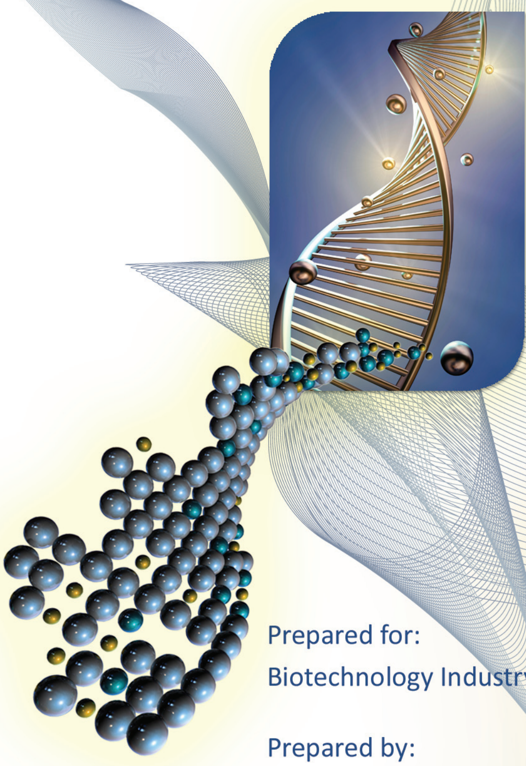
Battelle/BIO State Bioscience Initiatives 2010



Prepared for:
Biotechnology Industry Organization

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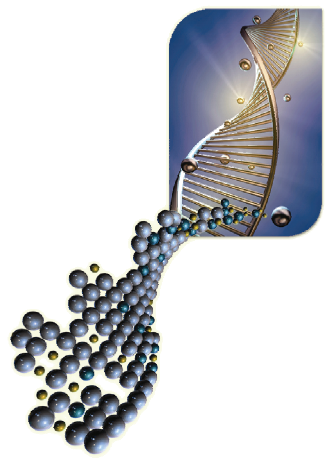
Bio BIOTECHNOLOGY INDUSTRY ORGANIZATION
Battelle The Business of Innovation

The Project Team

Battelle is the world's largest nonprofit independent research and development organization, providing innovative solutions to the world's most pressing needs through its four global businesses: Laboratory Management, National Security, Energy Technology, and Health and Life Sciences. In 1991, Battelle created the Technology Partnership Practice (TPP). We focus Battelle's broad experience to better serve economic development organizations, universities, and nonprofit technology organizations across the U.S.

BIO—Biotechnology Industry Organization—BIO represents more than 1,200 biotechnology companies, academic institutions, state biotechnology centers and related organizations across the United States and in more than 30 other nations. BIO members are involved in the research and development of innovative healthcare, agricultural, industrial and environmental biotechnology products. BIO also produces the BIO International Convention, the world's largest gathering of the biotechnology industry, along with industry-leading investor and partnering meetings held around the world.

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



Acknowledgement

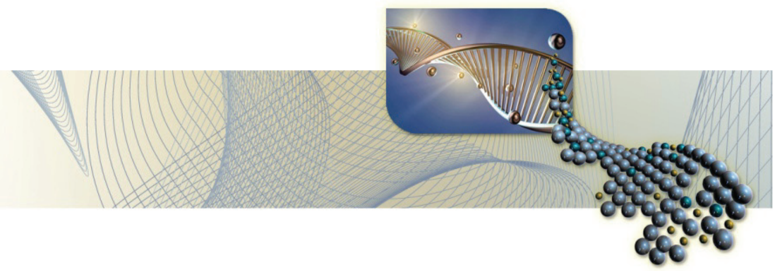
The project team wishes to thank BIO's Council of State Biotechnology Associations (CSBA) members who provided updates on state policies and programs to promote the biosciences in their states.

Contents

List of Figures

List of Tables

Executive Summary



In the 21st century, the biosciences are already shaping up to be a key engine of economic growth in the United States. Major advancements are taking place on a host of bioscience fronts, ranging from high-precision personalized human biomedical applications to widespread biomass-based innovations in agbioscience, bioenergy, and industrial biotechnology. Without a doubt, the biosciences promise solutions to many of the global challenges the world faces.

Battelle, BIO, and PMP Public Affairs Consulting, Inc., have tracked the development of the U.S. bioscience industry on a state and metropolitan area basis, along with trends in key innovation and talent drivers of bioscience development and the implementation of state policies and programs to support the bioscience industry, on a 2-year basis since 2004. This 2010 report presents the following:

- Data on national, state, and metropolitan bioscience employment and growth trends from 2001 to 2008, with a 1 year view into how the biosciences have fared in the midst of the current recession
- National and state-level data on bioscience research and development (R&D), venture capital investments, patents, degrees awarded, employment by occupation and clinical trials activity
- An examination at the national level of the financial performance of the bioscience sector, which addresses its long-term sustainability and growth.

These data are presented for all 50 states, the District of Columbia, and Puerto Rico.

Defining the "Biosciences"

The biosciences are a diverse group of industries and activities with a common link—they apply knowledge of the way in which plants, animals, and humans function. The sector spans different markets and includes manufacturing, services, and research activities. By definition, the biosciences are a unique industry cluster and are constantly changing to incorporate the latest research and scientific discoveries.

The bioscience industry sector is defined as including the following four subsectors:

- *Agricultural Feedstock and Chemicals*
- *Drugs and Pharmaceuticals*
- *Medical Devices and Equipment*
- *Research, Testing, and Medical Labs*

A Note About the Data: This report presents employment data for 2008, the most current year for which detailed industry data are available. While 2008 encompasses the first year of the recent recession, the real impacts of the recession are likely to be reflected in the 2009 data once these data become available. Other data sources suggest that the bioscience industry, while impacted by the recession, was not as negatively affected as many other industry sectors and appears to be rebounding more quickly. The first quarter of 2010 saw the Amex Biotech Index (BTK) hit an all-time high and the Nasdaq Biotech Index (NBI) climbed to its highest level in more than 8 years. Both of these biotech indices are up since the financial crises began in October 2007, something no sector in the S&P 500 can claim. Source: http://insidebioia.com/, 04/13/2010

Key Findings: Bioscience Industry and Development Trends

The overall bioscience industry employment base continued to grow, even during the first year of the recession. Total employment in the U.S. bioscience sector reached 1.42 million in 2008 (the latest year for which data are currently available), continuing its strong job gains from the previous economic expansion through 2007, and through 2008 (Table ES-1). During the first year of the recession, employment in the bioscience industry grew 1.4 percent, while total private sector employment declined by 0.7 percent. This 2008 growth was broadly shared across the following bioscience subsectors:

The total employment impact of the bioscience sector is 8 million jobs, taking into account the additional jobs created in the economy as a result of the sector's direct jobs. On a national basis, for every new bioscience job, another 5.8 jobs are created.

- Research, testing, and medical labs adding 11,670 jobs or 2.1 percent from 2007 to 2008
- Medical devices and equipment adding 10,140 jobs or 2.4 percent from 2007 to 2008
- Agricultural feedstock and chemicals adding 5,021 jobs or 4.6 percent from 2007 to 2008.

Only drugs and pharmaceuticals shed jobs from 2007 to 2008, with a decrease of 7,445 jobs or 2.3 percent.

