



2023 LIFE SCIENCE

SCIENCE

ECONOMIC IMPACT REPORT



THE INNOVATION AND GROWTH OF THE LIFE SCIENCE INDUSTRY IN CALIFORNIA

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EXECUTIVE SUMMARY



The 2023 Biocom California Life Science Economic Impact Report provides data on the performance of the life science industry in California during 2022[1], an overview of its economic impact in terms of jobs, labor income, and business output. The report also includes a discussion on key trends that were impacting the industry during the year, which was informed by a survey of executives conducted by the Deloitte Center for Health Solutions[2].

The key findings highlighted below are further detailed in the body of the report:

- **The life science industry has a wide-reaching economic impact in California.** Combining direct, indirect, and induced factors, the industry supports 1.19 million jobs, \$130 billion in labor and sole proprietor income, and \$413.7 billion in business output. Every job directly supported by a life science organization generated more than 1.5 additional jobs (in the state economy, employment multiplier of 2.5X).
- **Life science organizations in California expanded employment by 6.0 percent in 2022, which outpaced all other industries in California (4.2 percent) as well as the US overall (3.5 percent) during the period.** Overall, the life science industry added 26,672 jobs to the state economy during the year, with the largest job gains coming from research and development in biotechnology (+9,074 jobs), analytical laboratory instrument manufacturing (+4,315 jobs), and other research sectors (research and development in general life science added 4,174 jobs and colleges and universities added 4,658 jobs). Medical device manufacturing sectors also registered strong growth, adding 2,401 jobs.
- **Funding from the National Science Foundation (NSF) and the National Institute of Health (NIH) to the state of California grew by 3.9 percent overall in 2022 to a total of \$6.1 billion, which represented a 23.2 percent decline in NSF funding and an 8.5 percent increase in NIH funding.** Congress expanded the National Institute of Health's (NIH) base budget allocation by \$2 billion, with specific earmarks for pandemic preparedness and workforce diversity. The Biden administration also established a dedicated program for transformative biomedical research projects. Out of 103 awards issued during the year, 31 were granted to California-based investigators. NSF funding in the US overall has been experiencing reduced demand in terms of number of applications over the last decade, particularly in the biology directorate.[3]

[1] Due to availability of data at time of data collection, the report's reference to the year "2022" refers to the financial year starting Oct. 1, 2021, and ending Sept. 30, of 2022. All YOY comparisons are based on the previous 12-month financial year.

[2] Deloitte Center for Health solutions conducts pulse surveys of life science companies and the insights in this report are informed by survey results from 131 C-suite executives representing US biopharmaceutical companies, medical device manufacturers, health systems, and health plans.

[3] [Odds improve for winning NSF grants, but drop in applications troubles some observers | Science | AAAS](#)

- **Although private investment activity declined in 2022 compared to 2021, there was a steady cadence of meaningful mergers and acquisitions (M&A) deals.** High inflation led to interest rate hikes, and investors exercised increased restraint during this period. Amgen’s acquisition of ChemoCentryx—which represented a strengthening of Amgen’s inflammation and nephrology portfolio—highlights how leading pharmaceutical companies are increasingly using the M&A market for value addition rather than mega mergers.
- **Despite the challenging financing environment, California’s regional clusters were able to attract a meaningful number of Foreign Direct Investment (FDI) projects during the year.** The largest projects include a \$70 million investment from Japan-based Astellas to open a new 14,000 ft² integrated biotechnology campus in South San Francisco, as well as Fujifilm’s \$60 million investment to expand its Armstrong Center of Excellence at its headquarters in Santa Ana. Canada-based Entos Pharmaceuticals is a pharmaceutical company with a focus on the development of nucleic acid-based therapies and plans to invest \$62 million to build a new 9,500 ft² R&D facility located at the MUSE life science campus in San Diego.
- **Global pharmaceutical companies are increasingly sourcing innovation externally through alliances and partnerships.** California-based Amgen’s partnership with Generate Biomedicines—which leverages machine learning and Artificial Intelligence to program novel protein therapeutics—highlights how the rise in successful use cases of Artificial Intelligence in drug development is driving greater adoption of the partnership-based innovation model in the pharmaceutical industry.
- **California is well-positioned to benefit from greater focus on increasing diversity in clinical trials.** Amgen’s adoption of Pharmaceutical Research and Manufacturers of America’s Principles on Clinical Trials Diversity—which focus on four main areas: building trust and acknowledging the historic mistrust within Black and Brown communities, reducing barriers to clinical trial access, using real-world data to enhance information on diverse populations beyond product approval, and enhancing information about diversity and inclusion in clinical trial participation—highlights California’s key role in advancing the representation of diverse patient populations. Amgen also established a dedicated team to address the systemic issues that deter people from participating in research, especially those who have been historically excluded due to race, ethnicity, sex, age, and other factors.
- **Experience with digital technologies will be a key growth skillset for life science organizations going forward.** Most medical device companies are either currently investing or plan to invest in digital manufacturing technologies (i.e., Internet of Things (IoT), Artificial Intelligence (AI)) over the next few years. Biopharmaceutical companies are increasingly adopting digital platforms as well. California’s deep talent pool in technology occupations is well-positioned to capture growth opportunities coming from the life science sector.

INTRODUCTION

The California life science industry was an engine of growth for the California economy in 2022. Overall, in 2022, the state's life science industry, composed of the six major sub-sectors defined below, expanded direct employment by 26,672 jobs, attracted \$6.1 billion in National Institute of Health (NIH) and National Science Foundation (NSF) funding, generated an overall business output of \$413.7 billion, and contributed a meaningful cadence of M&A and partnership activity particularly in drug discovery and biotech sectors. Although the year also presented macro environment challenges and regulatory shifts, the California life science industry continues to actively adjust to market changes.

LIFE SCIENCE SCOPE

Six major sub-sectors comprise the Life Sciences industry scope^[4]:

Biotechnology: Research and development in biotechnology; research and development in nanobiotechnology; artificial and synthetic fiber manufacturing; research and development in physical engineering and life science^[5]

Biopharmaceuticals: Medicinal and botanical manufacturing; pharmaceutical preparation manufacturing; intro-vitro diagnostic substance manufacturing; biological product manufacturing; drugs merchant wholesalers

Medical Devices and Equipment: Ophthalmic goods manufacturing; irradiation equipment manufacturing; surgical and medical instrument manufacturing; surgical appliance and supplies manufacturing; optical instrument and lens manufacturing^[5]; dental laboratories; medical, dental, and hospital equipment and supplies merchant wholesalers

Research and Testing: Colleges, universities, and professional schools^[5]; medical laboratories; testing laboratories^[5]

Scientific/Research Tools: Laboratory instruments manufacturing; laboratory chemicals (basic organic) manufacturing; electromedical and electrotherapeutic apparatus manufacturing

Food and Agriculture Biotechnology: Ethyl alcohol manufacturing; nitrogenous fertilizer manufacturing^[5]; phosphatic fertilizer manufacturing^[5]; pesticide and other agriculture chemical manufacturing^[5]

^[4] See Appendix for the complete composition of North American Industry Classification System (NAICS) codes considered for life science industries; the 2023 edition of the Biocom California Life Science Economic Impact Report re-categorizes "Research and development in physical engineering and life science" as a "Biotechnology" sub-sector, and re-labeled sub-sector No. 4 as "Research and Testing"

^[5] Life Science represents a fraction of overall activity in this NAICS area where other industry sectors may be more substantial

2022 PERFORMANCE

CALIFORNIA

IMPACT BY THE NUMBERS

\$5.41B

Total NIH Awards

\$129.6B

Total Labor Income

\$413.7B

Total Economic Output

\$645M

Total NSF Awards

1.19M

Total Jobs Supported

26,672

Total Jobs Added

MORE KEY METRICS

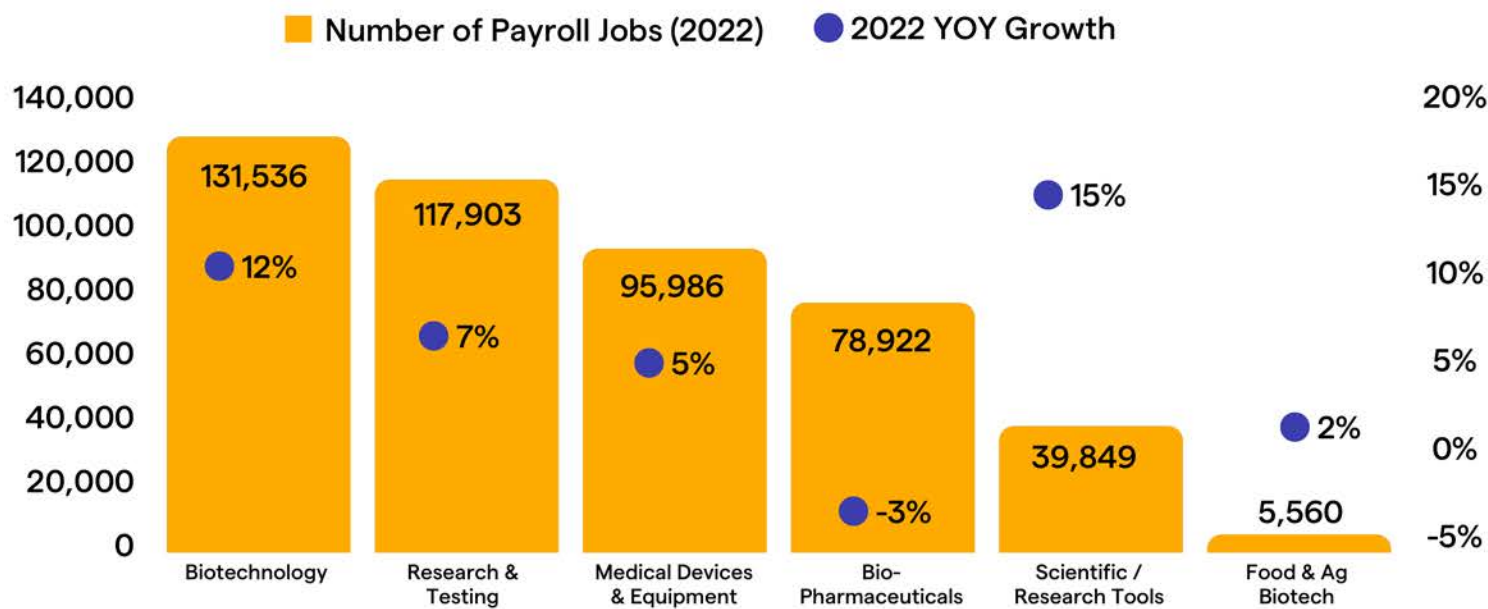
Establishments..... **16,645**
Avg. Wages per Worker... **\$131,838**
Directly Employed
Life Science Workers **469,756**
Annual Patents Granted
in Core Life Sciences..... **1,661**

2022 PERFORMANCE

Underlying growth of the life science industry remained strong in 2022, driven by sustained demand during the third year of the pandemic response, public funding increases, and continued corporate reinvestment in research and development (R&D). The pandemic appeared to accelerate underlying trends in the industry in 2022, with biopharmaceutical companies increasingly focusing on innovation and collaboration for value-creation, and the role of digital health technology growing both in the patient care setting as well as in R&D. At the same time, the year also presented challenges in terms of geopolitical conflicts driving supply chain disruptions, a high inflation environment and corresponding federal interest rate response, along with a shifting regulatory landscape.

The life science industry in California experienced solid growth in 2022, adding 26,672 jobs statewide. California is the largest employer of life science workers in the nation, and with six percent growth in life science employment during 2022, California added more life science jobs to the economy than any other state. The largest jobs gains were driven by growth in biotech and nano-biotech R&D sectors, as well as growth in analytical and measuring instrument manufacturing. There is some evidence of job loss in pharmaceutical manufacturing, part of a national trend during 2022 that saw several large bio-pharmaceutical companies announce workforce reductions.

Figure 1: Number of Payroll Jobs and YOY Growth in California Life Science Sectors in 2022



ECONOMIC IMPACT

STATE OF CALIFORNIA

Life science activity in California generated \$413.7 billion in total business output, contributed approximately \$129.6 billion in salaries and sole-proprietor income, and supported approximately 1.19 million jobs in 2022. These totals refer to the overall economic impact of life science sub-sectors defined in Appendix B and depicted in Figures 4 and 5, and represent the aggregate direct, indirect, and induced impact.

Figure 2: Overall Impact of Life Science: Employment, Labor Income, and Output

| Impact Type | Direct Impact | Indirect Impact | Induced Impact | Total | Multiplier |
|--------------|---------------|-----------------|----------------|-----------|------------|
| Employment | 469,756 | 319,460 | 402,132 | 1,191,349 | 2.5X |
| Labor Income | \$66.9B | \$33.1B | \$29.6B | \$129.6B | 1.9X |
| Output | \$242.6B | \$87.2B | \$83.9B | \$413.7B | 1.7X |

Direct impact refers to the business activity (i.e., output, labor income, and employment) of payroll jobs within establishments discussed in the Payroll Jobs section on page 6. These establishments directly employed 469,756 workers in 2022, generated \$66.9 billion in labor income and produced \$242.6 billion in business sales output.

Indirect impact refers to inter-industry activity that results from the purchase transactions of life science establishments, i.e., the business activity of life science supplier and sub-contractor industries. Life science supplier and sub-contractor industries in California employed 319,460 workers in 2022, contributed \$33.1 billion in labor income, and generated total business sales output of \$87.2 billion. Indirect impact tends to be higher in manufacturing operations that have numerous suppliers and raw material inputs. Tradeable goods sectors also tend to have higher relative indirect impacts, given their demand for transportation and distribution services.

Induced impact refers to household spending of labor income that is generated by the direct and indirect life science activity, i.e., those impacts generated by the household spending of the employees within the life science value chain. Household spending of labor income (e.g. on housing, food, recreation, etc.) generates additional output, labor income, and jobs in the economy, which is recorded and measured as the induced impact. Household spending spurred by life science activity in California supported 402,132 jobs in 2022, contributing \$29.6 billion in labor income, and generating \$83.9 billion in total business sales output. Induced impact tends to be higher in sectors featuring either higher wages or higher levels of overall labor income, or both, which spurs greater consumption spending in the economy.

ECONOMIC IMPACT- STATE OF CALIFORNIA

Sectors with high indirect and induced impact, relative to their direct impact, are considered to have a high multiplier effect.[6] Pharmaceutical manufacturers and wholesale drug distributors have the highest employment multiplier among life science sub-sectors. Every job directly supported by these establishments in California generates more than three additional jobs in the state economy. This appears to reflect the more specialized raw material and labor needs associated with drug development relative to other life science sectors. Most biologics manufacturing, for example, requires sterile clean-room infrastructure, operating technicians with four-year degrees, and sophisticated raw material inputs with strict storage and distribution requirements. See appendix for full list of sub-sectors and their respective multipliers.

Figure 3: Employment Impact of Life Science in California (2022)

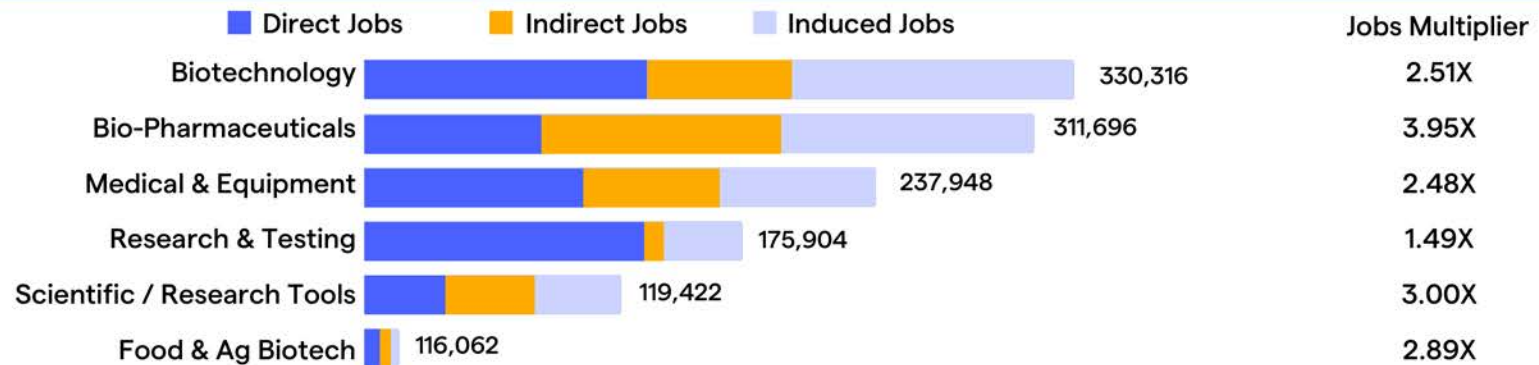
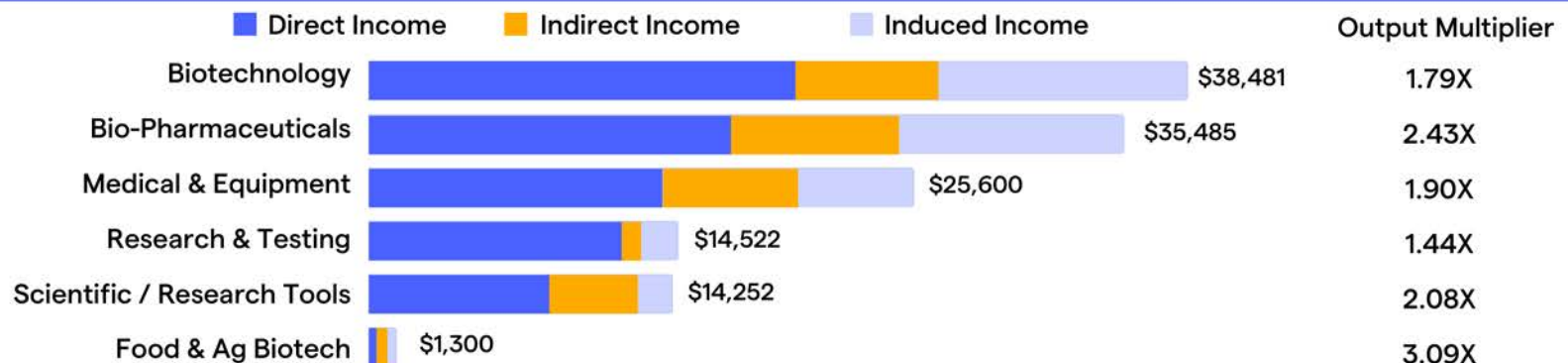
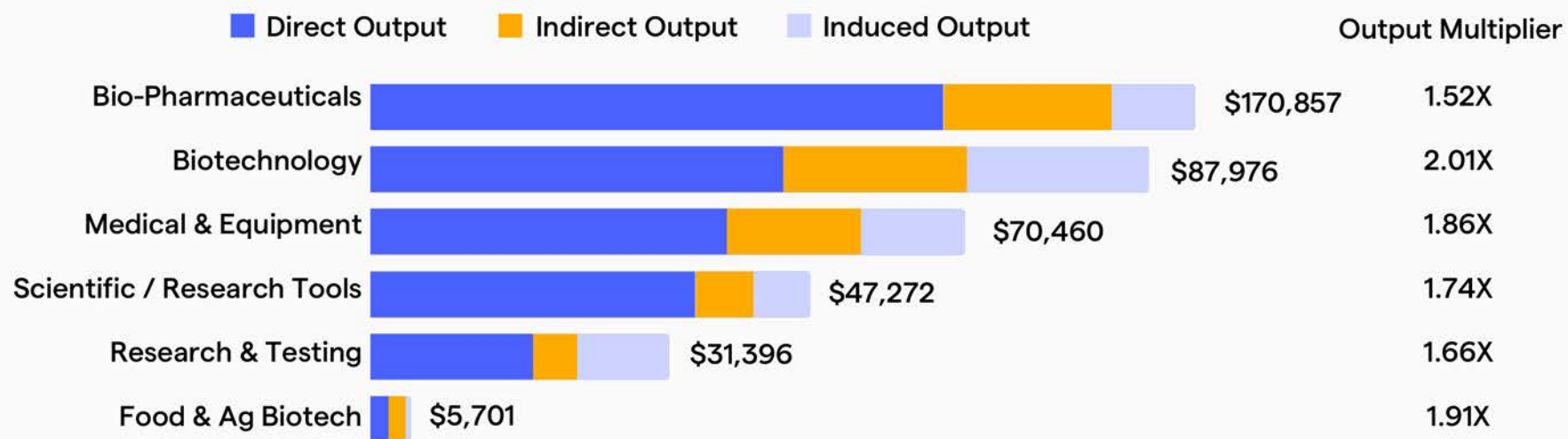


Figure 4: Labor Income Impact of Life Science in California (2022)



[6] Input-output analysis is a means of examining the relationships within an economy among businesses and among businesses and consumers. It attempts to capture all monetary market transactions for consumption within a specific time period. The underlying mathematical formula facilitates the examination of the effects of a change in one or several economic activities upon an entire economy (impact analysis). The methodology assumes that industries respond to meet consumption (demand) directly or indirectly by supplying goods and services to other industries. Each industry that produces goods and services generates demand for other goods and services. These iterations can be mathematically summarized and described by "multipliers." This buying of goods and services (indirect purchases) continues until leakages from the region (i.e., transactions with residents or business outside the state) stop the cycle.

