable States:** Indiana, Florida, Pennsylvania, Puerto Rico, Texas, Utah, Michigan, New Jersey

Employment Concentration: Fourteen states and Puerto Rico have a specialized concentration of jobs in the medical device and equipment subsector.

- **Specialized States:** Puerto Rico, Minnesota, Utah, Massachusetts, Delaware, Indiana, Connecticut, California, South Dakota, Nebraska, New Hampshire, Rhode Island, Wisconsin, Colorado, Vermont
- **Concentrated States:** Arizona, New Jersey, Michigan, Pennsylvania, Tennessee

Employment Growth: Over the 2019 to 2023 time period, 31 states and Puerto Rico experienced some increase in subsector employment, led by California, Puerto Rico, Minnesota, Texas, and Florida.

Large and Specialized States: Three states have both a large employment share and a specialized concentration of jobs in medical devices and equipment (Table 19).

Table 20: Metropolitan Statistical Areas with the Largest Employment Levels in Medical Devices and Equipment, 2023

Metropolitan Statistical Area	2023 Employment
Minneapolis-St. Paul-Bloomington, MN-WI	32,673
Los Angeles-Long Beach-Anaheim, CA	32,455
Boston-Cambridge-Newton, MA-NH	20,493
San Francisco-Oakland-Fremont, CA	14,100
New York-Newark-Jersey City, NY-NJ	13,859
San Diego-Chula Vista-Carlsbad, CA	11,961
San Jose-Sunnyvale-Santa Clara, CA	11,935
Salt Lake City-Murray, UT	11,548
Chicago-Naperville-Elgin, IL-IN	10,211
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	7,790
Memphis, TN-MS-AR	6,967
Dallas-Fort Worth-Arlington, TX	5,815
Pittsburgh, PA	5,708
Phoenix-Mesa-Chandler, AZ	5,656
Bloomington, IN	5,526
Milwaukee-Waukesha, WI	5,082
Seattle-Tacoma-Bellevue, WA	5,029
Portland-Vancouver-Hillsboro, OR-WA	4,854
Miami-Fort Lauderdale-West Palm Beach, FL	4,556
Denver-Aurora-Centennial, CO	4,281
Kalamazoo-Portage, MI	3,993
Providence-Warwick, RI-MA	3,990
Cleveland, OH	3,907
Tampa-St. Petersburg-Clearwater, FL	3,455
Atlanta-Sandy Springs-Roswell, GA	3,116

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Table 19: States with Large and Specialized Employment in Medical Devices and Equipment, 2023

State	Establishments, 2023	Employment, 2023	Location Quotient, 2023	Share of U.S. Employment
California	1,611	83,209	1.71	20.0%
Minnesota	427	32,895	4.14	7.9%
Massachusetts	354	24,594	2.44	5.9%

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Table 21: Metropolitan Statistical Areas with the Highest Location Quotients in Medical Devices and Equipment, by Size of MSA, 2023

Metropolitan Statistical Area	Location Quotient	2023 Employment
Large MSAs (Total Private Employment Greater than 250,000)		
Minneapolis-St. Paul-Bloomington, MN-WI	6.14	32,673
Salt Lake City-Murray, UT	5.27	11,548
Memphis, TN-MS-AR	4.09	6,967
San Jose-Sunnyvale-Santa Clara, CA	3.65	11,935
San Diego-Chula Vista-Carlsbad, CA	2.95	11,961
Boston-Cambridge-Newton, MA-NH	2.70	20,493
Milwaukee-Waukesha, WI	2.19	5,082
Worcester, MA	2.13	2,000
San Francisco-Oakland-Fremont, CA	2.12	14,100
Providence-Warwick, RI-MA	2.07	3,990
Madison, WI	1.95	1,943
Los Angeles-Long Beach-Anaheim, CA	1.91	32,455
Pittsburgh, PA	1.84	5,708
Durham-Chapel Hill, NC	1.82	1,584
Tucson, AZ	1.82	1,799
Medium MSAs (Total Private Employment Between 75,000 and 250,000)		
Kalamazoo-Portage, MI	11.76	3,993
Naples-Marco Island, FL	4.79	2,300
Boulder, CO	4.69	2,438
Gainesville, FL	3.00	1,073
Reading, PA	2.59	1,247
Santa Maria-Santa Barbara, CA	2.55	1,456
Ogden, UT	2.51	1,686
Santa Rosa-Petaluma, CA	2.43	1,384
South Bend-Mishawaka, IN-MI	2.17	793
Scranton--Wilkes-Barre, PA	2.13	1,496
Manchester-Nashua, NH	2.10	1,197
Florence, SC	2.08	468
Binghamton, NY	2.07	489
Lafayette-West Lafayette, IN	1.96	510
Huntington-Ashland, WV-KY-OH	1.95	696
Small MSAs (Total Private Employment Less than 75,000)		
Bloomington, IN	31.84	5,526
Flagstaff, AZ	14.09	2,174
Glens Falls, NY	11.38	1,508
Sumter, SC	10.01	945
State College, PA	5.69	794
Niles, MI	5.31	873
Elmira, NY	4.24	365
Sheboygan, WI	4.00	691
Staunton-Stuarts Draft, VA	3.94	526
Dover, DE	2.82	451
Jackson, MI	2.82	435
Lebanon, PA	2.57	359
Bay City, MI	2.15	196
Logan, UT-ID	2.14	371
Saginaw, MI	2.12	461