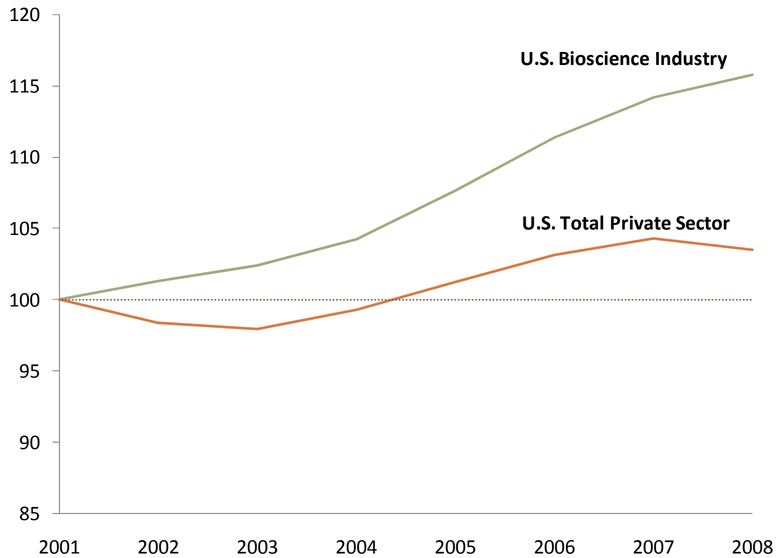
Table ES-1. U.S. Bioscience Employment and Establishments, 2008, and Changes, 2001–08 and 2007–08

Bioscience Subsector	2008 Establishments	Change in Establishments, 2001–08	Change in Establishments, 2007–08	2008 Employment	Change in Employment, 2001–08	Change in Employment, 2007–08
Agricultural Feedstock & Chemicals	2,440	16.0%	6.4%	114,793	1.9%	4.6%
Drugs & Pharmaceuticals	2,771	6.4%	2.0%	311,882	2.3%	-2.3%
Medical Devices & Equipment	15,227	0.4%	1.6%	435,509	2.0%	2.4%
Research, Testing, & Medical Laboratories	27,154	57.7%	6.1%	558,140	46.1%	2.1%
Total U.S. Biosciences	**47,593**	**28.3%**	**4.4%**	**1,420,324**	**15.8%**	**1.4%**

Source: Battelle analysis of BLS, QCEW data from the Minnesota IMPLAN Group.

Bioscience employment growth greatly outpaced national employment growth from 2001 to 2008. The bioscience industry added 193,748 jobs from 2001 to 2008, a hefty growth rate of 15.8 percent. This rapid rate of job growth was 4.5 times as much as the overall growth rate for the national private sector (3.5 percent) (Figure ES-1).

Figure ES-1. U.S. Bioscience and Total Private Sector Employment, 2001–08, Indexed (2001=100)



Rapid job growth in the biosciences has been fueled primarily by growth in research, testing, and medical laboratories. The subsector has continuously grown since 2001, adding more than 176,000 jobs or 46.1 percent to its employment base during the 7-year period (Figure ES-2). This growth represents 9 out of every 10 new bioscience jobs created. Research, testing, and medical labs now account for 39 percent of total bioscience employment, up from 35 percent in 2006 (Figure ES-3). Agricultural feedstock and chemicals maintained its 8 percent share of bioscience employment; drugs and pharmaceuticals and medical devices and equipment now account for 22 percent and 31 percent of bioscience employment, respectively.

Figure ES-2. U.S. Employment by Bioscience Subsector, 2001, 2007, and 2008

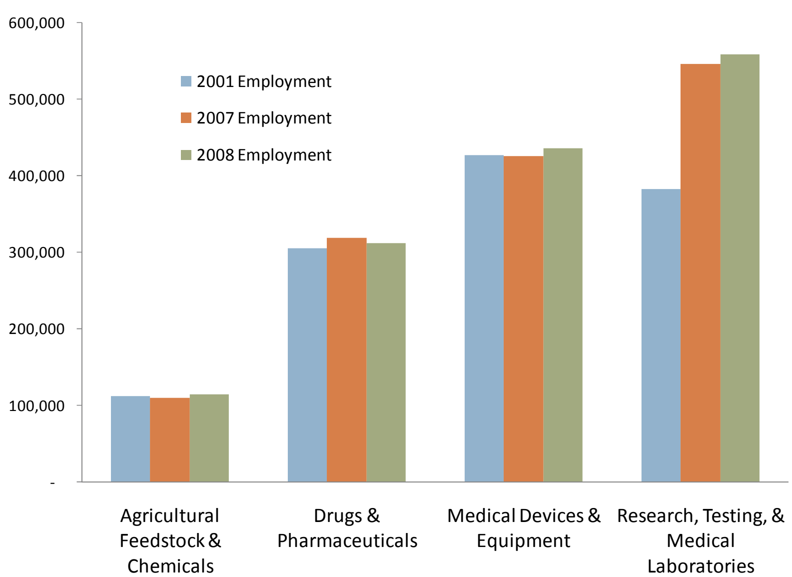
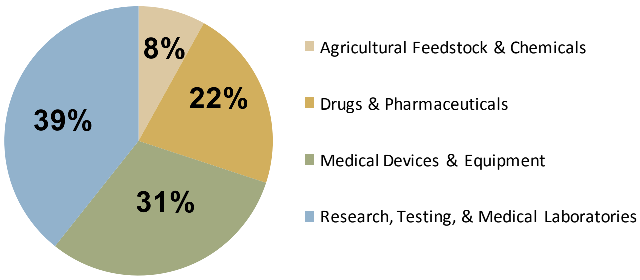


Figure ES-3. Employment Composition of the U.S. Bioscience Sector, 2008



The bioscience sector continues to be a source of high-wage jobs. The overall bioscience sector paid average annual wages of $77,595 in 2008, up from $70,959 in 2006 (Table ES-2). On average, bioscience jobs paid $32,366 more than the average annual wage of the total U.S. private sector, which was $45,229 in 2008. Bioscience wages also are outpacing the national private sector in growth. Since 2001, real (inflation-adjusted) earnings for biosciences industry workers have increased by 10.1 percent, compared with 3.2 percent for the U.S. private sector.

Table ES-2. Average Annual Wages in the Biosciences and Other Major Industries, 2008

U.S. Average Annual Wages per Employee, 2008		
Drugs & Pharmaceuticals	**$**	**93,378**
Finance and Insurance	$	85,274
Research, Testing, & Medical Laboratories	**$**	**80,785**
Total Biosciences	**$**	**77,595**
Professional, Scientific, and Technical Services	$	74,354
Agricultural Feedstock & Chemicals	**$**	**72,279**
Information	$	70,780
Medical Devices & Equipment	**$**	**63,606**
Manufacturing	$	54,392
Construction	$	49,014
U.S. Total Private Sector	**$**	**45,229**
Real Estate and Rental and Leasing	$	43,239
Transportation and Warehousing	$	42,969
Health Care and Social Assistance	$	42,150
Retail Trade	$	26,181

Source: Battelle analysis of BLS, QCEW data from the Minnesota IMPLAN Group

Looking to the future, the biosciences remain positioned for strong economic growth. The U.S. Department of Labor projects that the biosciences will grow at an average annual rate of 1.5 percent between 2008 and 2018, making it one of the fastest-growing industry sectors. Overall private sector employment is projected to grow by an average annual rate of 1 percent during this time period.

