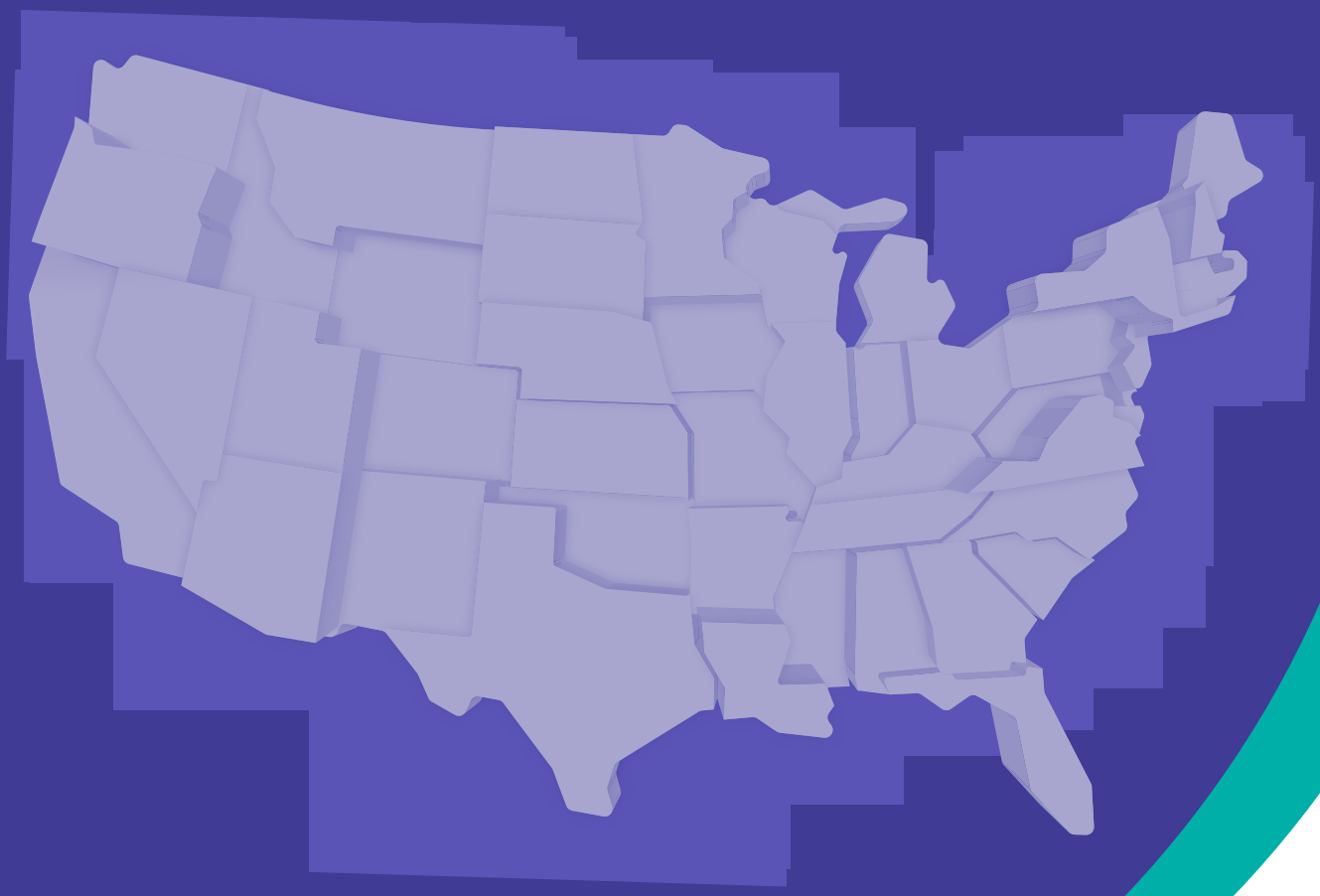
TEConomy/BIO

# The U.S. Bioscience Industry:

## Fostering Innovation and Driving America's Economy Forward

2022



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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. BIOtechNOW is BIO's blog chronicling "innovations transforming our world."

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CSBA Council of State Bioscience 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

# Table of Contents

## Figures



## Tables

# Introduction, Highlights, and Key Findings

The bioscience industry and its supporting ecosystem have always focused on bold innovations to address unmet human needs in the U.S. and around the world. The collective efforts between the industry and its public and private stakeholders have met head-on the challenges of the COVID pandemic, while working to lessen the impacts of climate change and nourish a growing world population. The bioscience industry is also a significant contributor to the economic vitality of states and regions where its diverse companies operate. This report provides an updated assessment of the U.S. bioscience industry with data that both highlight its economic value, and the performance of its supportive ecosystem with respect to research funding, patents, venture capital, and other major efforts for continued success amidst increasing global competition for the industry.

Marking the tenth edition in a biennial series dating back to 2004, this report finds an industry thriving amidst the economic and public health challenges of the last two and a half years. The industry has steadily grown during this period and has yet again offered a critical buffer against national economic challenges, generating high-wage jobs and significant economic impacts while the overall economy has struggled.

Yet economic headwinds and ecosystem challenges persist, including the ongoing struggle in 2022 to tame national and global inflation, a slower pace of economic growth, and continuing supply chain challenges. Couple these macroeconomic factors with slower growth in NIH funding and academic R&D, as well as recent declines in patent awards and applications, and the near-term outlook is concerning.

In 2021, the U.S. bioscience industry represents:

- 2.1 million employees in more than 127,000 business establishments
- A high-growth engine, increasing employment by 11% since 2018, while the overall economy shed 1.5% of its jobs base
- A high-impact contributor to the U.S. economy with economic output impacts totaling $2.9 trillion

But this industry continually delivers on its dual characteristics of intensive innovation that saves and improves lives and contributes a breadth of diverse employment opportunities with wages and incomes that sustain families and strong standards of living.

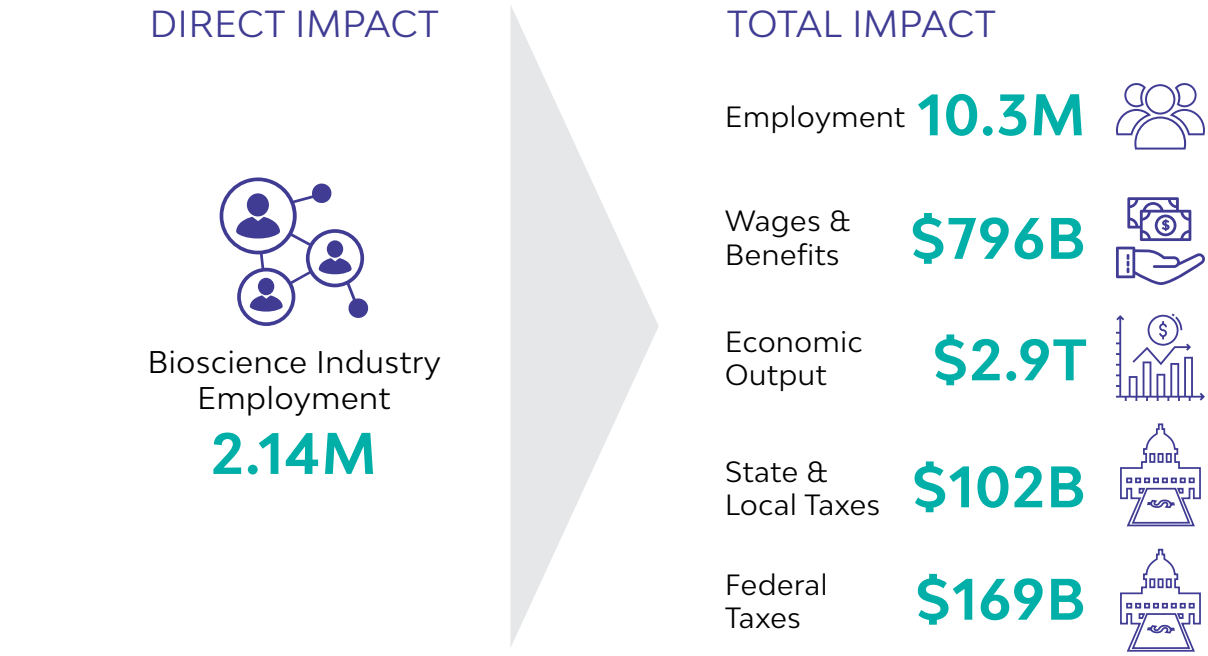
In this 2022 edition, and in the accompanying state profiles made available online, the report maintains its focus on the industry's footprint and economic opportunities across states and regions, as the bio-science industry offers extensive economic reach and broad-based impacts that benefit every region of the U.S. Unlike in past editions, the 2022 report includes industry employment data from the immediate past calendar year, rather than the previous 24-month lag.

## National Industry Highlights

The nation's bioscience industry steadily grew during the last three years—a period that included the significant economic and public health challenges of the global pandemic—bolstering the struggling national economy while generating high-wage, high-quality jobs, and substantial economic impacts for the U.S.

- In 2021, national bioscience industry employment reached 2.1 million jobs across more than 127,000 business establishments spread across every state throughout the U.S.
- Since 2018, bioscience employers grew their payrolls by 11 percent while the private sector overall experienced a net jobs decline of 1.5 percent, due to the steep job losses experienced during the initial pandemic wave and economic shutdowns of 2020. Bioscience industry establishments and average wages also have risen at double-digit rates over the latest three-year period.
- The bioscience industry has outperformed the overall economy in recent years in its employment growth, including other knowledge- and technology-intensive industry sectors such as tech and aerospace manufacturing.
- All five of the industry's major subsectors—agricultural feedstock and industrial biosciences; medical devices and equipment; pharmaceuticals; research, testing, and medical labs; and bioscience-related distribution—have contributed to the employment growth seen since 2018, led by impressive, double-digit job gains in research, testing, and medical labs; and in pharmaceutical manufacturing—not surprising given the intense mobilization and expansion of these sectors during the pandemic.

Figure 1: Economic Impacts of the U.S. Bioscience Industry, 2021




Source: TEConomy Partners data and analysis using U.S. IMPLAN Input-Output Model.

- The bioscience industry continues to generate high-wage jobs reflecting the industry's outsized demand for STEM talent and a highly skilled workforce. In 2021, U.S. bioscience workers earned nearly $126,000 per year, on average, which is $58,000 or 85 percent greater than that earned by their counterparts in the overall private sector.

- The total economic impact of the bioscience industry on the U.S. economy, as measured by overall output, totaled $2.9 trillion dollars in 2021 (Figure 1).

## State and Metropolitan Area Industry Highlights

The nation's bioscience industry spans every U.S. state, with a well-distributed geographic footprint. 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 of employment in at least one of the five bioscience subsectors.

- Thirty-four states and Puerto Rico have a specialization in at least one of the five bioscience subsectors in 2021.

- Industry job growth has been widespread—over the 2018 to 2021 period, 48 states and Puerto Rico experienced job growth in the bioscience industry.

Likewise, the industry is an important economic engine for the nation's metropolitan regions.

- Just over half of all U.S. metropolitan areas have a specialized employment concentration in at least one bioscience industry subsector. Of the nation's 384 metropolitan regions, 205 (53 percent) can claim this distinction.

## Innovation Ecosystem Assessment Highlights

For a science- and technology-driven industry powered by innovation, the supporting ecosystem providing access to scientific R&D from the nation's research institutions, federal funding, strong intellectual property protection in the form of patents, and access to vital sources of risk capital is especially critical for bioscience industry development. The following headlines and highlights show the ecosystem's continued progression, though recent signals point to potentially challenging slowdowns in research activity, funding, and innovation outcomes in terms of patent awards.

- **Bioscience Patent Awards Reveal Breadth of U.S. Innovation, Though Recent Totals Have Declined.** Patent awards with at least one U.S. inventor or assignee in bioscience-related technology classifications totaled nearly 28,000 in 2021. This total has declined for two consecutive years from the more than 30,000 awards recorded in 2019.

- **Bioscience Venture Capital Reached Impressive Record Highs in 2021.** The 2021 venture capital investment total reached $79.4 billion for biosciences, or two times the average level invested during the prior three years.

- **University Bioscience R&D Activity: Pace of Growth Slows.** In 2020 U.S. biosciences academic R&D exceeded $51 billion, an increase of 9 percent since 2018. U.S. research universities have significantly increased their bioscience-related R&D activities since 2015 by $11 billion or 28 percent. Since 2015, R&D expenditures have averaged 5 percent growth year-over-year, however that growth slowed in 2020, increasing just 2.8 percent from 2019.

- **NIH Research Funding Sees Slower Growth in 2021.** In 2021, NIH awarded $34.8 billion in

external or "extramural" research and related funding, representing lower growth from 2020 to 2021 relative to the stronger pace of growth in prior years.

The report is divided into three major sections—first, an assessment of the national bioscience industry's position and recent performance and economic impacts, as well as highlights of state and regional industry performance; second, an assessment of the performance of key innovation ecosystem elements for biosciences development; and third, a section focused on the position of states and metro regions across each of the industry's five major subsectors.

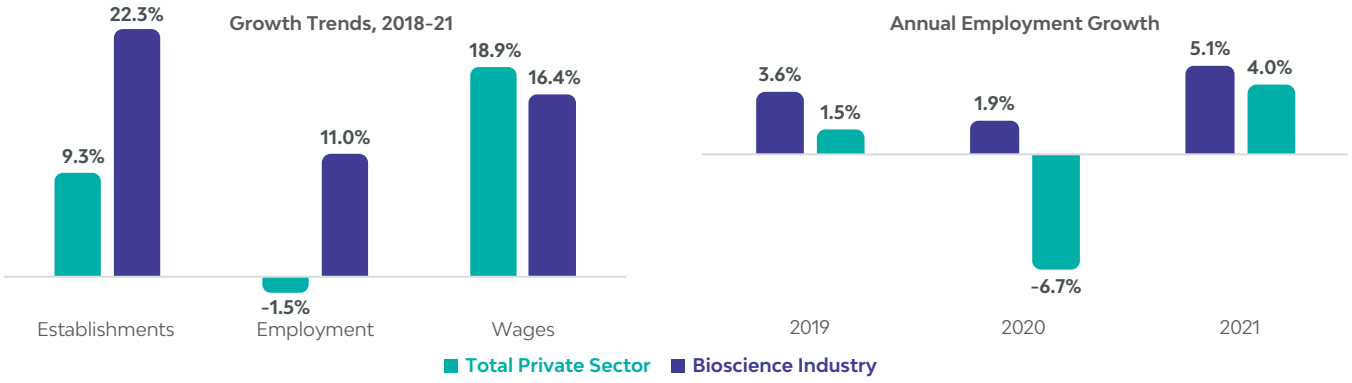
# The U.S. Bioscience Industry:

## A Steady, Long-Term Growth Driver for the Nation's Economy Accelerates its Growth Through the Pandemic Years

The nation's bioscience industry steadily grew during the last three years—a period which included the significant economic and public health challenges of the global pandemic—and by 2021 exceeded 2.1 million jobs in more than 127,000 business establishments spread across every state throughout the U.S. Since 2018, bioscience employers grew their payrolls by 11 percent while the overall private sector experienced a net jobs decline of 1.5 percent, due to the steep job losses experienced during the initial pandemic wave and economic shutdowns of 2020 (Figure 2). Industry establishments and average wages also have risen at double-digit rates.

Biosciences job growth has averaged 3.6 percent from 2019 through 2021 while the private sector's average annual growth rate has been flat (-0.4 percent) as the overall economy continues to claw back the jobs shed in 2020. The industry—called upon to innovate, manufacture, and distribute critical COVID-related diagnostics, vaccines, and therapeutics during this period—has not only outperformed the overall economy, but also other knowledge- and technology-intensive industry sectors in its employment growth (Figure 3).