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Research, Testing, & Medical Laboratories

The research, testing, and medical laboratories subsector includes firms performing a range of activities; from highly research-oriented companies working to develop and commercialize new industrial biotechnologies, drug discovery/delivery systems, and gene and cell therapies, to more service-oriented firms engaged in medical and other life sciences testing services. The subsector is closely tied to pharmaceuticals and unique in that some companies will "graduate" or shift out of the subsector and into pharmaceuticals when technologies or discoveries are successfully commercialized.

Examples of Products

- Stem cell/regenerative research
- Molecular diagnostics and testing
- Preclinical drug development
- Drug delivery systems
- DNA synthesis
- Research/laboratory support services

Examples of Companies

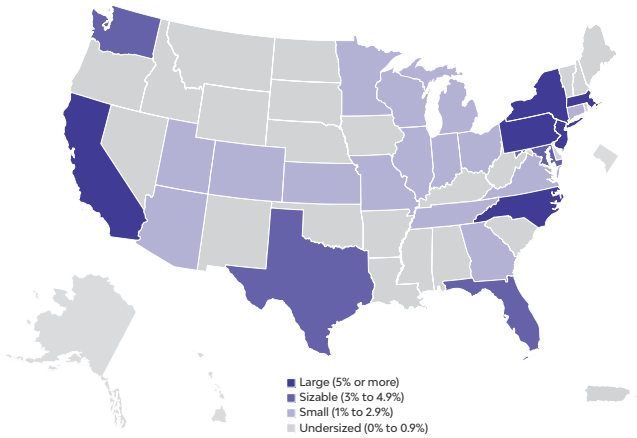
- Charles River Laboratories
- Fortrea
- IQVIA
- Labcorp
- PPD
- Quest Diagnostics
- Rallybio
- Virent

States that are Both Large and Specialized*

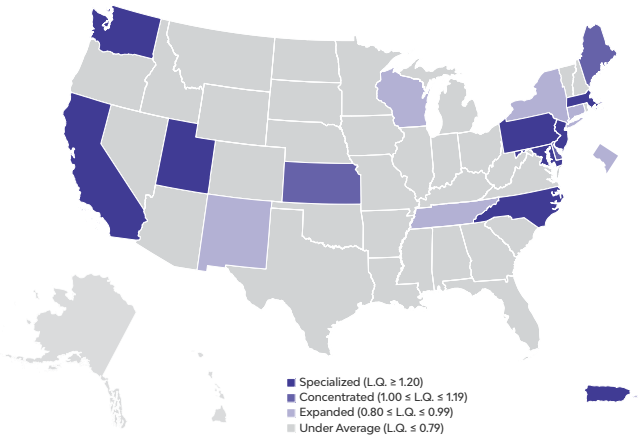
- California
- Massachusetts
- North Carolina
- New Jersey
- Pennsylvania

*States are listed in descending order by subsector employment levels.

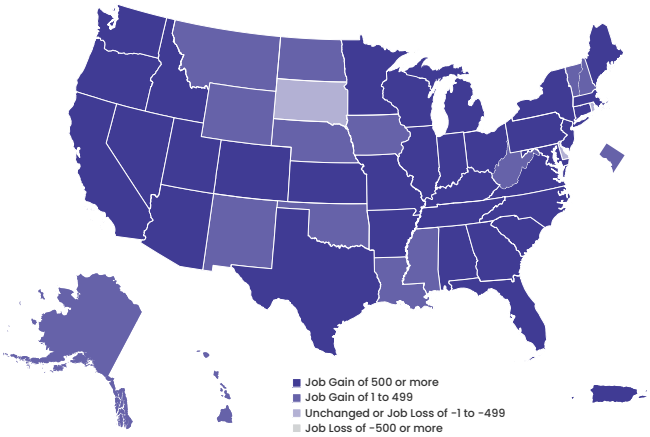
State Share of Total U.S. Employment, 2023



Employment Concentration Relative to the U.S., 2023



Employment Gains and Losses, 2019-2023



Research, Testing, & Medical Laboratories

State Leaders & Highlights

Employment Size: With the largest employment base among the five subsectors, the research, testing, and medical labs subsector has a significant presence in most states. The top ten employer states make up 68 percent of national employment, and the top 21 all have more than 10,000 subsector jobs.