Figure 5: Business Output (\$M) Impact of Life Science in California (2022)



RESEARCH FUNDING

The federal government plays a critical role in funding basic biomedical and behavioral research. In 2022, federal funding to California from National Science Foundation (NSF) and National Institute of Health (NIH) totaled approximately \$6.1 billion, with approximately \$2.8 billion directed to core life science topics^[7]. NSF funding declined by 23.2 percent to \$650 million, while NIH funding increased by 8.5 percent to \$5.41 billion.

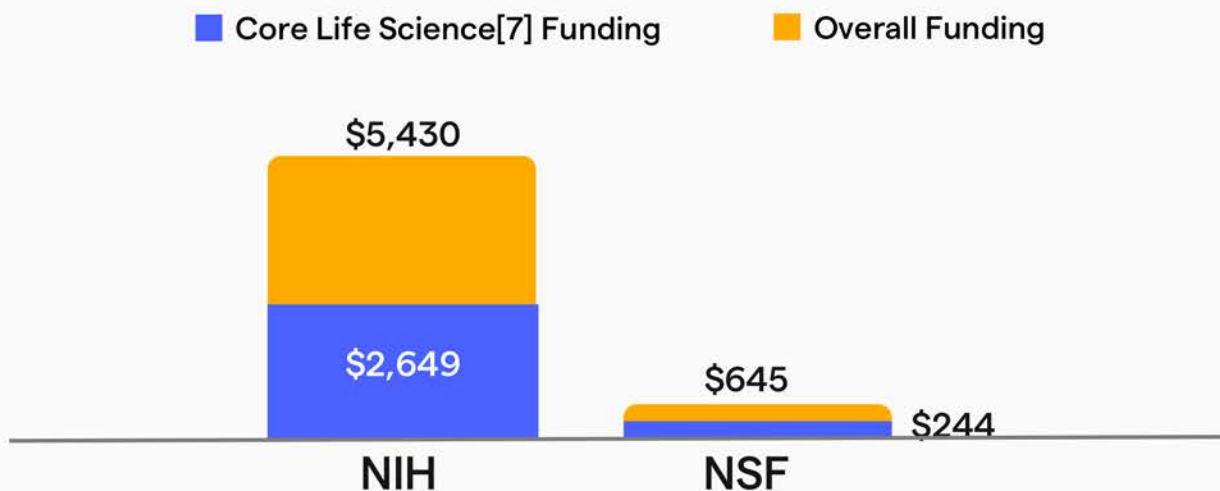
Congress increased its base budget allocation to NIH in 2022 to a total of \$45 billion, with funding earmarked for specific uses, namely in terms of pandemic preparedness (i.e., vaccine R&D, disease surveillance, expanded clinical trial infrastructure), as well as increasing workforce diversity (e.g., the UNITE initiative which seeks to advance racial equity in the biomedical research workforce).

The NIH made a special commitment to transformative biomedical research projects in 2022. Congress allocated \$1 billion to establish a new sub-agency designed to accelerate biomedical innovation, and the initiative approved 103 awards during the year. The Biden administration is seeking to expand funding to the new sub-agency—the Advance Research Projects Agency for Health (ARPA-H)—and requesting an additional \$5 billion base budget for FY2023.

California institutions were top recipients of core life science funding from NIH in 2022 (see Figure 6). Out of the 103 awards supported by the agency’s new focus on transformative biomedical research projects, 31 were awarded to California-based research institutions. California research awards range in thematic areas—from building a global map of interactions among human cell surface proteins and secreted ligands (California Institute of Technology) to leveraging natural phenotype variations that enable scalable drug discovery (UC San Francisco) to developing a framework for the social impact of algorithms in health care (Stanford University) to developing methods to rapidly explore combinatorial diversity and their application to CRISPR-CaS Systems (UC San Diego).

^[7] Core life science funding considers the following sub-sectors: biorenewables, biofuels, biopharmaceuticals, biotechnology, nano-technology, bioagriculture, bio-agriculture

Figure 6: Life Science Contribution to Public Research Funding



Core life science funding to California totaled \$2.9 billion in 2022, referring to research projects that focused on bio-renewables, biofuels, biopharmaceuticals, biotechnology, nano-technology, bioagriculture, and bio-agriculture. Among peer life science markets, California was the largest recipient of NIH funding to core life science projects in 2022, with three California institutions among the top 15 NIH-funded institutions (UC San Francisco, UC Los Angeles, and UC San Diego)[8].

[7] Core life science funding considers the following sub-sectors: biorenewables, biofuels, biopharmaceuticals, biotechnology, nano-technology, bioagriculture, bio-agriculture

[8] Blue Ridge Institute for Medical Research Rankings of NIH Funding in 2022

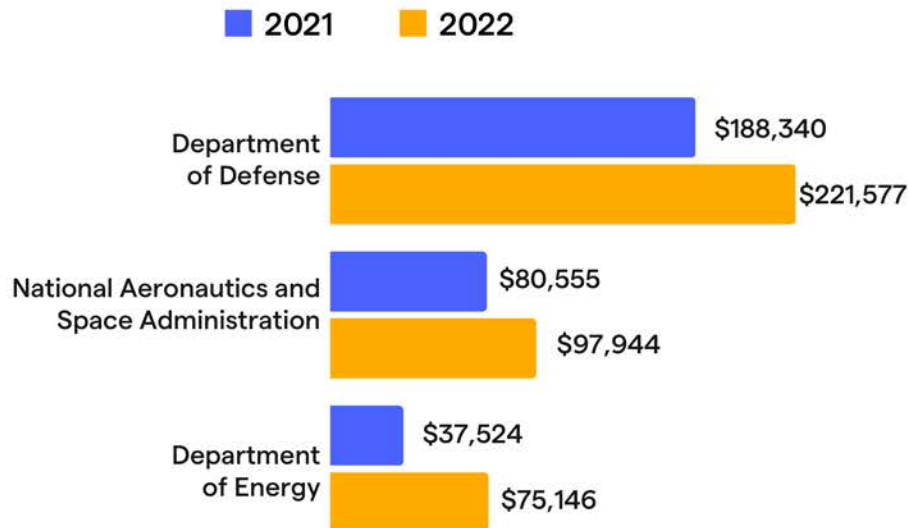
GOVERNMENT CONTRACTS

In addition to its contracting activity through NIH and NSF, the life science industry is a major recipient of federal government contracts. Government contracts to life science entities in California grew by 28 percent in 2022 to a total of \$401 billion, which is driven by increases in contracting volume at the top three sponsor agencies—the Department of Defense, the National Aeronautics and Space Administration, and the Department of Energy. The Department of Defense spending featured the largest ever budget to-date in 2022 for R&D and included a continued focus on pandemic preparedness and COVID-19 procurement spending.

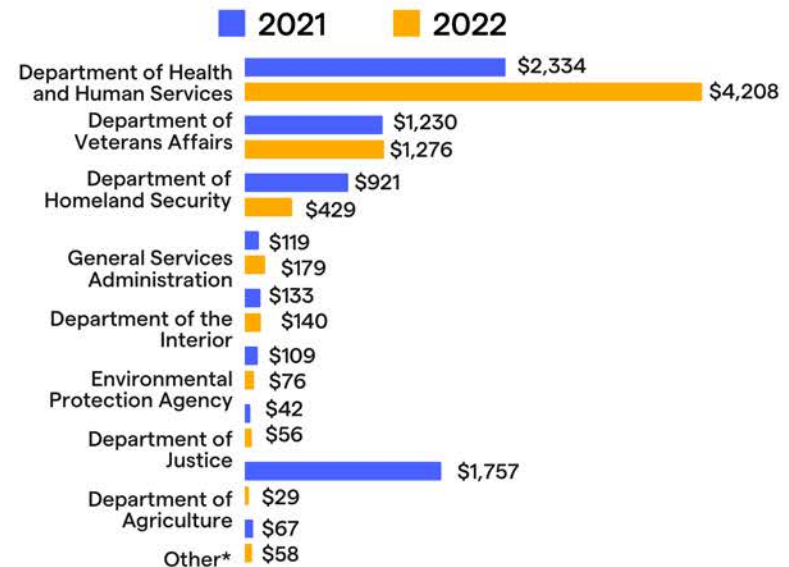
Other notable increases in 2022 include the Department of Health and Human Services, which increased research funding (e.g., NIH and NSF) and expanded funding for public health agencies and health care departments. For example, the Health Resources and Services Administration provided approximately \$7.5 million in funding to the state of California in 2022 to increase health care access, strengthen health networks, and focus on care quality improvements for Critical Access Hospitals and small rural hospitals.

Figure 7: Government Contracts with California Organizations, 2022

Top 3 Gov't Contractors in California Total contracting value in 2022, \$ millions



Other Major Gov't Contractors in California Total contracting value in 2022, \$ millions



PRIVATE INVESTMENT

Private investment in life science from traditional sources declined during 2022, especially compared to the dynamic private financing environment during the first two years of the pandemic. The IPO market in the second quarter of 2022, which featured 21 IPOs overall, was the slowest three-month period for new stock offerings since 2009, and 2022 was one of the lowest years for drug developer IPOs since 2012. Venture capital funding for core life science also declined in 2022 to pre-pandemic levels. The number of venture capital deals declined from 280 deals in 2021 to 233 deals in 2022 (year ending Sept 30), which was an 18% decline. The total value of venture capital funding in 2022 (year ending Sept 30) was \$12.5 billion. Private equity activity, which raised more than \$8.7 billion in 2021, was relatively quiet during the period, recording no substantial capital raise (see Figure 8). The decline in private investment in 2022 was not exclusive to the life science industry, whereby geopolitical conflict, supply chain disruptions, and rising interest rates all contributed to cooling investor sentiment in 2022.

Underlying the performance of 2022 is a larger shift in the pharmaceutical industry’s strategy for deploying cash, which started before the pandemic. Reinvestment in corporate R&D has been increasing, and innovation is increasingly being sourced through external partnerships and alliances.

Although M&A activity was relatively low during 2022, there was a steady cadence of meaningful deals in the biotech sub-sector, including Amgen’s acquisition of ChemoCentryx, which was intended to enhance Amgen’s leadership in inflammation and nephrology therapy areas. Motivated by the expiration of key patents as well as the emergence of novel mechanisms of action (e.g., cell and gene therapies), the M&A market is less used for mega mergers and more for specialized acquisitions that can fill revenue gaps and/or scale therapeutic focus areas.

Figure 8: Capital Raised by Life Science Companies in California, \$ millions

Note: Private equity activity during the period was too small to register representation

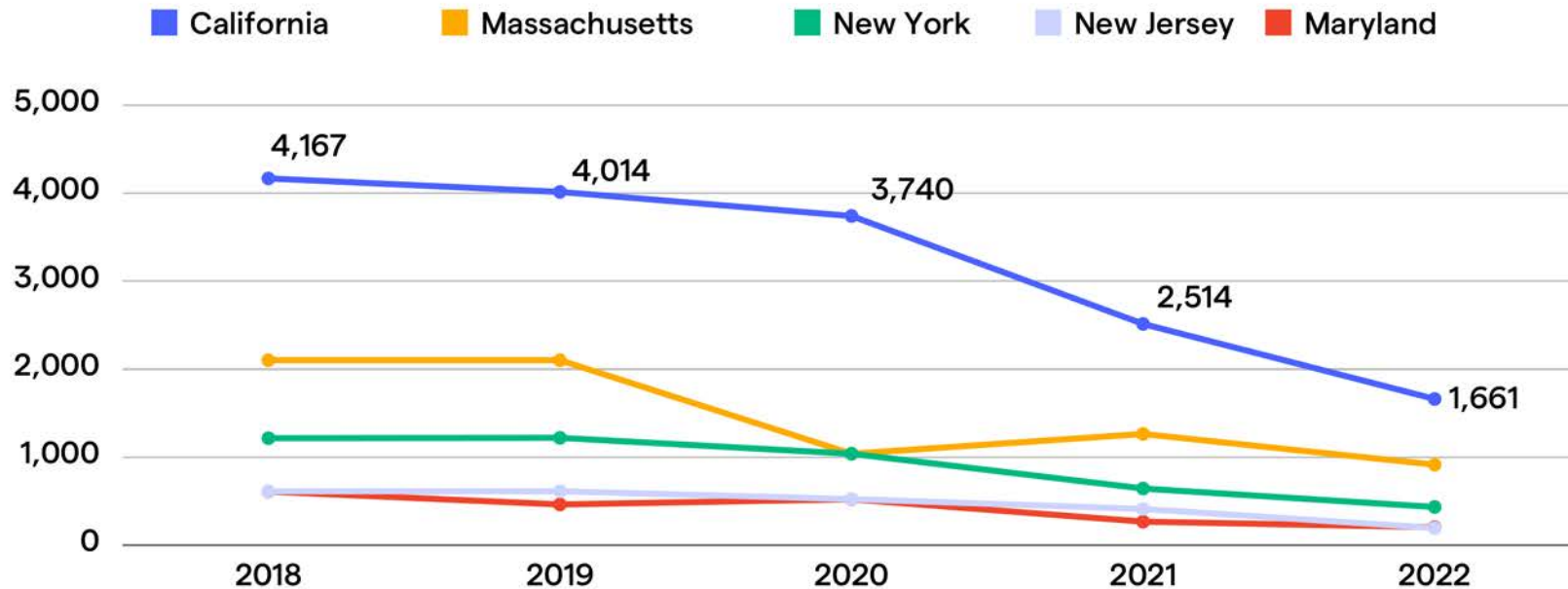


PATENTS

Annual patents granted in core life science applications declined 33 percent to 1,661 in 2022, down from 2,514 patents granted in 2021. California accounted for approximately 15-18 percent of the total annual patents granted in core life science applications from 2018 to 2022, representing the largest single state total during this period. Even before COVID-19, there was some evidence that annual patents granted at the US Patent and Trade Office (USPTO) had leveled off. While the number of worldwide patents grew by more than five percent in 2018, patents in the US dropped by 1.6 percent, and since the pandemic, US patent approvals have dropped steadily.

Figure 9: Annual Number of Patents Granted in Core Life Science, 2018 to 2022 [9]

Note: states included for comparison are the top states for patent filings; other peer markets register volumes that are too low for representation



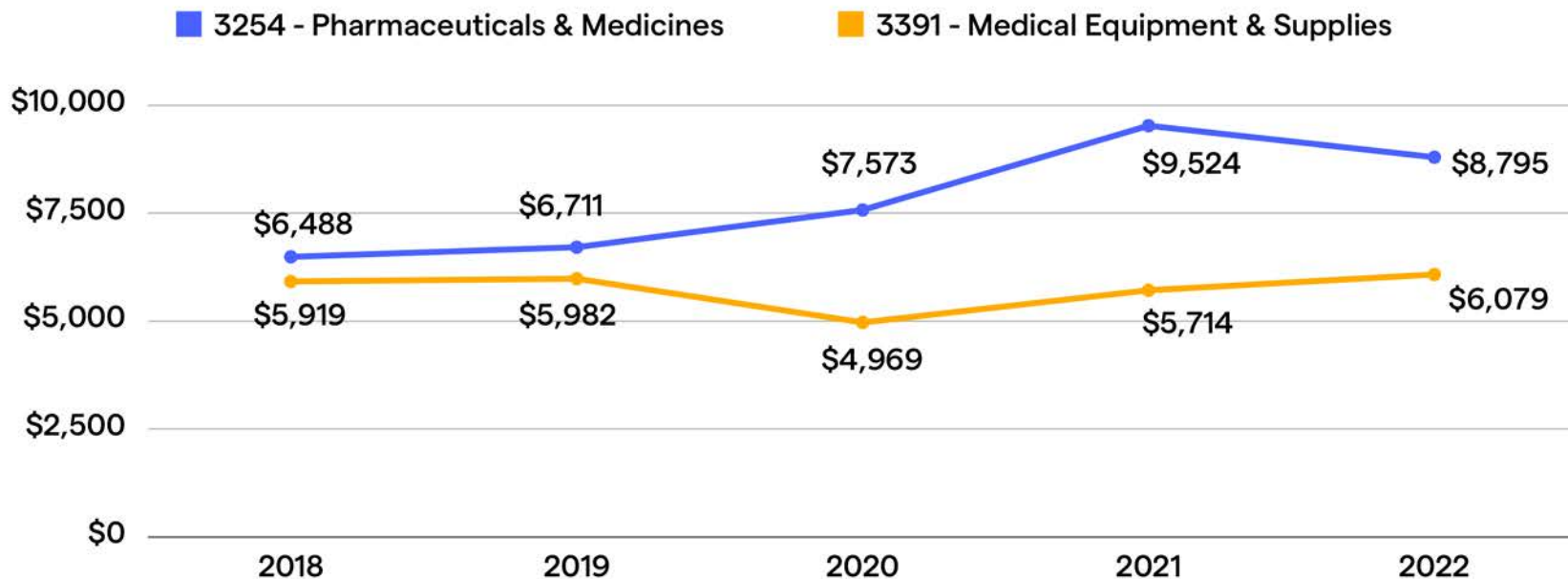
[9] Data was collected from the USPTO patent search covering all active and approved patents; annual figures can be obtained by setting data parameters in the "Filing date" field

EXPORTS

California exported \$8.8 billion of pharmaceuticals and medicines in 2022, which was a 7.7 percent decrease from the previous year, yet still higher than export levels before the pandemic (see Figure 10). Top destinations for pharmaceuticals and medicines exports were, in order of ranking: Japan, Germany, China, Netherlands, Ireland, Switzerland, Belgium, and Canada. South Korea and India have been major growth markets for drug exports; California exports to South Korea grew from \$101 billion in 2017 to \$248 billion in 2022, while exports to India grew from \$51 billion in 2017 to \$162 billion in 2022.