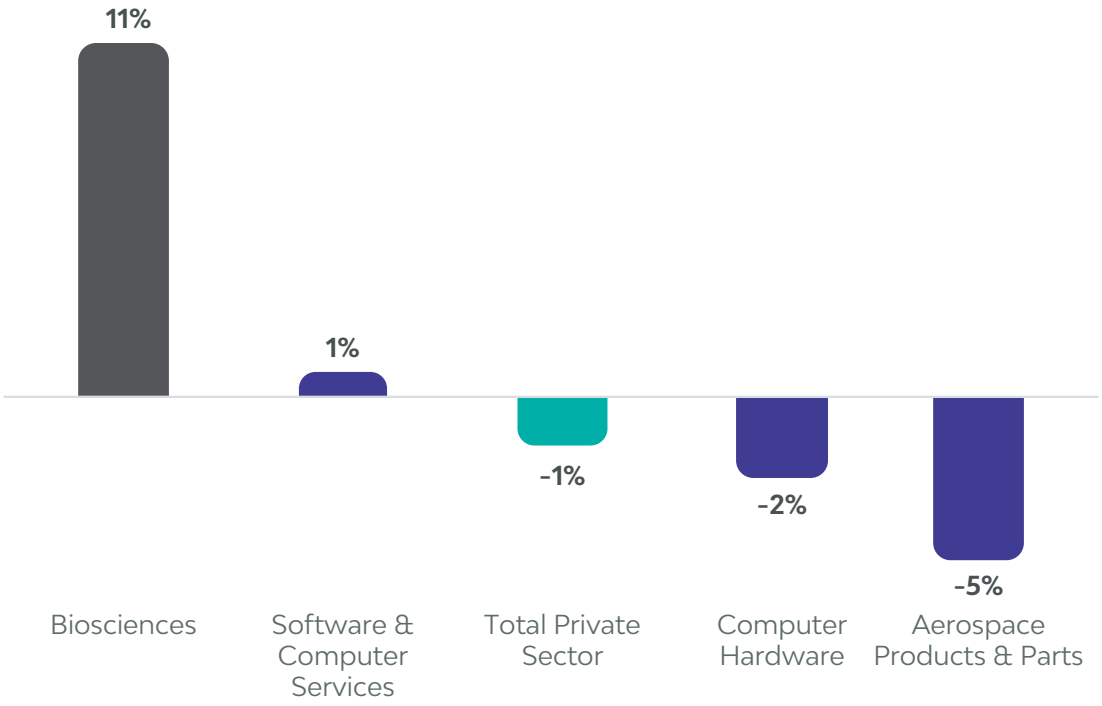
Figure 2: Employment, Establishment, and Wage Trends for the U.S. Bioscience Industry, 2018-21




Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

The bioscience industry—called upon to innovate, manufacture, and distribute critical COVID-related diagnostics, vaccines, and therapeutics during this period—has not only outperformed the overall economy, but also other knowledge- and technology-intensive industry sectors in its employment growth.

Figure 3: Employment Growth Trends—Biosciences vs. Other Technology Industries, 2018-21



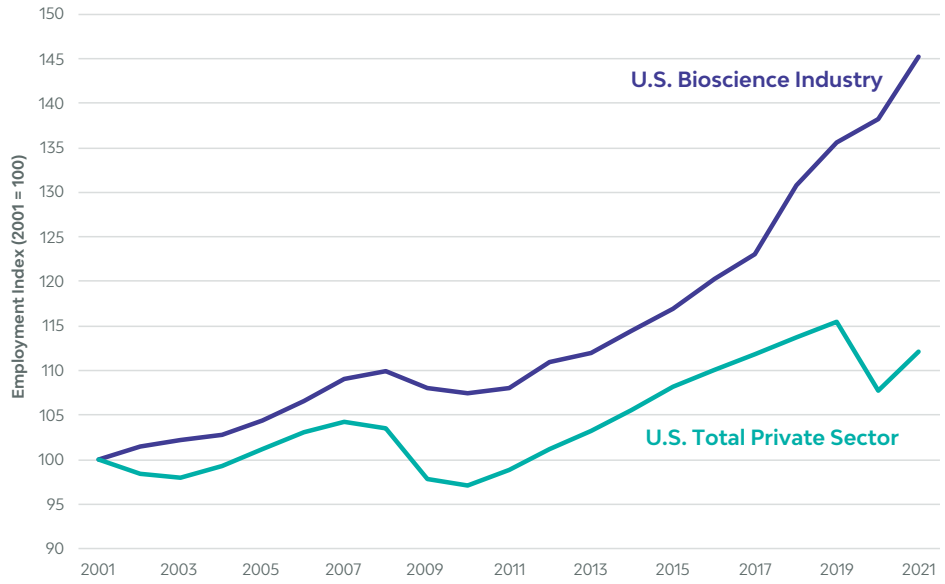

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

The steady growth of the bioscience industry is a continuation of a longer-term trend over nearly all of the two decades this report has tracked industry progress. Recent years have seen growth accelerate (Figure 4). In the last decade the industry has generated especially strong job growth, increasing employment by 35 percent since 2010—compared with 15 percent for the private sector. In just the last six years hiring has gained speed, more than double the pace, on average, of the previous five years.

The two-decade trend for the biosciences clearly demonstrates its resilience and role as a consistent economic growth driver. The industry has bolstered the U.S. economy during recent recessions and downturns.

All five of the major industry subsectors have contributed to the employment growth seen since 2018 (see Figure 5, Table 1), led by impressive, double-digit job gains in research, testing, and medical labs; and in pharmaceutical manufacturing. The recent strong growth in these subsectors has been driven by the intense mobilization and expansion during the pandemic of diagnostic lab testing, industrial R&D in biotech and the biosciences broadly, and vaccine and therapeutic production.

Figure 4: Employment Growth Trends for the U.S. Bioscience Industry and Private Sector, 2001-21




Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

## 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 or link 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 production and processing, organic chemical manufacturing, and fertilizer manufacturing. The subsector includes industry activity in the production of ethanol and other biofuels.

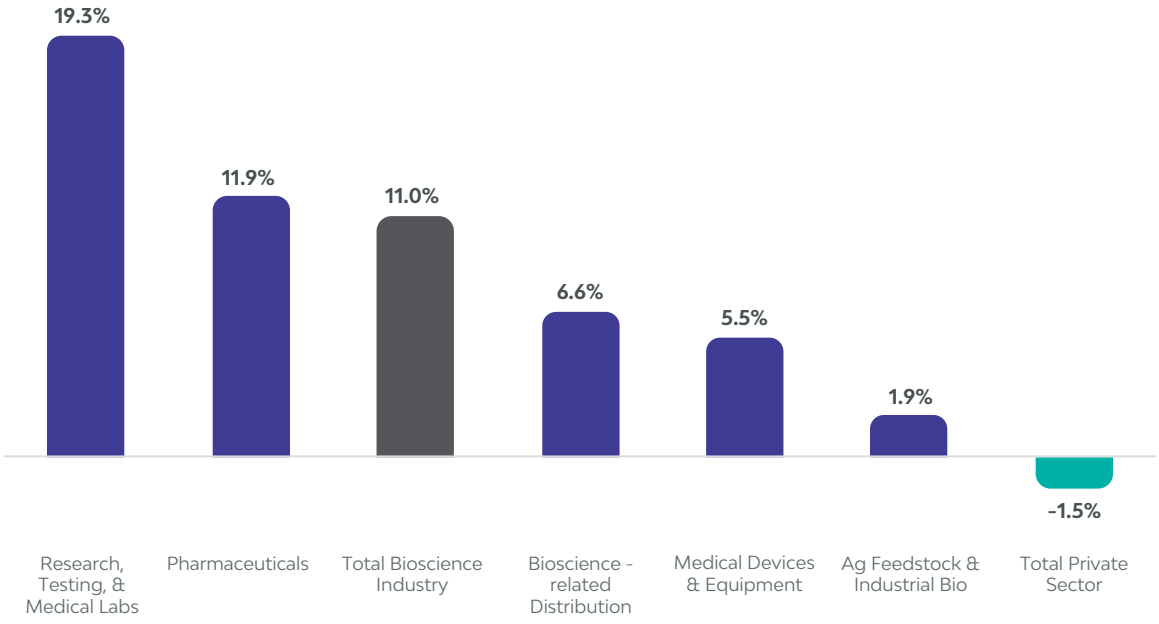
**Bioscience-related distribution**—Firms that coordinate the delivery of bioscience-related products spanning pharmaceuticals, medical devices, and ag biotech. Distribution in the biosciences is unique in its deployment of specialized technologies including cold storage, highly regulated monitoring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

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

**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.

**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.

Figure 5: Employment Growth Trends, Bioscience Industry and Major Subsectors, 2018-21




Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

Highlights across the subsectors and their respective performance include:

- With total employment at nearly 720,000 U.S. jobs, **research, testing, and medical laboratories** is the largest of the major subsectors, and since 2018 it has been the fastest growing. Accounting for one of every three biosciences jobs, the subsector has seen extremely strong growth of 19 percent over the last three years. In the years leading up to the pandemic, the subsector had strong growth, averaging 4.4 percent annually from 2015-18, then from 2018-21 employers accelerated their hiring to average 6.1 percent growth annually. The subsector's commercial research and development component—including biotech and other biosciences R&D conducted by biopharmaceutical, medical device, and agtech firms—accounts for two-thirds of employment and has been the leading employment growth driver, increasing its jobs base by 23 percent since 2018. The remainder are employed in medical labs, which has grown by 13 percent.

- Growth in **pharmaceutical manufacturing** has been similarly impressive, with employers increasing their payrolls by nearly 12 percent from 2018 to almost 345,000 employees in 2021, accounting for 16 percent of U.S. bioscience jobs. Job growth rates for the three years since 2018 each exceeded that for any individual year since 2010, averaging 3.8 percent growth year-over-year. While accounting for 16 percent of U.S. bioscience jobs, the subsector can and should be thought of as more extensive as it is closely tied to commercial R&D firms and establishments, including biotechnology R&D, that are included within research, testing, and medical labs. Within the pharmaceuticals subsector, each component industry has grown since 2018, with most growing by double-digits.

- **Medical device and equipment manufacturers** employ nearly 400,000 in the U.S., accounting for 19 percent of the nation's biosciences jobs. Since 2018, the subsector has grown by 5.5 percent and has averaged 1.8 percent growth annually, about the same average growth rate seen since 2015 for medical device jobs. Performance across the individual component sectors has been mixed, with strong double-digit job growth in electromedical equipment production and analytical lab instruments and above-average growth in medical and surgical instrument manufacturing offset by slower growth in other sectors.

- **Agricultural feedstock and industrial biosciences** grew its employment base by 2 percent from 2018 to reach nearly 70,000 jobs, or 3 percent of all U.S. biosciences jobs. Over the last 3-year period, subsector employers increased their job totals by 0.6 percent annually, on average. This compared with average annual declines seen during the prior three years. Net job gains in the agricultural chemicals components and in sectors contributing bio-based feedstocks were somewhat offset by declines in the biofuels (ethanol) sector.

- **Bioscience-related distribution** operations added nearly 7 percent to their payrolls from 2018 through 2021 to employ more than 602,000 across nearly 63,000 individual business establishments throughout the country. Accounting for 28 percent of U.S. biosciences jobs, the industry's growth has been led by strong gains in medical, dental, and hospital equipment distribution (up 13 percent since 2018), and more modest gains in pharmaceutical distribution.

Table 1: U.S. Bioscience Establishment and Employment Summary, 2021 and Recent Trends

| Bioscience Industry & Major Subsectors | Establishments | | Employment | |
|---|---|---|---|---|
| | Count, 2021 | Change, 2018-21 | Count, 2021 | Change, 2018-21 |
| Agricultural Feedstock & Industrial Biosciences | 1,948 | 10% | 69,573 | 2% |
| Bioscience-related Distribution | 62,697 | 15% | 602,589 | 7% |
| Medical Devices & Equipment | 10,268 | 17% | 398,847 | 5% |
| Pharmaceuticals | 5,973 | 35% | 344,839 | 12% |
| Research, Testing, & Medical Laboratories | 46,503 | 35% | 719,856 | 19% |
| **Total Biosciences** | **127,389** | **22%** | **2,135,704** | **11%** |

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

# An Industry Addressing Global Challenges by Advancing Agricultural and Environmental Solutions

A major focus for numerous BIO member companies is advancing innovative solutions to meet global challenges in the agricultural and environmental space. The industry, in partnership with BIO and other stakeholders, is working to address climate change via decarbonization with strategic shifts toward biobased products and the development and deployment of sustainable fuels. At the same time, the industry is addressing how to feed and nourish a growing global population by developing and leveraging more productive and sustainable agricultural inputs, technologies, and applications. BIO's agricultural and environmental division[1] is emphasizing three areas for its advocacy and support:

- Biobased manufacturing and the biobased economy
- Food and farm innovation
- Sustainable fuels

According to the USDA, **biobased products** are those that are "composed, in whole or in significant part, of biological products, including renewable domestic agricultural materials, renewable chemicals, and forestry materials; or an intermediate ingredient or feedstock."[2] The benefits of biobased products include providing an alternative to petroleum-derived products; offering more options to manufacturers to develop their products; opportunities for new biobased brands and growth markets; and ultimately addressing environmental issues and challenges such as recycling or disposing of single-use plastics.

Biobased products span a diverse range of solutions and markets including many in the chemicals space such as lubricants, detergents, inks, fertilizers, and bioplastics. The USDA, under the Department's BioPreferred Program established in 2011 and its associated product labeling, has catalogued more than 16,000 registered products. The Department measured the economic impacts of the biobased economy in 2020 and according to the report, in 2017,[3] the biobased products industry:

- Supported 4.6 million American jobs through direct, indirect, and induced contributions.
- Contributed $470 billion to the U.S. economy.
- Generated 2.79 jobs in other sectors of the economy for every biobased job.

Further, the report finds that biobased products displace approximately 9.4 million barrels of oil each year and have the potential to reduce greenhouse gas emissions by an estimated 12.7 million metric tons of $CO_2$ equivalents annually.[4]

**Sustainable fuels** represent an important opportunity and avenue for meeting the ambitious decarbonization targets set out by the Paris Climate Accord and other agreements. While electric vehicles are a critical path toward decarbonization, they must be adopted in concert with sustainable fuels for remaining internal combustion engine vehicles particularly in aviation and heavy-duty trucks, buses, and other transportation. To this end, McKinsey estimates that sustainable fuels could account for up to 37 percent of transportation energy demand by 2050.[5] McKinsey is tracking major investments across the globe in sustainable fuels production facilities totaling $40 to $50 billion.

The recently passed Inflation Reduction Act (IRA) included support for the nation's efforts to reduce transportation-related emissions via tax credits for cellulosic biofuels, creation of a sustainable aviation

1 See: https://www.bio.org/agriculture-environment.
2 See: https://www.biopreferred.gov/BioPreferred/faces/pages/BiobasedProducts.xhtml.
3 U.S. Department of Agriculture (UDSA), "USDA Releases Economic Impact Analysis of the U.S. Biobased Products Industry," News Release, July 29, 2021.
4 Ibid.
5 McKinsey & Company, "Charting the global energy landscape to 2050: Sustainable fuels," July 7, 2022.

fuel (SAF) tax credit, additional funding for blender pumps and other biofuels infrastructure, and a grant program to incentivize production of SAF.

Food and farm innovation is driven by **agricultural technology or "agtech"**—inclusive of a range of technologies, including ag-biotech, that boost crop yields and enhance farming efficiency, productivity, and resilience. These technologies include biotech inputs (e.g., seeds, organic agricultural chemicals) as well as leverage software and hardware, sensing technologies, geospatial data and technologies, and modern farm machinery in an increasingly "precision" approach to agriculture.

BIO recognizes that supporting innovative agricultural biotechnology will be critical to enacting many of the climate-smart agriculture provisions in the recent IRA legislation.

**From an economic development perspective, each of these priority areas support high-wage, family-sustaining jobs in rural areas of America where biomass is sourced and crops and livestock are harvested.** Supporting the biobased economy and innovative agtech also has a strategic benefit with respect to domestically-sourced energy and inputs.

## The Biosciences Continue to Generate High-Quality, High-Wage Jobs Driven by Outsized Demand for Highly Skilled STEM Talent

The bioscience industry stands out for being a steady generator and source of high-wage jobs. Industry wages are consistently significantly higher, on average, than those for the overall economy, reflecting the mix of skilled, high-quality jobs in demand within an industry advancing a wide range of value-adding products and services, and it further reflects the importance of the industry as a national economic engine.