- **Large States:** California, Massachusetts, New York, North Carolina, New Jersey, Pennsylvania
- **Sizable States:** Texas, Florida, Maryland, Washington

Employment Concentration: Eight states and Puerto Rico have a specialized concentration of jobs in the research, testing, and medical laboratories subsector.

- **Specialized States:** Massachusetts, Maryland, New Jersey, North Carolina, California, Utah, Washington, Puerto Rico, Pennsylvania
- **Concentrated States:** Kansas, Maine, Delaware

Employment Growth: Over the 2019 to 2023 time period, 48 states, DC, and Puerto Rico experienced some increase in subsector employment, led by California, Massachusetts, North Carolina, Texas, and Florida.

Large and Specialized States: Five states have both a large employment share and a specialized concentration of jobs in research, testing, and medical laboratories (Table 22).

Table 23: Metropolitan Statistical Areas with the Largest Employment Levels in Research, Testing, and Medical Labs, 2023

Metropolitan Statistical Area	2023 Employment
Boston-Cambridge-Newton, MA-NH	86,193
New York-Newark-Jersey City, NY-NJ	59,201
San Francisco-Oakland-Fremont, CA	54,066
San Diego-Chula Vista-Carlsbad, CA	34,639
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	28,649
Los Angeles-Long Beach-Anaheim, CA	27,474
Washington-Arlington-Alexandria, DC-VA-MD-WV	25,978
Seattle-Tacoma-Bellevue, WA	18,431
Durham-Chapel Hill, NC	14,259
Chicago-Naperville-Elgin, IL-IN	14,157
San Jose-Sunnyvale-Santa Clara, CA	14,066
Baltimore-Columbia-Towson, MD	11,658
Houston-Pasadena-The Woodlands, TX	11,330
Salt Lake City-Murray, UT	11,176
Raleigh-Cary, NC	10,293
Dallas-Fort Worth-Arlington, TX	10,098
Phoenix-Mesa-Chandler, AZ	9,721
Miami-Fort Lauderdale-West Palm Beach, FL	9,326
Madison, WI	8,352
Atlanta-Sandy Springs-Roswell, GA	7,930
Minneapolis-St. Paul-Bloomington, MN-WI	7,035
Knoxville, TN	6,934
Kansas City, MO-KS	6,925
Tampa-St. Petersburg-Clearwater, FL	6,858
Pittsburgh, PA	6,755

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Table 22: States with Large and Specialized Employment in Research, Testing, and Medical Labs, 2023

State	Establishments, 2023	Employment, 2023	Location Quotient, 2023	Share of U.S. Employment
California	6,773	148,568	1.61	18.8%
Massachusetts	3,312	94,354	4.92	11.9%
North Carolina	3,166	42,469	1.72	5.4%
New Jersey	2,244	41,415	1.90	5.2%
Pennsylvania	2,393	39,937	1.26	5.1%

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Table 24: Metropolitan Statistical Areas with the Highest Location Quotients in Research, Testing, and Medical Labs, by Size of MSA, 2023

Metropolitan Statistical Area	Location Quotient	2023 Employment
Large MSAs (Total Private Employment Greater than 250,000)		
Durham-Chapel Hill, NC	8.63	14,259
Boston-Cambridge-Newton, MA-NH	5.98	86,193
San Diego-Chula Vista-Carlsbad, CA	4.50	34,639
Madison, WI	4.41	8,352
San Francisco-Oakland-Fremont, CA	4.28	54,066
Knoxville, TN	3.23	6,934
Raleigh-Cary, NC	2.78	10,293
Salt Lake City-Murray, UT	2.68	11,176
Albany-Schenectady-Troy, NY	2.52	5,219
San Jose-Sunnyvale-Santa Clara, CA	2.26	14,066
Worcester, MA	2.26	4,026
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	1.90	28,649
Baltimore-Columbia-Towson, MD	1.78	11,658
Washington-Arlington-Alexandria, DC-VA-MD-WV	1.77	25,978
Seattle-Tacoma-Bellevue, WA	1.70	18,431
Medium MSAs (Total Private Employment Between 75,000 and 250,000)		
Trenton-Princeton, NJ	4.78	5,358
Kennewick-Richland, WA	4.07	2,815
Wilmington, NC	3.27	3,133
Boulder, CO	3.23	3,192
Oshkosh-Neenah, WI	2.37	1,158
Barnstable Town, MA	2.17	1,060
College Station-Bryan, TX	1.82	971
Syracuse, NY	1.71	2,459
Gainesville, FL	1.67	1,130
Lafayette-West Lafayette, IN	1.58	778
Huntsville, AL	1.51	1,844
Ann Arbor, MI	1.41	1,128
Rochester, MN	1.37	887
Augusta-Richmond County, GA-SC	1.29	1,459
Florence, SC	1.15	494
Small MSAs (Total Private Employment Less than 75,000)		
Burlington, NC	13.68	4,907
Idaho Falls, ID	4.63	1,964
Lexington Park, MD	2.67	787
Ithaca, NY	1.71	428
Kankakee, IL	1.48	315
Morgantown, WV	1.42	442
Logan, UT-ID	1.35	445
Lima, OH	1.29	339
Bangor, ME	1.25	435
Mount Vernon-Anacortes, WA	1.25	302
Jefferson City, MO	1.19	370
Pueblo, CO	1.16	355
Johnson City, TN	1.16	461
Ames, IA	1.14	272
Warner Robins, GA	1.05	303