California exported \$6.1 billion of medical equipment and supplies in 2022—a 6.4 percent increase from the previous year—and approximately the same as pre-pandemic levels (see Figure 10). Top destinations for medical equipment suppliers were, in order of ranking: Netherlands, Mexico, Canada, China, Japan, Australia, Germany, Belgium. South Korea ranks 10th in terms of equipment exports, while India ranks 15th.

Figure 10: Life Science Merchandise Exports from California, 2018 to 2022, \$ millions



CHARACTERISTICS OF LIFE SCIENCE ASSETS IN CALIFORNIA

The state of California possesses a distinct set of assets that have driven activity and growth in the life science industry. This includes a network of leading colleges and universities, researchers and drug developers, hospital and clinical laboratory infrastructure, as well as an education system that is a substantial producer of masters and doctoral-level talent.

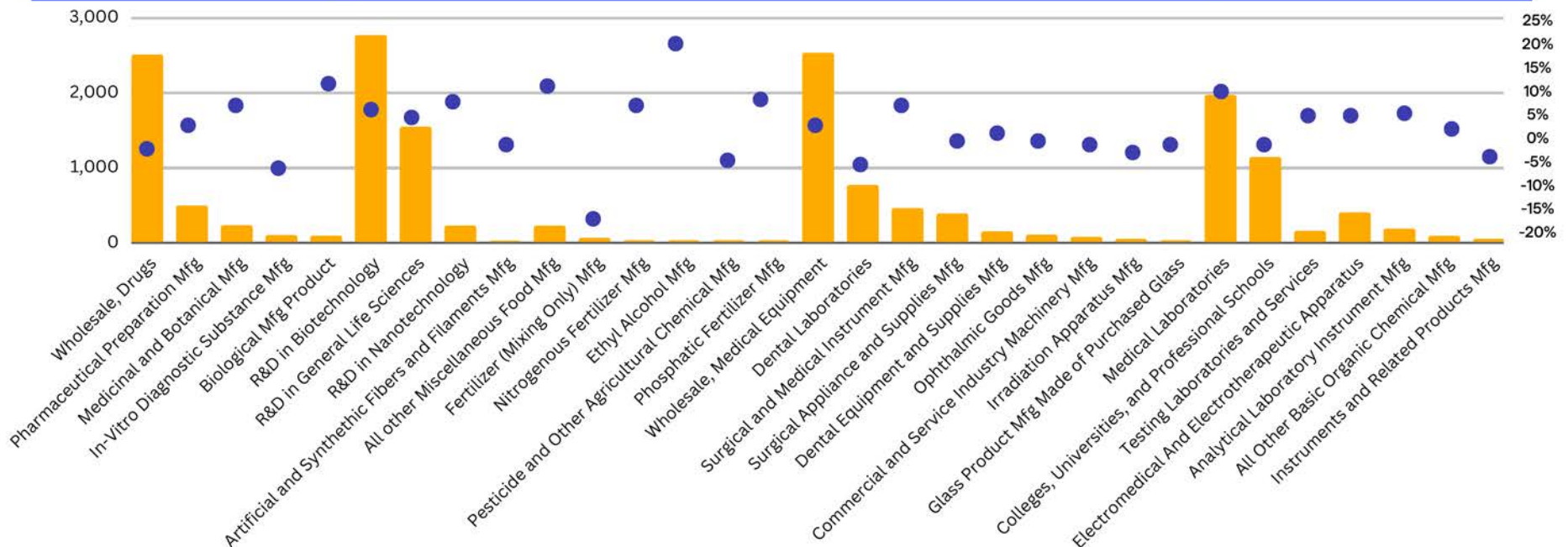


ESTABLISHMENTS

The life science industry in California features a diverse spectrum of real estate operations, ranging from wet lab space for R&D and clean-room environment for cGMP[10] manufacturing to specialized storage infrastructure for transportation and distribution operations. California is a leading provider of infrastructure to the life science industry, and in 2022 there were 16,645 establishments in California reporting involvement in life science activity during 2022, a five percent increase on the previous year. The main industry sectors contributing to growth in establishments are: R&D in biotechnology, medical laboratories, wholesalers of medical equipment, R&D in general life science, and surgical and medical instrument manufacturing.

California continues to be a leading destination for life science company headquarters. A number of global multinationals have a long history of headquarters operations in California (e.g., Amgen, Edwards Laboratories, Gilead Sciences, etc.), and the state attracted a number of relocations in 2022. Massachusetts-based Totus Medicines, a chemical biology and artificial intelligence biotechnology start-up, announced it will invest \$9.2 million to relocate its headquarters to Emeryville in northern California. South Korea-based Genome Insight, a start-up that provides whole-genome sequence analysis and interpretation, relocated its global headquarters from Seoul to San Diego. Fujifilm Irvine Scientific, a provider of cell culture solutions and subsidiary of Japan-based Fujifilm, announced its investments of \$60 million to expand the Armstrong Center of Excellence at its headquarters in Santa Ana.

Figure 11: Life Science Establishments in California and YOY Growth, 2022



[10] cGMP stands for "current good manufacturing practice" and refers to the methods, facilities, and controls used in manufacturing, processing, and packing of drug product, as regulated by the FDA

OCCUPATIONS

The California life science industry employs a variety of workers with a range of education, skills, and pay requirements. Pharmaceutical and medicinal manufacturing operations tend to hire a high proportion of roles in machine operator occupations (e.g., filling machine operator, chemical equipment operators), and often require specific training and exposure to cGMP and clean-room environments, often contributing to higher wage levels compared to other types of manufacturing. R&D operations tend to hire clusters of highly educated occupations (e.g., medical scientists, biophysicists) as well as clusters of highly technical occupations (e.g., mechanical engineers, software developers). Medical and research equipment manufacturing tends to hire a high proportion of fabricator and assembler occupations, as well as specialty engineering occupations (e.g., industrial, electrical, mechanical). There are a number of occupations common across life science sectors, namely the technician/technologist occupation (e.g., clinical, biological, inspector, sampler, etc.), with experience and pay requirements varying based on commercial orientation of the sector.



Figure 12: Top Occupations in Life Science Industries in California, by Sector (2022)

| Rank | Occupation | 2022 Emp | Avg. wages/yr |
|---------------------------|--|----------|---------------|
| Biopharmaceuticals | | | |
| 1 | Packaging and Filling Machine Operators and Tenders | 5,254 | \$87,586 |
| 2 | Sales Representatives, Technical Products | 3,362 | \$200,730 |
| 3 | Chemical Equipment Operators and Tenders | 3,220 | \$106,044 |
| 4 | Sales Representatives, Non- Technical Products | 3,172 | \$139,293 |
| 5 | Inspectors, Testers, Sorters, Samplers, and Weighers | 2,516 | \$115,693 |
| 6 | Laborers and Freight, Stock, and Material Movers, Hand | 2,339 | \$78,544 |
| 7 | General and Operations Managers | 2,278 | \$329,615 |
| 8 | Chemists | 2,211 | \$181,372 |
| 9 | First-Line Supervisors of Production and Operating Workers | 1,926 | \$171,368 |
| 10 | Customer Service Representatives | 1,714 | \$92,231 |
| Biotechnology | | | |
| 1 | Medical Scientists, Except Epidemiologists | 4,897 | \$184,906 |
| 2 | Software Developers | 4,611 | \$225,618 |
| 3 | General and Operations Managers | 3,318 | \$299,856 |
| 4 | Natural Sciences Managers | 3,205 | \$300,249 |
| 5 | Biological Technicians | 3,056 | \$87,853 |
| 6 | Biochemists and Biophysicists | 2,369 | \$192,651 |
| 7 | Business Operations Specialists, All Other | 1,986 | \$147,059 |
| 8 | Project Management Specialists | 1,928 | \$189,055 |
| 9 | Mechanical Engineers | 1,638 | \$180,945 |
| 10 | Managers, All Other | 1,623 | \$287,858 |

Figure 12: Top Occupations in Life Science Industries in California, by Sector (2022) continued

| Rank | Occupation | 2022 Emp | Avg. wages/yr |
|---------------------------------------|---|----------|---------------|
| Food & Agriculture Biotech | | | |
| 1 | Packaging and Filling Machine Operators and Tenders | 592 | \$45,708 |
| 2 | Food Batchmakers | 392 | \$45,465 |
| 3 | Packers and Packagers, Hand | 237 | \$38,096 |
| 4 | Laborers and Freight, Stock, and Material Movers, | 216 | \$43,758 |
| 5 | Chemical Equipment Operators and Tenders | 207 | \$61,319 |
| 6 | First-Line Supervisors of Production and Operating Workers | 204 | \$81,747 |
| 7 | Industrial Truck and Tractor Operators | 181 | \$50,599 |
| 8 | Inspectors, Testers, Sorters, Samplers, and Weighers | 146 | \$49,971 |
| 9 | Industrial Machinery Mechanics | 141 | \$73,428 |
| 10 | Mixing and Blending Machine Setters, Operators, and Tenders | 133 | \$48,281 |
| Medical Equipment and Supplies | | | |
| 1 | Miscellaneous Assemblers and Fabricators | 7,627 | \$64,157 |
| 2 | Dental Laboratory Technicians | 4,578 | \$80,126 |
| 3 | Sales Representatives, Non-Technical Products | 3,121 | \$140,927 |
| 4 | Sales Representatives, Technical Products | 2,820 | \$183,750 |
| 5 | Customer Service Representatives | 2,576 | \$88,154 |
| 6 | Inspectors, Testers, Sorters, Samplers, and Weighers | 2,335 | \$79,628 |
| 7 | General and Operations Managers | 2,282 | \$273,997 |
| 8 | Industrial Engineers | 2,044 | \$162,281 |
| 9 | First-Line Supervisors of Production and Operating Workers | 1,806 | \$123,822 |
| 10 | Laborers and Freight, Stock, and Material Movers, Hand | 1,517 | \$78,314 |

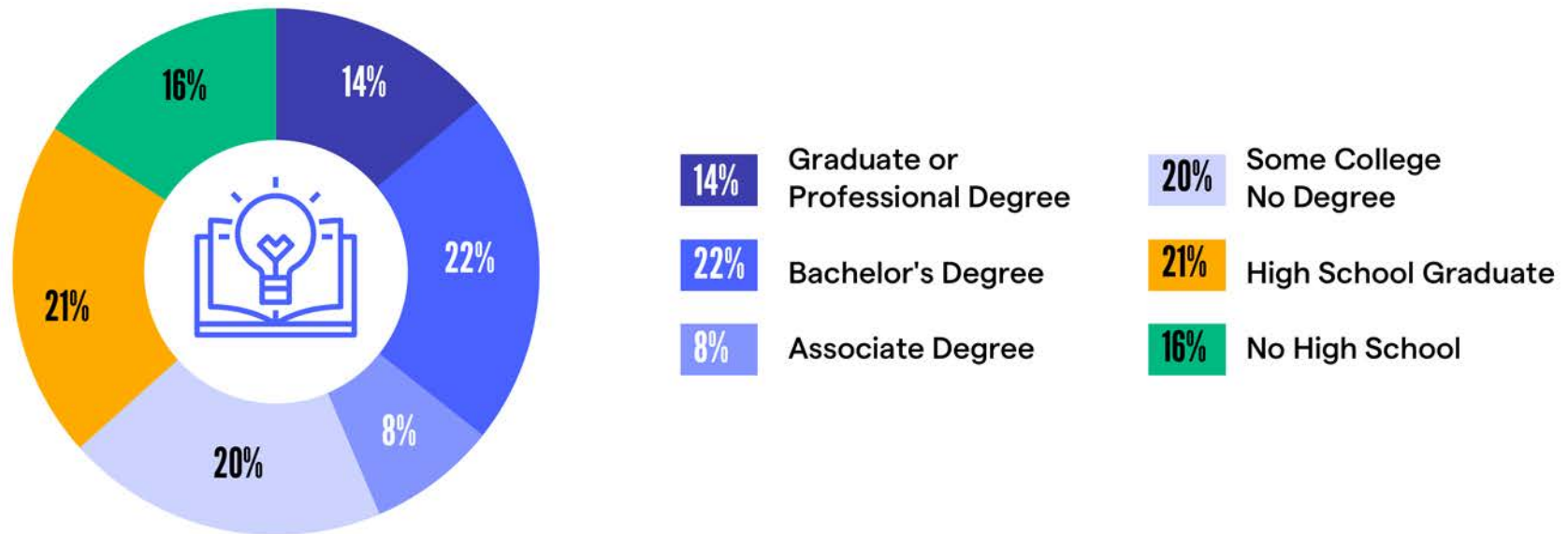
Figure 12: Top Occupations in Life Science Industries in California, by Sector (2022) continued

| Rank | Occupation | 2022 Emp | Avg. Wages/yr |
|------------------------------------|--|----------|---------------|
| Research and Testing | | | |
| 1 | Clinical Laboratory Technologists and Technicians | 6,684 | \$118,053 |
| 2 | Phlebotomists | 4,298 | \$81,351 |
| 3 | Health Specialties Teachers, Postsecondary | 3,368 | \$107,238 |
| 4 | Postsecondary Teachers, All Other | 2,894 | \$73,535 |
| 5 | Education Administrators, Postsecondary | 2,866 | \$92,193 |
| 6 | Secretaries and Administrative Assistants, Except Legal, Medical, and Executive | 2,403 | \$41,827 |
| 7 | Office Clerks, General | 1,904 | \$33,252 |
| 8 | Educational, Guidance, and Career Counselors and Advisors | 1,863 | \$46,119 |
| 9 | Customer Service Representatives | 1,671 | \$75,316 |
| 10 | General and Operations Managers | 1,673 | \$184,072 |
| Scientific / Research Tools | | | |
| 1 | Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers | 4,149 | \$70,996 |
| 2 | Software Developers | 2,854 | \$205,987 |
| 3 | Miscellaneous Assemblers and Fabricators | 1,662 | \$66,114 |
| 4 | Industrial Engineers | 1,494 | \$172,872 |
| 5 | Electrical Engineers | 1,225 | \$187,790 |
| 6 | Inspectors, Testers, Sorters, Samplers, and Weighers | 1,116 | \$84,726 |
| 7 | Mechanical Engineers | 1,084 | \$176,077 |
| 8 | General and Operations Managers | 952 | \$276,664 |
| 9 | First-Line Supervisors of Production and Operating Workers | 830 | \$127,009 |
| 10 | Architectural and Engineering Managers | 763 | \$277,047 |

EDUCATIONAL ATTAINMENT

The talent pipeline for life science in California remains robust, with an overall general population talent pool of more than 3.7 million residents with a graduate degree, and a composition of workforce development initiatives focused on career pathways in life science.

Figure 13: Educational Attainment in California (Percent of Population Aged 25+, 2021)



ECONOMIC

AND FINANCIAL FORCES IMPACTING LIFE SCIENCE

How sensitive is the life science industry to changes in the overall economy, financial markets, and national policies regarding interest rates and research funding? To understand the major economic and financial forces that impact the performance of the life science sector in California, an econometric model was developed.

Four factors appear to significantly influence sector employment, including:

U.S. Real Gross Domestic Product (GDP):

Upswings and downswings in the national economy significantly affect the life science industry, although other factors can moderate that influence. Isolating the US economy's effect, each percentage point change in real (inflation-adjusted) GDP growth causes a 0.7 percent change in total life science employment.

NIH and NSF Grant Funding:

The combined dollar amounts from the NIH and NSF significantly influence the number of life science jobs in California.

Interest Rates:

The base short-term interest rate targeted by the Federal Reserve impacts life science employment in California. Lower interest rates lead to more hiring in the sector, while higher rates result in less hiring. Interest rates affect the amount of risk life science organizations are willing to accept with respect to expansion and their ability to borrow funds.

Index Performance and M&A Activity:

The performance of indices such as the NASDAQ Composite stock market index, S&P 500, the Dow Jones Index, NASDAQ Biotechnology Index and S&P Biotechnology Select Industry Index show changes in investors' demand for technology and other stocks targeted for growth. Rising stock prices, especially as measured by these indices, reflect investor appetite to deploy capital in areas such as life science.

The combination of these variables provides context for the performance of life science employment in California.

INDUSTRY TRENDS

IMPACTING LIFE SCIENCE

In addition to economic and financial factors, the life science industry is subject to influence from emerging trends that shape activity and decision among industry leaders^[11]. The following analysis captures the key areas most likely to influence the performance and evolution of the life science sector over the coming years – and how California assets responded during the year.

Talent/Workforce Development

Life science leaders are rethinking talent development by anticipating the skills required to create next-generation therapeutics and emphasizing diversity, equity, and inclusion as a workforce attraction and retention tactic.

- MedTech executives report an increasing interest in hiring people who have expertise in digital technologies. Approximately 75 percent of executives report internet of things (IoT) and artificial intelligence (AI) as manufacturing technologies that are either current investment priorities or will be over the next three years. The COVID-19 pandemic has accelerated a shift toward greater digitalization of the workplace, and biopharmaceutical companies have also embraced cloud platforms, AI, and wearables at an increasing rate. Experience with digital technologies will increasingly be a key hiring criterion for life science roles.
- Approximately 90 percent of surveyed biopharmaceutical executives intend to invest in workforce development, including a focus on diversity, equity and inclusion. Several major biopharmaceutical companies have committed to specific targets, in terms of the percentage of management positions held by women or people of color, or in terms of percent growth in the number of management positions. Others have devoted specific resources to partners who are considered diverse suppliers defined, for example, as companies with employment of more than 50 percent Black, Hispanic, disabled, LGBTQ, or from other underrepresented groups.^[12]
- The life science industry in California has a strong track record of workforce development initiatives. Biocom California is working with colleges, universities, and school districts to provide input and direction into curriculum development and career pathways, and competency-based certifications. The goal is to bridge the gap between degree completion and employment through career exploration fellowships, internships, and programming focused on diversifying the workforce.

^[11] Deloitte insights are informed by a survey of 131 C-suite executives representing US biopharmaceutical companies, medical device manufacturers, health systems, and health plans.

^[12] [Big Pharma sets ambitious diversity goals to ensure 'pipeline' of talent | S&P Global Market Intelligence \(spglobal.com\)](#)



Industry Collaboration

During the past two years, regulators and industry have been working more closely than ever. Regulators improved information sharing with private companies—sharing research results, leveraging inspection reports, and disseminating information—and demonstrated a willingness to accelerate approval processes and facilitate more comprehensive responses from the public sector. Inter-industry collaboration also increased, with companies sharing knowledge, resources and turning to external providers for services such as robotic cloud labs or lab-as-a-service (LaaS).