Bioscience employment is distributed across the United States, with many states developing strong niches in certain specializations. Thirty-nine states, the District of Columbia, and Puerto Rico—up from 35 in 2006—now have a specialization in one of the bioscience subsectors. Four states—Wyoming, South Carolina, Wisconsin and Montana developed specializations in the agricultural feedstock and chemicals subsector since 2006. Massachusetts developed a specialization in the drugs and pharmaceuticals subsector and Vermont and New Jersey developed specializations in the medical devices and equipment subsector. Five states—California, Indiana, Massachusetts, New Jersey, and North Carolina—and Puerto Rico are specialized in three of the four bioscience subsectors. Table ES-3 shows the states that have both large (accounting for 5 percent or more of total U.S. employment) and specialized (an employment concentration that is 20 percent or more above the U.S concentration) bioscience subsectors.

Table ES-3. States with Both Large and Specialized Bioscience Subsectors, 2008

States	Agricultural Feedstock & Chemicals	Drugs & Pharmaceuticals	Medical Devices & Equipment	Research, Testing, & Medical Laboratories
California		●	●	●
Illinois	●	●		
Indiana		●		
Iowa	●			
Massachusetts			●	●
Minnesota			●	
New Jersey		●		●
North Carolina		●		
Ohio	●			
Pennsylvania		●		●
Puerto Rico		●		
Tennessee	●			
Texas	●			

Source: Battelle analysis of BLS, QCEW data from the Minnesota IMPLAN Group.

The following pages show the geographical distribution of bioscience employment in each of the four bioscience subsectors—agricultural feedstock and chemicals, which includes ethanol and biodiesel production; drugs and pharmaceuticals; medical devices and equipment; and research, testing and medical laboratories.

AGRICULTURAL FEEDSTOCK and CHEMICALS

The agricultural feedstock and chemicals subsector applies life sciences knowledge, biochemistry, and biotechnologies to the processing of agricultural goods and the production of organic and agricultural chemicals. The subsector also includes activities around the production of biofuels.

Examples of Products

Fertilizers, pesticides, herbicides, and fungicides

Corn and soybean oil

Ethanol and biodiesel fuels

Biodegradable materials synthesized from plant-based feedstock

Sustainable industrial oils and lubricants

Biocatalysts

Examples of Companies

Archer Daniels Midland

BASF Plant Science

Bayer CropScience

Bunge

Cargill

Dow AgroSciences

DuPont

Intrepid Potash

Monsanto

Scotts Miracle-Gro

Syngenta

States that are Both Large and Specialized*

Texas

Illinois

Iowa

Ohio

Tennessee

Metro Areas with the Largest Employment Levels*

Houston-Baytown-Sugar Land, TX

New York-Northern New Jersey-Long Island, NY-NJ-PA

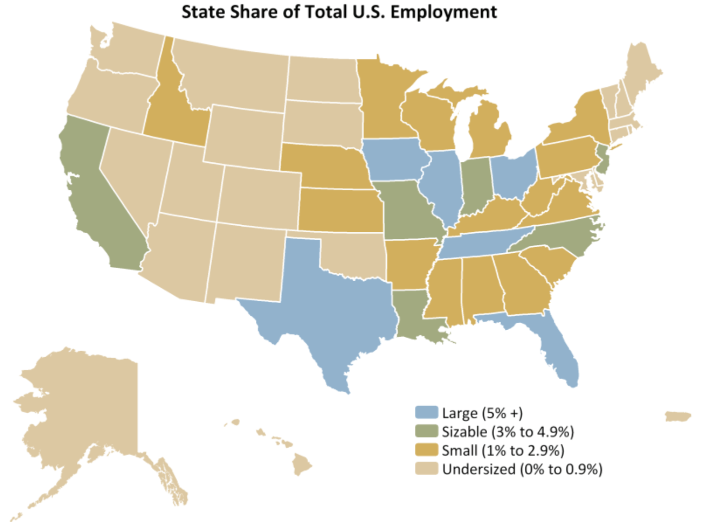
Decatur, IL

Indianapolis, IN

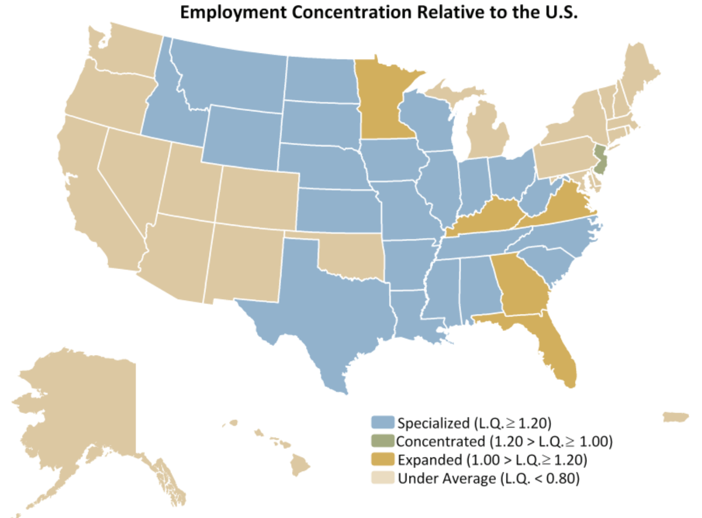
Memphis, TN-MS-AR

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

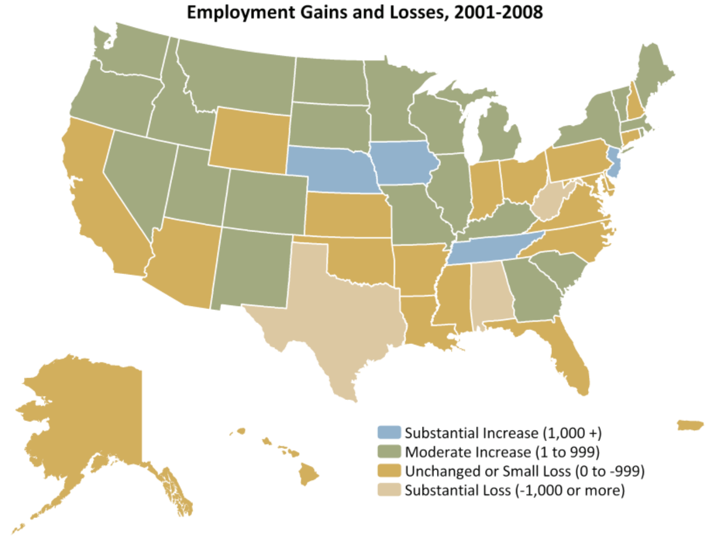
State Share of Total U.S. Employment



Employment Concentration Relative to the U.S.