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Bioscience-Related Distribution

The bioscience-related distribution subsector coordinates the delivery of bioscience-related products spanning pharmaceuticals, medical devices and equipment, and ag biotech products. The subsector leverages and deploys specialized technologies such as cold storage, highly regulated product monitoring, radio frequency identification (RFID) technologies, and automated drug distribution systems.

Examples of Products

Distribution of:

- Pharmaceuticals
- Vaccines
- Plasma/blood
- Veterinary medicines
- Surgical instruments/appliances
- Diagnostic and bioimaging equipment
- Plant seeds
- Agricultural chemicals

Examples of Companies

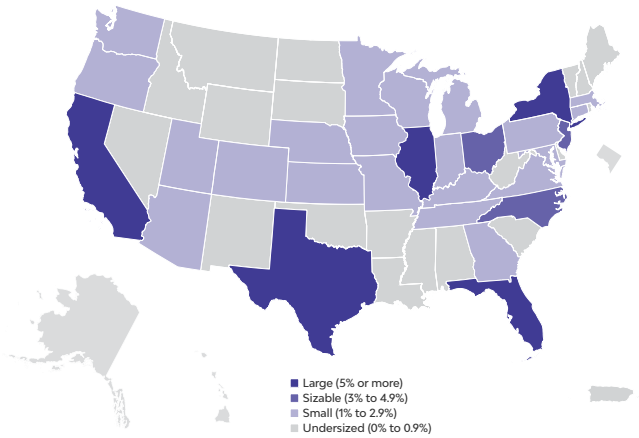
- Apria Healthcare
- Cardinal Health
- Cencora
- McKesson
- Owens & Minor
- Park Seed
- Patterson Companies
- PharMerica Corporation
- Seminis
- Wilbur-Ellis

States that are Both Large and Specialized*

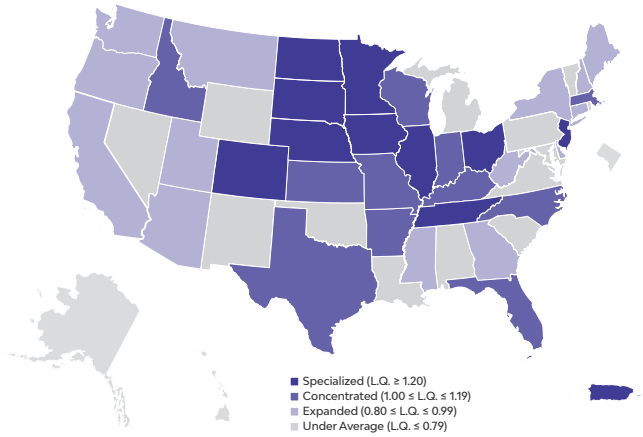
- Illinois†

*States are listed in descending order by subsector employment levels.
†Illinois is the specialized state with the largest share of national employment at 4.9%

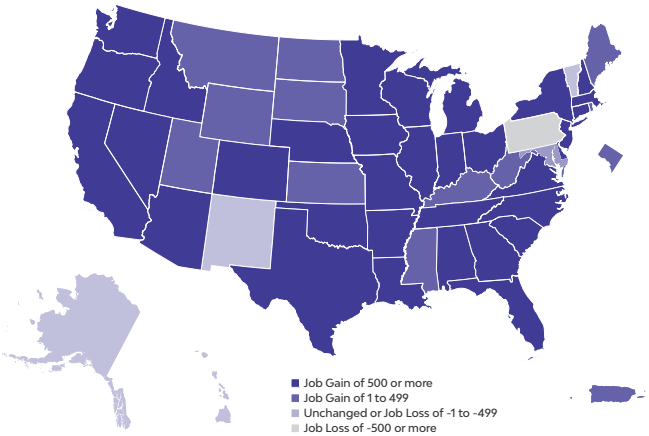
State Share of Total U.S. Employment, 2023



Employment Concentration Relative to the U.S., 2023



Employment Gains and Losses, 2019-2023



Bioscience-Related Distribution

State Leaders & Highlights

Employment Size: The distribution subsector's large employment base is well distributed across the U.S., with the top 10 employing states making up just 55 percent of all employment and every state having a presence to some degree.