- With increasing focus on novel mechanisms of action, life science organizations are increasingly seeking to bolster their drug development pipelines through partnerships and alliances. There were 181 alliances announced in the third quarter of 2022 for a total deal volume of \$38 billion, including Roche’s partnership with Poseida Therapeutics for \$6.1 billion to co-develop allogenic CAR-T cell therapies against multiple myeloma, B-cell lymphomas, and other hematologic indications.
- Life science organizations are turning to external providers for services such as robotics, cloud labs, and LaaS. These are labs where companies provide proprietary hardware, single-platform software, and services that allow automated research to be done remotely. Automated experiments can run around the clock and have greatly contributed to reducing the time it takes to develop new drugs.
- The proliferation of health data and the increasing digitalization of collection points has introduced new opportunities for partnership. Eli Lilly, for example, collaborated with Flatiron Health to fill evidence gaps in its FDA submission for a new dosing regimen of Cetuximab. The findings were critical to the FDA’s approval of the bi-weekly treatment.
- California biopharmaceutical companies were active in building partnerships and alliance opportunities during 2022. Amgen was involved in a number of AI-focused partnerships, while Gilead Sciences recently announced its oncology collaboration to develop a bispecific antibody as a potential treatment for blood cancers.

Patient and Site Centricity

The pandemic has fundamentally shifted habits, capabilities, and data related to people's interaction with their health. Most people around the country now have exposure to at-home tests for a global virus, some experience with digital health technology, and are increasingly likely to access health information or health care either at home or at a local clinic. The new environment is re-shaping the way that regulators and companies think about researching, developing, and testing new products.

- Research has shown that decentralized clinical trials (i.e., trials conducted at-home or at a local clinic, versus a research center) grew three-fold during the pandemic, and recent surveys of potential trial candidates reveal that participants are 17 percent more willing to participate in a clinical trial if offered at home versus at a research center.
- Pharmacies, community health centers, and grocery stores were ranked as the most trusted organizations that consumers want to see hospitals partner with to improve patient outcomes. The entrance of pharmacy chains Walgreens and CVS into the clinical trial business highlights how community-based organizations provide access to citizens with traditionally underrepresented socioeconomic backgrounds through localized locations and more flexible hours.
- Fewer patients are visiting centralized care sites, driven in part by the rise in virtual checks and smart phone enabled diagnostic tools, but also by advancements in wearable devices that can track and monitor patient data remotely. This is leading to digital partnerships becoming an approach that life science organizations are embracing to enhance their patient-centric offering. Biogen and MedRhythms, for example, co-developed a digital therapeutic aimed at improving gait deficits in patients with multiple sclerosis, using shoe sensor technology to detect and monitor walking gait.
- The proliferation of use and adoption of digital health technologies and the data they produce is driving innovation in the application of artificial intelligence for drug discovery. AI's ability to crunch large amounts of data allows it to rapidly identify drug targets, such as molecules and proteins associated with specific diseases. More than \$30 billion has been invested in high profile AI-centered drug discovery partnerships in the last 2 years.
- California was active during the year in expanding health care access. In 2022, the Health and Human Resources Administration provided approximately \$7.5 million to the state of California to increase health care access, strengthen health networks, and focus on care quality improvements for Critical Access Hospitals and small rural hospitals. By increasing access to quality services and training a more skilled workforce, the program has enabled communities in California to improve outcomes and address health disparities.

Research and Development Innovation

While R&D spending among the top 20 biggest biopharma and medtech companies fell slightly in 2022, it remains above the level in 2020 and is one of the top actions in which senior life science executives are planning to invest more heavily. Real-world evidence, new approaches to clinical trials and partnerships, and AI are expected to be areas of focus for life science companies in 2023.

- During the COVID-19 pandemic, real-world evidence enabled the sector to innovate faster by understanding the incidence and severity of the virus for vaccine development. Ninety percent of surveyed biopharmaceutical executives reported their organizations to be using real-world evidence to speed product life cycles and design synthetic control arms and adaptive trials. With new regulatory pathways for real-world data, advanced information management and analytics, there appear to be meaningful applications of real-world evidence to advancing drug discovery.
- The pandemic forced the sector to learn how technology could be used to collect and monitor patient data more quickly. Data can be collected through wearable technologies, home visits, telemedicine, and mobile engagement apps. Remote testing capabilities not only increase the amount of data collected, but they also give the manufacturer greater insight into patient safety. The qualification and context of these digital health technologies for use in remote clinical trial investigations is the focus of a new draft guidance document issued by the FDA. Key considerations include the privacy of the DHT, the consistency of data collection, and most importantly, the accuracy and precision at measuring a specific clinical event or characteristic.
- California-based pharmaceuticals have been investing heavily in building up their AI capabilities and the application to drug discovery. Amgen pledged \$1.9 billion to an alliance with AI specialist Generate, whose machine learning platform is directed at teasing out the three-dimensional structure of human proteins, and from there, to predict the structure of drugs—including short peptides, proteins like enzymes and cytokines, and antibodies—that will bind to a target.

Reimbursement & Regulatory

Pharmaceutical executives overwhelmingly report that expected reimbursement and pricing changes introduced in 2022 would have an impact on their organization's strategy in 2023^[13]. Passage of the Inflation Reduction Act (IRA) is impacting pipeline planning and dealmaking in the industry. With the IRA, companies are actively reassessing R&D priorities, launch planning, and pricing/access strategies.

- Passage of the IRA allows Medicare to impose price controls on innovative products and compels drug makers to pay rebates if prices rise faster than inflation. Biopharma companies have started planning to adapt to IRA implementation and mitigate its impact through recent pipeline modifications or terminations altogether, and face pressure to maintain margins among the pricing uncertainty.
- Among other new areas of focus, the FDA released updated guidance on the inclusion of racial and ethnic minorities in clinical trials, populations that are often underrepresented in medical research yet disproportionately impacted by certain diseases. Life science companies are now advised to create action plans at the start of trial development to guarantee diverse participant representation.



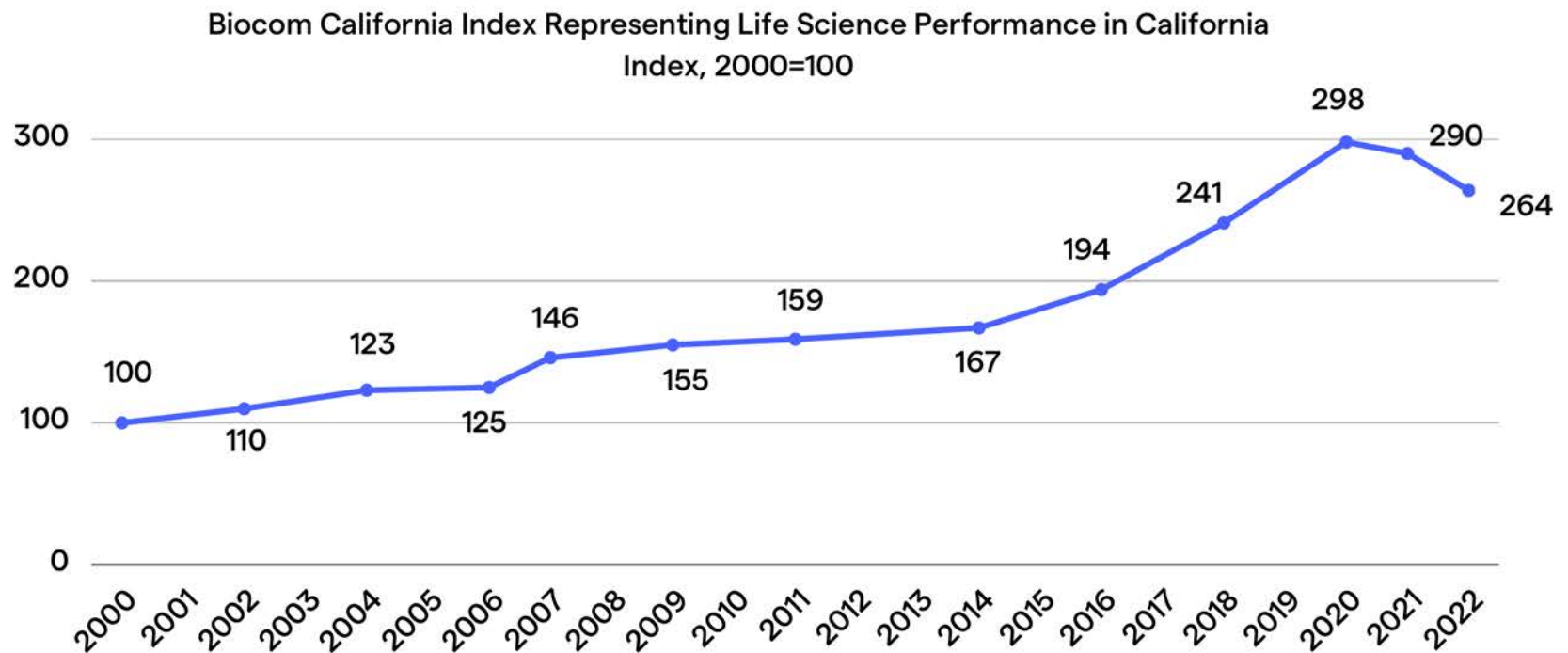
^[13] Deloitte Center for Health Solutions conducted a survey of 131 C-suite executives in 2022, representing US biopharmaceutical companies, medical device manufacturers, health systems and health plans.

BIOCOM CALIFORNIA INDEX

The Biocom California Index was developed based on key metrics of the performance of the life science sector in California over time and in consultation with Biocom California. The index components and weights encompass the number and value of NIH grants, number and value of NSF grants, number of patents, number of payroll jobs, number of establishments, and value of venture capital investments.

The Index continued a decline in 2022, falling to an indexed value of 264 from a high of 298 in 2020. Despite the decline over the past two years, the Biocom California Index is still higher than the pre-pandemic level of 241 in 2019. This year's decline is primarily due to lower levels of venture capital activity during the year, a trend neither exclusive to California nor to life science, rather more generally by greater investor caution resulting from high inflation and interest rate hikes. Patent activity is also a key driver of the Biocom California Index, which declined significantly during the pandemic, but also follows a national trend in the leveling off of annual USPTO filings, which pre-dated the pandemic.

Figure 14: Biocom California Index, 2000 to 2022



BAY AREA REGIONAL

SPOTLIGHT

IMPACT BY THE NUMBERS

\$2.1B

Total NIH Awards

\$43.1B

Total Labor Income

\$133.5B

Total Economic Output

\$143.5M

Total NSF Awards

258,165

Total Jobs Supported

MORE KEY METRICS

Establishments.....**3,760**

Avg. Wages per Worker
in Life Science Industry... **\$150,222**

Directly Employed
Life Science Workers **158,449**

BAY AREA REGIONAL SPOTLIGHT

The Bay Area region comprising nine counties—Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma—together employed 158,449 life science workers in 2022, which represented seven percent growth on the previous year. The largest employment gains came from research and development in biotechnology and analytical laboratory manufacturing, which added 4,248 jobs and 4,128 jobs to the Bay Area during the year, respectively. The region’s highly educated workforce, reinforced by close proximity to research institutions such as UC San Francisco, Stanford, and UC Berkeley, continues to position the region as one of the most elite and active life science clusters in the world.

Figure 15: Life Science Employment and Growth in Bay Area, 2022

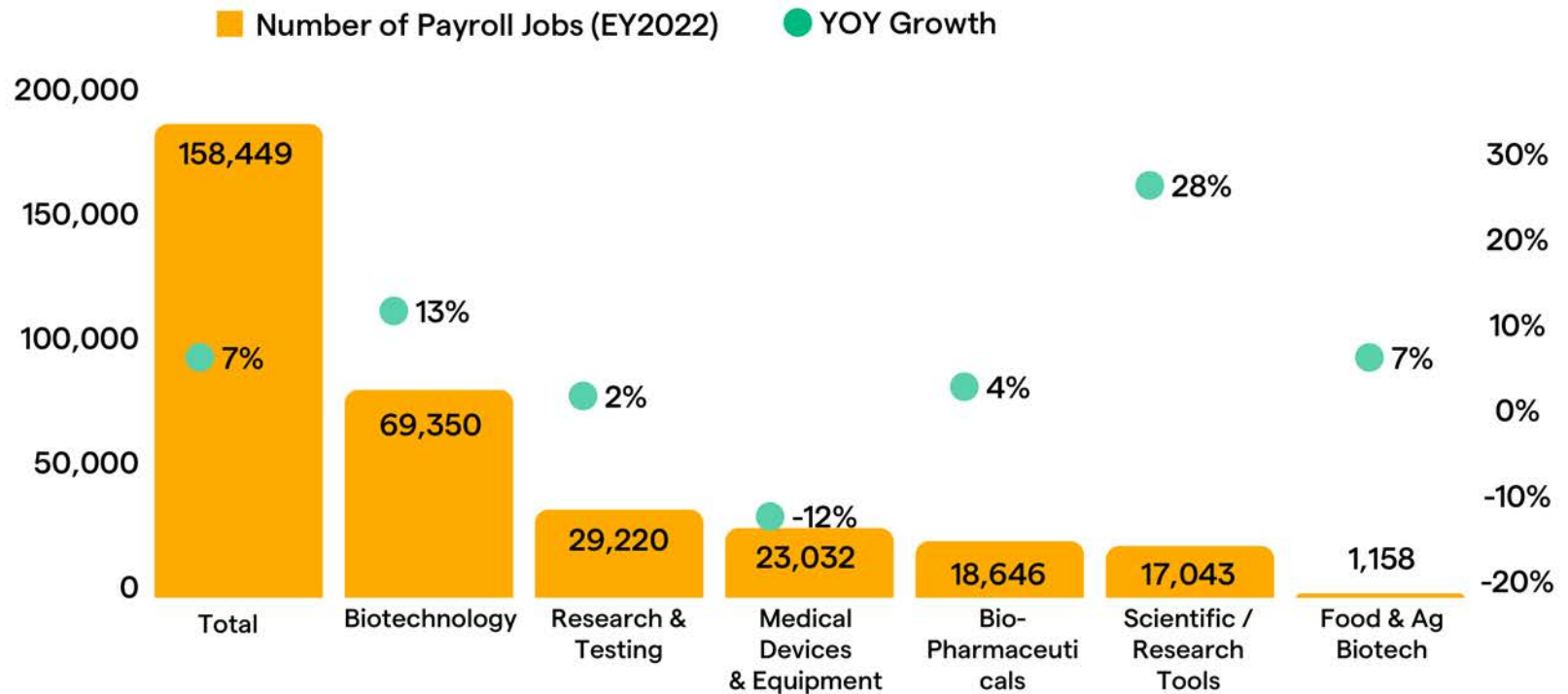


Figure 16: Life Science Employment and Growth in Bay Area, by Geography, 2022

| County | | Bio- Pharmaceuticals | Biotechnology | Food & Ag Biotech | Medical Devices & Equipment | Research & Testing | Scientific / Research Tools |
|----------------------------------|--------|-------------------------|---------------|----------------------|--------------------------------|-----------------------|--------------------------------|
| Alameda County | Emp | 3,308 | 18,030 | 511 | 7,010 | 6,273 | 4,214 |
| | Growth | 3% | 11% | 7% | 2% | 0% | 7% |
| Contra Costa County | Emp | 757 | 1,729 | 195 | 995 | 840 | 616 |
| | Growth | 9% | 5% | 11% | 5% | -2% | -6% |
| Marin County | Emp | 2,041 | 784 | 27 | 114 | 240 | 56 |
| | Growth | 1% | 11% | 768% | 15% | 22% | 54% |
| Napa County | Emp | 24 | 44 | 2 | 81 | 82 | 150 |
| | Growth | -35% | -9% | -5% | 3% | 10% | 71% |
| City and County of San Francisco | Emp | 552 | 8,288 | 192 | 591 | 8,449 | 741 |
| | Growth | -14% | 17% | 5% | 4% | -3% | 49% |
| San Mateo County | Emp | 11,771 | 24,648 | 79 | 2,506 | 3,909 | 1,647 |
| | Growth | 0% | 15% | -9% | 8% | 15% | 0% |
| Santa Clara County | Emp | 2,817 | 15,335 | 37 | 5,565 | 8,313 | 9,148 |
| | Growth | -52% | 10% | 8% | 6% | 5% | 49% |
| Solano County | Emp | 1,426 | 164 | 6 | 553 | 413 | 17 |
| | Growth | 1% | 8% | -60% | 1% | 0% | -3% |
| Sonoma County | Emp | 337 | 328 | 111 | 1,230 | 700 | 453 |
| | Growth | -7% | 16% | 1% | -2% | -3% | 43% |

Major life science employers in the region include: AbbVie (Regional Office), Amgen (Regional Office), Bayer (Regional Office), BioMarin (HQ), Bristol Myers Squibb (Regional Office), Exelixis (HQ), Gilead Sciences (HQ), Illumina (Regional Office), Zymogen (HQ).

Significant private investment activity during the period included^[14]:

- Alameda County, March 2022. Alabama-based Molecular Designs, a biotechnology research organization, announced the investment of \$62 million in opening its new R&D office focused on in-vitro diagnostics manufacturing in Pleasanton, CA.
- Alameda County, April 2022. Massachusetts-based Totus Medicines, a chemical biology and artificial intelligence biotechnology start-up, announced it will invest \$9.2 million to relocate its headquarters to Emeryville, CA.
- Alameda County, May 2022. Massachusetts-based Meadowhawk Biolabs, a preclinical contract research organization, opened a new laboratory in Hayward, CA, to serve west coast markets.
- San Mateo County, July 2022. Japan-based Astellas Pharma announced plans to invest \$70 million to open a new integrated biotechnology campus in South San Francisco, a 14,000 ft² facility which will include research, technical, medical, and development and commercial operations as well as relevant administrative support functions
- Alameda County, September 2022. China-based Frontage Laboratories, a contract research organization, announced plans to invest \$62 million in the opening of a 1,700 ft² laboratory facility offering services including exploratory and GLP-compliant Ligand Binding Assay services, supporting pharmacokinetics, immunogenicity, and biomarker analysis.

Figure 17: Key Metrics in Bay Area Geographies, 2022

| County | Direct Employment | YOY Growth % | Establishments | Avg. Wages/yr | LQ | NIH Awards | NSF Awards |
|----------------------------------|-------------------|--------------|----------------|---------------|------|------------|------------|
| Alameda County | 39,346 | 6% | 804 | \$153,000 | 4.5 | \$361M | \$60M |
| Contra Costa County | 5,133 | 3% | 300 | \$113,000 | 1.6 | \$6M | \$2M |
| Marin County | 3,261 | 7% | 115 | \$207,000 | 29.7 | \$23M | \$0.5M |
| Napa County | 384 | 17% | 26 | \$88,000 | 1.8 | \$7M | - |
| City and County of San Francisco | 18,813 | 6% | 530 | \$176,000 | 2.1 | \$992M | \$17M |
| San Mateo County | 44,560 | 9% | 690 | \$237,000 | 13.8 | \$53M | \$11M |
| Santa Clara County | 41,214 | 5% | 1,076 | \$184,000 | 4.1 | \$710M | \$51M |
| Solano County | 2,579 | 1% | 78 | \$92,000 | 3.1 | \$2M | \$1M |
| Sonoma County | 3,159 | 4% | 141 | \$102,000 | 2.4 | \$2M | \$1M |

^[14] Private investment activity during the period refers to major investment announcements by Pharmaceutical or Biotechnology companies reported by FDI Markets during the period from 10/01/2021 to 09/30/2022. FDI Markets typically only covers larger transactions that receive press coverage.