A recent assessment of biosciences talent by TEConomy and the Coalition of State Bioscience Institutes (CSBI) highlighted the especially intensive employment within the industry of "STEM" related roles, finding that:

> *"The life sciences are among the most intensive in their deployment of STEM talent—nearly one-in-three industry workers is employed in a STEM occupation, a concentration five times that of all U.S. industries."*[6]

In 2021, U.S. bioscience workers earned nearly $126,000 per year, on average (Table 2). This average wage is $58,000 or 85 percent greater than that earned by their counterparts in the overall U.S. private sector ($67,826), reflecting the outsized industry demand for more highly-paid STEM talent and a highly skilled workforce. The TEConomy/CSBI study found that not only is the industry especially STEM-intensive in its jobs requirements but also has a much greater concentration of both high- and middle-skilled roles requiring postsecondary credentials, including certifications. Specifically, the study found:

> *"In 2020, nearly half (47%) of life science industry employment was in high-skilled occupations compared with 27% for all other industries. These include the vast majority of scientist, engineering, IT, and data sciences roles, or "STEM"-related talent and reinforce the critical need for robust national postsecondary education degree programs to meet industry talent needs.*
>
> *At the same time, about one-in-three life science industry jobs fall in the middle skills categories, again well above the share for all industries. As a leading advanced manufacturing industry, life science companies rely heavily on the skilled technician workforce, both in engineering and scientific domains; production workers with varied skills; transportation and material moving occupations; installation, maintenance, and repair; and more. These workers are operating in increasingly digital and automated manufacturing environments, a shift represented by "Industry 4.0" with significant and important implications for community colleges and other training providers."*[7]

Each bioscience subsector has average wages well above those for the overall private sector, as well as exceeding those for most other major U.S. industries. Employees within the research, testing and medical labs; pharmaceuticals; and distribution subsectors earn average wages exceeding $120,000 annually.

**"The life sciences are among the most intensive in their deployment of STEM talent—nearly one-in-three industry workers is employed in a STEM occupation, a concentration five times that of all U.S. industries."**

**—TEConomy/CSBI Life Sciences Workforce Trends Report, 2021**

6 TEConomy Partners LLC and CSBI, "2021 Life Sciences Workforce Trends Report: Taking Stock of Industry Talent Dynamics Following a Disruptive Year," June 2021.
7 Ibid.

## Table 2: Average Annual Wages for the Bioscience Industry and Other Major U.S. Industries, 2021

| Biosciences & Other Major U.S. Industries | Average Annual Wages, 2021 |
|---|---|
| Information | $152,605 |
| Research, Testing, & Medical Laboratories | $147,396 |
| Finance and Insurance | $131,637 |
| Pharmaceuticals | $126,153 |
| Total Biosciences | $125,750 |
| Bioscience-related Distribution | $121,606 |
| Professional, Scientific, and Technical Services | $114,379 |
| Medical Devices & Equipment | $98,481 |
| Agricultural Feedstock & Industrial Biosciences | $91,989 |
| Manufacturing | $76,572 |
| Construction | $69,892 |
| Real Estate and Rental and Leasing | $69,885 |
| Total Private Sector | $67,826 |
| Health Care and Social Assistance | $58,071 |
| Transportation and Warehousing | $57,959 |
| Retail Trade | $39,729 |

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

# Bioscience Industry Economic Impacts: A $2.9 Trillion Contribution to the U.S. Economy

The 2.1 million U.S. bioscience industry workers employed across every U.S. state and Puerto Rico create a substantial national economic impact. The biosciences have an extensive, interdependent supply chain for research, production, and distribution activities. The industry both supports and depends upon other sectors to supply everything from business services to 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 biosciences have a national economic impact that extends and multiplies well beyond the industry's direct employment and earnings.

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.

**Generating a direct value added of $582 billion and supporting a total value added of $1,468 billion, the U.S. biosciences industry accounted for 2.9 percent and 7.3 percent of U.S. GDP, respectively, in 2021.**

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 2021 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 jobs created;
- *Value-Added.* The difference between an industry's total output and the cost of its labor and other inputs or its contribution to gross state or domestic product (GSP or GDP); and
- *Output.* The total value of production or sales in all industries.[8]

Additionally, the model allows for a high-level estimation of tax revenues generated by the economic activity at the local/county, state, and federal levels. 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.

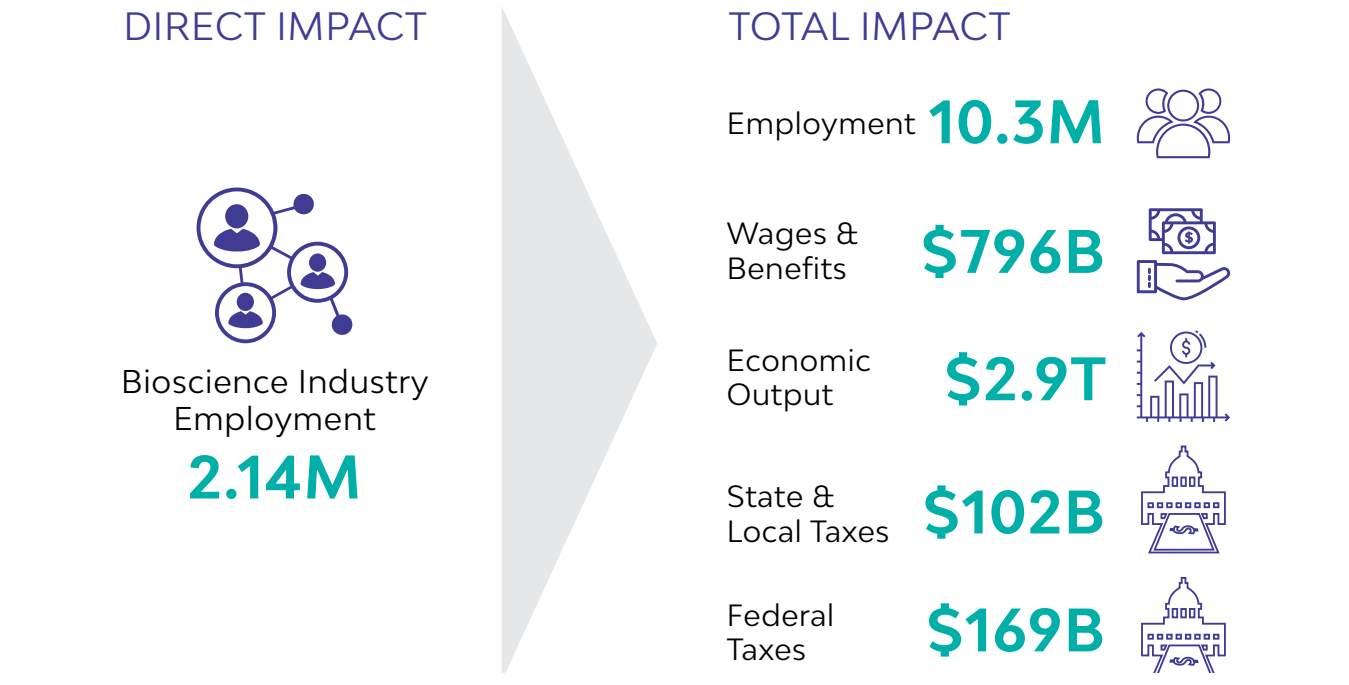
8 The total output impacts are often referred to as the "economic impact" of an industry, project, or investment.

The total economic impact of the bioscience industry on the U.S. economy, as measured by overall output, totaled $2.86 trillion dollars in 2021 (Figure 6 and Table 3). This impact is generated by the direct industry output ($1.21 trillion) combined with the indirect and induced impacts, which total $1.65 trillion for an industry output "multiplier" of 2.36. This means that for every $1 in industry output, an additional $1.36 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. Generating a direct value added of $581.69 billion and supporting a total value added of $1,467.86 billion, the U.S. biosciences industry accounted for 2.9 percent and 7.3 percent of U.S. GDP, respectively, in 2021.

The 2.14 million bioscience employees and their associated economic output support nearly 8.2 million additional jobs throughout the entire economy through both indirect and induced effects. These additional jobs span numerous other industries including key purchased product inputs, real estate, consulting, legal services, transportation, information technology, and utilities. The industry's employment multiplier is 4.82, which means that for every one bioscience job an additional 3.82 jobs are supported throughout the rest of the U.S. economy.

Additional economic impacts of the industry extend to local/county, state, and federal tax revenues through the corporate, personal income, and other taxes paid by bioscience firms, their suppliers, and their workers. These total taxes, through combined direct and multiplier effects, are estimated to have contributed $44 billion to local/county governments, $57 billion to state governments, and $169 billion to the federal government in 2021.

Figure 6: Economic Impacts of the U.S. Bioscience Industry, 2021




Source: TEConomy Partners data and analysis using U.S. IMPLAN Input-Output Model.

Table 3: Economic Impacts of the U.S. Bioscience Industry, 2021 ($ in Millions)

| Impact Type | Employ-ment | $ in Millions | | | | | |
|---|---|---|---|---|---|---|---|
| | | Labor Income | Value Added | Output | Local/County Tax Revenue | State Tax Revenue | Federal Tax Revenue |
| Direct Effect | 2,135,704 | $266,560 | $581,686 | $1,214,649 | $15,539 | $20,924 | $64,543 |
| Indirect Effect | 3,577,568 | $266,350 | $421,836 | $825,804 | $11,205 | $15,941 | $54,556 |
| Induced Effect | 4,581,896 | $263,020 | $464,339 | $823,887 | $17,474 | $20,512 | $50,005 |
| Total Effect | 10,295,167 | $795,929 | $1,467,861 | $2,864,340 | $44,218 | $57,376 | $169,103 |
| Multiplier | 4.82 | 2.99 | 2.52 | 2.36 | | | |

Source: TEConomy Partners data and analysis using U.S. IMPLAN Input-Output Model.

## The Industry's Response to COVID-19:
## Tracking the Pipeline for Ongoing Therapeutic Development

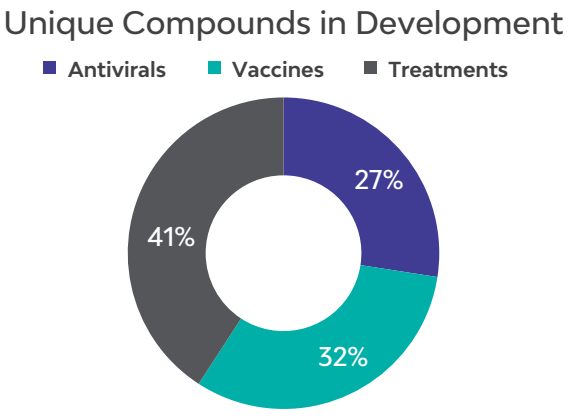
The bioscience industry's response to the health challenges of the global pandemic may now feel like "old news" to some, but it deserves recognition and an acknowledgement that challenges remain, and the industry continues to work steadfast toward innovative solutions, as well as maintaining vigilance in looking ahead to the next potential pandemic.

The Industry Analysis Team at BIO has developed the COVID-19 Therapeutic Development Tracker (available at https://www.bio.org/policy/human-health/vaccines-biodefense/coronavirus/pipeline-tracker) synthesizing and updating detailed pipeline data from BioCentury and Biomedtacker within an interactive online tool. The Tracker, according to BIO, reveals two key themes:

- Biopharma companies, particularly small biotech companies, are undertaking a monumental campaign to combat, and hopefully eradicate, COVID-19.
- Innovation is being led by U.S.-based companies.

As of this writing, the Tracker identifies 747 unique active compounds in various stages of development/approval. These span the categories in the chart to the right.

In addition to novel compounds, the industry is and has further met the challenges of the pandemic through innovation in diagnostic testing.




Source: BIO, COVID-19 Therapeutic Development Tracker.

# State-by-State and Metropolitan Area Bioscience Industry Key Findings and Highlights

The nation's bioscience industry spans every U.S. state, with a well-distributed geographic footprint. The industry's breadth and diversity translates into significant market and economic development opportunities for most states; in fact, a majority of states have a "specialized" concentration of employment in at least one of the five bioscience subsectors. Likewise, the industry is an important economic engine for the nation's metropolitan 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 2021 (see Table 4). These include:
  - 17 states specialized in Agricultural Feedstock & Industrial Biosciences
  - 9 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
  - 9 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 eight states have a specialization in three subsectors (see sidebar), no state has a specialization in all five subsectors.
- Industry job growth has been widespread—over the 2018 to 2021 period, 48 states and Puerto Rico experienced 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: Eight States and Puerto Rico have a Specialized Employment Concentration in Three or More Bioscience Industry Subsectors

**California, Illinois, Indiana, Minnesota, Nebraska, New Jersey, Puerto Rico, South Dakota, Utah**

## Table 4: State Specializations and Job Growth by Bioscience Subsector, 2021

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

| State | Agricultural Feedstock & Industrial Biosciences | | Pharmaceuticals | | Medical Devices & Equipment | | Research, Testing, & Medical Laboratories | | Bioscience-related Distribution | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LQ | Growth | LQ | Growth | LQ | Growth | LQ | Growth | LQ | Growth |
| NY | | | | ● | | | | ● | | ● |
| NC | | ● | ● | ● | | | ● | ● | | ● |
| ND | ● | ● | | ● | | | | ● | ● | |
| OH | | ● | | ● | | | | ● | | ● |
| OK | ● | | | ● | | ● | | ● | | ● |
| OR | | | | ● | | | | ● | | ● |
| PA | | ● | ● | ● | | ● | ● | ● | | |
| PR | | | ● | | ● | ● | ● | ● | ● | ● |
| RI | | ● | | ● | ● | ● | | ● | | ● |
| SC | | | | ● | | ● | | ● | | ● |
| SD | ● | | | ● | ● | ● | | ● | ● | ● |
| TN | | | | ● | | ● | | ● | ● | ● |
| TX | | | | ● | | ● | | ● | | ● |
| UT | | | ● | ● | ● | ● | ● | ● | | ● |
| VT | | | | | | ● | | ● | | ● |
| VA | | ● | | ● | | ● | | ● | | ● |
| WA | | | | ● | | ● | ● | ● | | ● |
| WV | | | ● | | | | | ● | | ● |
| WI | ● | ● | | ● | ● | ● | | ● | | ● |
| 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 2022.3).

## Highlights of Metropolitan Area Industry Performance

Just over 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 384 metropolitan regions, 205 (53 percent) can claim this distinction, further evidence of the industry's widespread footprint and development.

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

Nineteen 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)
- Ames, IA (3)
- Bloomington, IN (3)
- Boston-Cambridge-Newton, MA-NH (3)
- Burlington-South Burlington, VT (3)
- Durham-Chapel Hill, NC (3)
- Fort Collins, CO (3)
- Lafayette-West Lafayette, IN (3)
- Lima, OH (3)
- Memphis, TN-MS-AR (3)
- Morgantown, WV (3)
- Raleigh-Cary, NC (3)
- Salt Lake City, UT (3)
- San Diego-Chula Vista-Carlsbad, CA (3)
- San Francisco-Oakland-Berkeley, CA (3)
- San Jose-Sunnyvale-Santa Clara, CA (3)
- Trenton-Princeton, NJ (3)
- Worcester, MA-CT (3)

# Advancing the Nation's Biomanufacturing Sector: A Strategic Imperative for the U.S., States, and Regions

As transformative research and development of a medicine continues to be an early and mid-stage focus of the bioscience industry, downstream in the process is the need to have that medicine manufactured for distribution to the patient. COVID-19 and the potential for future pandemics have placed a new strategic emphasis and focus on biomanufacturing efforts in the U.S., and the need to develop the facilities and processes to adequately accomplish the goal of maintaining a strong on-shore presence of this vital product manufacturing and distribution network all across the nation.

But scaling-up to meet the demand requires better understanding the complex and lengthy process of establishing the manufacturing capacity. Building a new biomanufacturing facility, for example, can cost up to $2 billion and take five to ten years before it is operational, including the time and costs related to comply with various federal and state regulatory requirements. This special section provides an overview and background on biomanufacturing, its unique context and technology and production challenges facing the industry, and public-private initiatives to address these challenges.

Biomanufacturing uses living cells and biological systems to make commercial products, or to extract and utilize a particular molecule via the bioprocessing of tissues or cells. These products or biological molecules are used across a varied set of applications and markets for medicines and vaccines (biopharmaceuticals); food and beverage ingredients and processing; and industrial uses in plastics and other commercial products and applications. Biomanufactured products can be harvested from animal or plant cells, from blood, or from microbes.

Exciting innovation in biopharmaceuticals is yielding medicines that save and improve millions of lives by treating and preventing some of the most prevalent and devastating diseases affecting humans including cancer, diabetes, autoimmune disorders, and infectious diseases, and therefore represents one of the most critical and strategic industry sectors globally. Biopharmaceuticals reflect an ongoing paradigm shift from traditional small-molecule therapeutic product manufacturing to products based on biomaterials and biomolecules with applications expected to continue growing rapidly. Many of the leading pharmaceuticals on the market today are biologics/biopharmaceuticals that span monoclonal antibodies, vaccines, recombinant hormones, cell and gene therapies, and others.

### Biopharmaceutical/Biologics Represent a High-Growth Market:

**Emergen Research pegs the global biologics market size at $300B in 2020 and expects it to reach $568B by 2028, an annual growth rate of 8.4%.**

**National employment in the biologics manufacturing sector has averaged nearly 5% annual growth over the last decade.**

Source: Emergen Research; U.S. Bureau of Labor Statistics, CEW program data.