- **Large States:** California, Texas, Florida, New York, Illinois
- **Sizable States:** Ohio, New Jersey, North Carolina

Employment Concentration: Ten states and Puerto Rico have a specialized concentration of jobs in the bioscience-related distribution subsector.

- **Specialized States:** South Dakota, Iowa, Nebraska, North Dakota, New Jersey, Puerto Rico, Minnesota, Tennessee, Illinois, Ohio, Colorado
- **Concentrated States:** Massachusetts, Missouri, Florida, North Carolina, Arkansas, Kansas, Indiana, Wisconsin, Idaho, Kentucky, Texas

Employment Growth: Over the 2019 to 2023 time period, 44 states, DC, and Puerto Rico experienced some increase in subsector employment, led by Texas, Florida, North Carolina, New Jersey, and New York.

Large and Specialized States: One state, Illinois, has both a large employment share and a specialized concentration of jobs in bioscience-related distribution (Table 25).

Table 26: Metropolitan Statistical Areas with the Largest Employment Levels in Bioscience-Related Distribution, 2023

Metropolitan Statistical Area	2023 Employment
New York-Newark-Jersey City, NY-NJ	36,509
Los Angeles-Long Beach-Anaheim, CA	22,263
Chicago-Naperville-Elgin, IL-IN	21,374
Dallas-Fort Worth-Arlington, TX	19,460
Miami-Fort Lauderdale-West Palm Beach, FL	14,317
Boston-Cambridge-Newton, MA-NH	12,728
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	11,749
Minneapolis-St. Paul-Bloomington, MN-WI	11,568
Atlanta-Sandy Springs-Roswell, GA	11,565
Phoenix-Mesa-Chandler, AZ	10,777
Houston-Pasadena-The Woodlands, TX	9,783
Denver-Aurora-Centennial, CO	9,726
San Francisco-Oakland-Fremont, CA	6,591
Seattle-Tacoma-Bellevue, WA	6,365
Detroit-Warren-Dearborn, MI	6,042
San Diego-Chula Vista-Carlsbad, CA	6,024
Nashville-Davidson--Murfreesboro--Franklin, TN	5,747
Columbus, OH	5,600
Raleigh-Cary, NC	5,527
Indianapolis-Carmel-Greenwood, IN	5,313
Kansas City, MO-KS	5,290
Tampa-St. Petersburg-Clearwater, FL	5,269
Riverside-San Bernardino-Ontario, CA	5,104
Memphis, TN-MS-AR	5,071
St. Louis, MO-IL	4,960

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Table 25: States with Large and Specialized Employment in Bioscience-Related Distribution, 2023

State	Establishments, 2023	Employment, 2023	Location Quotient, 2023	Share of U.S. Employment
Illinois	2,176	31,895	1.24	4.9%

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Table 27: Metropolitan Statistical Areas with the Highest Location Quotients in Bioscience-Related Distribution, by Size of MSA, 2023

Metropolitan Statistical Area	Location Quotient	2023 Employment
Large MSAs (Total Private Employment Greater than 250,000)		
Des Moines-West Des Moines, IA	2.17	3,707
Memphis, TN-MS-AR	1.91	5,071
Raleigh-Cary, NC	1.82	5,527
Denver-Aurora-Centennial, CO	1.42	9,726
Minneapolis-St. Paul-Bloomington, MN-WI	1.39	11,568
Oxnard-Thousand Oaks-Ventura, CA	1.31	1,838
Provo-Orem-Lehi, UT	1.30	1,672
Louisville/Jefferson County, KY-IN	1.27	3,793
Columbus, OH	1.25	5,600
Nashville-Davidson--Murfreesboro--Franklin, TN	1.21	5,747
Miami-Fort Lauderdale-West Palm Beach, FL	1.19	14,317
Portland-South Portland, ME	1.17	1,416
Kansas City, MO-KS	1.16	5,290
Indianapolis-Carmel-Greenwood, IN	1.14	5,313
Fresno, CA	1.13	2,140
Medium MSAs (Total Private Employment Between 75,000 and 250,000)		
Naples-Marco Island, FL	2.75	2,066
Trenton-Princeton, NJ	1.79	1,647
Kiryas Joel-Poughkeepsie-Newburgh, NY	1.75	1,886
Fort Collins-Loveland, CO	1.71	1,148
Champaign-Urbana, IL	1.59	599
Boulder, CO	1.56	1,265
Slidell-Mandeville-Covington, LA	1.51	596
Sioux Falls, SD-MN	1.49	1,139
Kingsport-Bristol, TN-VA	1.44	715
Fargo, ND-MN	1.41	889
Canton-Massillon, OH	1.39	980
Lakeland-Winter Haven, FL	1.32	1,498
Springfield, IL	1.30	498
Visalia, CA	1.23	852
Topeka, KS	1.09	470
Small MSAs (Total Private Employment Less than 75,000)		
Albany, OR	3.74	779
Harrisonburg, VA	3.31	895
Dubuque, IA	2.31	612
El Centro, CA	2.30	517
Ames, IA	2.07	407
Morgantown, WV	1.87	478
Iowa City, IA	1.84	533
Wheeling, WV-OH	1.77	433
Minot, ND	1.76	236
Kenosha, WI	1.74	550
Jonesboro, AR	1.73	433
Texarkana, TX-AR	1.69	373
Bloomington, IN	1.56	424
Elmira, NY	1.39	186
Twin Falls, ID	1.29	299