Figure 18: Educational Attainment in Bay Area Geographies, 2022

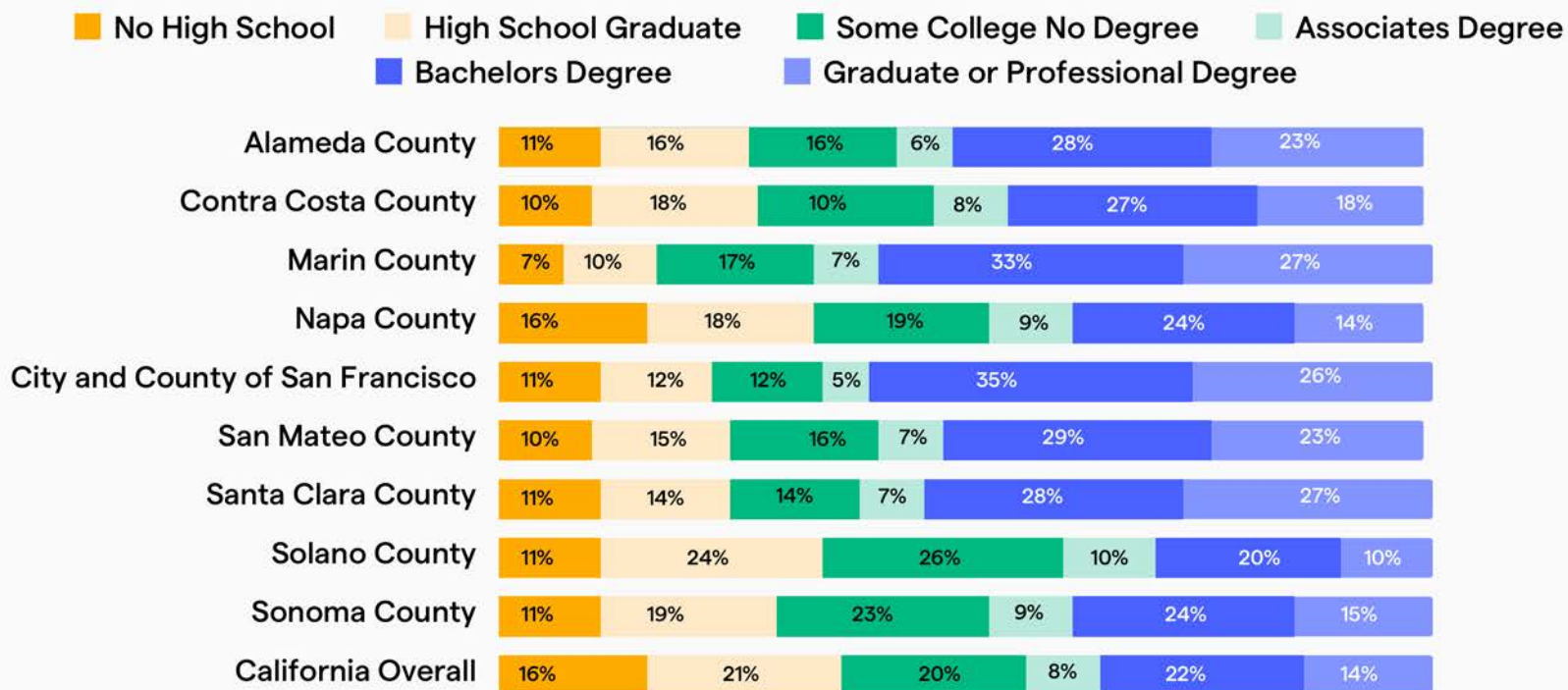


Figure 19: Overall Impact of Life Science Sectors in Bay Area, 2022

| Impact Type | Direct Impact | Indirect Impact | Induced Impact | Total | Multiplier |
|--------------|---------------|-----------------|----------------|----------|------------|
| Employment | 158,449 | 54,950 | 44,766 | 258,165 | 1.63X |
| Labor Income | \$31.2B | \$8.1B | \$3.8B | \$43.1B | 1.38X |
| Output | \$105.7B | \$18.0B | \$9.8B | \$133.5B | 1.26X |

Figure 20: County-Level Economic Impact of Life Science Sectors in Bay Area Geographies, 2022

| County | Total Employment | Total Labor Income | Total Output |
|----------------------------------|------------------|--------------------|--------------|
| Alameda County | 71,019 | \$8.5B | \$24.7B |
| Contra Costa County | 8,675 | \$0.9B | \$2.7B |
| Marin County | 5,868 | \$1.0B | \$3.6B |
| Napa County | 583 | \$0.05B | \$0.2B |
| City and County of San Francisco | 26,099 | \$4.1B | \$8.8B |
| San Mateo County | 70,754 | \$15.7B | \$60.3B |
| Santa Clara County | 65,282 | \$11.9B | \$28.7B |
| Solano County | 4,036 | \$0.4B | \$3.0B |
| Sonoma County | 5,852 | \$0.6B | \$1.7B |

LOS ANGELES REGIONAL

SPOTLIGHT

IMPACT BY THE NUMBERS

\$1.2B

Total NIH Awards

\$17.8B

Total Labor Income

\$61.5B

Total Economic Output

\$165M

Total NSF Awards

202,335

Total Jobs Supported

MORE KEY METRICS

Establishments.....**3,939**

Avg. Wages per Worker
in Life Science Industry... **\$93,333**

Directly Employed
Life Science Workers **97,117**

LOS ANGELES REGIONAL SPOTLIGHT

The Los Angeles region is composed of three counties—Los Angeles, San Bernardino, and Ventura—which together employed 97,117 life science workers in 2022, representing a four percent increase on the previous year. The largest employment gains came from expansions at college, university, and professional schools as well as R&D in biotechnology organizations, which added 2,050 jobs and 695 jobs to the regional economy in 2022, respectively. Los Angeles has leveraged historical strengths in diagnostics going back to the formation of Beckman Instruments out of Caltech in 1935, namely the development of a talent pool in molecular and immunological testing techniques, to grow a local base of medical diagnostic testing companies. A number of Los Angeles-based companies that achieved success meeting the demand for COVID-19 testing (e.g., Fulgent, Sameday Technologies) have branched out into other forms of testing, e.g. genetic testing, basic telemedicine, and other personalized health services.

Figure 21: Life Science Employment and Growth in Greater Los Angeles, 2022

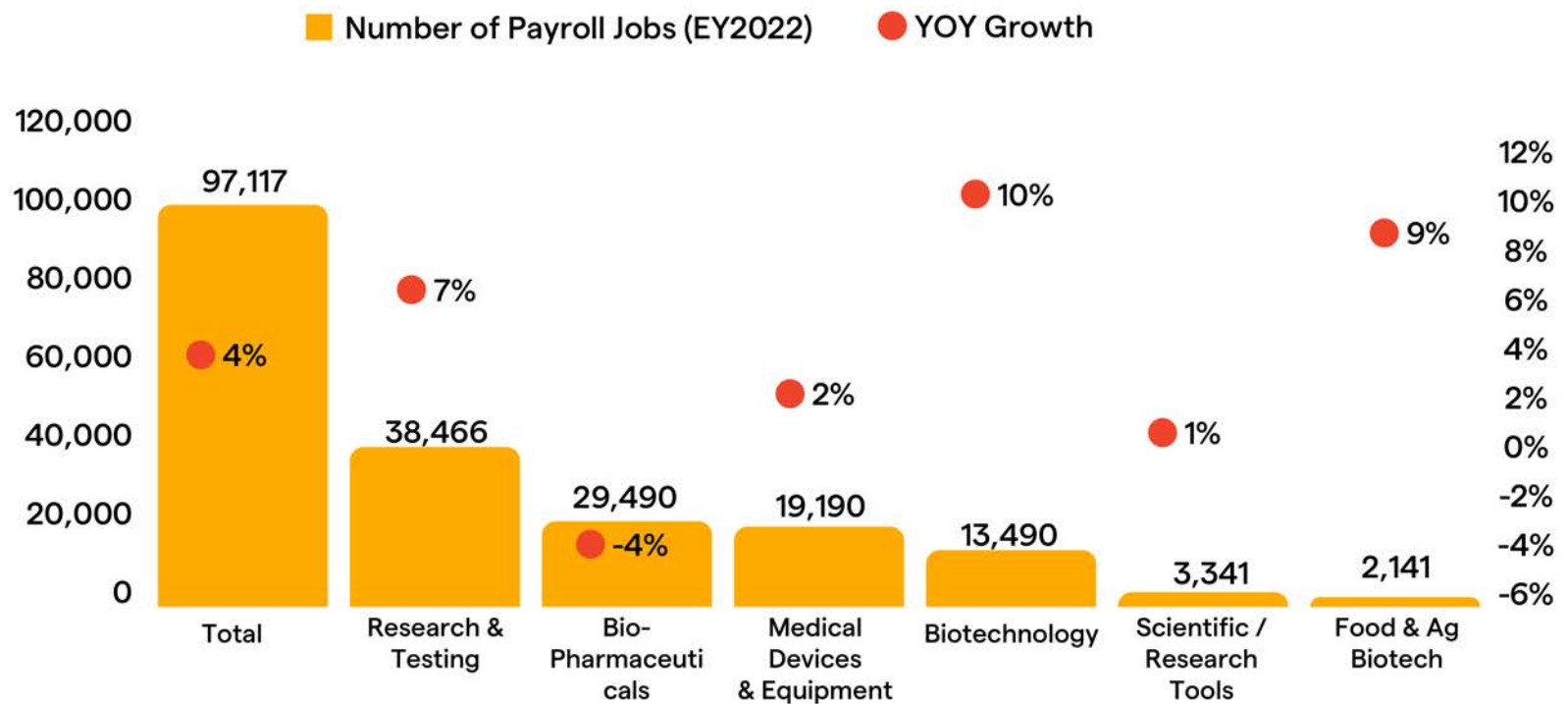


Figure 22: Life Science Employment and Growth in Los Angeles, by Geography, 2022

| County | | Bio- Pharmaceuticals | Biotechnology | Food & Ag Biotech | Medical Devices & Equipment | Research & Testing | Scientific / Research Tools |
|-----------------------|------------|-------------------------|---------------|----------------------|--------------------------------|-----------------------|--------------------------------|
| Los Angeles County | 2022 Emp | 16,626 | 11,859 | 1,502 | 15,626 | 35,378 | 2,806 |
| | YOY Growth | -6% | 8% | 16% | 2% | 7% | 0% |
| San Bernardino County | 2022 Emp | 1,743 | 179 | 405 | 2,375 | 2,090 | 434 |
| | YOY Growth | 10% | -11% | -20% | -1% | 13% | 13% |
| Ventura County | 2022 Emp | 2,121 | 1,453 | 233 | 1,188 | 997 | 100 |
| | YOY Growth | 5% | 29% | 43% | -3% | 1% | -16% |
| City of Los Angeles | 2022 Emp | 5,068 | 3,107 | 401 | 3,757 | 17,628 | 490 |
| | YOY Growth | -5% | 10% | 7% | 2% | 4% | 13% |

Major life science employers in the region include: Amgen (HQ), Baxter (Regional Office), Grifols (HQ), Kite Pharma (HQ), Seigfried (Regional Office), Xencor (HQ).

Significant private investment activity during the period included^[15]:

- Los Angeles, January 2022. Los Angeles-based Amgen and Generate Biomedicines announced a partnership to discover and develop protein therapeutics for five clinical targets, focusing on leveraging machine learning and artificial intelligence to program novel protein therapies around generative biology.
- Los Angeles, August 2022. Los Angeles-based Amgen agreed to invest \$3.7 billion to acquire ChemoCentryx, expanding Amgen’s autoimmune portfolio with an approved drug from regulators in Europe and Japan, and two clinical phase candidates.

[15] Private investment activity during the period refers to major investment announcements by pharmaceutical or biotechnology companies reported by FDI Markets during the period from 10/01/2021 to 09/30/2022. FDI Markets typically only covers larger transactions that receive press coverage.

Figure 23: Key Metrics in Los Angeles Area Geographies, 2022

| County | Direct Employment | YOY Growth % | Establishments | Avg. Wages/yr | LQ | NIH Awards | NSF Awards |
|-----------------------|-------------------|--------------|----------------|---------------|-----|------------|------------|
| Los Angeles County | 83,798 | 3% | 3,248 | \$106,000 | 1.0 | \$1,187M | \$159M |
| San Bernardino County | 7,227 | 5% | 393 | \$75,000 | 0.5 | \$13M | \$4M |
| Ventura County | 6,093 | 8% | 298 | \$99,000 | 1.6 | \$5M | \$2M |
| City of Los Angeles | 30,450 | 3% | N/A | \$107,000 | 1.2 | \$1,124M | \$105M |

Figure 24: Educational Attainment in Los Angeles Area Geographies, 2022

■ No High School
 ■ High School Graduate
 ■ Some College No Degree
 ■ Associates Degree
■ Bachelors Degree
■ Graduate or Professional Degree

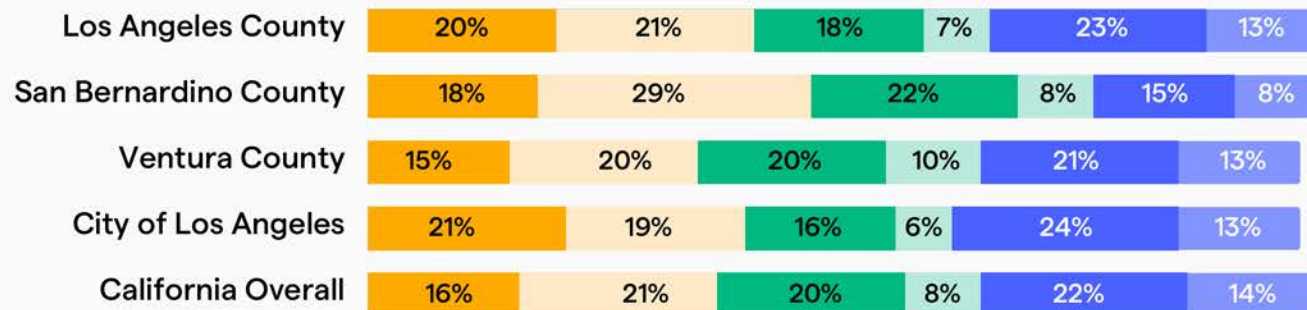


Figure 25: Overall Impact of Life Science Sectors in Los Angeles[16], 2022

| Impact Type | Direct Impact | Indirect Impact | Induced Impact | Total | Multiplier |
|--------------|---------------|-----------------|----------------|---------|------------|
| Employment | 97,117 | 58,237 | 46,986 | 202,335 | 2.08X |
| Labor Income | \$9.6B | \$5.1B | \$3.1B | \$17.8B | 1.86X |
| Output | \$39.4B | \$13.3B | \$8.9B | \$61.5B | 1.56X |

Figure 26: County-Level Economic Impact of Life Science Sectors in Los Angeles Geographies, 2022

| County | Total Employment | Total Labor Income | Total Output |
|---------------------|------------------|--------------------|--------------|
| Los Angeles | 175,156 | \$15.5B | \$52.4B |
| San Bernardino | 12,535 | \$0.9B | \$4.2B |
| Ventura | 14,643 | \$1.4B | \$5.0B |
| City of Los Angeles | 30,450 | \$5.0B | \$15.5B |

[16] In this analysis, the City of Los Angeles is considered a sub-set of Los Angeles County

ORANGE COUNTY

REGIONAL SPOTLIGHT

IMPACT BY THE NUMBERS

\$240M

Total NIH Awards

\$14.2B

Total Labor Income

\$46.7B

Total Economic Output

\$53M

Total NSF Awards

141,768

Total Jobs Supported

MORE KEY METRICS

Establishments..... **1,871**

Avg. Wages per Worker
in Life Science Industry... **\$108,000**

Directly Employed
Life Science Workers **63,683**

ORANGE COUNTY

REGIONAL SPOTLIGHT

Orange County employed 63,684 workers in 2022, which represented a four percent increase on the previous year. The largest job gains came from expansions at medical laboratories as well as surgical and medical instrument manufacturing operations, which added 471 and 399 jobs to the state economy during the year, respectively. Research and development in biotechnology and in-vitro diagnostics manufacturing each added more than a hundred jobs, which drove local growth in biopharmaceuticals and biotechnology. Life science activity in Orange County grows out of UC Irvine, which broke ground on a new medical complex in 2022 and will include a 144-bed acute care hospital, an outpatient Center for Advanced Care with primary and specialty health services, a Center for Children’s Health, and the Chao Family Comprehensive Cancer Center and Ambulatory Care building. In addition to its university system, Orange County has been a leader in the medical device industry, with a number of industry giants headquartered in the area.

Figure 27: Life Science Employment and Growth in Orange County, 2022

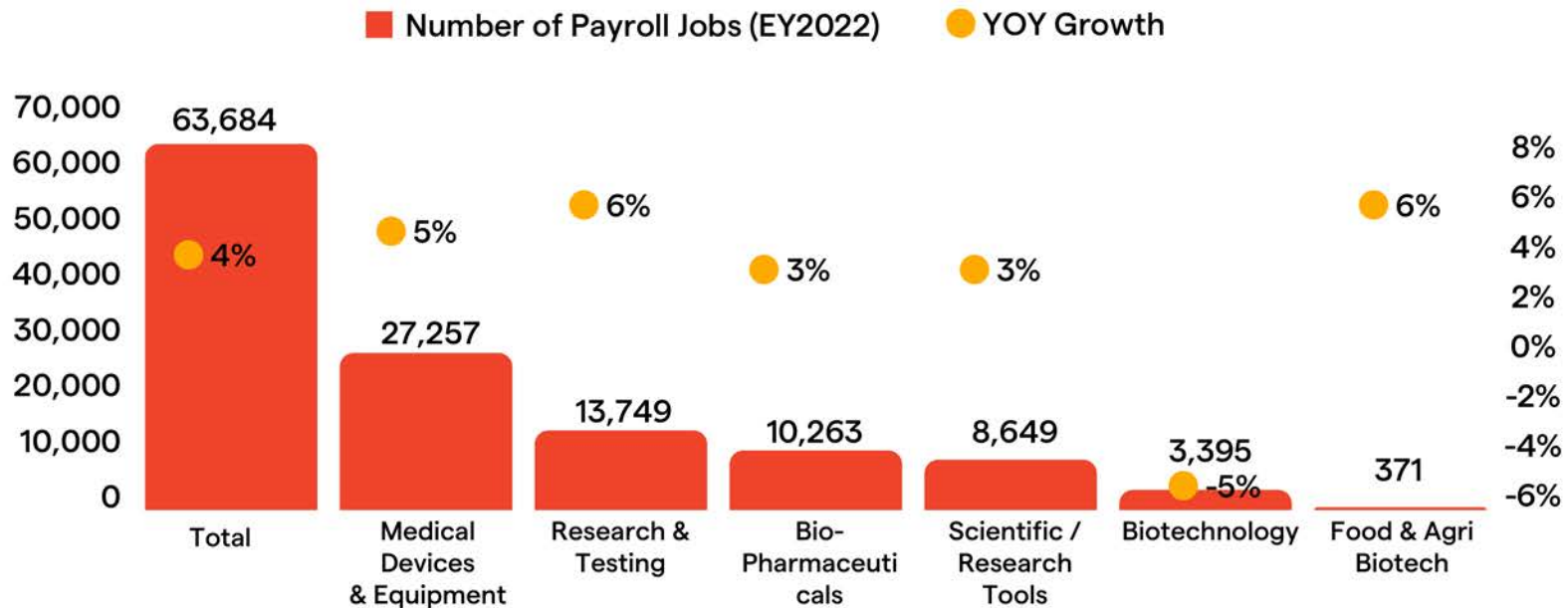


Figure 28: Life Science Employment and Growth in Orange County, by Geography, 2022

| County | | Bio- Pharmaceuticals | Biotechnology | Food & Ag Biotech | Medical Devices & Equipment | Research & Testing | Scientific / Research Tools |
|---------------|------------------------|-------------------------|---------------|----------------------|--------------------------------|-----------------------|--------------------------------|
| Orange County | 2022 Emp YOY Growth | 10,263 3% | 3,395 -5% | 371 6% | 27,257 5% | 13,749 6% | 8,649 3% |

Major life science employers in the region include: Edwards Life Sciences (HQ), Masimo (HQ), Medtronic (Regional Office).