But biopharmaceutical manufacturing is highly complex and requires novel processing and production approaches to ensure safety, quality, and reliability under strict FDA regulations. The biology-driven context of biopharmaceutical manufacturing is especially challenging recognizing the implications for quality control amid process variability including: the sensitive nature of living cells to variations in raw materials or environmental conditions in the scale-up process requiring especially close monitoring; purification requires ongoing optimization due to variability from batch to batch; and formulation requires sterilization and sensitivity to temperature conditions.

Areas of innovation in biopharmaceutical manufacturing aimed at addressing these and other challenges include:

- Continuous manufacturing

- Novel, single-use systems
- Use of modular bioreactors
- Next-generation cell expression platforms
- Advanced purification technologies
- New cell preservation, distribution, and handling methods

Manufacturers are increasingly seeking to improve the speed and scale of their production to enhance patient access, while ensuring compliance with strict FDA guidelines. To resolve complex manufacturing challenges, companies have a need for test beds, including expensive industry-grade equipment, access to cell lines and consumables, access to talent and customized workforce development programming, and other enabling infrastructure.

There is fierce competition globally for both innovation and production capabilities in biopharmaceuticals. The sector has strategic importance with respect to human health, national security, and economic competitiveness. In this context, many public-private partnership initiatives are actively investing to grow capacity, to implement new production and processing technologies, and to address unique infrastructure and ecosystem needs for a robust biomanufacturing sector. Examples of some of the nation's recent, notable initiatives and investments include:

- **The National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL)**, a public-private partnership that is part of the federally-sponsored manufacturing innovation institutes known as Manufacturing USA, and whose mission is to "accelerate biopharmaceutical innovation, support the development of standards that enable more efficient and rapid manufacturing capabilities, and educate and train a world-leading biopharmaceutical manufacturing workforce, fundamentally advancing U.S. competitiveness in this industry."[9] NIIMBL brings together an impressive network of companies, universities, states, government agencies, NGOs, and others to collaborate on common challenges they face.

- **The U.S. Economic Development Administration's $1 billion Build Back Better Regional Challenge**, is investing millions in several regional signature initiatives in the bioeconomy and biopharmaceutical development in states and regions including North Carolina, Greater Oklahoma City, the City of Manchester New Hampshire, and Virginia.

- **President Biden's recent Executive Order launching a National Biotechnology and Biomanufacturing Initiative**, with funding of more than $2 billion, which has numerous strategic aims that span the broader bioeconomy but includes several directed at strategic U.S. biopharmaceutical development. These include funding for HHS to expand the role of biomanufacturing for active pharmaceutical ingredients (APIs), antibiotics, and key ingredients for essential medications for pandemic response and preparedness.

- **Just some examples of states, coalitions, and individual organizations that have invested significantly in biomanufacturing development assets** include California through the California Biomanufacturing Center; North Carolina and Massachusetts' long-standing biomanufacturing workforce development efforts and shared-use facility capabilities; the Northeast Biomanufacturing Center and Collaborative (NBC2) located in Pennsylvania and serving the broader region in education and training; investments by individual universities such as the Waisman Center at the University of Wisconsin-Madison, and the National Center for Therapeutics Manufacturing at Texas A&M University; and many more.

The U.S. and numerous states, recognizing the promise of and intense global competition for biomanufacturing, are prioritizing domestic production to reduce offshoring, to ensure secure supplies of medicines and pandemic preparedness, and to advance health outcomes for their citizens.

9 https://niimbl.force.com/s/about-niimbl

# The Innovation Ecosystem for the Biosciences:

## National Highlights and Leading States

The strong, continuous and long-term industry growth and resulting outsized economic impacts generated by the biosciences do not exist without a robust and supportive innovation ecosystem in which to thrive. As a highly innovative science and technology driven sector, the biosciences are especially dependent upon and enabled by a high-functioning national ecosystem that supports basic and applied research and development with appropriate resources, protects intellectual property, and allocates capital to promising new, emerging and existing businesses. Each of these elements, combined with the appropriate access to and pipeline for talent at all skill levels, combine to determine hard-earned economic outcomes and benefits, as well as the products and services that improve lives. This ecosystem and industry success cannot be taken for granted, particularly in a high-stakes, globally competitive environment.

This section takes stock of the nation's overall position and performance of this ecosystem and highlights leading states across four key elements of the industry's unique innovation ecosystem.

### Elements of the U.S. Innovation Ecosystem Assessed

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

## University Bioscience R&D Activity: Pace of Growth Slows

The nation's colleges and universities are steadily increasing their R&D expenditures in key life science-related research fields in recent years, with 2020 U.S. biosciences academic R&D exceeding $51 billion (Figure 7). These fields, which span and include health, biological, biomedical, and agricultural sciences, as well as biological and biomedical engineering, form a critical and valuable foundation in both fundamental, basic scientific inquiry as well as applied research and important collaborative partnerships with both emerging and established industry players to advance commercialization.

Following a period of stagnation in the early part of the last decade, U.S. research universities have significantly increased their R&D activities since 2015 by $11 billion or 28 percent. Since 2015, R&D expenditures have averaged 5 percent growth year-over-year, however that growth slowed in 2020, increasing just 2.8 percent from 2019.

Across the nation's academic research complex, bioscience disciplines account for a majority of all R&D activity. Combined, they account for 59 percent of all U.S. university R&D expenditures in 2020, a share that has increased from 43 percent a decade earlier as growth in biosciences R&D has outpaced growth for overall science and engineering disciplines.

Figure 7: University Bioscience R&D Expenditures, FY 2015-20 ($ 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.

Table 5 highlights leading states in both the latest levels of academic bioscience R&D spending and growth. These leading states tend to be both larger overall, home to multiple research universities and sizable medical schools. The majority of leading states now exceed $2 billion in annual academic bioscience-related R&D expenditures. High-growth states include numerous smaller states where growth rates are calculated on a smaller, more modest base. An exception is the growth of Texas' academic R&D complex, which is not only among the leading states in overall magnitude, but also among the fastest growing since 2018.

Additional states stand out in the intensive nature of their university biosciences R&D relative to the size of their populations and others as a share of their overall academic science and engineering research complex. Smaller states/districts with multiple research institutions such as Washington, DC, Connecticut, and Wisconsin lead relative to their size on a per capita basis (Table 6). In addition, some leading life sciences R&D states such as Maryland, Massachusetts, and North Carolina do not have the larger populations of other leaders and so the intensive concentrations are much greater.

For other states, the biosciences are an especially intensive component of their broader academic R&D complex and therefore account for the vast majority of overall expenditures—which, in several cases, are as high as 80 percent or more.

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

| Academic Bioscience R&D Expenditures, 2020 | |
|---|---|
| Leading States | Total R&D Expenditures ($ Billions) |
| California | $7.0 |
| New York | $4.7 |
| Texas | $4.1 |
| Pennsylvania | $3.0 |
| North Carolina | $2.5 |
| Maryland | $2.1 |
| Massachusetts | $2.0 |
| Illinois | $1.7 |
| Michigan | $1.6 |
| Ohio | $1.6 |

| Academic Bioscience R&D Growth, 2018-20 | |
|---|---|
| Leading States | Growth Rate, % |
| Vermont | 30% |
| Nevada | 27% |
| Indiana | 23% |
| Texas | 17% |
| Colorado | 16% |
| Montana | 16% |
| Oregon | 15% |
| Wyoming | 14% |
| Wisconsin | 14% |
| Missouri | 14% |

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, 2020

| Per Capita Expenditures | |
|---|---|
| Leading States | $ Per Capita |
| District of Columbia | $545 |
| Maryland | $336 |
| Connecticut | $312 |
| Massachusetts | $285 |
| North Carolina | $238 |
| New York | $235 |
| Pennsylvania | $233 |
| Vermont | $223 |
| Nebraska | $211 |
| Wisconsin | $196 |

| Share of Total Science & Engineering R&D | |
|---|---|
| Leading States | % Share |
| Missouri | 84% |
| Connecticut | 82% |
| Kentucky | 82% |
| Arkansas | 81% |
| Vermont | 79% |
| Oregon | 77% |
| North Carolina | 77% |
| Nebraska | 76% |
| Minnesota | 74% |
| South Carolina | 71% |

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 Sees Slower Growth in 2021

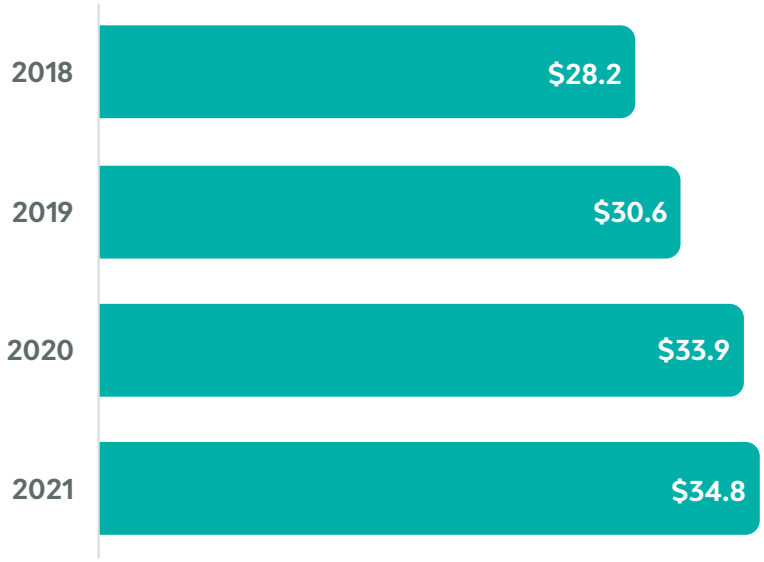
Federal funding for bioscience-related research is critical to continually advancing scientific R&D and innovation. Several agencies fund life sciences research at U.S. colleges and universities, with the National Institutes of Health (NIH) recognized as the "gold standard" for the largest component of bioscience research—biomedical. NIH also funds research at hospitals and other biomedical research institutions as well as industry, to a lesser extent.

In 2021, NIH awarded $34.8 billion in external or "extramural" research and related funding, representing lower growth from 2020 to 2021 relative to the stronger pace of growth in prior years (Figure 8). After several years of declining or flat funding levels in the early 2010s, NIH funding returned to a stronger growth trajectory and from 2016 through 2020 averaged 8 percent growth annually. In 2021, however, growth slowed to 3 percent over the year.

In 2021, nine of the leading states in total NIH funding received awards exceeding $1 billion across all state institutions and organizations (Table 7). Two of the leading states in funding totals—Massachusetts and Maryland—are smaller and also rise to the top on a per capita basis with these normalized funding levels several times higher than the national average ($105).

Nationally, NIH funding levels grew by 23 percent from 2018 through 2021. During this period, several states surpassed that growth rate and are highlighted in Table 7. Already among the national leaders in overall funding, North Carolina institutions saw their NIH funding increase by 60 percent from 2018—especially impressive given its already large base. Smaller states including Arkansas, North Dakota, West Virginia, and Delaware had increases exceeding 40 percent, though these growth rates can reflect a modest base from which they grew.

Figure 8: National Institutes of Health Awards, FY 2018-21 ($ in billions)




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

Table 7: Leading States in NIH Funding, FY 2021

| Total NIH Funding | |
|---|---|
| Leading States | Funding ($ Billions) |
| California | $5.1 |
| New York | $3.2 |
| Massachusetts | $3.2 |
| Maryland | $2.3 |
| North Carolina | $2.2 |
| Pennsylvania | $2.0 |
| Texas | $1.5 |
| Washington | $1.4 |
| Illinois | $1.1 |
| Ohio | $0.9 |

| Per Capita NIH Funding | |
|---|---|
| Leading States | $ Per Capita |
| Massachusetts | $458 |
| Maryland | $378 |
| District of Columbia | $331 |
| Rhode Island | $223 |
| North Carolina | $211 |
| Connecticut | $191 |
| Washington | $181 |
| New York | $162 |
| Pennsylvania | $158 |
| California | $130 |

| NIH Funding Growth, 2018-21 | |
|---|---|
| Leading States | Growth Rate |
| North Carolina | 60% |
| Arkansas | 58% |
| North Dakota | 43% |
| West Virginia | 42% |
| Delaware | 42% |
| New Jersey | 41% |
| Washington | 36% |
| Louisiana | 35% |
| Oklahoma | 33% |
| Indiana | 32% |

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

## Bioscience Patent Awards Reveal Breadth of U.S. Innovation, Though Recent Totals Have Declined

Bioscience-related innovation is uniquely challenging—the time, talent, and resources required to successfully navigate the research and development and regulatory requirements of a commercial therapeutic, medical device, or a biobased product is daunting. Robust and enforced legal protections of intellectual property, in the form of patents, are necessary to encourage and incent these types of investments both in the U.S. and globally.

Patent awards with at least one U.S. inventor or assignee in bioscience-related technology classifications totaled nearly 28,000 in 2021 (Figure 9). And while this represents a 7 percent increase from 2018 levels, the total has declined for two consecutive years from the more than 30,000 awards recorded in 2019.

An examination of patent activity during the first year of the pandemic (2020), published in Bloomberg Law,[10] finds that:

> *"The number of patent applications filed in the U.S. Patent and Trademark Office (USPTO) from 2000 to 2020 only experienced two prominent drops—one in 2009 when the U.S. economy tanked and one in 2020 when the Covid-19 pandemic reached the U.S." And further that:*
>
> *"From 2016 to 2019, the percentage of applications that were abandoned dropped from 49% to 41%. Then in 2020, the abandonment rate jumped to 62%."*

The arrival of COVID impacted company decisions on whether to apply for and maintain patent applications, with costs certainly a consideration. The author finds no evidence that patent applications at USPTO were affected by a shift to telework, which the Office had in place back to 1997.

10 Gzybowski, Michael, "Covid-19's Impact on U.S. Patent Filings," Bloomberg Law, May 24, 2021.

Figure 9: Bioscience-related U.S. Patents, 2018-21


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

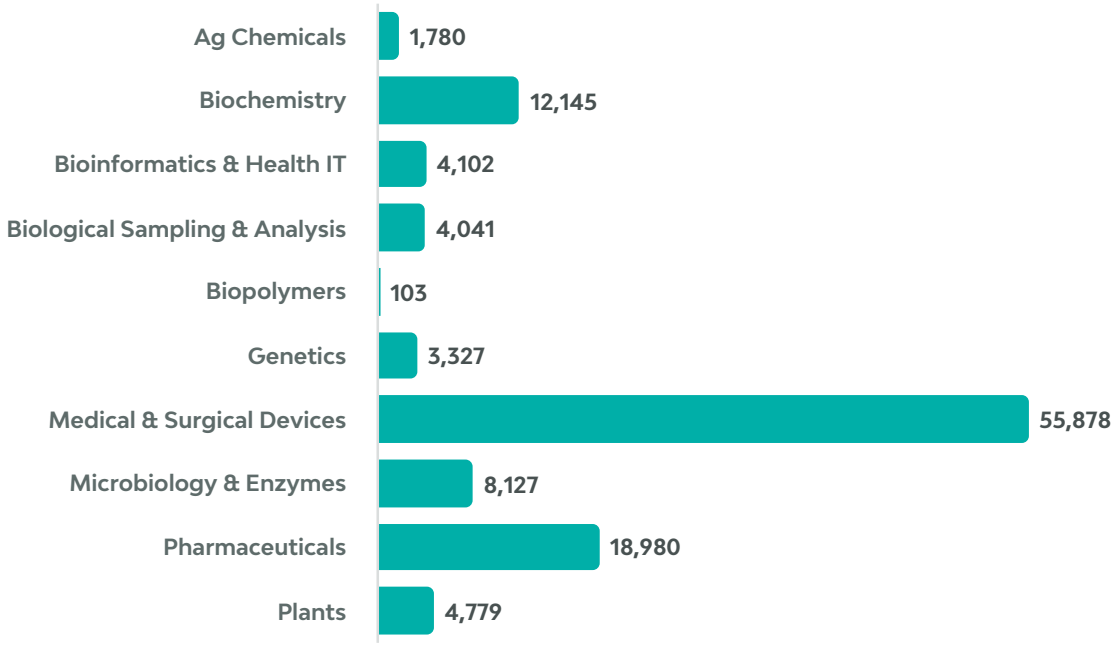
From an ecosystem evaluation perspective, analysis of patent classifications provides a window and progressive snapshot of technology innovation and product and process development areas in which major investments are concentrated as well as emerging areas. A high-level assessment, shown in Figure 10, shows cumulative patent awards from 2018 through 2021 and the impressive range and breadth of areas of bioscience-related innovation.