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2024.3).

Appendix: Data & Methodology

Industry Employment, Establishments, and Wages

The bioscience industry employment analysis in this report examines national, state, and metropolitan area data and corresponding trends in the biosciences from 2001 through 2023. For employment analysis, TEConomy Partners used the Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW) data. The QCEW data provide the most current, detailed industry employment, establishment, and wage figures available at both a national and subnational level. TEConomy utilizes an enhanced version of these data from a private vendor, Lightcast.

The QCEW program is a cooperative program involving BLS and the State Employment Security Agencies. The QCEW program produces a comprehensive tabulation of employment and wage information for workers covered by state unemployment insurance (UI) laws and federal workers covered by the Unemployment Compensation for Federal Employees (UCFE) program. Publicly available files include data on the number of establishments, monthly employment, and quarterly wages, by NAICS (North American Industry Classification System) industry, by county and by ownership sector, for the entire United States. These data are aggregated to annual levels, to higher industry levels (NAICS industry groups, sectors and supersectors) and to higher geographic levels (national, state, and metropolitan statistical area [MSA]).

Since 2001, the QCEW has been producing and publishing data according to the NAICS. Compared with the prior classification system—the 1987 Standard Industrial Classification (SIC) system, NAICS better incorporates new and emerging industries. Employment, establishment. and wage data produced by the QCEW program for 2001 to present are not comparable with SIC-based industry data from prior years. This limits the ability to construct a longer time series for data analysis; however, 23 years of NAICS-based data (2001-2023) are now available.

Twenty-six NAICS industries at the most detailed (6-digit) level make up the TEConomy definition of the biosciences and its subsectors. These detailed industries are aggregated up to five major subsectors of the bioscience industry. Five of the detailed NAICS industries, Testing Laboratories (NAICS 541380); Research and Development in Nanotechnology (541713); Research and Development in the Physical, Engineering, and Life Sciences (except Nanotechnology and Biotechnology) (541715); Drug and Druggists' Sundries Merchant Wholesalers (424210); and Farm Supplies Merchant Wholesalers (424910) are adjusted in this analysis by TEConomy to include only the share of these industries directly involved in biological or other life science activities. To isolate these relevant life science components, TEConomy used the most current available data from the U.S. Census Bureau's Economic Census.

Table A-1: Bioscience Industry Definition

Bioscience Subsector	NAICS Code	NAICS Description
Agricultural Feedstock & Industrial Biosciences	311221	Wet Corn Milling
	311224	Soybean and Other Oilseed Processing
	325193	Ethyl Alcohol Manufacturing
	325311	Nitrogenous Fertilizer Manufacturing
	325312	Phosphatic Fertilizer Manufacturing
	325314	Fertilizer (Mixing Only) Manufacturing
	325315	Compost Manufacturing
	325320	Pesticide and Other Agricultural Chemical Manufacturing
Pharmaceuticals	325411	Medicinal and Botanical Manufacturing
	325412	Pharmaceutical Preparation Manufacturing
	325413	In-Vitro Diagnostic Substance Manufacturing
	325414	Biological Product (except Diagnostic) Manufacturing
Medical Devices & Equipment	334510	Electromedical and Electrotherapeutic Apparatus Manufacturing
	334516	Analytical Laboratory Instrument Manufacturing
	334517	Irradiation Apparatus Manufacturing
	339112	Surgical and Medical Instrument Manufacturing
	339113	Surgical Appliance and Supplies Manufacturing
	339114	Dental Equipment and Supplies Manufacturing
Research, Testing, & Medical Laboratories	541380*	Testing Laboratories
	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
Bioscience-related Distribution	423450*	Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers
	424210*	Drugs and Druggists' Sundries Merchant Wholesalers
	424910*	Farm Supplies Merchant Wholesalers

*Note: Includes only the portion of these industries engaged in relevant life science activities.