Significant private investment activity during the period included^[17]:

- Orange County, October 2021. Fujifilm Irvine Scientific, a provider of cell culture solutions and subsidiary of Japan-based Fujifilm, announced its investment of \$60 million to expand the Armstrong Center of Excellence at its headquarters in Santa Ana, CA. Expanded footprint will include dedicated space for analytical chemistry, virology, assisted reproductive technology, and additional cell culture and molecular-based assay development.
- Orange County, May 2022. Invicro, an imaging informatics company and ultimate subsidiary of Japan-based Konica Minolta, has announced its investment of \$10 million to expand its capabilities in pathology services and tissue imaging, including histopathology and immunohistochemistry, among others.

Figure 29: Key Metrics in Orange County Geographies, 2022

| County | Direct Employment | YOY Growth % | Establishments | Avg. Wages/yr | LQ | NIH Awards | NSF Awards |
|---------------|----------------------|-----------------|----------------|------------------|-----|------------|------------|
| Orange County | 63,684 | 4.0% | 1,871 | \$108,000 | 3.6 | \$240M | \$53M |

^[17] Private investment activity during the period refers to major investment announcements by pharmaceutical or biotechnology companies reported by FDI Markets during the period from 10/01/2021 to 09/30/2022. FDI Markets typically only covers larger transactions that receive press coverage.

Figure 30: Educational Attainment in Orange County Geographies, 2022

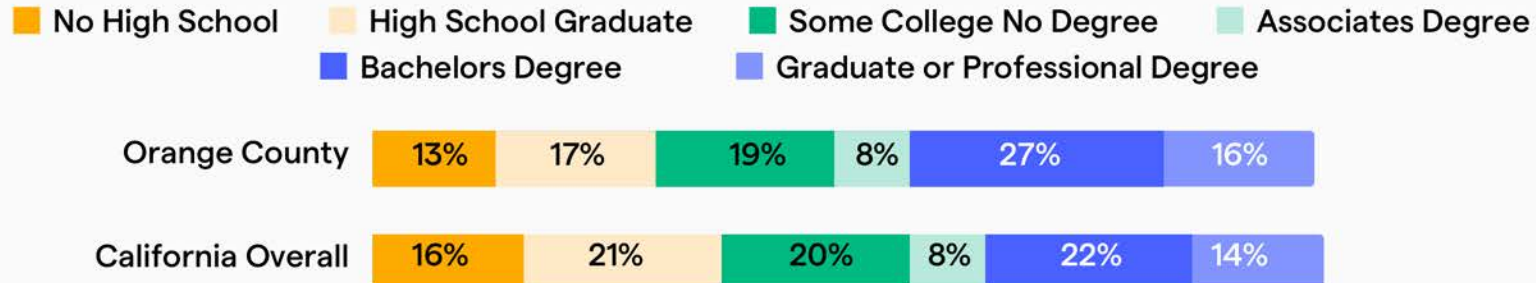


Figure 31: Overall Impact of Life Science Sectors in Orange County, 2022

| Impact Type | Direct Impact | Indirect Impact | Induced Impact | Total | Multiplier |
|--------------|---------------|-----------------|----------------|---------|------------|
| Employment | 63,683 | 40,962 | 37,123 | 141,768 | 2.23 |
| Labor Income | \$7.7B | \$4.0B | \$2.5B | \$14.2B | 1.84 |
| Output | \$29.6B | \$10.0B | \$7.1B | \$46.7B | 1.58 |

Figure 32: County-Level Economic Impact of Life Science Sectors in Orange County Geographies, 2022

| County | Total Employment | Total Labor Income | Total Output |
|---------------|------------------|--------------------|--------------|
| Orange County | 141,768 | \$14.2B | \$46.7B |

SAN DIEGO REGIONAL

SPOTLIGHT

IMPACT BY THE NUMBERS

\$1.2B

Total NIH Awards

\$18.3B

Total Labor Income

\$57.4B

Total Economic Output

\$117M

Total NSF Awards

178,426

Total Jobs Supported

MORE KEY METRICS

Establishments.....**2,080**

Avg. Wages per Worker
in Life Science Industry... **\$144,000**

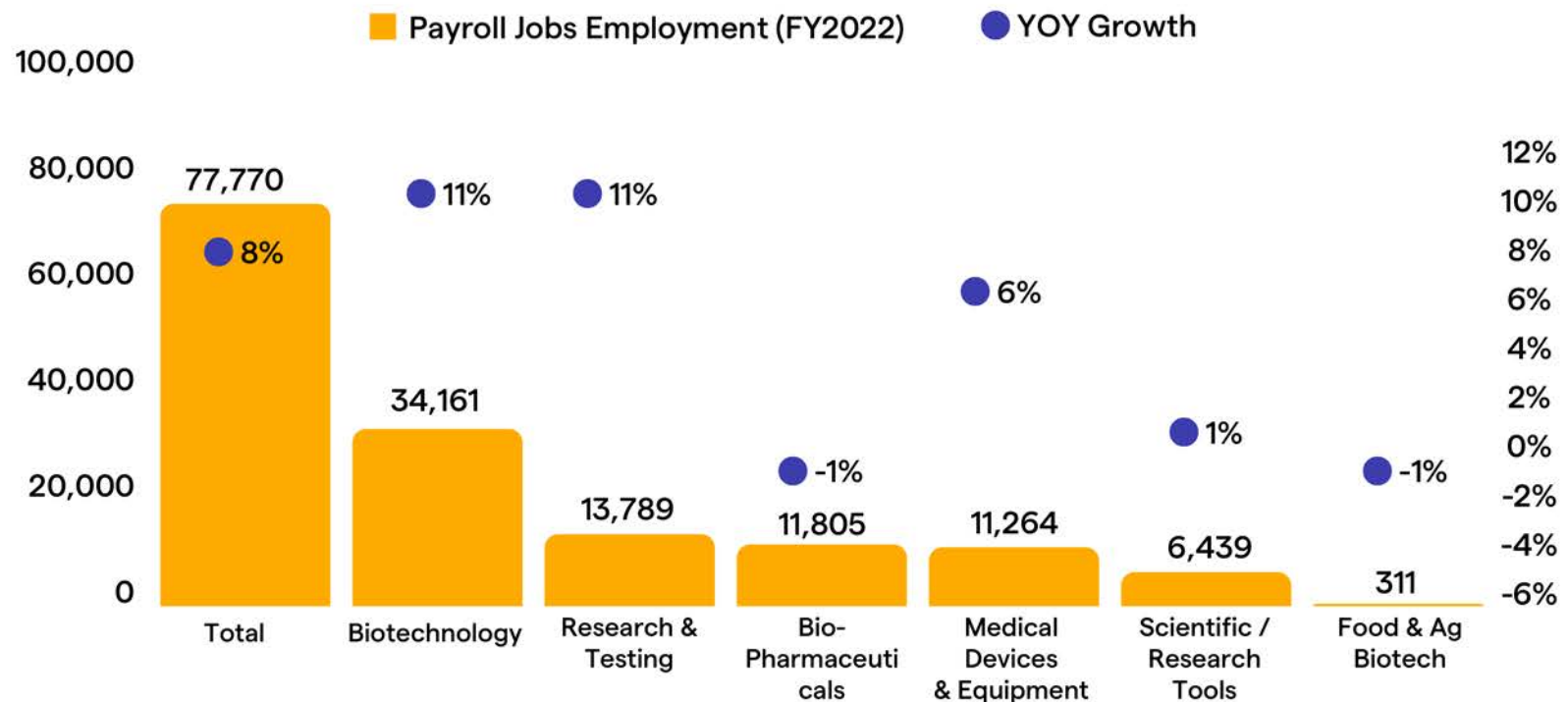
Directly Employed
Life Science Workers **77,770**

SAN DIEGO REGIONAL

SPOTLIGHT

In 2022, life science employment grew by eight percent overall in the San Diego region, continuing to solidify its position as one of the country's preeminent life science research destinations. The cluster is anchored around the coastal suburb of Torrey Pines, home to UC San Diego and a number of private research institutions, including Scripps Research, the Salk Institute, and the Sanford Burnham Prebys Medical Discovery Institute. Continued growth of the regional cluster has been fueled by public, private, and academic collaboration, a talented workforce, and strong industry anchors such as Bristol Myers Squibb, Eli Lilly, Illumina, Pfizer, and Takeda.

Figure 33: Life Science Employment and Growth in San Diego, 2022



1

Figure 34: Life Science Employment and Growth in San Diego, by Geography, 2022

| County | | Bio- Pharmaceuticals | Biotechnology | Food & Ag Biotech | Medical Devices & Equipment | Research & Testing | Scientific / Research Tools |
|-------------------|------------|-------------------------|---------------|----------------------|--------------------------------|-----------------------|--------------------------------|
| San Diego County | 2022 Emp | 11,805 | 34,161 | 311 | 11,264 | 13,789 | 6,439 |
| | YOY Growth | 1% | 11% | -1% | 6% | 11% | 1% |
| City of San Diego | 2022 Emp | 5,937 | 29,829 | 204 | 6,304 | 9,968 | 2,714 |
| | YOY Growth | 2% | 10% | 9% | 9% | 12% | 11% |

Major life science employers in the region include: BMS/Celgene (Regional R&D Center), Eli Lilly (Regional R&D Center), Dexcom (HQ), Illumina (HQ), Hologic (Regional R&D Center), Pfizer (Regional R&D Center), Quidel (HQ), Scripps Research (HQ), Takeda (Regional R&D Center), and Vertex (Regional R&D Center).

Significant private investment activity during the period included [18]:

- San Diego County, October 2021. China-based I-Mab Biopharma, a clinical-stage biopharmaceutical company, announced plans to invest \$62 million in an R&D facility that will focus on translational medicine as well as formulation research.
- San Diego County, March 2022. South Korea-based Genome Insight, a start-up that provides whole-genome sequence analysis and interpretation, has relocated its global headquarters from Seoul to San Diego at Torrey Pines.
- San Diego County, April 2022. UK-based Abzena, which engages in the provision of services and technologies for the development and commercialization of biopharmaceutical products, has announced plans to invest \$62 million to open a new biologics testing lab. The new hub will provide Abzena’s partners with access to cell-based and PCR safety assays as well as viral clearance studies.
- San Diego County, June 2022. Canada-based Entos Pharmaceuticals is a pharmaceutical company with a focus on the development of nucleic acid-based therapies and plans to invest \$62 million to build a new 9,500 ft² R&D facility located at the MUSE life science campus in Torrey Pines

[18] Private investment activity during the period refers to major investment announcements by pharmaceutical or biotechnology companies reported by FDI Markets during the period from 10/01/2021 to 09/30/2022. FDI Markets typically only covers larger transactions that receive press coverage.

Figure 35: Key Metrics in San Diego Geographies, 2022

| County | Direct Employment | YOY Growth % | Establishments | Avg. Wages/yr | LQ | NIH Awards | NSF Awards |
|-------------------|-------------------|--------------|----------------|---------------|-----|------------|------------|
| San Diego County | 77,770 | 8% | 2,080 | \$144,000 | 4.0 | \$1,204M | \$117M |
| City of San Diego | 54,955 | 10% | N/A | \$149,000 | 6.0 | \$102M | \$18M |

Figure 36: Educational Attainment in San Diego Geographies, 2022

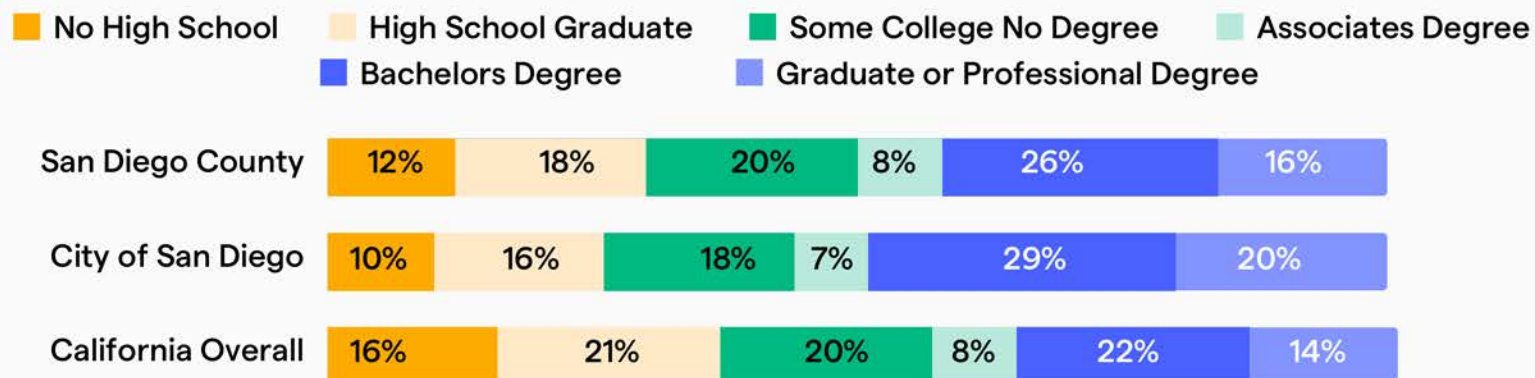


Figure 37: Overall Impact of Life Science Sectors in San Diego[19], 2022

| Impact Type | Direct Impact | Indirect Impact | Induced Impact | Total | Multiplier |
|--------------|---------------|-----------------|----------------|---------|------------|
| Employment | 77,770 | 43,628 | 57,025 | 178,426 | 2.29 |
| Labor Income | \$10.8B | \$4.0B | \$3.5B | \$18.3B | 1.69 |
| Output | \$36.6B | \$10.4B | \$10.3B | \$57.4B | 1.57 |

Figure 38: County-Level Economic Impact of Life Science Sectors in San Diego Geographies, 2022

| County | Total Employment | Total Labor Income | Total Output |
|-------------------|------------------|--------------------|--------------|
| San Diego | 178,426 | \$18.3B | \$57.4B |
| City of San Diego | 123,379 | \$12.4B | \$35.2B |

[19] In this analysis, the City of San Diego is considered a sub-set of San Diego County.

APPENDIX A: COMPARISON WITH PAST ECONOMIC IMPACT REPORTS



The 2023 edition of the Biocom California Life Science Economic Impact Report features several key updates to the data collection methodology, which are summarized as follows:

- **NAICS code adjustment:** The 2023 edition of the Biocom California Life Science Economic Impact Report intends to introduce one NAICS code re-categorization: Research and development in the physical, engineering, and life sciences (NAICS code 541715), which was previously mapped to “Research and Manufacturing” is now mapped to “Biotechnology.”
- **Industry sector re-labeling.** Previous year’s reports referred to the industry sector category “Research and Manufacturing.” With the NAICS code adjustment introduced to this year’s edition, the category is labeled and now referred to as “Research and Testing.”
- **Period of performance.** Due to the availability of Q4 data at the time of data collection, the period of performance for FY2022 is defined as Q4 of 2021 through Q3 of 2022, i.e., the year beginning Oct. 1, 2021, and ending on Sept. 30, 2022.
- **Peer markets.** The 2023 edition introduces a comparison of California with selected peer markets in the US, which were selected on the basis of being either existing or growing clusters of life science activity.
- **YOY Growth.** Data for each metric has been collected for the year ending Sept. 30, 2022, as well as for the year ending Sept. 30, 2021, in order to characterize YOY growth.
- **Location Quotient.** The weighted average calculation of location quotient is more likely to accentuate the presence of a large cluster within a county. For the purpose of highlighting where significant life science employment clusters exist at the county level in California, the 2023 report utilizes a weighted average calculation of the respective Location Quotients across the 31 individual NAICS industries in each county. Adopting this calculation produces some variance with previous reports’ treatment of Location Quotient.

Due to the NAICS code and period of performance changes, number and growth comparisons with past year’s reports will vary, given the NAICS code recategorization and the difference in period of performance considered.

APPENDIX B: NAICS CODE DEFINITIONS

1. Biotechnology

325220 Artificial and Synthetic Fibers and Filaments Manufacturing
541713 Research and Development in Nanotechnology
541714 Research and Development in Biotechnology
541715 Research and Development in the Physical, Engineering, and Life Sciences (except Nanotechnology and Biotechnology) (46%)

2. Biopharmaceuticals

325411 Medicinal and Botanical Manufacturing
325412 Pharmaceutical Preparation Manufacturing
325413 In-Vitro Diagnostic Substance Manufacturing
325414 Biological Product (except Diagnostic) Manufacturing
424210 Drugs and Druggists' Sundries Merchant Wholesalers

3. Medical Devices and Equipment

327215 Glass Product Manufacturing Made of Purchased Glass (15%)
333314 Commercial and Service Industry Machinery Manufacturing^[20] (15%)
334517 Irradiation Apparatus Manufacturing
339112 Surgical and Medical Instrument Manufacturing
339113 Surgical Appliance and Supplies Manufacturing
339114 Dental Equipment and Supplies Manufacturing
339115 Ophthalmic Goods Manufacturing
339116 Dental Laboratories
334510 Electromedical and Electrotherapeutic Apparatus Manufacturing (25%)
423450 Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers

4. Research and Manufacturing

541380 Testing Laboratories (12%)
611310 Colleges, Universities, and Professional Schools (Private) (25%)
621511 Medical Laboratories

5. Scientific/Research Tools

325199 All Other Basic Organic Chemical Manufacturing
334516 Analytical Laboratory Instrument Manufacturing
334510 Electromedical and Electrotherapeutic Apparatus Manufacturing (75%)

6. Food and Agriculture Biotechnology

325193 Ethyl Alcohol Manufacturing
311999 All Other Miscellaneous Food Manufacturing (10%)
325311 Nitrogenous Fertilizer Manufacturing (15%)
325312 Phosphatic Fertilizer Manufacturing (15%)
325314 Fertilizer (Mixing Only) Manufacturing (15%)
325320 Pesticide and Other Agricultural Chemical Manufacturing (15%)

^[20] The Census Bureau introduced changes to NAICS code classifications which impacted one life science NAICS code. "Optical Instrument and Lens Manufacturing" is now recorded under "Commercial and Service Industry Machinery Manufacturing."