Employment Gains and Losses, 2001-2008



DRUGS and PHARMACEUTICALS

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

Examples of Products

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

Examples of Companies

Abbott Laboratories
Amgen
Biogen Idec
Cornerstone Therapeutics
Eli Lilly & Co.
Merck & Co.
Mylan
Novartis
Pfizer
Roche Group – Genentech
Sanofi-Aventis/Sanofi Pasteur

States that are Both Large and Specialized*

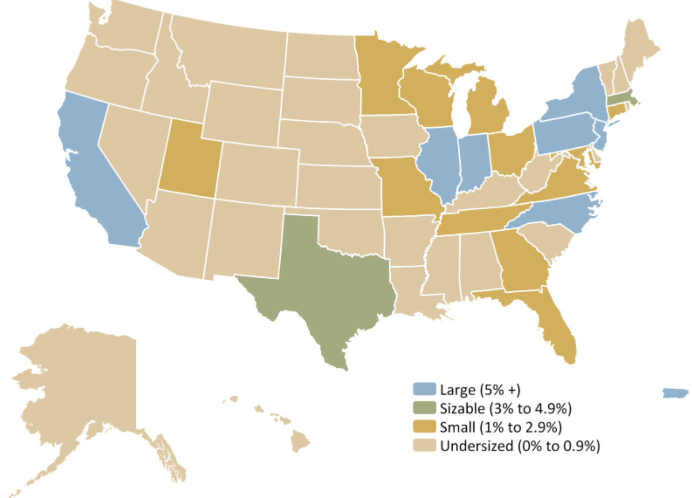
California
New Jersey
Puerto Rico
Pennsylvania
Indiana
North Carolina
Illinois

Metro Areas with the Largest Employment Levels*

New York-Northern New Jersey-Long Island, NY-NJ-PA
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD
Chicago-Naperville-Joliet, IL-IN-WI
Indianapolis, IN
San Francisco-Oakland-Fremont, CA

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

State Share of Total U.S. Employment



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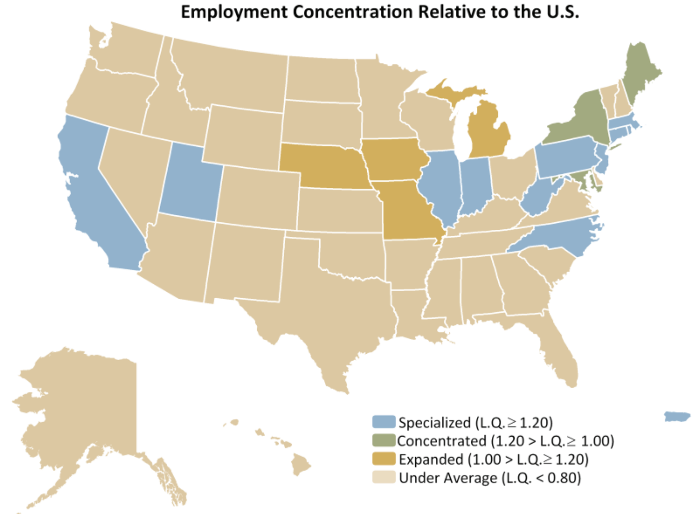
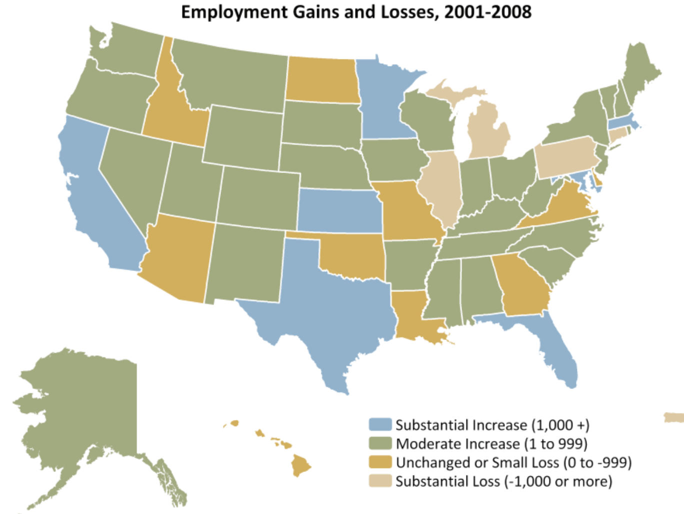


Employment Gains and Losses, 2001-2008



MEDICAL DEVICES and EQUIPMENT

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

Examples of Products

Bioimaging equipment
Surgical supplies and instruments
Orthopedic/prosthetic implants and devices
Laser eye surgery instruments
Automated external defibrillators (AEDs)
Vascular stents and other implantable devices
Dental instruments and orthodontics
Walkers, wheelchairs, and beds

Examples of Companies

Alcon
Becton, Dickinson and Co.
Boston Scientific Corp.
GE Healthcare
Medtronic
Roche Group – Ventana
Siemens Medical Solutions
STERIS
Stryker
Zimmer
3M Health Care

States that are Both Large and Specialized*

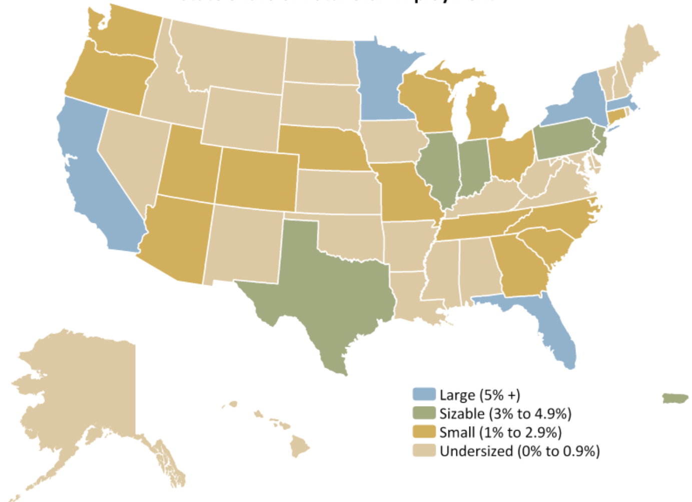
California
Minnesota
Massachusetts

Metro Areas with the Largest Employment Levels*

Los Angeles-Long Beach-Santa Ana, CA
Minneapolis-St. Paul-Bloomington, MN-WI
New York-Northern New Jersey-Long Island, NY-NJ-PA
Boston-Cambridge-Quincy, MA-NH
Chicago-Naperville-Joliet, IL-IN-WI

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

State Share of Total U.S. Employment



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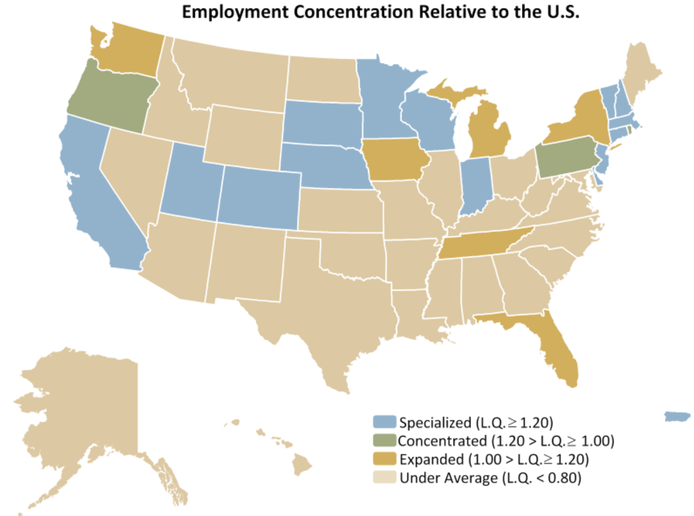