In the latest 4-year period, the segments related to medical and surgical device innovations remained by far the largest, accounting for one of every two biosciences patents. Pharmaceuticals and biochemistry represent other large and significant segments, but the analysis also finds innovation advancing in bioinformatics and health IT, genetics, and agricultural biotech. Compared against the prior 4-year period, bioinformatics and health IT patenting activity, in particular, has risen substantially.

California and Massachusetts represent clear leaders in bioscience-related patenting, with the two combining to account for more than four in ten national patents (Table 8). Massachusetts, given its relatively small size, is far and away the leader on a per capita award basis. Other smaller states have strong concentrations of biosciences patents including Minnesota, Connecticut, New Hampshire, Rhode Island, Delaware, and Maryland.

Table 9 presents the leading states across the breadth of patent class technology groups, with darker circles signifying the leading five states and open circles rounding out the top ten. A number of states are leaders across many areas of innovation, including: California, Florida, Illinois, Maryland, Massachusetts, Minnesota, New Jersey, New York, North Carolina, Ohio, Pennsylvania, and Texas. Other states demonstrate more focused areas of strength for example: Missouri in genetics and areas of agtech; Iowa in novel plant variants; Indiana in agricultural chemicals; and Arizona in biopolymers.

## Figure 10: Bioscience-related U.S. Patents by Segment, Cumulative 2018-21




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

## Table 8: Leading States in Bioscience-Related Patents, Cumulative 2018-21

| Patent Totals, 2018-21 | |
|---|---|
| Leading States | Total Patents |
| California | 34,389 |
| Massachusetts | 14,154 |
| New York | 7,980 |
| New Jersey | 7,309 |
| Pennsylvania | 7,298 |
| Minnesota | 6,425 |
| Ohio | 5,810 |
| Florida | 5,805 |
| Texas | 5,312 |
| Maryland | 4,066 |

| Patents Per 1M Population | |
|---|---|
| Leading States | Patents per 1M Population |
| Massachusetts | 524 |
| Minnesota | 260 |
| Connecticut | 258 |
| New Hampshire | 254 |
| California | 215 |
| New Jersey | 197 |
| Rhode Island | 192 |
| Delaware | 189 |
| Maryland | 159 |
| Colorado | 146 |

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

## Table 9: Leading States in Bioscience-related Patents by Class Group, Cumulative 2018-21

| State | Total Biosciences | Agricultural Chemicals | Biochemistry | Bioinformatics & Health IT | Biological Sampling & Analysis | Biopolymers | Pharmaceuticals | Genetics | Medical & Surgical Devices | Microbiology & Enzymes | Novel Plant Variants |
|---|---|---|---|---|---|---|---|---|---|---|---|
| AZ | | | | | | ○ | | | | | |
| CA | ● | ● | ● | ● | ● | | ● | ● | ● | ● | ● |
| CO | | | | | | | | | ○ | | |
| CT | | | ○ | | | | | | | | |
| FL | ○ | ○ | | ○ | | ● | ○ | ○ | ● | | ○ |
| IL | | | ○ | ○ | ○ | ○ | | | | | ● |
| IN | | ● | | | | | | ○ | | | ○ |
| IA | | | | | | | | ○ | | | ● |
| MD | ○ | | ○ | | ● | | ○ | ○ | | ● | |
| MA | ● | | ● | ● | ● | ● | ● | ● | ● | ● | |
| MI | | | | | | ○ | | | | | ○ |
| MN | ○ | ● | | | | ● | | | ● | | ● |
| MO | | ○ | | | | | | ● | | | ○ |
| NE | | | | | | | | | | | ○ |
| NJ | ● | ● | ● | ○ | ● | ○ | ● | | ○ | ○ | |
| NY | ● | ○ | ● | ● | ● | ● | ● | ● | ○ | ● | |
| NC | | ● | ○ | ○ | | | ○ | ● | | ○ | |
| OH | ○ | | | | ○ | ● | ○ | | ● | | |
| PA | ● | ● | ● | ● | ○ | | ● | ○ | ○ | ● | |
| 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.

## Bioscience Venture Capital Reached Impressive Record Highs in 2021

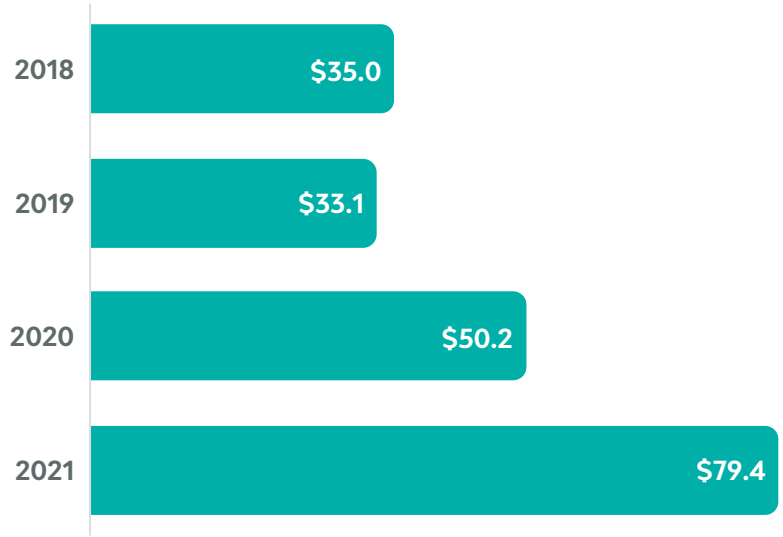
Investment capital is critical to emerging technology-driven companies developing new products, but especially vital for R&D-intensive bioscience companies that face difficult, expensive, and lengthy time horizons to commercialization and steady revenues. This is particularly true for seed- and early-stage bioscience companies that often require multiple rounds of funding to sustain product development and conduct rigorous pre-clinical and clinical testing under regulatory frameworks.

The 2021 investment total for biosciences VC funding reached $79.4 billion, an impressive new high that is two times the average level invested during the prior three years (Figure 11). As *PitchBook* succinctly summarizes in a recent article, "The need for scientific innovation during the height of the COVID-19 outbreak fueled investor interest in pharmaceutical and biotech startups."[11]

Over the last decade, the bioscience industry's average annual share of total U.S. VC funding has been 25 percent, and in the latest four-year period, this average has held. Though in the record-breaking year of 2021, that share dipped to 23 percent, indicating IT and other VC-backed sectors were also experiencing especially strong investment totals. The jump in biosciences VC investments in 2021 were not necessarily at the expense or in lieu of private equity funding to other sectors.

Comparisons of average investment deals highlight the record-breaking totals—two years ago this publication reported average bioscience-related investments per deal of $8.9 million and that figure has reached $12.9 million, a figure that is smoothed as an average over four years (Table 10). Average investment levels per company were $15 million in the 2016-19 period and now top $22 million for 2018-21. A recent report by *Evaluate Vantage* highlighted the shift toward much larger investment rounds from 2020 to 2021 among biotechs.[12]

Figure 11: Bioscience-related Venture Capital Investments, 2018-21 ($ in Billions)




Source: TEConomy Partners analysis of PitchBook Data, Inc.

11 Temkin, Marina, "Biotech VC funding softens amid macroeconomic headwinds," PitchBook News & Analysis, June 23, 2022.

12 Evaluate Vantage, "Biopharma and Medtech Review, 2021," February 2022.

Later-stage investments tend to be significantly larger than those at the earliest stages, although deal volumes tend to be higher among those earlier stages as investors often fund multiple, smaller rounds. In 2020 and 2021, investment levels (dollars) tilted even more significantly toward later-stage companies relative to historical averages, explaining some of the underlying shifts toward record levels of funding. From 2020 through 2021, 60 percent of the dollars invested in the biosciences were in later-stage companies, much higher than the average share over the prior five years of 54 percent.

Looking ahead to the first half of 2022, and amidst the current macroeconomic headwinds, biosciences VC funding has held relatively strong through the first half of the year—recording a funding total of $33 billion. So, while the industry is not on pace to match the record funding levels seen in 2021, funding is on pace for a strong year with respect to recent history.

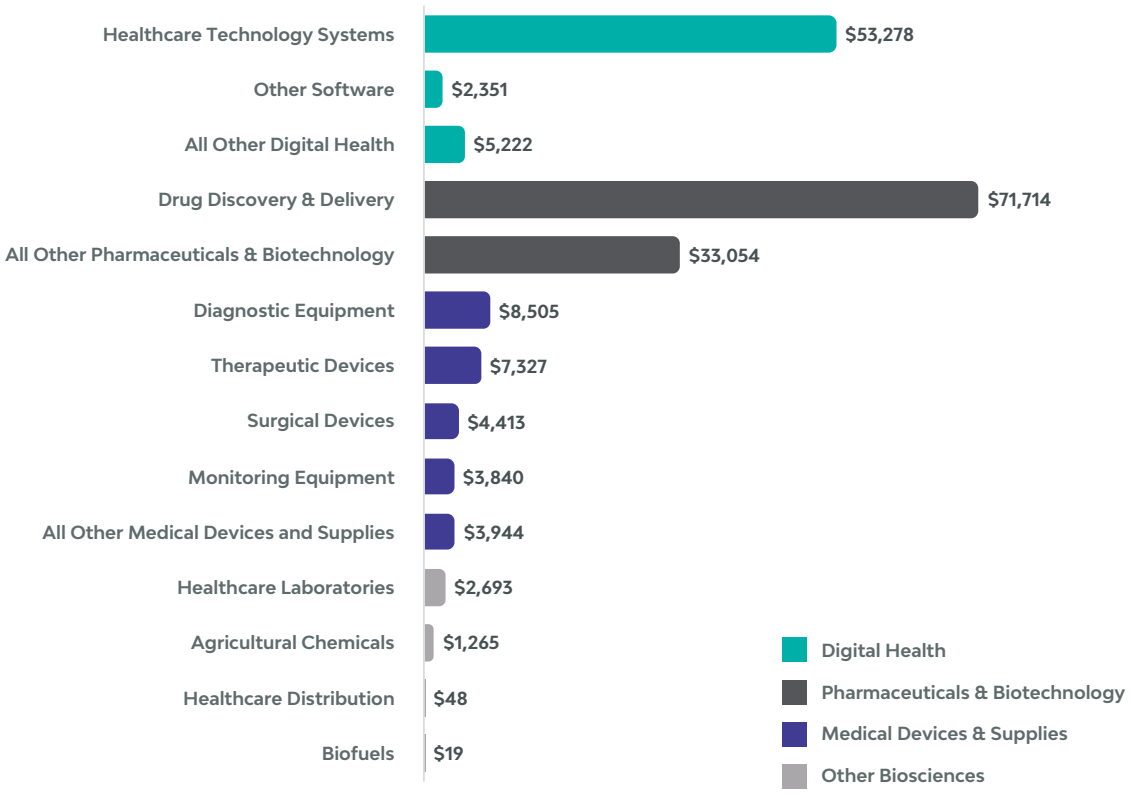
Since 2018, just over half of bioscience-related VC investments (53 percent) have been in companies engaged in biopharmaceutical development inclusive of biotechnology, drug discovery and delivery, and pharmaceuticals segments, shown in dark gray in Figure 12. Nearly one-third of funding (31 percent) has been directed toward companies in the digital health and health technology segments, a rising share for the sector.

Table 10: U.S. Bioscience Venture Capital Investments by Stage, Cumulative 2018-21

| Stage | Number of Deals | Number of Companies | Total VC Investments ($ Millions) | Average Investment Per Deal ($ Millions) | Average Investment Per Company ($ Millions) |
|---|---|---|---|---|---|
| Pre-Seed | 3,087 | 2,360 | $406 | $0.13 | $0.17 |
| Angel | 1,134 | 989 | $1,145 | $1.01 | $1.16 |
| Seed | 3,300 | 2,724 | $9,406 | $2.85 | $3.45 |
| Early Stage | 3,751 | 2,825 | $72,061 | $19.21 | $25.51 |
| Later Stage | 4,107 | 2,782 | $114,657 | $27.92 | $41.21 |
| **Total** | **15,379** | **8,820** | **$197,675** | **$12.85** | **$22.41** |

Source: TEConomy Partners analysis of PitchBook Data, Inc.

Figure 12: Bioscience-related Venture Capital Investments by Segment, Cumulative 2018-21 ($ in Millions)




Source: TEConomy Partners analysis of PitchBook Data, Inc.

Among states, VC investments in biosciences companies continue to be highly concentrated in two states—California and Massachusetts, which combine to account for 61 percent of cumulative national totals since 2018 (Table 11). Investments in New York firms exceeded $18 billion, or 9 percent of national totals. The remainder of leading states had funding totals exceed $3 billion.

Per capita concentrations stand out in smaller states including Delaware, Connecticut, Washington, Minnesota, Utah, Colorado, and Maryland.

Table 11: Leading States in Bioscience Venture Capital Investments, Cumulative 2018-21

| Total VC Investments, 2018-21 | |
|---|---|
| Leading States | Total ($ Billions) |
| California | $79.3 |
| Massachusetts | $41.4 |
| New York | $18.4 |
| Washington | $5.7 |
| Pennsylvania | $5.3 |
| Texas | $4.9 |
| Illinois | $4.2 |
| Minnesota | $3.9 |
| Colorado | $3.4 |
| Maryland | $3.4 |

| Per Capita VC Investments | |
|---|---|
| Leading States | $ Per Capita |
| Massachusetts | $5,963 |
| California | $2,012 |
| New York | $931 |
| Delaware | $861 |
| Connecticut | $789 |
| Washington | $745 |
| Minnesota | $682 |
| Utah | $678 |
| Colorado | $592 |
| Maryland | $554 |

Source: TEConomy Partners analysis of PitchBook Data, Inc.

States with leading areas of VC funding across the varied segments of the industry are shown in Table 12.

Table 12: Leading States in Bioscience Venture Capital Investments by Segment, Cumulative 2018-21

| State | Agricultural Chemicals & Biofuels | Digital Health | | | Healthcare Distribution | Healthcare Laboratories | Medical Devices and Supplies | | | | | Pharmaceuticals & Biotechnology | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Healthcare Technology Systems | Software | All Other Digital Health | | | Diagnostic Equipment | Monitoring Equipment | Surgical Devices | Therapeutic Devices | All Other Medical Devices and Supplies | Drug Discovery & Delivery | All Other Pharmaceuticals & Biotechnology |
| CA | ● | ● | ● | ● | | ● | ● | ● | ● | ● | ● | ● | ● |
| CO | ● | | | | | | | | | | ● | | |
| CT | ● | | | | | | ● | | | | | | |
| FL | | | | | ● | ● | | | ● | | | | |
| GA | | | | | ● | | | | | | | | |
| IL | | ● | | | | | | | | | | | |
| IN | | | | ● | | | | | | | | | |
| MA | | ● | ● | | ● | | ● | ● | ● | ● | ● | ● | ● |
| MN | | ● | | | | | ● | | ● | ● | | | |
| MO | | | | ● | | | | | | | | | |
| NJ | | | | | | ● | | | | ● | | | |
| NM | | | | | | | | ● | | | | | |
| NY | | ● | ● | ● | ● | ● | | ● | | ● | | ● | ● |
| NC | ● | | | | | | | | | | | | |
| PA | | | | | | | | | | | ● | ● | ● |
| TX | | | ● | ● | ● | ● | | | ● | | ● | | |
| WA | ● | | | | | | ● | ● | | | | ● | ● |
| WI | | | ● | | | | | | | | | | |

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 2018 to 2021 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 and production of agricultural goods 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

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

## Examples of Companies

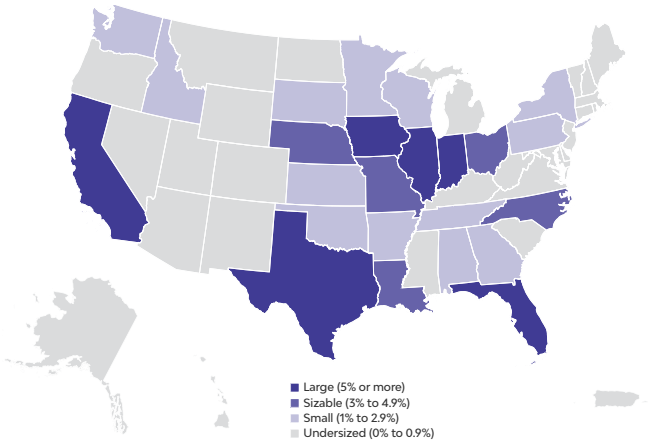
- Amyris
- BASF Enzymes
- Bayer CropScience
- Corteva Agriscience
- Evolva
- Genus
- Novozymes
- Poet
- Scotts Miracle-Gro
- Simplot Plant Sciences
- Syngenta