APPENDIX C: GLOSSARY OF TERMS

| Term | Description |
|-------------------|--|
| Employment | Payroll Jobs |
| Labor income | Salaries, compensation, and sole proprietor income |
| Output | Business sales |
| Direct impact | Those impacts (employment, labor income, output) that are attributed directly to life sciences establishments |
| Indirect impact | Those impacts (employment, labor income, output) that result from activity between life sciences establishments and their suppliers and contractors |
| Induced impact | Those impacts (employment, labor income, output) that result from consumer expenditures of life science workers, and the workers in supplier and contractor industries |
| Total impact | A sum aggregate of the direct, indirect, and induced impacts |
| Multiplier | The ratio of the total impact relative to the direct impact, i.e. the total impact divided by the direct impact |
| Productivity | Output (sales) per worker |
| Location quotient | The concentration of industry activity in geographic area relative to the industry's concentration in the US overall |
| M&A | Mergers and acquisitions |
| PE | Private equity |
| VC | Venture capital |
| FDA | Food and Drug Administration |
| NIH | National Institute of Health |
| NSF | National Science Foundation |
| IRA | Inflation Reduction Act |
| AI | Artificial intelligence |
| IoT | Internet of Things |
| LaaS | Laboratory as a Service |
| DHT | Digital health technologies |

APPENDIX D: DATA COLLECTION

Data collection was performed using two distinct methods. For some sources that did not provide search by NAICS codes, keyword searches were used. The keywords used across all platforms were bio renewable, biofuel, biopharmaceutical, biotechnology, nanotechnology, bio-agriculture, and bio agriculture. The following sources required keyword searches:

- National Institutes of Health
- National Science Foundation
- Pitchbook Inc. Venture Capital Data
- US Patent and Trademark Office

NAICS Code searches were performed to collect data from the following sources:

- California EDD
- USASpending.gov

Some data was collected from the US Census Bureau American Community Surveys, not specific to Life Science companies.

IMPLAN

IMPLAN, a widely used econometric forecasting tool, uses unique industry codes. A majority of these codes for the life science map directly to NAICS codes. For those that were not direct matches, an intensive analysis was completed to ensure accuracy of the IMPLAN codes in relation to the industry. IMPLAN models were designed and built to generate the overall economic impacts (direct, indirect, and induced) for California and all four regions within California. These models were run using 2021 employment numbers by industry category.

Biocom California Index

The Index was developed based on key metrics of the performance of the life science sector in California over time and in consultation with Biocom California. The index components and weights encompass the following:

| Component | Weight |
|--------------------------------------|--------|
| Number of NIH grants | 0.02 |
| Value of NIH grants | 0.08 |
| Number of NSF grants | 0.02 |
| Value of NSF grants | 0.08 |
| Number of patents | 0.20 |
| Number of payroll Jobs | 0.35 |
| Number of establishments | 0.05 |
| Value of venture capital investments | 0.20 |

APPENDIX E:

ECONOMIC IMPACT OF LIFE SCIENCE SECTORS

| Employment Impact (Jobs) | | EMPLOYMENT (JOBS) | | | |
|-----------------------------|---|-------------------|----------|---------|------------|
| Sector | Sub-Sector | Direct | Indirect | Induced | Multiplier |
| Bio-Pharmaceuticals | Wholesale - Drugs | 30,704 | 68,170 | 44,997 | 4.7 |
| | Pharmaceutical Preparation Mfg | 28,872 | 42,167 | 45,337 | 4.0 |
| | In-Vitro Diagnostic Substance Mfg | 9,335 | 5,897 | 9,343 | 2.6 |
| | Medicinal and Botanical Mfg | 6,728 | 4,869 | 7,373 | 2.8 |
| | Biological Product Mfg | 3,283 | 1,680 | 2,941 | 2.4 |
| Biotechnology | Research and Development in Biotechnology | 72,417 | 43,398 | 66,024 | 2.5 |
| | Research and Development in General Life Sciences | 53,737 | 32,204 | 48,993 | 2.5 |
| | Research and Development in Nanotechnology | 5,300 | 3,176 | 4,832 | 2.5 |
| | Artificial and Synthetic Fibers and Filaments Mfg | 81 | 86 | 68 | 2.9 |
| Food & Agriculture Biotech | All Other Miscellaneous Food Mfg | 4,290 | 4,760 | 2,850 | 2.8 |
| | Fertilizer (Mixing Only) Mfg | 902 | 929 | 681 | 2.8 |
| | Nitrogenous Fertilizer Mfg | 119 | 312 | 184 | 5.2 |
| | Ethyl Alcohol Mfg | 95 | 189 | 119 | 4.2 |
| | Pesticide and Other Agricultural Chemical Mfg | 90 | 194 | 120 | 4.5 |
| | Phosphatic Fertilizer Mfg | 65 | 98 | 64 | 3.5 |
| Medical Equipment | Wholesale - Medical Equipment and Supplies | 31,127 | 26,478 | 31,806 | 2.9 |
| | Surgical and Medical Instrument Mfg | 29,865 | 15,495 | 23,958 | 2.3 |
| | Surgical Appliance and Supplies Mfg | 11,869 | 7,837 | 9,108 | 2.4 |
| | Dental Laboratories | 10,079 | 2,461 | 4,001 | 1.6 |
| | Ophthalmic Goods Mfg | 4,734 | 2,739 | 3,131 | 2.2 |
| | Dental Equipment and Supplies Mfg | 3,321 | 1,525 | 2,065 | 2.1 |
| | Irradiation Apparatus Mfg | 2,779 | 4,369 | 3,492 | 3.8 |
| | Commercial and Service Industry Machinery Mfg | 1,608 | 1,196 | 1,660 | 2.8 |
| | Glass Product Mfg Made of Purchased Glass | 604 | 327 | 312 | 2.1 |
| Research & Testing | Colleges, Universities, and Professional Schools | 80,541 | 8,174 | 22,385 | 1.4 |
| | Medical Laboratories | 34,488 | 4,485 | 20,846 | 1.7 |
| | Testing Laboratories and Services | 2,874 | 374 | 1,737 | 1.7 |
| Scientific / Research Tools | Electromedical and Electrotherapeutic Apparatus Mfg | 21,729 | 19,576 | 25,604 | 3.1 |
| | Analytical Laboratory Instrument Mfg | 14,360 | 10,950 | 14,166 | 2.7 |
| | All Other Basic Organic Chemical Mfg | 2,133 | 4,246 | 2,678 | 4.2 |
| | Instruments Measuring, Displaying, Etc Mfg | 1,628 | 1,100 | 1,253 | 2.4 |

APPENDIX E: ECONOMIC IMPACT OF LIFE SCIENCE SECTORS

Labor Income Impact (Wages, Compensation, and Sole Proprietor Income, \$M)

| Sector | Sub-Sector | LABOR INCOME (\$ MILLIONS) | | | |
|-----------------------------|---|----------------------------|----------|---------|------------|
| | | Direct | Indirect | Induced | Multiplier |
| Bio-Pharmaceuticals | Wholesale - Drugs | \$4,811 | \$6,360 | \$3,309 | 3.0 |
| | Pharmaceutical Preparation Mfg | \$6,271 | \$5,045 | \$3,334 | 2.3 |
| | In-Vitro Diagnostic Substance Mfg | \$1,675 | \$658 | \$687 | 1.8 |
| | Medicinal and Botanical Mfg | \$1,284 | \$558 | \$542 | 1.9 |
| | Biological Product Mfg | \$548 | \$186 | \$216 | 1.7 |
| Biotechnology | Research and Development in Biotechnology | \$11,830 | \$4,503 | \$4,855 | 1.8 |
| | Research and Development in General Life Sciences | \$8,778 | \$3,341 | \$3,602 | 1.8 |
| | Research and Development in Nanotechnology | \$866 | \$330 | \$355 | 1.8 |
| | Artificial and Synthetic Fibers and Filaments Mfg | \$8 | \$9 | \$5 | 2.7 |
| Food & Agriculture Biotech | All Other Miscellaneous Food Mfg | \$295 | \$416 | \$210 | 3.1 |
| | Fertilizer (Mixing Only) Mfg | \$84 | \$87 | \$50 | 2.6 |
| | Nitrogenous Fertilizer Mfg | \$12 | \$34 | \$14 | 5.0 |
| | Ethyl Alcohol Mfg | \$12 | \$18 | \$9 | 3.2 |
| | Pesticide and Other Agricultural Chemical Mfg | \$11 | \$19 | \$9 | 3.5 |
| | Phosphatic Fertilizer Mfg | \$7 | \$9 | \$5 | 3.0 |
| Medical Equipment | Wholesale - Medical Equipment and Supplies | \$5,412 | \$2,475 | \$2,339 | 1.9 |
| | Surgical and Medical Instrument Mfg | \$4,288 | \$1,660 | \$1,762 | 1.8 |
| | Surgical Appliance and Supplies Mfg | \$1,442 | \$820 | \$670 | 2.0 |
| | Dental Laboratories | \$741 | \$252 | \$294 | 1.7 |
| | Ophthalmic Goods Mfg | \$519 | \$259 | \$230 | 1.9 |
| | Dental Equipment and Supplies Mfg | \$360 | \$153 | \$152 | 1.8 |
| | Irradiation Apparatus Mfg | \$379 | \$499 | \$257 | 3.0 |
| | Commercial and Service Industry Machinery Mfg | \$272 | \$141 | \$122 | 2.0 |
| | Glass Product Mfg Made of Purchased Glass | \$48 | \$31 | \$23 | 2.1 |
| Research & Testing | Colleges, Universities, and Professional Schools | \$4,933 | \$648 | \$1,646 | 1.5 |
| | Medical Laboratories | \$4,782 | \$418 | \$1,533 | 1.4 |
| | Testing Laboratories and Services | \$399 | \$35 | \$128 | 1.4 |
| Scientific / Research Tools | Electromedical and Electrotherapeutic Apparatus Mfg | \$4,142 | \$2,332 | \$1,883 | 2.0 |
| | Analytical Laboratory Instrument Mfg | \$2,266 | \$1,314 | \$1,042 | 2.0 |
| | All Other Basic Organic Chemical Mfg | \$269 | \$400 | \$197 | 3.2 |
| | Instruments Measuring, Displaying, Etc Mfg | \$183 | \$133 | \$92 | 2.2 |

APPENDIX E: ECONOMIC IMPACT OF LIFE SCIENCE SECTORS

Output Impact (Business Sales, \$M)

| Sector | Sub-Sector | BUSINESS OUTPUT (\$ MILLIONS) | | | |
|-----------------------------|---|-------------------------------|----------|----------|------------|
| | | Direct | Indirect | Induced | Multiplier |
| Bio-Pharmaceuticals | Wholesale - Drugs | \$26,480 | \$15,353 | \$9,390 | 1.9 |
| | Pharmaceutical Preparation Mfg | \$67,543 | \$15,835 | \$9,464 | 1.4 |
| | In-Vitro Diagnostic Substance Mfg | \$7,489 | \$2,142 | \$1,951 | 1.5 |
| | Medicinal and Botanical Mfg | \$6,301 | \$1,871 | \$1,539 | 1.5 |
| | Biological Product Mfg | \$4,233 | \$652 | \$614 | 1.3 |
| Biotechnology | Research and Development in Biotechnology | \$24,073 | \$10,561 | \$13,776 | 2.0 |
| | Research and Development in General Life Sciences | \$17,864 | \$7,837 | \$10,223 | 2.0 |
| | Research and Development in Nanotechnology | \$1,762 | \$773 | \$1,008 | 2.0 |
| | Artificial and Synthetic Fibers and Filaments Mfg | \$56 | \$29 | \$14 | 1.8 |
| Food & Agriculture Biotech | All Other Miscellaneous Food Mfg | \$1,813 | \$1,237 | \$595 | 2.0 |
| | Fertilizer (Mixing Only) Mfg | \$642 | \$347 | \$142 | 1.8 |
| | Nitrogenous Fertilizer Mfg | \$170 | \$127 | \$38 | 2.0 |
| | Ethyl Alcohol Mfg | \$137 | \$73 | \$25 | 1.7 |
| | Pesticide and Other Agricultural Chemical Mfg | \$162 | \$59 | \$25 | 1.5 |
| | Phosphatic Fertilizer Mfg | \$62 | \$35 | \$13 | 1.8 |
| Medical Equipment | Wholesale - Medical Equipment and Supplies | \$13,720 | \$5,842 | \$6,638 | 1.9 |
| | Surgical and Medical Instrument Mfg | \$11,411 | \$4,519 | \$5,002 | 1.8 |
| | Surgical Appliance and Supplies Mfg | \$4,852 | \$2,218 | \$1,901 | 1.8 |
| | Dental Laboratories | \$1,413 | \$640 | \$835 | 2.0 |
| | Ophthalmic Goods Mfg | \$1,620 | \$727 | \$654 | 1.9 |
| | Dental Equipment and Supplies Mfg | \$1,095 | \$408 | \$431 | 1.8 |
| | Irradiation Apparatus Mfg | \$2,772 | \$1,308 | \$729 | 1.7 |
| | Commercial and Service Industry Machinery Mfg | \$734 | \$297 | \$346 | 1.9 |
| | Glass Product Mfg Made of Purchased Glass | \$188 | \$94 | \$65 | 1.8 |
| Research & Testing | Colleges, Universities, and Professional Schools | \$7,630 | \$2,034 | \$4,672 | 1.9 |
| | Medical Laboratories | \$10,386 | \$1,012 | \$4,350 | 1.5 |
| | Testing Laboratories and Services | \$866 | \$84 | \$363 | 1.5 |
| Scientific / Research Tools | Electromedical and Electrotherapeutic Apparatus Mfg | \$16,294 | \$6,037 | \$5,346 | 1.7 |
| | Analytical Laboratory Instrument Mfg | \$7,086 | \$3,066 | \$2,957 | 1.9 |
| | All Other Basic Organic Chemical Mfg | \$3,085 | \$1,647 | \$559 | 1.7 |
| | Instruments Measuring, Displaying, Etc Mfg | \$634 | \$299 | \$261 | 1.9 |

APPENDIX F: REST OF CALIFORNIA JOBS, GROWTH, AND METRICS

Life Science Jobs^[21] and Growth in the Rest of California (County-Level), 2022

| County | | Bio- Pharmaceuticals | Bio- technology | Food & Ag Biotech | Research & Testing | Medical Devices & Equipment |
|------------------------------|------------|-------------------------|--------------------|----------------------|-----------------------|--------------------------------|
| Alpine County, California | 2022 Emp | 0 | 0 | 0 | 0 | 0 |
| | YOY Growth | n/a | n/a | n/a | n/a | n/a |
| Amador County, California | 2022 Emp | 1 | 1 | 1 | 3 | 9 |
| | YOY Growth | -56% | -5% | 89% | 12% | -23% |
| Butte County, California | 2022 Emp | 8 | 24 | 2 | 695 | 179 |
| | YOY Growth | -8% | -5% | -5% | 4% | -6% |
| Calaveras County, California | 2022 Emp | 1 | 1 | 0 | 0 | 0 |
| | YOY Growth | 11% | -5% | n/a | n/a | n/a |
| Colusa County, California | 2022 Emp | 16 | 0 | 0 | 1 | 0 |
| | YOY Growth | -29% | 140% | n/a | 54% | n/a |
| Del Norte County, California | 2022 Emp | 0 | 0 | 1 | 2 | 0 |
| | YOY Growth | n/a | n/a | -12% | 6% | n/a |
| El Dorado County, California | 2022 Emp | 30 | 16 | 4 | 96 | 248 |
| | YOY Growth | 191% | 0% | -21% | -23% | 7% |
| Fresno County, California | 2022 Emp | 1,003 | 107 | 155 | 1,554 | 544 |
| | YOY Growth | 6% | -30% | -27% | 15% | 2% |
| Glenn County, California | 2022 Emp | 0 | 1 | 12 | 0 | 7 |
| | YOY Growth | n/a | 76% | -44% | n/a | 157% |
| Humboldt County, California | 2022 Emp | 101 | 15 | 84 | 384 | 13 |
| | YOY Growth | -40% | 19% | -29% | 8% | -6% |
| Imperial County, California | 2022 Emp | 42 | 9 | 5 | 25 | 12 |
| | YOY Growth | 77% | 31% | -71% | 28% | 65% |
| Inyo County, California | 2022 Emp | 0 | 1 | 0 | 0 | 0 |
| | YOY Growth | n/a | -41% | n/a | n/a | n/a |
| Kern County, California | 2022 Emp | 81 | 187 | 76 | 814 | 344 |
| | YOY Growth | 6% | 1% | 8% | 8% | 2% |
| Kings County, California | 2022 Emp | 12 | 39 | 4 | 17 | 4 |
| | YOY Growth | -5% | 379% | -15% | 12% | -31% |
| Lake County, California | 2022 Emp | 4 | 2 | 1 | 5 | 1 |
| | YOY Growth | 53% | -5% | -6% | 53% | 0% |

APPENDIX F: REST OF CALIFORNIA JOBS, GROWTH, AND METRICS

Life Science Jobs and Growth in the Rest of California (County-Level), 2022

| County | | Bio- Pharmaceuticals | Bio- technology | Food & Ag Biotech | Research & Testing | Medical Devices & Equipment |
|----------------------------------|------------|-------------------------|--------------------|----------------------|-----------------------|--------------------------------|
| Lassen County, California | 2022 Emp | 0 | 0 | 0 | 17 | 1 |
| | YOY Growth | n/a | n/a | n/a | -18% | -5% |
| Madera County, California | 2022 Emp | 1 | 1 | 2 | 36 | 12 |
| | YOY Growth | -5% | -5% | 5% | 45% | -16% |
| Mariposa County, California | 2022 Emp | 0 | 1 | 0 | 3 | 1 |
| | YOY Growth | n/a | -5% | n/a | -66% | -5% |
| Mendocino County, California | 2022 Emp | 20 | 3 | 5 | 9 | 19 |
| | YOY Growth | -41% | 17% | -26% | 21% | -2% |
| Merced County, California | 2022 Emp | 13 | 14 | 43 | 501 | 40 |
| | YOY Growth | -9% | -7% | 24% | 3% | 0% |
| Modoc County, California | 2022 Emp | 0 | 0 | 0 | 0 | 0 |
| | YOY Growth | n/a | n/a | n/a | n/a | n/a |
| Mono County, California | 2022 Emp | 0 | 1 | 0 | 0 | 0 |
| | YOY Growth | n/a | -5% | n/a | n/a | n/a |
| Monterey County, California | 2022 Emp | 53 | 158 | 29 | 497 | 51 |
| | YOY Growth | 12% | 6% | -22% | 13% | -1% |
| Nevada County, California | 2022 Emp | 58 | 10 | 3 | 39 | 35 |
| | YOY Growth | -14% | -9% | -12% | -2% | 11% |
| Placer County, California | 2022 Emp | 233 | 161 | 23 | 150 | 1,409 |
| | YOY Growth | 16% | 305% | -58% | -20% | 30% |
| Plumas County, California | 2022 Emp | 0 | 0 | 0 | 0 | 6 |
| | YOY Growth | n/a | n/a | n/a | n/a | 6% |
| Riverside County, California | 2022 Emp | 1,981 | 182 | 180 | 2,817 | 4,111 |
| | YOY Growth | -1% | 30% | -9% | 17% | 12% |
| Sacramento County, California | 2022 Emp | 909 | 3,461 | 108 | 2,085 | 1,939 |
| | YOY Growth | -12% | 2% | -22% | 7% | 1% |
| San Benito County, California | 2022 Emp | 160 | 44 | 3 | 3 | 3 |
| | YOY Growth | 69% | 45% | -35% | 2% | -7% |