National and state data were tabulated and presented in both summary analytical and state profile tables. Data for Puerto Rico and the District of Columbia are included in this report at both the "state" and national level. U.S. employment, establishment and wage totals in this report reflect the sum of all state data and include both Puerto Rico and DC. For all states and DC, the enhanced data from Lightcast were utilized. Because Lightcast does not provide enhanced data for Puerto Rico, the original QCEW files from BLS were used instead.

For more information on the BLS Quarterly Census of Employment and Wages, see http://www.bls.gov/cew/.

Industry Economic Impacts and Multipliers

The economic impact of the U.S. bioscience industry is estimated using national employment at a detailed industry sector level as inputs; and was developed using Input-Output (I-O) models from IMPLAN (U.S. national and Puerto Rico). The IMPLAN models' data matrices track the flow of commodities to industries from producers and institutional consumers within the nation. The data also model consumption activities by workers, owners of capital and imports. The inter-industry trade flows built into the model permit estimating the impacts of one sector on all other sectors with which it interacts.

The model's estimated results provide the impacts typically measured in an economic impact study quantifying direct, indirect, and induced job creation, associated personal incomes, business value added and output, and associated revenues to federal, state, and local/county taxing jurisdictions. For the non-tax revenue estimations, a multiplier is provided that relates the total impacts to the direct effects that generated them. For example, an employment multiplier of 3.15 indicates that for every 1 direct job in the industry an additional 2.15 jobs are supported within the economy.

Bioscience Academic R&D Expenditures

Based upon data from the National Science Foundation's (NSF) Higher Education Research and Development Survey, national and state totals (summation of all state's responding institutions) are calculated for FY 2022 (most current year available) as well as the previous three years (FY 2019 – FY 2021). Data are provided for total R&D expenditures (including per capita measures) as well as in chart form for the bioscience fields including Health Sciences, Biological and Biomedical Sciences, Agricultural Sciences, Biological/Biomedical Engineering, Natural Resources and Conservation, and Other Life Sciences.

For more information on the NSF Higher Education Research and Development Survey, see https://www.nsf.gov/statistics/herd/.

National Institutes of Health (NIH) Funding

NIH extramural funding data for FY 2023 (the most current full year available) and for previous years were obtained using the NIH RePORTER tool within the RePORT database. Data are provided for total NIH extramural funding, while growth from FY 2019 through FY 2023 and FY 2023 per capita measures are also calculated.

For more information on the NIH Awards data, see https://reporter.nih.gov/.

Bioscience Venture Capital Investments

Venture capital investments, while not the only source of equity capital for bioscience firms, are often the largest and typically the most publicly known and reported source of investment funds allowing for comparability among states.

Venture capital data were collected using the PitchBook venture capital database capturing all venture capital (including "Angel" and pre-seed investment activity) from January 1, 2019 through December 31, 2023. The analysis includes selected investments categorized in PitchBook in the Healthcare industry sector, including all companies in Healthcare Devices and Supplies, Healthcare Technology Systems, Pharmaceuticals and Biotechnology and Other Healthcare as well as all additional companies included in PitchBook's Digital Health and HealthTech industry verticals. Only Healthcare Distributors and Laboratory Services companies are included from PitchBook's Healthcare Services industry group; the analysis excludes hospitals, clinics, elder care facilities and other healthcare service

companies. Investments in Agricultural Chemicals within PitchBook's Materials and Resources industry sector were also included. Additionally, specific investments in venture capital deals related to ethanol/biofuel/biodiesel-related companies were included from the Alternative Energy Equipment and Energy Production industry codes located within the Energy sector in PitchBook.

Bioscience Patents

The use of patent data provides a surrogate (though not perfect) approach to understanding those innovations that bioscience-related industrial organizations, research institutions, and general inventors deem significant enough to register and protect. Patents provide some measure of comparability among regions in one facet of innovation in terms of activity levels within distinct technology areas. Furthermore, examining recent patent activity provides some insight into firms' recent R&D investment areas and strategies, and hence, potential future lines of business.

Each patent document references at least two distinct entities who are associated with the intellectual property (IP) that was generated—the inventor(s) of the patent, or the person(s) who generated the IP disclosed in the patent, and the assignee(s) of the patent, or the entity(ies) which currently have ownership of the IP outlined in the patent. Each patent can have multiple inventors and assignees, and multiple inventors are very common. For this analysis, TEConomy uses the address location of the named inventor(s) in the analysis of geographic distribution of bioscience patent areas across states, with the credit for invention being "shared" across all the unique states represented by the set of listed inventors in the patent document. Hence, if a bioscience patent is invented by individuals in two states, each state will receive "credit" for generating the patent, but at a national level the patent is counted only once. Similarly, when two or more named inventors are from the same state the patent only gets counted once.