## States that are Both Large and Specialized*

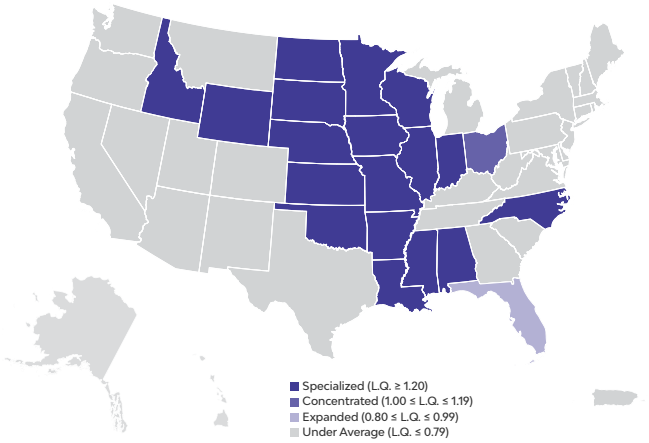
- Illinois
- Iowa
- Indiana

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

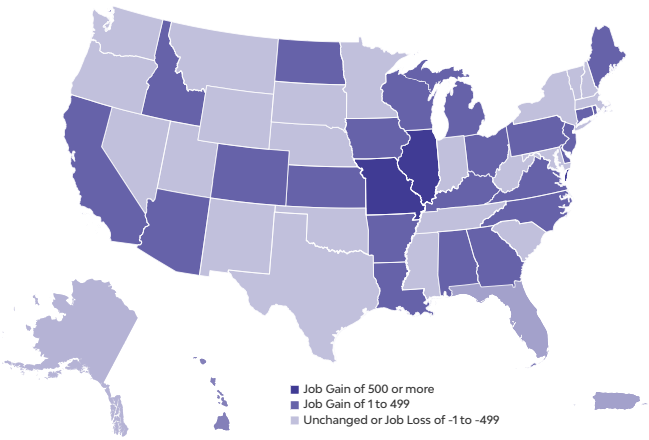
State Share of Total U.S. Employment, 2021




Employment Concentration Relative to the U.S., 2021




Employment Gains and Losses, 2018-2021



# 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, California, Indiana
- **Sizable States**: Missouri, Ohio, Louisiana, Nebraska, North Carolina

**Employment Concentration:** Seventeen 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, North Dakota, Illinois, Louisiana, Wyoming, Idaho, Indiana, Missouri, Alabama, Kansas, Oklahoma, Arkansas, Wisconsin, Minnesota, Mississippi
- **Concentrated States:** North Carolina, Ohio

**Employment Growth:** Over the 2018 to 2021 time period, 27 states experienced some increase in subsector employment, with Illinois, Missouri, California, Virginia, 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, 2021

| Metropolitan Statistical Area | 2021 Employment |
|---|---|
| Decatur, IL | 5,557 |
| Chicago-Naperville-Elgin, IL-IN-WI | 2,397 |
| Houston-The Woodlands-Sugar Land, TX | 2,168 |
| Lakeland-Winter Haven, FL | 1,519 |
| Baton Rouge, LA | 1,285 |
| Lafayette-West Lafayette, IN | 1,245 |
| New Orleans-Metairie, LA | 1,166 |
| Indianapolis-Carmel-Anderson, IN | 1,075 |
| Cedar Rapids, IA | 1,005 |
| Omaha-Council Bluffs, NE-IA | 1,001 |
| Kansas City, MO-KS | 980 |
| St. Louis, MO-IL | 861 |
| Columbus, OH | 810 |
| Tampa-St. Petersburg-Clearwater, FL | 774 |
| Mobile, AL | 721 |
| Memphis, TN-MS-AR | 712 |
| Stockton, CA | 657 |
| Des Moines-West Des Moines, IA | 653 |
| Madison, WI | 641 |
| St. Joseph, MO-KS | 595 |
| Peoria, IL | 579 |
| Dallas-Fort Worth-Arlington, TX | 556 |
| Fresno, CA | 556 |
| Greensboro-High Point, NC | 555 |
| Orlando-Kissimmee-Sanford, FL | 537 |

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

Table 13: States with Large and Specialized Employment in Agricultural Feedstock and Industrial Biosciences, 2021

| State | Establishments, 2021 | Employment, 2021 | Location Quotient, 2021 | Share of U.S. Employment |
|---|---|---|---|---|
| Illinois | 102 | 9,035 | 3.24 | 13.0% |
| Iowa | 136 | 8,017 | 11.20 | 11.5% |
| Indiana | 69 | 3,542 | 2.39 | 5.1% |

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

Table 15. Metropolitan Statistical Areas with the Highest Location Quotients in Agricultural Feedstock and Industrial Biosciences, by Size of MSA, 2021

| Metropolitan Statistical Area | Location Quotient | 2021 Employment |
|---|---|---|
| **Large MSAs (Total Private Employment Greater than 250,000)** | | |
| Baton Rouge, LA | 7.41 | 1,285 |
| New Orleans-Metairie, LA | 4.69 | 1,166 |
| Omaha-Council Bluffs, NE-IA | 4.37 | 1,001 |
| Madison, WI | 3.76 | 641 |
| Des Moines-West Des Moines, IA | 3.54 | 653 |
| Greensboro-High Point, NC | 3.22 | 555 |
| Fresno, CA | 3.05 | 556 |
| Memphis, TN-MS-AR | 2.39 | 712 |
| Indianapolis-Carmel-Anderson, IN | 2.13 | 1,075 |
| Kansas City, MO-KS | 1.97 | 980 |
| Columbus, OH | 1.64 | 810 |
| Houston-The Woodlands-Sugar Land, TX | 1.51 | 2,168 |
| St. Louis, MO-IL | 1.35 | 861 |
| Tulsa, OK | 1.31 | 272 |
| Rochester, NY | 1.29 | 296 |
| **Medium MSAs (Total Private Employment Between 75,000 and 250,000)** | | |
| Lafayette-West Lafayette, IN | 29.22 | 1,245 |
| Cedar Rapids, IA | 14.75 | 1,005 |
| Lakeland-Winter Haven, FL | 12.47 | 1,519 |
| Mobile, AL | 8.58 | 721 |
| Beaumont-Port Arthur, TX | 7.38 | 511 |
| Peoria, IL | 7.07 | 579 |
| Stockton, CA | 5.23 | 657 |
| Lubbock, TX | 5.10 | 329 |
| Fargo, ND-MN | 4.60 | 314 |
| Fayetteville, NC | 3.01 | 185 |
| Evansville, IN-KY | 2.71 | 203 |
| Greeley, CO | 2.63 | 135 |
| Sioux Falls, SD | 2.13 | 172 |
| Yakima, WA | 2.00 | 108 |
| Kennewick-Richland, WA | 2.00 | 121 |
| **Small MSAs (Total Private Employment Less than 75,000)** | | |
| Decatur, IL | 248.12 | 5,557 |
| St. Joseph, MO-KS | 23.57 | 595 |
| Rocky Mount, NC | 17.63 | 442 |
| Decatur, AL | 15.53 | 404 |
| Mankato, MN | 15.00 | 378 |
| Sioux City, IA-NE-SD | 13.75 | 504 |
| Pocatello, ID | 13.04 | 225 |
| Yuma, AZ | 10.95 | 332 |
| Valdosta, GA | 9.98 | 236 |
| Lima, OH | 8.90 | 215 |
| Cheyenne, WY | 8.28 | 154 |
| Kankakee, IL | 6.03 | 120 |
| Greenville, NC | 5.87 | 174 |
| Gettysburg, PA | 5.67 | 94 |
| Bellingham, WA | 5.08 | 211 |

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

# 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

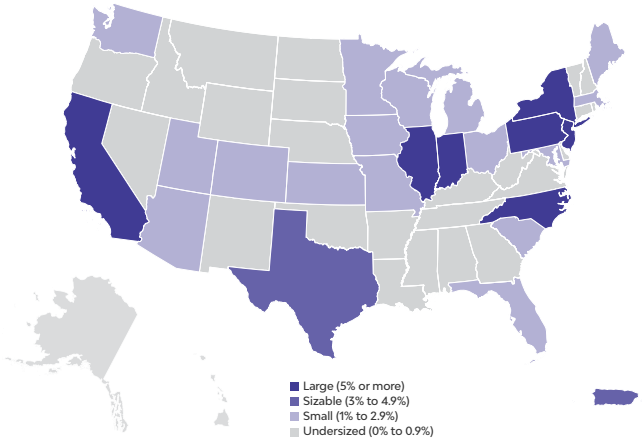
- Acorda Therapeutics
- Alkermes
- Alnylam Pharmaceuticals
- Amgen
- Bayer
- Biogen
- Eli Lilly and Company
- GlaxoSmithKline
- Novo Nordisk
- Pfizer
- Roche Group-Genentech
- Sangamo Therapeutics
- Vertex Pharmaceuticals

## States that are Both Large and Specialized*

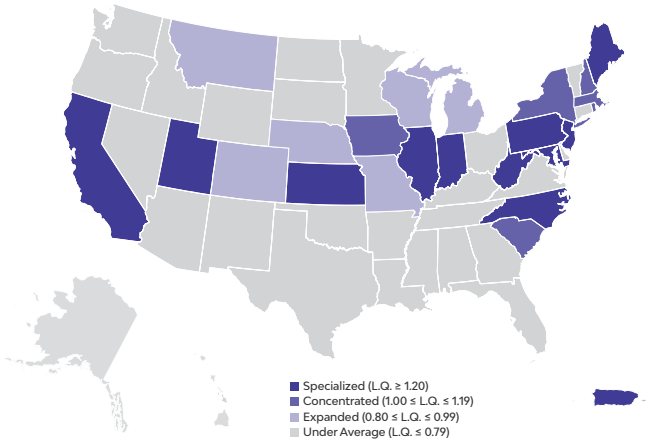
- California
- New Jersey
- North Carolina
- Illinois
- Indiana
- Pennsylvania

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

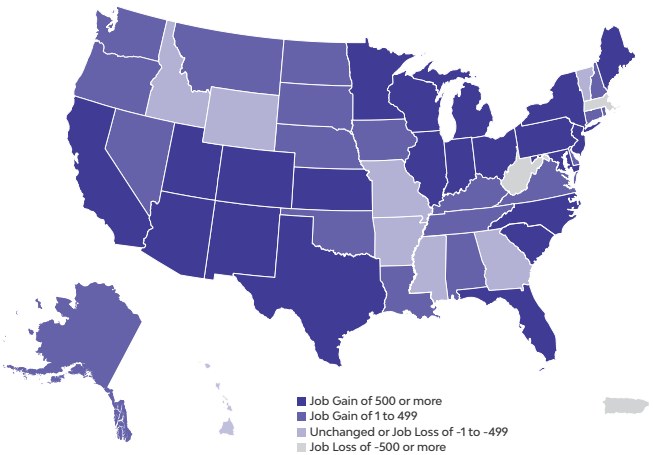
State Share of Total U.S. Employment, 2021




Employment Concentration Relative to the U.S., 2021




Employment Gains and Losses, 2018-2021



# 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, New York, North Carolina, Illinois, Indiana, Pennsylvania
- **Sizable States:** Texas, Puerto Rico

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

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

**Employment Growth:** Over the 2018 to 2021 time period, 41 states and DC experienced some increase in subsector employment. Of those states, Indiana, New Jersey, Florida, California, and New York experienced substantial job increases.

**Large and Specialized States:** Six 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, 2021

| Metropolitan Statistical Area | 2021 Employment |
|---|---|
| New York-Newark-Jersey City, NY-NJ-PA | 34,510 |
| Chicago-Naperville-Elgin, IL-IN-WI | 20,596 |
| San Francisco-Oakland-Berkeley, CA | 16,545 |
| Philadelphia-Camden-Wilmington, PA-NJ-DE-MD | 15,777 |
| Indianapolis-Carmel-Anderson, IN | 14,603 |
| Los Angeles-Long Beach-Anaheim, CA | 12,510 |
| San Diego-Chula Vista-Carlsbad, CA | 8,696 |
| Boston-Cambridge-Newton, MA-NH | 8,390 |
| Washington-Arlington-Alexandria, DC-VA-MD-WV | 6,824 |
| Durham-Chapel Hill, NC | 6,498 |
| Dallas-Fort Worth-Arlington, TX | 4,925 |
| San Jose-Sunnyvale-Santa Clara, CA | 4,868 |
| Miami-Fort Lauderdale-Pompano Beach, FL | 4,546 |
| Minneapolis-St. Paul-Bloomington, MN-WI | 4,348 |
| Raleigh-Cary, NC | 4,211 |
| Phoenix-Mesa-Chandler, AZ | 3,980 |
| St. Louis, MO-IL | 3,778 |
| Trenton-Princeton, NJ | 3,701 |
| Albany-Schenectady-Troy, NY | 3,514 |
| Portland-South Portland, ME | 3,255 |
| Houston-The Woodlands-Sugar Land, TX | 3,237 |
| Madison, WI | 3,171 |
| Charlotte-Concord-Gastonia, NC-SC | 3,164 |
| Kalamazoo-Portage, MI | 3,127 |
| Bloomington, IN | 2,893 |

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

Table 16: States with Large and Specialized Employment in Pharmaceuticals, 2021

| State | Establishments, 2021 | Employment, 2021 | Location Quotient, 2021 | Share of U.S. Employment |
|---|---|---|---|---|
| California | 812 | 49,252 | 1.21 | 14.3% |
| New Jersey | 343 | 25,562 | 2.70 | 7.4% |
| North Carolina | 130 | 23,967 | 2.24 | 7.0% |
| Illinois | 310 | 22,400 | 1.62 | 6.5% |
| Indiana | 101 | 20,801 | 2.83 | 6.0% |
| Pennsylvania | 151 | 20,317 | 1.45 | 5.9% |

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

Table 18: Metropolitan Statistical Areas with the Highest Location Quotients in Pharmaceuticals, by Size of MSA, 2021

| Metropolitan Statistical Area | Location Quotient | 2021 Employment |
|---|---|---|
| **Large MSAs (Total Private Employment Greater than 250,000)** | | |
| Durham-Chapel Hill, NC | 8.57 | 6,498 |
| Indianapolis-Carmel-Anderson, IN | 5.84 | 14,603 |
| Albany-Schenectady-Troy, NY | 3.82 | 3,514 |
| Madison, WI | 3.75 | 3,171 |
| San Francisco-Oakland-Berkeley, CA | 2.95 | 16,545 |
| Raleigh-Cary, NC | 2.71 | 4,211 |
| San Diego-Chula Vista-Carlsbad, CA | 2.60 | 8,696 |
| Columbia, SC | 2.40 | 1,964 |
| Philadelphia-Camden-Wilmington, PA-NJ-DE-MD | 2.38 | 15,777 |
| Buffalo-Cheektowaga, NY | 2.21 | 2,596 |
| Worcester, MA-CT | 2.11 | 1,885 |
| Chicago-Naperville-Elgin, IL-IN-WI | 1.95 | 20,596 |
| Greenville-Anderson, SC | 1.84 | 1,748 |
| San Jose-Sunnyvale-Santa Clara, CA | 1.75 | 4,868 |
| New York-Newark-Jersey City, NY-NJ-PA | 1.67 | 34,510 |
| **Medium MSAs (Total Private Employment Between 75,000 and 250,000)** | | |
| Kalamazoo-Portage, MI | 10.76 | 3,127 |
| Norwich-New London, CT | 7.90 | 1,925 |
| Trenton-Princeton, NJ | 7.36 | 3,701 |
| Portland-South Portland, ME | 4.96 | 3,255 |
| Boulder, CO | 4.69 | 2,063 |
| Waco, TX | 4.55 | 1,292 |
| Vallejo, CA | 4.34 | 1,333 |
| Ogden-Clearfield, UT | 3.47 | 2,124 |
| Provo-Orem, UT | 3.35 | 2,300 |
| Lincoln, NE | 3.35 | 1,299 |
| Salisbury, MD-DE | 2.55 | 963 |
| Hickory-Lenoir-Morganton, NC | 2.49 | 887 |
| Fort Collins, CO | 2.42 | 876 |
| Santa Cruz-Watsonville, CA | 2.34 | 541 |
| Gainesville, GA | 2.13 | 482 |
| **Small MSAs (Total Private Employment Less than 75,000)** | | |
| East Stroudsburg, PA | 21.48 | 2,634 |
| Bloomington, IN | 19.87 | 2,893 |
| Rocky Mount, NC | 17.97 | 2,234 |
| Greenville, NC | 16.49 | 2,421 |
| Kankakee, IL | 14.45 | 1,423 |
| Morgantown, WV | 12.93 | 1,785 |
| St. Joseph, MO-KS | 7.62 | 954 |
| Lebanon, PA | 6.48 | 759 |
| Iowa City, IA | 4.76 | 758 |
| Harrisonburg, VA | 4.55 | 672 |
| Decatur, IL | 4.51 | 501 |
| Terre Haute, IN | 2.70 | 407 |
| Ames, IA | 2.55 | 271 |
| Weirton-Steubenville, WV-OH | 2.39 | 198 |
| Columbus, IN | 2.05 | 243 |