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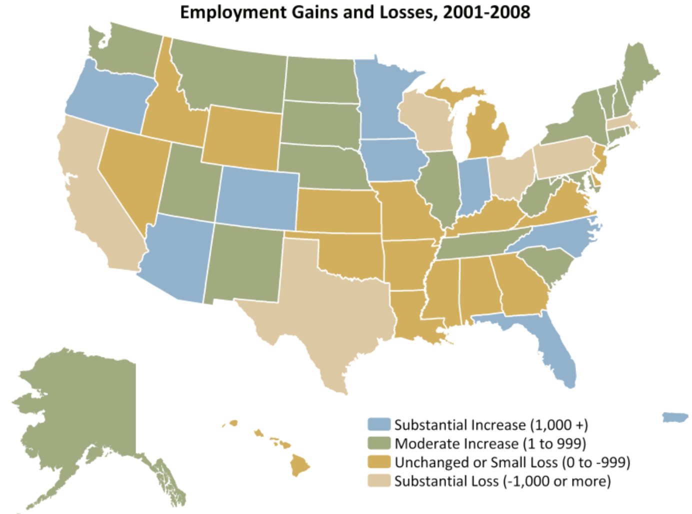

RESEARCH, TESTING, and MEDICAL LABORATORIES

The research, testing, and medical laboratories subsector includes a range of activities; from highly research-oriented companies working to develop and commercialize new drug discovery/delivery systems, and gene and cell therapies, to more service-oriented firms engaged in medical and other life sciences testing services.

Examples of Products

Preclinical drug development
Drug delivery systems
Diagnostic imaging and testing
Stem cell/regenerative research
Biomarkers
Research/laboratory support services

Examples of Companies

Albany Molecular Research
Celera
Charles River Laboratories
Covance
Laboratory Corp. of America
NeoGenomics
Orchid Cellmark
Pacific Biomarkers
Pharmaceutical Product Development
Quest Diagnostics

States that are Both Large and Specialized*

California
Massachusetts
Pennsylvania
New Jersey

Metro Areas with the Largest Employment Levels*

New York-Northern New Jersey-Long Island, NY-NJ-PA
Boston-Cambridge-Quincy, MA-NH
Los Angeles-Long Beach-Santa Ana, CA
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD
San Francisco-Oakland-Fremont, CA

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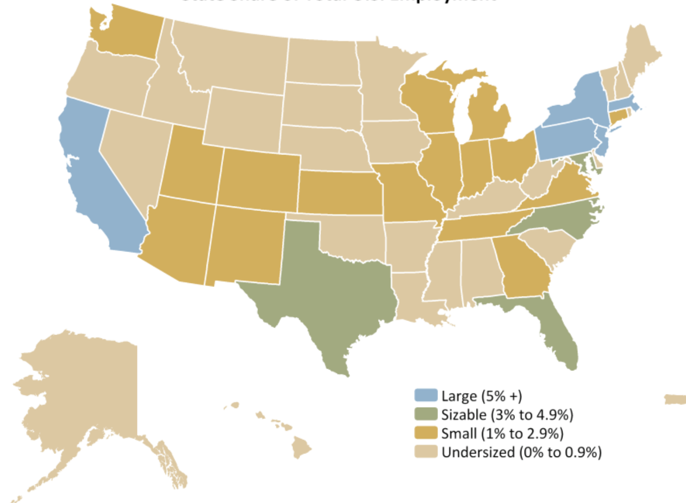

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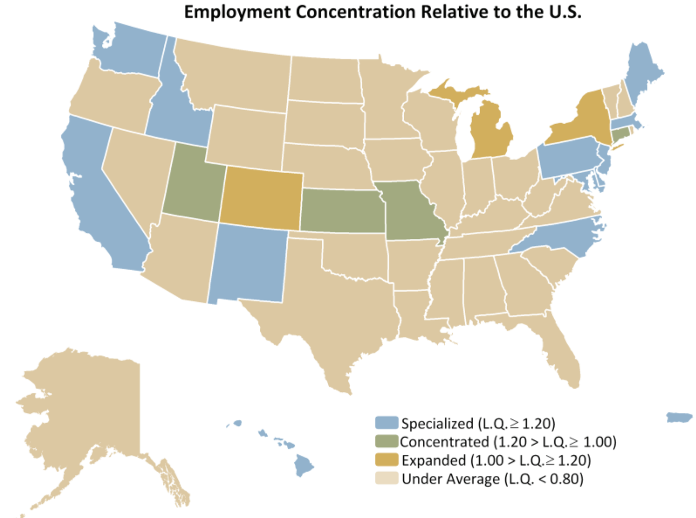

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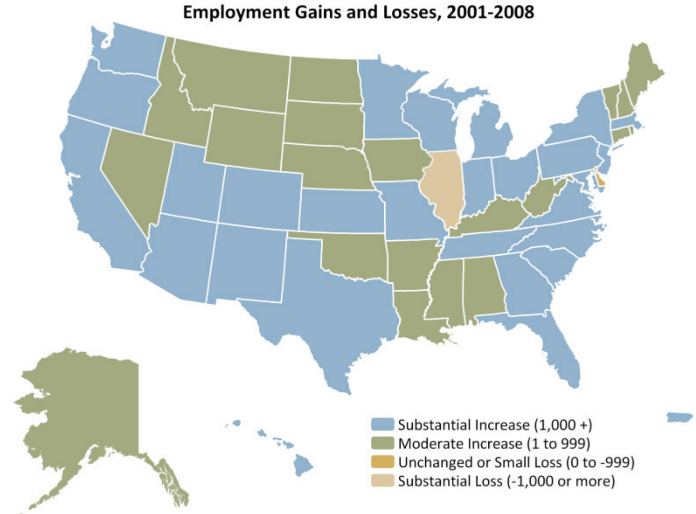


Key Findings: Bioscience Performance Measures

A special analysis of the financial performance of 649 public bioscience companies in 2009 suggests that, even during the recession, the bioscience industry is a positive generator of net income across each subsector, whether research, testing, and medical labs; agricultural feedstock and chemicals; medical devices and equipment; or drugs and pharmaceuticals. What does differentiate the financial performance of bioscience companies is their size. Those below $100 million in revenues do not, on average, record a positive net income, while the 79 public bioscience firms with over $1 billion in revenue generate nearly all of the net income for the biosciences. This reflects the long periods before the research and development of these companies pays off in net income.