APPENDIX F: REST OF CALIFORNIA JOBS, GROWTH, AND METRICS

Life Science Jobs and Growth in the Rest of California (County-Level), 2022

| County | | Bio- Pharmaceuticals | Bio- technology | Food & Ag Biotech | Research & Testing | Medical Devices & Equipment |
|------------------------------------|------------|-------------------------|--------------------|----------------------|-----------------------|--------------------------------|
| San Joaquin County, California | 2022 Emp | 64 | 78 | 386 | 744 | 576 |
| | YOY Growth | 35% | 65% | -4% | 15% | -1% |
| San Luis Obispo County, California | 2022 Emp | 169 | 223 | 4 | 1,026 | 97 |
| | YOY Growth | -12% | 8% | -73% | 2% | -4% |
| Santa Barbara County, California | 2022 Emp | 319 | 579 | 56 | 2,133 | 1,150 |
| | YOY Growth | 2% | 8% | -50% | 17% | -10% |
| Santa Cruz County, California | 2022 Emp | 1,178 | 568 | 55 | 1,371 | 200 |
| | YOY Growth | 46% | 16% | 101% | 18% | -5% |
| Shasta County, California | 2022 Emp | 42 | 13 | 3 | 149 | 112 |
| | YOY Growth | 85% | -37% | -35% | 11% | -12% |
| Sierra County, California | 2022 Emp | 0 | 0 | 0 | 0 | 0 |
| | YOY Growth | n/a | n/a | n/a | n/a | n/a |
| Siskiyou County, California | 2022 Emp | 0 | 0 | 1 | 6 | 6 |
| | YOY Growth | n/a | n/a | -5% | -15% | -37% |
| Stanislaus County, California | 2022 Emp | 136 | 76 | 53 | 753 | 252 |
| | YOY Growth | -1% | 45% | -29% | 4% | 11% |
| Sutter County, California | 2022 Emp | 2 | 1 | 1 | 32 | 3 |
| | YOY Growth | -37% | -5% | -5% | -4% | -20% |
| Tehama County, California | 2022 Emp | 2 | 0 | 0 | 0 | 4 |
| | YOY Growth | -45% | n/a | n/a | n/a | 6% |
| Trinity County, California | 2022 Emp | 32 | 4 | 0 | 0 | 0 |
| | YOY Growth | 1034% | -6% | n/a | n/a | n/a |
| Tulare County, California | 2022 Emp | 105 | 30 | 70 | 106 | 317 |
| | YOY Growth | -5% | -3% | -37% | 3% | -2% |
| Tuolumne County, California | 2022 Emp | 0 | 3 | 0 | 5 | 3 |
| | YOY Growth | n/a | -7% | n/a | -49% | -4% |
| Yolo County, California | 2022 Emp | 231 | 644 | 161 | 4,516 | 166 |
| | YOY Growth | 17% | 3% | 37% | 8% | 46% |
| Yuba County, California | 2022 Emp | 0 | 28 | 1 | 16 | 0 |
| | YOY Growth | n/a | -14% | -8% | -12% | n/a |

APPENDIX F: REST OF CALIFORNIA JOBS, GROWTH, AND METRICS

Life Science Key Metrics (County Level)

| County | Emp | Growth | Establish-ments | Avg. Wage | LQ | NIH Awards | NSF Awards |
|--------------------|------|--------|-----------------|-----------|------|------------|------------|
| Alpine County | 0 | n/a | n/a | n/a | n/a | - | - |
| Amador County | 16 | -18% | 8 | \$50,736 | 2.37 | - | - |
| Butte County | 908 | 2% | 77 | \$63,860 | 1.39 | - | \$0.8M |
| Calaveras County | 3 | 1% | 3 | \$55,050 | 0.39 | - | - |
| Colusa County | 18 | -29% | 3 | \$68,013 | 1.91 | - | - |
| Del Norte County | 4 | -1% | 2 | \$74,011 | 1.11 | - | - |
| El Dorado County | 395 | 2% | 41 | \$81,819 | 1.18 | \$0.7M | - |
| Fresno County | 3363 | 5% | 193 | \$61,537 | 0.59 | \$1.5M | \$2.5M |
| Glenn County | 20 | -19% | 2 | \$63,429 | 2.91 | - | - |
| Humboldt County | 597 | -11% | 69 | \$68,902 | 2.13 | \$0.2M | \$0.2M |
| Imperial County | 93 | 24% | 22 | \$58,565 | 0.31 | - | - |
| Inyo County | 3 | -45% | 2 | \$6,260 | 0.02 | - | - |
| Kern County | 1502 | 6% | 127 | \$60,556 | 0.47 | \$0.6M | \$1.4M |
| Kings County | 76 | 63% | 12 | \$73,278 | 0.48 | - | - |
| Lake County | 13 | 29% | 3 | \$86,011 | 0.14 | - | - |
| Lassen County | 18 | -30% | 3 | \$65,904 | 1.17 | - | - |
| Madera County | 51 | 21% | 11 | \$34,781 | 0.36 | - | - |
| Mariposa County | 5 | -55% | 3 | \$38,954 | 4.67 | - | - |
| Mendocino County | 56 | -21% | 13 | \$71,577 | 0.52 | - | - |
| Merced County | 611 | 4% | 21 | \$54,973 | 1.14 | \$6.3M | \$11.7M |
| Modoc County | 0 | n/a | n/a | \$67,803 | 0.12 | - | - |
| Mono County | 2 | -10% | 1 | n/a | 0.03 | - | - |
| Monterey County | 789 | 9% | 79 | \$76,615 | 0.28 | \$0.6M | \$5.0M |
| Nevada County | 146 | -5% | 30 | \$79,338 | 1.07 | - | - |
| Placer County | 1976 | 26% | 85 | \$79,645 | 1.09 | \$0.29M | \$0.4M |
| Plumas County | 7 | -4% | 2 | \$63,089 | 0.35 | - | \$0.8M |
| Riverside County | 9270 | 10% | 431 | \$65,411 | 0.80 | \$43.4M | \$32.1M |
| Sacramento County | 8501 | 1% | 309 | \$85,561 | 0.72 | \$9.1M | \$1.5M |
| San Benito County | 214 | 57% | 10 | \$95,782 | 4.64 | - | - |
| San Joaquin County | 1848 | 7% | 86 | \$62,970 | 0.86 | \$0.6M | \$1.5M |

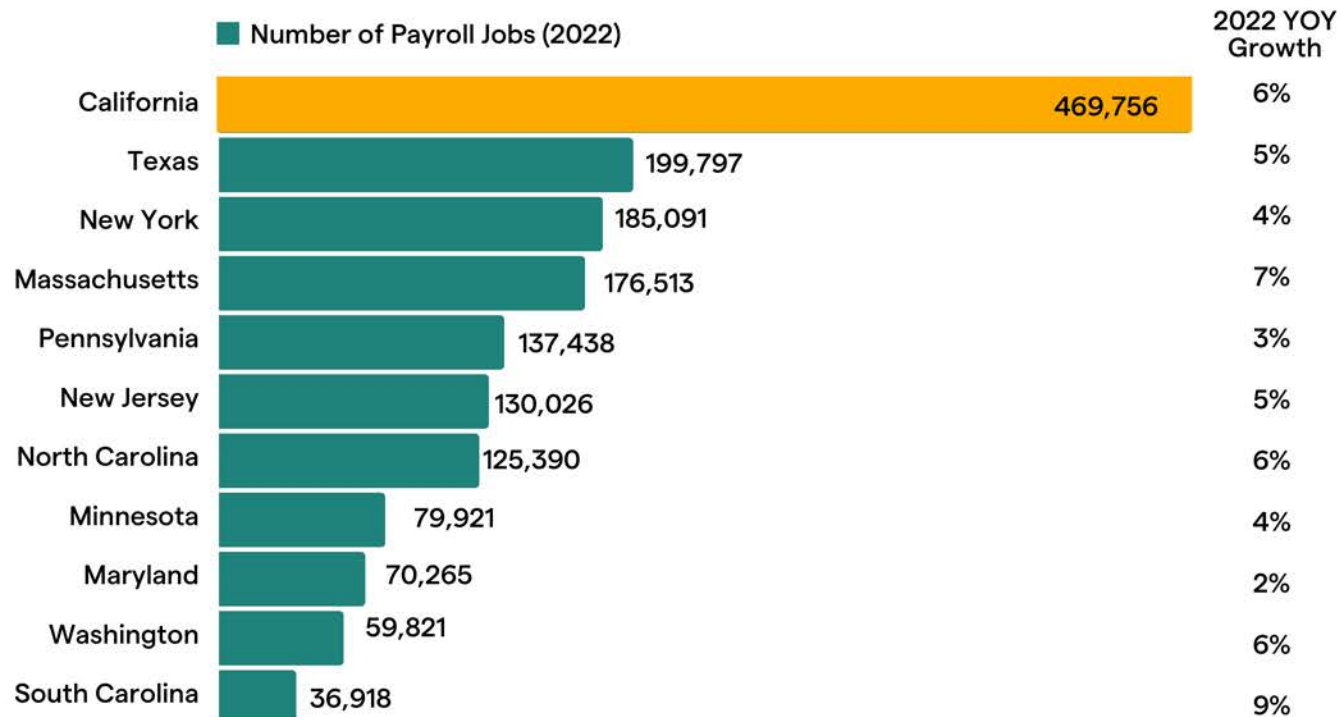
APPENDIX F: REST OF CALIFORNIA JOBS, GROWTH, AND METRICS

Life Science Key Metrics (County Level)

| County | Emp | Growth | Establish-ments | Avg. Wage | LQ | NIH Awards | NSF Awards |
|------------------------|------|--------|-----------------|-----------|-------|------------|------------|
| San Luis Obispo County | 1520 | 0% | 100 | \$79,398 | 0.86 | \$1.6M | - |
| Santa Barbara County | 4236 | 4% | 136 | \$118,140 | 1.59 | \$26.0M | \$40.M |
| Santa Cruz County | 3373 | 25% | 83 | \$74,433 | 1.73 | \$51.1M | \$23.1M |
| Shasta County | 318 | 3% | 50 | \$64,659 | 0.63 | - | - |
| Sierra County | 0 | n/a | n/a | n/a | n/a | - | - |
| Siskiyou County | 14 | -24% | 4 | \$52,220 | 0.50 | - | - |
| Stanislaus County | 1270 | 4% | 95 | \$71,832 | 0.69 | \$0.1M | \$0.3M |
| Sutter County | 39 | -8% | 9 | \$79,864 | 0.43 | - | - |
| Tehama County | 6 | -17% | 6 | \$63,000 | 0.14 | - | - |
| Trinity County | 36 | 372% | 2 | \$122,042 | 35.85 | - | - |
| Tulare County | 628 | -7% | 54 | \$54,960 | 0.89 | - | - |
| Tuolumne County | 11 | -42% | 6 | \$53,441 | 0.76 | - | - |
| Yolo County | 5716 | 9% | 77 | \$93,010 | 1.50 | \$277.2M | \$39.3M |
| Yuba County | 45 | -13% | 4 | \$56,988 | 0.60 | - | - |

APPENDIX G: CALIFORNIA COMPARISON WITH PEER LIFE SCIENCE MARKETS

Life Science Payroll Jobs, California vs Life Science Peers^[22], 2022

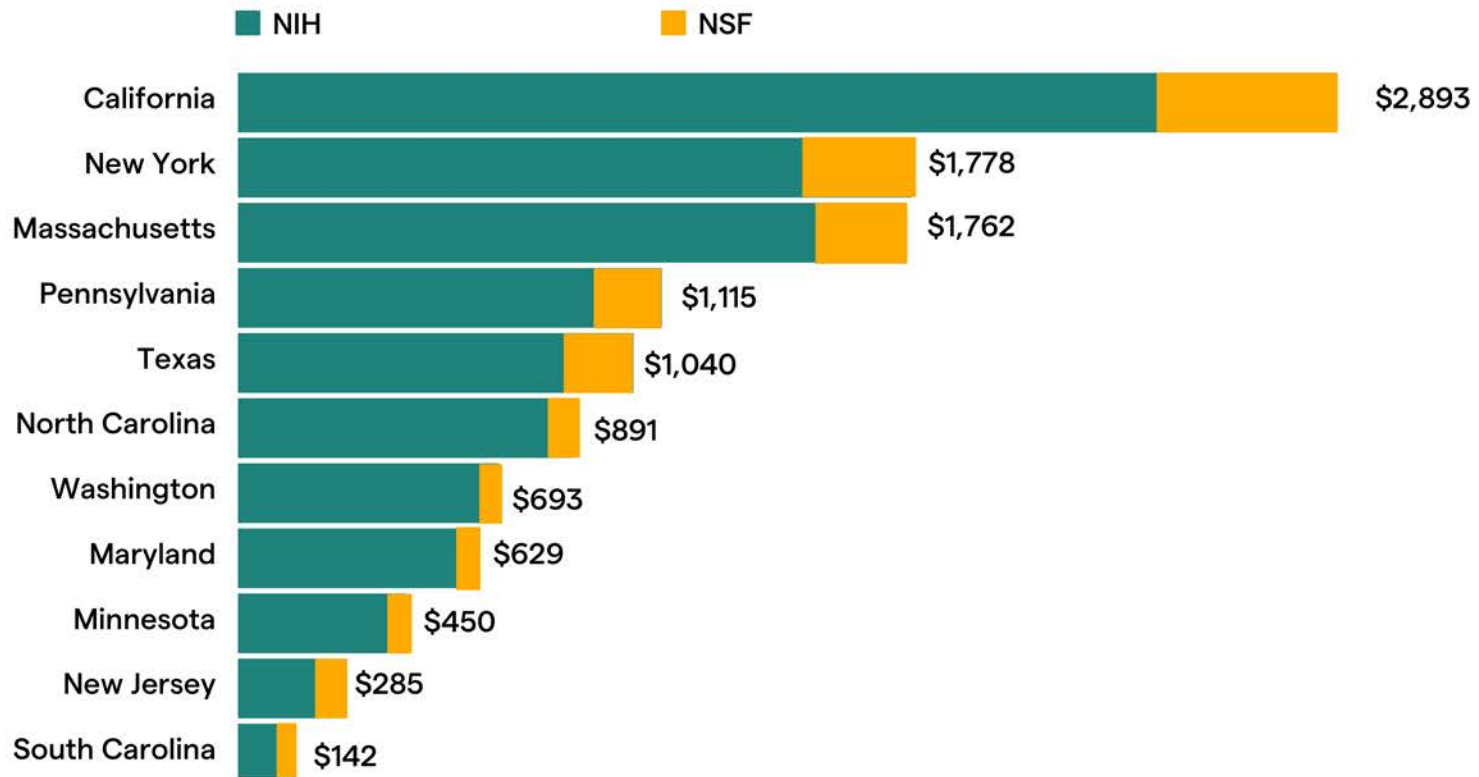


[22] The 2023 edition of the Biocom California Life Science Economic Impact Report introduces comparisons to other life science peer markets; peer markets were identified on the basis of being significant existing or growing clusters of life science activity in the US.

APPENDIX G: CALIFORNIA COMPARISON WITH PEER LIFE SCIENCE MARKETS

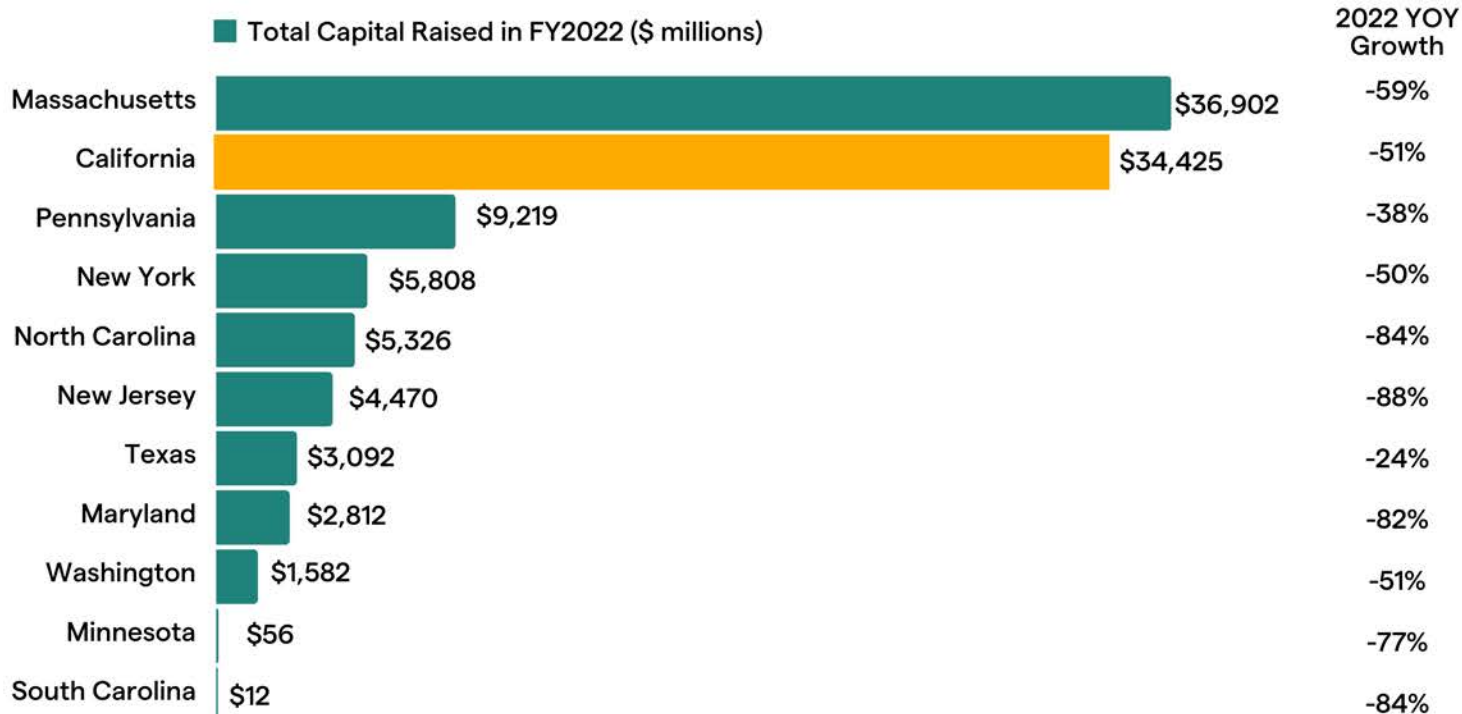
Public Research Funding to California vs Peer Life Science Markets, 2022

Total Award Value in Core Life Science Funding in 2022



APPENDIX G: CALIFORNIA COMPARISON WITH PEER LIFE SCIENCE MARKETS

Private Investment in Life Science in 2022: California vs Peer Markets



APPENDIX G: CALIFORNIA COMPARISON WITH PEER LIFE SCIENCE MARKETS

Educational Attainment in California vs Peer Life Science Markets