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

# 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

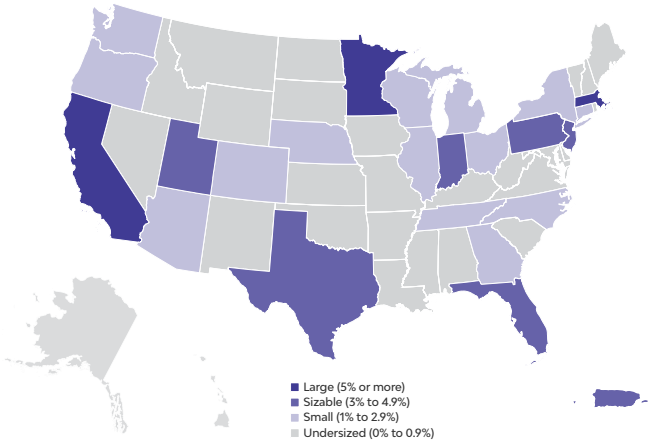
- 3M Health Care
- Auris Health
- Baxter
- Boston Scientific Corp.
- Cook Medical
- DuPuy Synthes
- GE Healthcare
- INSIGHTEC
- Medtronic
- Outset Medical
- Regenesis Biomedical
- Stryker
- Zimmer Biomet

## States that are Both Large and Specialized*

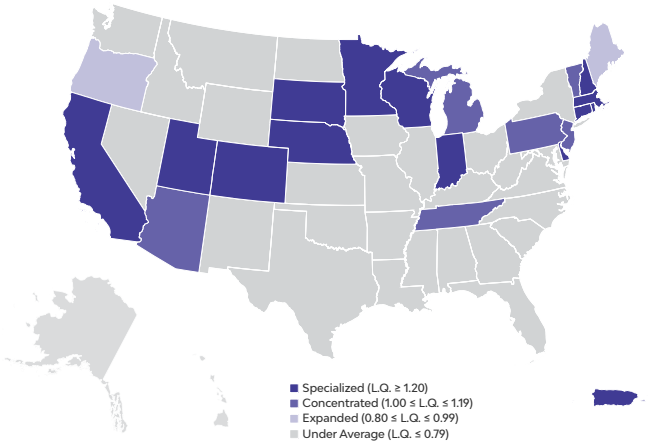
- California
- Minnesota
- Massachusetts

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

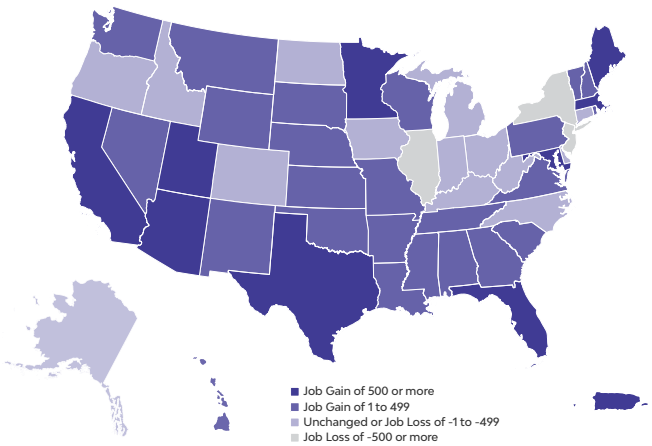
State Share of Total U.S. Employment, 2021




Employment Concentration Relative to the U.S., 2021




Employment Gains and Losses, 2018-2021



# 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 continue to account for 60 percent of employment in this subsector.

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

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

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

**Employment Growth:** Over the 2018 to 2021 time period, 34 states and Puerto Rico experienced some increase in subsector employment, led by California, Arizona, Texas, Minnesota, and Utah.

**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, 2021

| Metropolitan Statistical Area | 2021 Employment |
|---|---|
| Los Angeles-Long Beach-Anaheim, CA | 30,988 |
| Minneapolis-St. Paul-Bloomington, MN-WI | 30,278 |
| Boston-Cambridge-Newton, MA-NH | 19,385 |
| New York-Newark-Jersey City, NY-NJ-PA | 14,324 |
| San Francisco-Oakland-Berkeley, CA | 13,812 |
| San Diego-Chula Vista-Carlsbad, CA | 11,615 |
| Salt Lake City, UT | 10,990 |
| Chicago-Naperville-Elgin, IL-IN-WI | 10,561 |
| San Jose-Sunnyvale-Santa Clara, CA | 9,501 |
| Philadelphia-Camden-Wilmington, PA-NJ-DE-MD | 7,375 |
| Memphis, TN-MS-AR | 7,038 |
| Phoenix-Mesa-Chandler, AZ | 5,744 |
| Pittsburgh, PA | 5,486 |
| Milwaukee-Waukesha, WI | 5,484 |
| Seattle-Tacoma-Bellevue, WA | 5,417 |
| Dallas-Fort Worth-Arlington, TX | 5,233 |
| Bloomington, IN | 4,830 |
| Portland-Vancouver-Hillsboro, OR-WA | 4,474 |
| Miami-Fort Lauderdale-Pompano Beach, FL | 4,382 |
| Providence-Warwick, RI-MA | 3,962 |
| Cleveland-Elyria, OH | 3,808 |
| Denver-Aurora-Lakewood, CO | 3,758 |
| Kalamazoo-Portage, MI | 3,551 |
| Atlanta-Sandy Springs-Alpharetta, GA | 3,224 |
| Tampa-St. Petersburg-Clearwater, FL | 3,148 |

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

Table 19: States with Large and Specialized Employment in Medical Devices and Equipment, 2021

| State | Establishments, 2021 | Employment, 2021 | Location Quotient, 2021 | Share of U.S. Employment |
|---|---|---|---|---|
| California | 1,556 | 77,510 | 1.65 | 19.4% |
| Minnesota | 375 | 30,591 | 3.93 | 7.7% |
| Massachusetts | 321 | 23,407 | 2.38 | 5.9% |

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

Table 21: Metropolitan Statistical Areas with the Highest Location Quotients in Medical Devices and Equipment, by Size of MSA, 2021

| Metropolitan Statistical Area | Location Quotient | 2021 Employment |
|---|---|---|
| **Large MSAs (Total Private Employment Greater than 250,000)** | | |
| Minneapolis-St. Paul-Bloomington, MN-WI | 5.79 | 30,278 |
| Salt Lake City, UT | 5.22 | 10,990 |
| Memphis, TN-MS-AR | 4.12 | 7,038 |
| San Diego-Chula Vista-Carlsbad, CA | 3.01 | 11,615 |
| New Haven-Milford, CT | 2.96 | 3,003 |
| San Jose-Sunnyvale-Santa Clara, CA | 2.95 | 9,501 |
| Boston-Cambridge-Newton, MA-NH | 2.62 | 19,385 |
| Milwaukee-Waukesha, WI | 2.37 | 5,484 |
| Bridgeport-Stamford-Norwalk, CT | 2.19 | 2,494 |
| San Francisco-Oakland-Berkeley, CA | 2.13 | 13,812 |
| Providence-Warwick, RI-MA | 2.10 | 3,962 |
| Madison, WI | 2.06 | 2,012 |
| Worcester, MA-CT | 2.05 | 2,117 |
| Durham-Chapel Hill, NC | 1.88 | 1,648 |
| Los Angeles-Long Beach-Anaheim, CA | 1.87 | 30,988 |
| **Medium MSAs (Total Private Employment Between 75,000 and 250,000)** | | |
| Kalamazoo-Portage, MI | 10.57 | 3,551 |
| Boulder, CO | 5.41 | 2,753 |
| Naples-Marco Island, FL | 4.60 | 2,058 |
| Gainesville, FL | 3.64 | 1,269 |
| Ogden-Clearfield, UT | 2.60 | 1,844 |
| Reading, PA | 2.54 | 1,195 |
| Fort Collins, CO | 2.53 | 1,061 |
| South Bend-Mishawaka, IN-MI | 2.27 | 810 |
| Santa Maria-Santa Barbara, CA | 2.18 | 1,252 |
| Manchester-Nashua, NH | 2.15 | 1,224 |
| Ann Arbor, MI | 2.13 | 879 |
| Syracuse, NY | 2.06 | 1,530 |
| Santa Rosa-Petaluma, CA | 2.05 | 1,145 |
| Huntington-Ashland, WV-KY-OH | 1.98 | 672 |
| Scranton--Wilkes-Barre, PA | 1.94 | 1,327 |
| **Small MSAs (Total Private Employment Less than 75,000)** | | |
| Bloomington, IN | 28.68 | 4,830 |
| Flagstaff, AZ | 11.11 | 1,644 |
| Glens Falls, NY | 10.61 | 1,387 |
| Sumter, SC | 8.86 | 1,001 |
| Niles, MI | 5.63 | 895 |
| State College, PA | 5.30 | 716 |
| Logan, UT-ID | 4.45 | 777 |
| Auburn-Opelika, AL | 4.30 | 618 |
| Staunton, VA | 4.17 | 531 |
| Sheboygan, WI | 3.47 | 597 |
| Dover, DE | 3.25 | 503 |
| Elmira, NY | 3.00 | 257 |
| Lebanon, PA | 2.61 | 353 |
| Jackson, MI | 2.31 | 355 |
| Florence, SC | 2.16 | 475 |

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

# 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

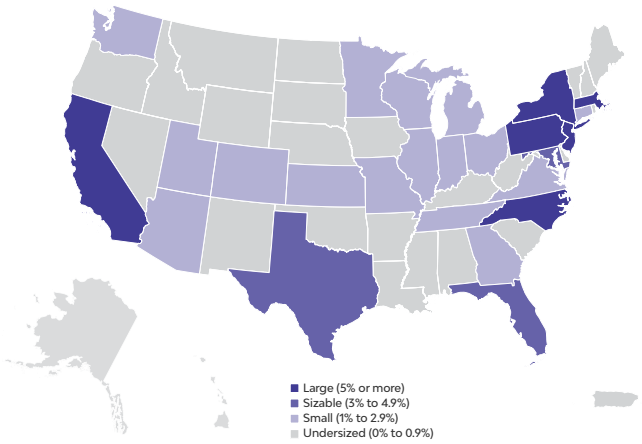
- Charles River Laboratories
- Covance
- IQVIA
- Laboratory Corp. of America
- PPD
- Quest Diagnostics
- Rallybio
- Sema4
- Virent

## States that are Both Large and Specialized*

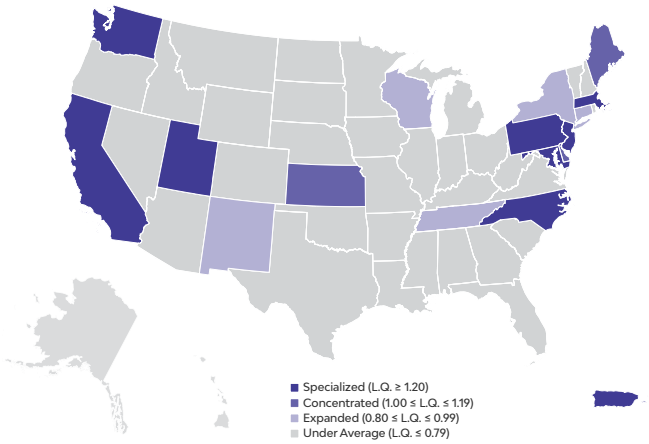
- California
- Massachusetts
- New Jersey
- North Carolina
- Pennsylvania

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

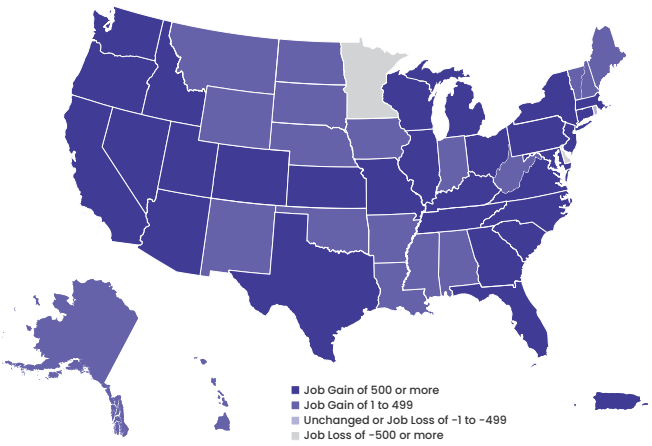
State Share of Total U.S. Employment, 2021




Employment Concentration Relative to the U.S., 2021




Employment Gains and Losses, 2018-2021



# 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 19 all have more than 10,000 subsector jobs.

- **Large States:** California, Massachusetts, New York, New Jersey, Pennsylvania, North Carolina
- **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, Puerto Rico, Washington, Pennsylvania
- **Concentrated States:** Kansas, Delaware, Maine

**Employment Growth:** Over the 2018 to 2021 time period, 48 states, DC, and Puerto Rico experienced some increase in subsector employment, led by California, Massachusetts, Texas, North Carolina, and New Jersey.

**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, 2021

| Metropolitan Statistical Area | 2021 Employment |
|---|---|
| Boston-Cambridge-Newton, MA-NH | 74,478 |
| New York-Newark-Jersey City, NY-NJ-PA | 58,475 |
| San Francisco-Oakland-Berkeley, CA | 48,413 |
| San Diego-Chula Vista-Carlsbad, CA | 32,717 |
| Los Angeles-Long Beach-Anaheim, CA | 27,052 |
| Philadelphia-Camden-Wilmington, PA-NJ-DE-MD | 26,985 |
| Washington-Arlington-Alexandria, DC-VA-MD-WV | 24,405 |
| Seattle-Tacoma-Bellevue, WA | 15,502 |
| Chicago-Naperville-Elgin, IL-IN-WI | 15,331 |
| San Jose-Sunnyvale-Santa Clara, CA | 13,454 |
| Durham-Chapel Hill, NC | 12,606 |
| Baltimore-Columbia-Towson, MD | 11,225 |
| Salt Lake City, UT | 10,121 |
| Houston-The Woodlands-Sugar Land, TX | 9,258 |
| Miami-Fort Lauderdale-Pompano Beach, FL | 9,018 |
| Dallas-Fort Worth-Arlington, TX | 8,984 |
| Phoenix-Mesa-Chandler, AZ | 8,706 |
| Raleigh-Cary, NC | 8,567 |
| Atlanta-Sandy Springs-Alpharetta, GA | 7,986 |
| Kansas City, MO-KS | 7,920 |
| Madison, WI | 7,781 |
| Pittsburgh, PA | 6,882 |
| Minneapolis-St. Paul-Bloomington, MN-WI | 6,456 |
| Knoxville, TN | 6,412 |
| Tampa-St. Petersburg-Clearwater, FL | 5,703 |

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

Table 22: States with Large and Specialized Employment in Research, Testing, and Medical Labs, 2021

| State | Establishments, 2021 | Employment, 2021 | Location Quotient, 2021 | Share of U.S. Employment |
|---|---|---|---|---|
| California | 6,069 | 136,656 | 1.61 | 19.0% |
| Massachusetts | 2,701 | 81,468 | 4.59 | 11.3% |
| New Jersey | 1,834 | 40,770 | 2.06 | 5.7% |
| North Carolina | 2,971 | 37,193 | 1.28 | 5.2% |
| Pennsylvania | 1,841 | 37,042 | 1.66 | 5.1% |