It is important to note that this analysis uses only the inventors of the patent as a measure of bioscience innovation activity levels. As companies acquire ownership of IP being generated by others, patents can be assigned to different geographies without any addition of significant innovative value to the original patent. As a result, tracking patent innovation levels by inventor allows for a more consistent and accurate assessment of the places where innovative bioscience IP is being generated by researchers as opposed to being retained or licensed by companies which may or may not align with the same geographic context.

The United States Patent and Trademark Office (USPTO), using the Cooperative Patent Classification (CPC) scheme, assigns each patent with a specific numeric major patent "class" as well as supplemental secondary patent classes which detail the primary technology areas being documented by the patented IP. These classes are assigned to patents by dedicated classification staff who examine the documented IP's key focus and end uses. For example, a patent for a new bio- pharmaceutical may have a main patent class detailing the therapeutic activity or formulation of the drug with supplemental classes documenting any novel synthesizing or manufacturing processes critically tied to creation of the drug. The major patent class and supplemental patent classes are chosen by the USPTO classification staff during the process of reviewing patent applications. By combining relevant patent classes across the wide array of bioscience-related activity, these class designations allow for an aggregation scheme, developed by TEConomy for the purposes of bioscience innovation trends analysis, that is specific to key bioscience technologies.

Patent data were collected using the Clarivate Analytics' Derwent Innovation patent analysis database and includes all granted patents from January 1, 2019, through December 31, 2023, as documented by USPTO. Table A-2 provides a listing of the bioscience-related patent classes that were used in this analysis as well as how these classes are grouped into major areas of bioscience-related technologies (class group).

Table A-2: Bioscience-Related Patents—Classes and Groups

Bioscience Patent Class Group	Patent Class	Patent Class Description
Agricultural Chemicals and Fertilizers	A01N*	Preservation, biocides, pest repellants/attractants, growth regulators
	C05B*	Phosphatic fertilizers
	C05C*	Nitrogenous fertilizers
	C05D*	Other inorganic fertilizers
	C05F*	Other organic fertilizers
	C05G*	Fertilizer mixtures and additives
Biochemistry	C07D*	Heterocyclic chemical compounds
	C07H*	Sugars and nucleic acids
	C07J*	Steroid compounds
	C07K*	Peptide compounds
Bioinformatics & Health IT	G16B*	Bioinformatics
	G16H*	Healthcare Informatics
Biological Sampling & Analysis	G01N 24	Assays (e.g. immunoassays or enzyme assays)
	G01N 25	Screening methods for compounds of potential therapeutic value G01N 26
	G01N 28	Detection or diagnosis of specific diseases
	G01N 33 (partial)	Investigation and analysis techniques pertaining
	G01R 33 (partial)	NMR spectroscopy analysis of biological material (e.g. in vitro testing) and NMR imaging systems
Biopolymers	C08 (partial)	Organic macromolecular compounds involving biological components
Drugs & Pharmaceuticals	A61K*	Drugs, pharmaceuticals, and therapeutics
	A61P*	Specific therapeutic activity of chemical compounds or medicinal preparations
Genetic Engineering	C12N*	Mutation or genetic engineering, DNA or RNA concerning genetic engineering, and delivery vectors (e.g. plasmids or hosts)
Medical & Surgical Devices	G06K 9 (partial)	Microscopic inspection of biological structures
	G06T 7 (partial)	Biomedical image processing and analysis
	A61B*	Diagnostic and surgical devices
	A61C*	Dentistry devices
	A61D*	Veterinary instruments, implements, tools, or methods
	A61F*	Medical filters, prosthetics, implantable devices, and bandages
	A61G*	Transport of patients
	A61H*	Physical therapy devices
	A61J*	Medical product storage, drug manufacturing, and devices for administering food or medicines orally
	A61L*	Disinfection, sterilization, and chemical or physical properties of surgical dressings

Bioscience Patent Class Group	Patent Class	Patent Class Description
	A61M*	Medical injection, inhalation, implantation, spraying or atomizing, drainage or pumping, probes, and anesthetic devices
	A61N*	Electrotherapy, magnetotherapy, radiation therapy, and ultrasound therapy
	H05B 1 (partial)	Electric heating, electric light sources, and electric circuits for medical applications.
	H05B 3 (partial)	Ohmic-resistance heating for medical applications.
Microbiology & Enzymes	C12M*	Apparatus for enzymology or microbiology
	C12P*	Fermentation or enzyme-using processes to synthesize a desired chemical compound or composition
	C12Q*	Measuring or testing processes involving enzymes or microorganisms
Novel Animal Types (Animal Models)	A01K 67 (partial)	New or modified breeds of vertebrates and invertebrates
	A01K 22** (partial)	Modified animals, including genetically modified animals
Novel Plant Types	A01H*	Novel plant types by non-transgenic techniques

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