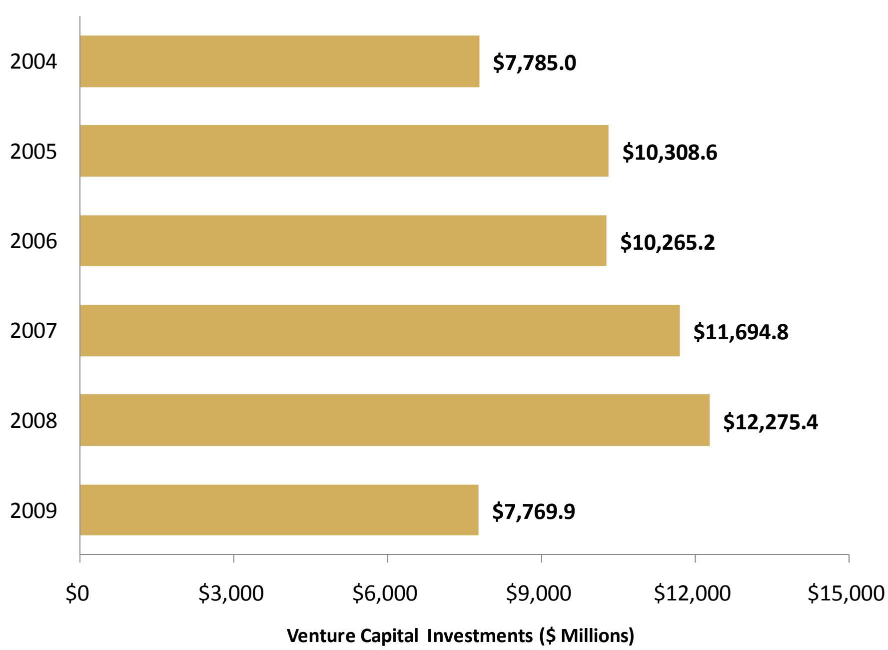
U.S. academic bioscience R&D expenditures have increased steadily from fiscal year (FY) 2004 through FY 2008. Bioscience R&D expenditures totaled nearly $32 billion in FY 2008, accounting for more than 60 percent of all U.S. academic R&D, with many individual states significantly exceeding that share.

The relative strength and innovation of the U.S. bioscience sector is reflected in the number of bioscience patents issued. Bioscience-related patents totaled 75,593 over the six-year, 2004 to 2009 period.[1] Bioscience-related patents reached 13,150 in 2009, the second-largest yearly total of the period.

But, there are clear warning signs of threats to future bioscience industry development.

- Capital Availability: Venture capital to bioscience companies fell a dramatic 36.7 percent between 2008 and 2009, from $12.275 billion to $7.770 billion. In 2009, bioscience venture capital stood below levels recorded back in 2004 (Figure ES-4).

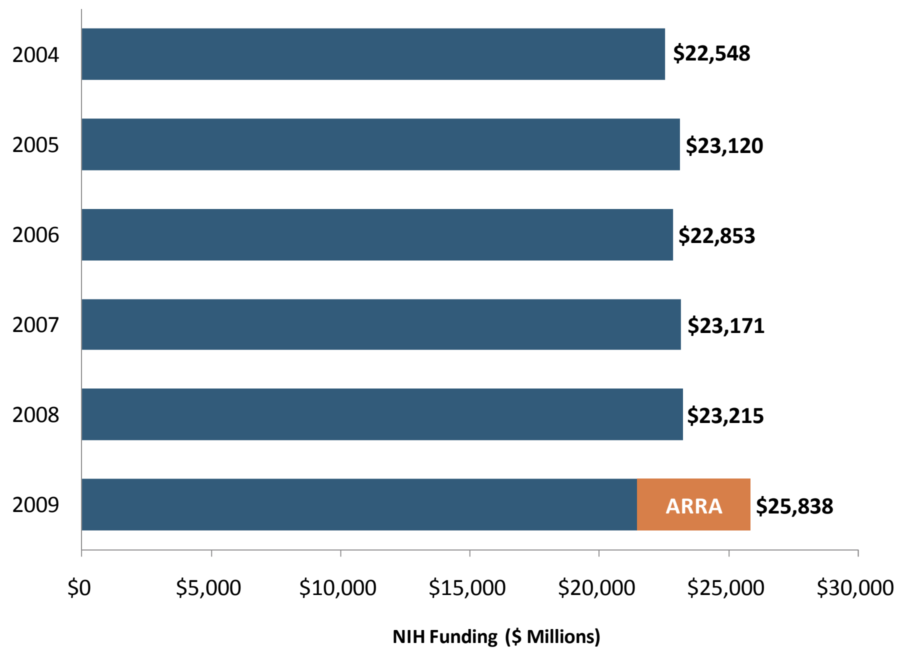
Figure ES-4. U.S. Bioscience Venture Capital Investments, 2004–2009



[1] This figure counts each patent once for the United States. Adding together each state's patent figures would yield a total of 96,948 as many patents have inventors located in more than one state, with each state receiving credit for the patent, and hence leading to a level of double-counting when adding individual state totals together.

- National Institutes of Health (NIH) Funding: Without the economic stimulus funding, NIH funding recorded a decline in extramural research funding of $1.732 billion or 7.46 percent from 2008 to 2009. The boost of $4.354 billion in stimulus funding was a very important infusion and allowed NIH extramural research funding to grow significantly over 2008. A key question in light of current federal budget woes is what happens after the recession (Figure ES-5).
- Bioscience Talent: While post-secondary bioscience graduates at all levels (associates, bachelor's, master's and doctorate) grew from 2006 to 2008 by a robust 12.8 percent, there is still concern that, at the K-12 level, the United States is continuing to fall behind in math and science education and may have trouble meeting the needs of bioscience companies for skilled, technical workers. A study conducted by Battelle, BIO, and the Biotechnology Institute in 2009 concluded that states are not measuring up in terms of K-12 bioscience education and that wide disparities exist among states in student performance in the biosciences and broader sciences.[2]

Figure ES-5. U.S. Extramural NIH Funding, FY 2004–FY 2009



[2] Battelle, *Taking the Pulse of Bioscience Education in America: A State by State Analysis*, May 2009.

Key Findings: State Bioscience Initiatives

States continue to make investments designed to encourage the growth of the bioscience sector despite challenging state fiscal conditions. According to the National Association of State Budget Officers, the 50 states are facing the worst fiscal period since the Great Depression, with fiscal conditions deteriorating significantly in fiscal year (FY) 2009 and the trend expected to continue through FY 2010 and into FY 2011. Forty-three states reduced their enacted budgets in FY 2009 as tax revenues declined as a result of the national recession.[3] In response, however, some states are creating new initiatives aimed at growing the economy by investing in technology-based economic development. Many of these initiatives are targeted to the biosciences, which have continued to be a key driver of economic growth.

Key Findings: States

- Continue to invest in bioscience development despite state fiscal challenges
- Are focusing on the agricultural biotechnology, bioenergy and bioproducts industry subsectors
- Are implementing new programs to build R&D capacity and advance commercialization of research discoveries
- Continue to address need for early-stage capital
- Are enacting tax policies that are supportive of the bioscience industry

States are actively promoting the growth of their agricultural biotechnology, bioenergy, and bioproducts industry subsectors. As discussed previously, the bioeconomy has arrived. Biobased materials and renewable products are becoming cost-effective alternatives to petroleum-based counterparts. States are actively supporting the development of this bioeconomy, using many of the same mechanisms and programs that also are used to support the biomedical sector. But, in addition, states are creating programs and partnerships that are targeted specifically to the bioagriculture, bioenergy, and biobased products industries.

States continue to put in place new programs to build bioscience R&D capacity and to encourage the commercialization of new discoveries. Recognizing that a strong bioscience R&D base is a prerequisite to growing a robust bioscience industry cluster, states continue to create mechanisms designed to position universities to compete for bioscience R&D awards and to commercialize the results of research findings.