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

Table 24: Metropolitan Statistical Areas with the Highest Location Quotients in Research, Testing, and Medical Labs, by Size of MSA, 2021

| Metropolitan Statistical Area | Location Quotient | 2021 Employment |
|---|---|---|
| **Large MSAs (Total Private Employment Greater than 250,000)** | | |
| Durham-Chapel Hill, NC | 7.96 | 12,606 |
| Boston-Cambridge-Newton, MA-NH | 5.57 | 74,478 |
| San Diego-Chula Vista-Carlsbad, CA | 4.69 | 32,717 |
| Madison, WI | 4.41 | 7,781 |
| San Francisco-Oakland-Berkeley, CA | 4.13 | 48,413 |
| Knoxville, TN | 3.31 | 6,412 |
| Salt Lake City, UT | 2.66 | 10,121 |
| Raleigh-Cary, NC | 2.64 | 8,567 |
| Albany-Schenectady-Troy, NY | 2.37 | 4,543 |
| San Jose-Sunnyvale-Santa Clara, CA | 2.32 | 13,454 |
| Worcester, MA-CT | 1.97 | 3,669 |
| Philadelphia-Camden-Wilmington, PA-NJ-DE-MD | 1.95 | 26,985 |
| Baltimore-Columbia-Towson, MD | 1.81 | 11,225 |
| Washington-Arlington-Alexandria, DC-VA-MD-WV | 1.79 | 24,405 |
| Seattle-Tacoma-Bellevue, WA | 1.56 | 15,502 |
| **Medium MSAs (Total Private Employment Between 75,000 and 250,000)** | | |
| Wilmington, NC | 5.05 | 3,392 |
| Trenton-Princeton, NJ | 4.46 | 4,680 |
| Kennewick-Richland, WA | 4.26 | 2,666 |
| Boulder, CO | 3.31 | 3,046 |
| Oshkosh-Neenah, WI | 3.15 | 1,468 |
| Barnstable Town, MA | 2.20 | 996 |
| Norwich-New London, CT | 1.95 | 994 |
| Syracuse, NY | 1.86 | 2,497 |
| College Station-Bryan, TX | 1.80 | 818 |
| Gainesville, FL | 1.70 | 1,071 |
| Lafayette-West Lafayette, IN | 1.61 | 708 |
| Huntsville, AL | 1.52 | 1,642 |
| Ann Arbor, MI | 1.41 | 1,055 |
| Rochester, MN | 1.20 | 740 |
| Lincoln, NE | 1.16 | 940 |
| **Small MSAs (Total Private Employment Less than 75,000)** | | |
| Burlington, NC | 10.45 | 3,413 |
| Idaho Falls, ID | 4.64 | 1,771 |
| California-Lexington Park, MD | 2.39 | 436 |
| Ithaca, NY | 2.02 | 481 |
| Mount Vernon-Anacortes, WA | 1.75 | 396 |
| Morgantown, WV | 1.30 | 373 |
| Lima, OH | 1.28 | 319 |
| Logan, UT-ID | 1.26 | 397 |
| Athens-Clarke County, GA | 1.24 | 476 |
| Florence, SC | 1.16 | 458 |
| Warner Robins, GA | 1.10 | 293 |
| Ames, IA | 1.03 | 229 |
| Brunswick, GA | 1.02 | 199 |
| Jefferson City, MO | 0.97 | 288 |
| Santa Fe, NM | 0.95 | 242 |

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

# 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, 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

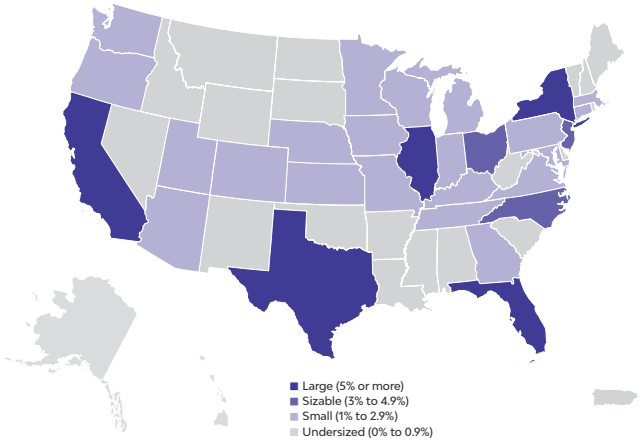
- AmerisourceBergen
- Apria Healthcare
- Cardinal Health
- CuraScript SD
- McKesson
- Omnicare
- Owens & Minor
- Park Seed
- Patterson Companies
- PharMerica Corporation
- Seminis Vegetable Seeds
- Wilbur-Ellis

## States that are Both Large and Specialized*

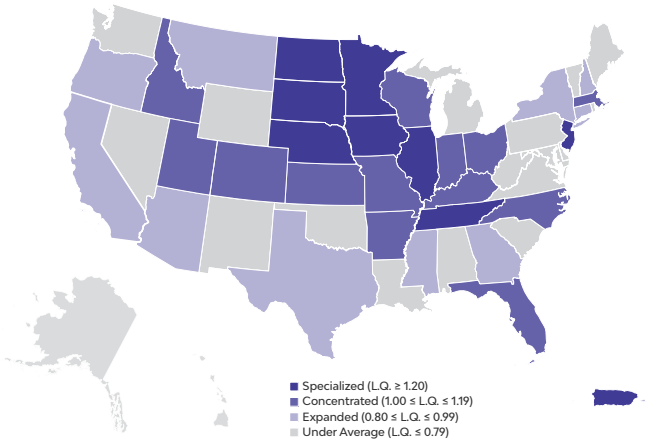
- Illinois

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

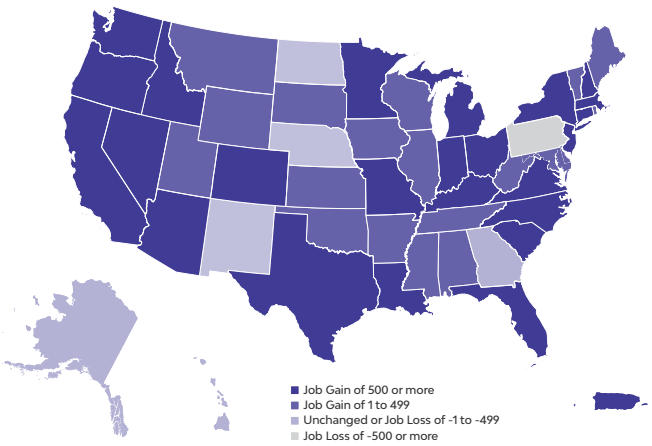
State Share of Total U.S. Employment, 2021




Employment Concentration Relative to the U.S., 2021




Employment Gains and Losses, 2018-2021



# 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:** Eight states and Puerto Rico have a specialized concentration of jobs in the bioscience-related distribution subsector.

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

**Employment Growth:** Over the 2018 to 2021 time period, 43 states, DC, and Puerto Rico experienced some increase in subsector employment, led by Texas, Massachusetts, North Carolina, Minnesota, and Florida.

**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, 2021

| Metropolitan Statistical Area | 2021 Employment |
|---|---|
| New York-Newark-Jersey City, NY-NJ-PA | 34,577 |
| Los Angeles-Long Beach-Anaheim, CA | 24,807 |
| Chicago-Naperville-Elgin, IL-IN-WI | 21,438 |
| Dallas-Fort Worth-Arlington, TX | 17,970 |
| Miami-Fort Lauderdale-Pompano Beach, FL | 14,578 |
| Boston-Cambridge-Newton, MA-NH | 12,296 |
| Atlanta-Sandy Springs-Alpharetta, GA | 11,142 |
| Minneapolis-St. Paul-Bloomington, MN-WI | 10,668 |
| Philadelphia-Camden-Wilmington, PA-NJ-DE-MD | 10,499 |
| Phoenix-Mesa-Chandler, AZ | 9,928 |
| Houston-The Woodlands-Sugar Land, TX | 8,713 |
| Denver-Aurora-Lakewood, CO | 8,254 |
| Columbus, OH | 6,037 |
| Seattle-Tacoma-Bellevue, WA | 6,031 |
| Detroit-Warren-Dearborn, MI | 5,819 |
| St. Louis, MO-IL | 5,501 |
| San Diego-Chula Vista-Carlsbad, CA | 5,482 |
| Riverside-San Bernardino-Ontario, CA | 5,262 |
| Nashville-Davidson--Murfreesboro--Franklin, TN | 5,244 |
| Memphis, TN-MS-AR | 4,926 |
| Raleigh-Cary, NC | 4,722 |
| Charlotte-Concord-Gastonia, NC-SC | 4,650 |
| Tampa-St. Petersburg-Clearwater, FL | 4,641 |
| Kansas City, MO-KS | 4,523 |
| Indianapolis-Carmel-Anderson, IN | 4,504 |

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

Table 25: States with Large and Specialized Employment in Bioscience-Related Distribution, 2021

| State | Establishments, 2021 | Employment, 2021 | Location Quotient, 2021 | Share of U.S. Employment |
|---|---|---|---|---|
| Illinois | 2,135 | 30,526 | 1.26 | 5.1% |

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

Table 27: Metropolitan Statistical Areas with the Highest Location Quotients in Bioscience-Related Distribution, by Size of MSA, 2021

| Metropolitan Statistical Area | Location Quotient | 2021 Employment |
|---|---|---|
| **La rge MSAs (Total Private Employment Greater than 250,000)** | | |
| Des Moines-West Des Moines, IA | 1.99 | 3,176 |
| Memphis, TN-MS-AR | 1.91 | 4,926 |
| Raleigh-Cary, NC | 1.74 | 4,722 |
| Oxnard-Thousand Oaks-Ventura, CA | 1.65 | 2,192 |
| Louisville/Jefferson County, KY-IN | 1.43 | 3,885 |
| Columbus, OH | 1.41 | 6,037 |
| Minneapolis-St. Paul-Bloomington, MN-WI | 1.35 | 10,668 |
| Miami-Fort Lauderdale-Pompano Beach, FL | 1.34 | 14,578 |
| Denver-Aurora-Lakewood, CO | 1.30 | 8,254 |
| Nashville-Davidson--Murfreesboro--Franklin, TN | 1.22 | 5,244 |
| Fresno, CA | 1.20 | 1,895 |
| Chicago-Naperville-Elgin, IL-IN-WI | 1.16 | 21,438 |
| Dallas-Fort Worth-Arlington, TX | 1.14 | 17,970 |
| Boston-Cambridge-Newton, MA-NH | 1.10 | 12,296 |
| Salt Lake City, UT | 1.07 | 3,406 |
| **Medium MSAs (Total Private Employment Between 75,000 and 250,000)** | | |
| Naples-Marco Island, FL | 2.48 | 1,675 |
| Provo-Orem, UT | 1.89 | 2,266 |
| Fort Collins, CO | 1.74 | 1,102 |
| Trenton-Princeton, NJ | 1.69 | 1,483 |
| Poughkeepsie-Newburgh-Middletown, NY | 1.62 | 1,608 |
| Sioux Falls, SD | 1.62 | 1,129 |
| Lakeland-Winter Haven, FL | 1.41 | 1,485 |
| Fargo, ND-MN | 1.40 | 828 |
| Burlington-South Burlington, VT | 1.35 | 633 |
| Visalia, CA | 1.33 | 860 |
| Boulder, CO | 1.32 | 1,013 |
| Canton-Massillon, OH | 1.19 | 811 |
| Scranton--Wilkes-Barre, PA | 1.17 | 1,212 |
| Kingsport-Bristol, TN-VA | 1.17 | 549 |
| Greeley, CO | 1.17 | 519 |
| **Small MSAs (Total Private Employment Less than 75,000)** | | |
| Albany-Lebanon, OR | 3.89 | 780 |
| Harrisonburg, VA | 2.41 | 622 |
| El Centro, CA | 2.33 | 517 |
| Dubuque, IA | 2.32 | 589 |
| Morgantown, WV | 1.97 | 475 |
| Ames, IA | 1.94 | 360 |
| Jonesboro, AR | 1.88 | 450 |
| Iowa City, IA | 1.77 | 491 |
| Longview, WA | 1.76 | 289 |
| Twin Falls, ID | 1.52 | 337 |
| Springfield, IL | 1.40 | 512 |
| Hammond, LA | 1.39 | 231 |
| Bloomington, IN | 1.37 | 348 |
| Texarkana, TX-AR | 1.37 | 297 |
| Altoona, PA | 1.31 | 312 |

Source: TEConomy Partners analysis of U.S. Bureau of Labor Statistics, QCEW data; enhanced by Lightcast (Datarun 2022.3).

# 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 2021. 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 (formerly known as Emsi Burning Glass).

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, 21 years of NAICS-based data (2001-2021) are now available.

Twenty-five 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. Six 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 (NAICS 424210); Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers (NAICS 423450); and Farm Supplies Merchant Wholesalers (NAICS 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 |
| | 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 Employment 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 a custom national Input-Output (I-O) model from IMPLAN. The IMPLAN model's 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 taxing jurisdictions.

## 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 2020 (most current year available) as well as the previous two years (FY 2018 – FY 2019). 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 http://www.nsf.gov/statistics/srvyherd/.

## National Institutes of Health (NIH) Funding

NIH extramural funding data for FY 2021 (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 2018 through FY 2021 and FY 2021 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, 2018 through December 31, 2021. 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) 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 biopharmaceutical 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 that focuses around broad technology themes that are specific to the biosciences. TEConomy has grouped US-invented patents into broader bioscience patent class groups for the purposes of bioscience innovation trends analysis.

Beginning in 2010, the UPSTO and the European Patent Office (EPO) began the process of moving towards a Cooperative Patent Classification (CPC) system enacted as a harmonization and compatibility effort to provide consistent technology class documentation of disclosed IP across international borders. The new class system uses a structure that is similar to and complies with the International Patent Classification (IPC) system but expands on it in documenting detailed new technology areas. TEConomy uses this CPC scheme to group US-invented patents into broader bioscience patent class groups for the purposes of bioscience innovation trends analysis.

Patent data were collected using the Clarivate Analytics' Derwent Innovation patent analysis database and includes all granted patents from January 1, 2018 through December 31, 2021 as documented by USPTO. Table A-2 provides a listing of the patent

classes and class groups that were used in this analysis to determine the set of bioscience-related patents as well as how they are grouped into major areas of bioscience-related technologies.

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

| Bioscience Patent Class Group | Patent Class | Patent Class Description |
|---|---|---|
| Agricultural Bioscience | A01H | New plant varieties, cultivars, genotypes, and processes for engineering them |
| | A01N | Preservation of human or animal bodies and plants, biocides/pesticides, and plant growth regulators |
| | C05B | Phosphatic fertilizers |
| | C05C | Nitrogenous fertilizers |
| | C05D | Inorganic fertilizers |
| | C05F | Organic fertilizers |
| | C05G | Fertilizer mixtures |
| Biochemistry | C07D | Organic chemistry (heterocyclic compounds) |
| | C07H | Sugars and derivatives thereof; nucleosides; nucleotides; nucleic acids |
| | C07J | Steroids |
| | C07K | Peptides |
| Bioinformatics & Health IT | G16B | Bioinformatics |
| | G16H | Healthcare and patient 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 | Assays involving molecular polymers |
| | G01N 28 | Detection or diagnosis of specific diseases |
| | G01N 33 (partial) | Investigation and analysis techniques pertaining to specific biological substances |
| | G01R 33 (partial) | NMR spectroscopy analysis of biological material (e.g. in vitro testing) and NMR imaging systems |
| Pharmaceuticals | A61K | Pharmaceuticals, biopharmaceuticals, and biologics |
| | A61P | Specific therapeutic activity of chemical compounds or medicinal preparations |
| Medical & Surgical Devices | G06K 9 (partial) | Microscopic inspection of biological structures |
| | G06T 7 (partial) | Biomedical image processing and analysis |
| | A61B | Surgical and diagnostic devices |
| | A61C | Dental instruments, implements, tools or methods |
| | A61D | Veterinary instruments, implements, tools or methods |

| Bioscience Patent Class Group | Patent Class | Patent Class Description |
|---|---|---|
| Medical & Surgical Devices (cont.) | A61F | Orthopedic and prosthetic equipment, implantable devices (e.g. stents), bandages and first aid devices, and other medical supplies |
| | A61G | Medical transport devices, operating chairs and tables for medical/dental patient applications |
| | A61H | Physical therapy apparatus, artificial respiration |
| | A61J | Containers and devices for administering pharmaceuticals, medicine and food and other medical materials; baby comforters |
| | A61L | Sterilizing/deodorization of materials; chemical materials for bandages, dressings and other surgical articles |
| | A61M | Devices for introducing or removing media from the body; devices for producing or ending sleep/stupor |
| | A61N | Electrotherapy; magnetotherapy; radiation therapy; ultrasound therapy |
| Microbiology & Genetics | C12M | Enzymology or microbiology equipment and devices |
| | C12N | Genetic engineering, culture media, and other microbiology methods or compositions |
| | C12P | Fermentation or enzyme-related synthesis of chemical compounds |
| | C12Q | Measuring or testing processes involving enzymes or microbiology |

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