States continue to create programs to address the need for early-stage capital for bioscience companies. Venture capital firms invested approximately $7.8 billion in bioscience companies nationally in 2009, down from $11.7 billion and $12.3 billion in 2007 and 2008, respectively. In addition to the fact that there has been a decline in overall venture capital investing, only about 6 percent of the total dollars invested between 2004 and 2009 was invested in start-up bioscience companies, with another 17.7 percent in early-stage bioscience firms. Also, bioscience venture investing is geographically concentrated, with about 70 percent of the total being invested going to firms in just five states: California, Massachusetts, New Jersey, Pennsylvania, and Texas. As a result, states seeking to grow their bioscience industry continue to look for ways to help firms within their state access needed capital by investing in funds that agree to make in-state investments or locate offices in a particular state, helping companies tap the federal Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) programs and directly investing in companies.

[3] National Governors Association and National Association of State Budget Officers, *Fiscal Survey of the States*, December 2009.

States continue to use tax policies to support the bioscience industry. Thirty-eight states reported offering R&D tax credits, an increasing number of which offer a larger credit if the research is conducted by an in-state university. States also use tax policies to encourage private investment in early-stage companies and/or in funds that make early-stage investments. Twenty states offer tax credits to angel investors who invest in technology companies, six of which are targeted specifically to angel investors who invest in bioscience companies. Twelve states reported providing tax credits to individuals who invest in early-stage venture funds. States also use tax credits to increase the availability of venture capital. As of 2010, 13 states reported investing in a fund of funds, 10 states reported investing state dollars in private venture-capital firms, and 14 states reported making direct investments in bioscience companies. Thirty-four states reported exempting sales tax for equipment used in R&D, including equipment purchased for biomanufacturing, and 33 states reported exempting equipment purchased for biomanufacturing from sales tax. Seven states have sales tax exemptions specifically targeted to bioscience firms.

Conclusion

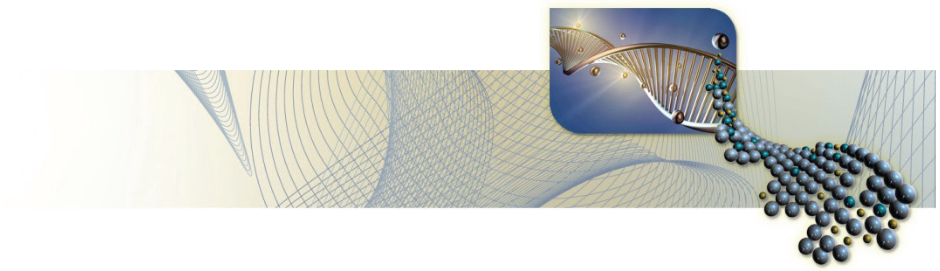
The bioscience industry is a diverse and rapidly growing sector that is contributing significantly to national, state and regional economies. The industry has recorded continued employment growth even through the first year of the recession, and the financial performance of public biosciences companies through the end of 2009 was positive.

Bioscience development is not simply about generating economic returns, however. The great promise of the biosciences is its ability to address global problems from human health to food generation and security to environmental sustainability and clean energy. Bioscience development pays huge social and quality-of-life dividends for the U.S. and the world.

But continued biosciences development is not guaranteed. States are facing difficult fiscal times that threaten to roll-back many of the key economic development programs that were put in place over the past decade. Federal fiscal woes threaten NIH funding, a key generator of U.S. leadership in basic research. The recent recession and its impact on capital markets have created a very sharp decline in venture capital for bioscience companies, which is critical to advancing biosciences innovation into the marketplace. And, in the long-term, the talent pipeline in the biosciences remains an area of significant concern. State and national policymakers have a key role to play in ensuring that these challenges are addressed in order to allow the U.S. to continue to be a world leader in the biosciences.

And finally, with the U.S. Congress just completing work on the most sweeping overhaul of the nation's healthcare system, it remains unclear what impact this legislation will have on bioscience industry development in the long term. The legislation included provisions to create a pathway for the approval of follow-on biotechnology medicines, and a $1 billion therapeutic discovery tax credit, both of which were widely supported by the bioscience industry. In addition, the legislation significantly expands Medicare and Medicaid discounts and rebates, and imposed an excise tax on the sales of drugs and medical devices. The impact of these increases in costs to drug and device makers, designed to be offset by the addition of 32 million uninsured to the marketplace, will take some time to determine.

Introduction



In the 21st century, which many have termed the BioCentury, the biosciences will be a key engine of economic growth in the United States. Major advancements are taking place on a host of bioscience fronts, ranging from high-precision personalized human biomedical applications to widespread biomass-based innovations in agbioscience, bioenergy, and industrial biotechnology. Without a doubt, the bioscience industry has become a proven and critical driver of national, state, and regional economies; all indications are that this industry will continue to expand as the biosciences promise solutions to many of the global challenges the world faces. The biosciences are a fundamental driver in the following:

- Advancing innovative solutions to unsolved human diseases and improving the quality of life of our aging population
- Addressing the threat of major disease outbreaks and food contamination events
- Sustaining growth in food production to meet the needs of the world's rapidly expanding population
- Developing biorenewable, biomass-based materials and products that will contribute to a sustainable, non-polluting future as well as to meeting our energy needs
- Preserving our natural resources and environmental assets.

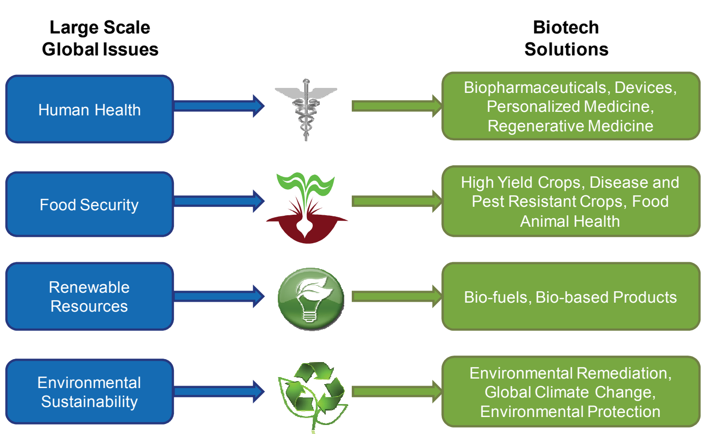
Defining the "Biosciences"

The biosciences are a diverse group of industries and activities with a common link—they apply knowledge of the way in which plants, animals, and humans function. The sector spans different markets and includes manufacturing, services, and research activities. By definition, the biosciences are a unique industry cluster and are constantly changing to incorporate the latest research and scientific discoveries.

The bioscience industry sector is defined as including the following four subsectors:

- *Agricultural Feedstock and Chemicals*
- *Drugs and Pharmaceuticals*
- *Medical Devices and Equipment*
- *Research, Testing, and Medical Labs*

Indeed, the biosciences represent a vibrant and diverse industry sector across the United States. Battelle, BIO, and PMP Public Affairs Consulting, Inc., have tracked the development of the U.S. bioscience industry on a state and metropolitan area basis, along with trends in key innovation and talent drivers of bioscience development and the implementation of state policies and programs to support the bioscience industry, on a 2-year basis since 2004. This 2010 report presents updated data on national, state, and metropolitan bioscience employment and growth trends from 2001 to 2008, with a 1-year view into how the biosciences have fared in the midst of the current recession that took hold in 2008. One new feature of the biennial study is a closer examination at the national level of the profitability of the bioscience sector, which gets at its long-term sustainability and growth.



In terms of bioscience innovation and talent drivers, we continue to report on innovation measures of bioscience research and development (R&D), patents issued, venture capital funding, as well as talent measures of degrees awarded and bioscience occupational employment. For this year's edition, we have added a measure on clinical trials activities, which is a critical step in advancing new product development for human health and reflects a measure of clinical as opposed to basic research occurring across states. Clinical trials represent a greater than $25 billion industry and so is an important component of a state's bioscience sector and biomedical infrastructure. These data are presented for all 50 states, the District of Columbia, and Puerto Rico.

A Note About the Data: This report presents employment data for 2008, the most current year for which detailed industry data are available. While 2008 encompasses the first year of the recent recession, the real impacts of the recession are likely to be reflected in the 2009 data once these data become available. Other data sources suggest that the bioscience industry, while impacted by the recession, was not as negatively affected as many other industry sectors and appears to be rebounding more quickly. The first quarter of 2010 saw the Amex Biotech Index (BTK) hit an all-time high and the Nasdaq Biotech Index (NBI) climbed to its highest level in more than 8 years. Both of these biotech indices are up since the financial crises began in October 2007, something no sector in the S&P 500 can claim. Source: http://insidebioia.com/, 04/13/2010

Key Findings: Bioscience Industry and Development Trends

The overall bioscience industry employment base continued to grow, even during the first year of the recession. Total employment in the U.S. bioscience sector reached 1.42 million in 2008 (the latest year for which data are currently available), continuing its strong job gains from the previous economic expansion and through 2008. During the first year of the recession, employment in the bioscience industry grew 1.4 percent while total private sector employment declined by 0.7 percent. This 2008 growth was broadly shared across the following bioscience subsectors:

- Research, testing, and medical labs adding 11,670 jobs or 2.1 percent from 2007 to 2008
- Medical devices and equipment adding 10,140 jobs or 2.4 percent from 2007 to 2008
- Agricultural feedstock and chemicals adding 5,021 jobs or 4.6 percent from 2007 to 2008.

Only drugs and pharmaceuticals shed jobs from 2007 to 2008 with a decrease of 7,445 jobs or 2.3 percent.

The total employment impact of the bioscience sector is 8 million jobs, taking into account the additional jobs created in the economy as a result of the sector's direct jobs. On a national basis, for every new bioscience job, another 5.8 jobs are created.

Bioscience employment growth greatly outpaced national employment growth from 2001 to 2008. The bioscience industry added 193,748 jobs from 2001 to 2008, a hefty growth rate of 15.8 percent. This rapid rate of job growth was 4.5 times as much as the overall growth rate for the national private sector (3.5 percent).

Rapid job growth in the biosciences has been fueled primarily by growth in research, testing, and medical laboratories. The subsector has continuously grown since 2001, adding more than 176,000 jobs or 46.1 percent to its employment base during the 7-year period. This growth represents 9 out of every 10 new bioscience jobs created. Research, testing, and medical labs now account for 39 percent of total bioscience employment, up from 35 percent in 2006. Agricultural feedstock and chemicals maintained its share of bioscience employment; drugs and pharmaceuticals and medical devices and equipment now account for a slightly smaller percentage of overall bioscience employment, both down by 2 percent.

The bioscience sector continues to be a source of high-wage jobs. The overall bioscience sector paid average annual wages of $77,595 in 2008, up from $70,959 in 2006. On average, bioscience jobs paid $32,366 more than the average annual wage of the total U.S. private sector, which was $45,229 in 2008. Bioscience wages also are outpacing the national private sector in growth. Since 2001, real (inflation-adjusted) earnings for biosciences industry workers have increased by 10.1 percent, compared with 3.2 percent for the U.S. private sector.

Bioscience employment is distributed across the United States, with many states developing strong niches in certain specializations. Thirty-nine states, the District of Columbia, and Puerto Rico—up from 35 in 2006—now have a specialization in one of the bioscience subsectors. The four states that developed a specialization since 2006 are Montana, South Carolina, Vermont, and Wyoming. Five states—California, Indiana, Massachusetts, New Jersey, and North Carolina—and Puerto Rico are specialized in three of the four bioscience subsectors. Massachusetts developed a specialization in drugs and pharmaceuticals since 2006.

A special analysis of the financial performance of 649 public bioscience companies in 2009 suggests that, even during the recession, the bioscience industry is a positive generator of net income across each subsector, whether research, testing, and medical labs; agricultural feedstock and chemicals; medical devices and equipment; or drugs and pharmaceuticals. What does differentiate the financial performance of bioscience companies is their size. Those below $100 million in revenues do not, on average, record a positive net income, while the 79 public bioscience firms with over $1 billion in revenue generate nearly all of the net income for the biosciences. This reflects the long periods before research and development pays off in net income.

Looking to the future, the biosciences remain positioned for strong economic growth. The U.S. Department of Labor projects that the biosciences will grow at an average annual rate of 1.5 percent between 2008 and 2018, making it one of the fastest-growing industry sectors. Overall private sector employment is projected to grow by an average annual rate of 1 percent during this time period.

But, there are clear signs of threats to future bioscience industry development. Venture capital fell dramatically from 2008 to 2009. Baseline funding from the National Institutes of Health declined from 2008 to 2009, and actual funding from NIH would have fallen had it not been for the economic stimulus. In bioscience talent generation, data show the U.S. continuing to fall behind in math and science education and may have trouble meeting the needs of bioscience companies for skilled, technical workers.[4]

And finally, with the U.S. Congress just completing work on the most sweeping overhaul of the nation's healthcare system, it remains unclear what impact this legislation will have on bioscience industry development in the long term. The legislation included provisions to create a pathway for the approval of follow-on biotechnology medicines, and a $1 billion therapeutic discovery tax credit, both of which were widely supported by the bioscience industry. In addition, the legislation significantly expands Medicare and Medicaid discounts and rebates, and imposed an excise tax on the sales of drugs and medical devices. The impact of these increases in costs to drug and device makers, designed to be offset by the addition of 32 million uninsured to the marketplace, will take some time to determine.

[4] Battelle, *Taking the Pulse of Bioscience Education in America: A State by State Analysis*, May 2009.

Understanding the Financial Performance of the Bioscience Industry

One concern about the bioscience industry expressed over the years is that the sector is R&D driven and not able to create and sustain viable businesses for the long term. Clearly, the strong growth of the biosciences in employment indicates that it is a sustainable industry sector, but a more direct measure is its overall profitability as measured by net income.

To this end, Battelle developed a dataset of public bioscience companies to assess both total revenue and total net income on a subsector basis. This dataset was constructed using Hoover's corporate database (financial data from Morningstar Financial) and corporate SEC filings (primarily 10-Ks). The industry codes and product descriptions included with these sources were used to classify firms into one of the four bioscience industry subsectors. In this classification effort, the firm was classified based upon the sector of the overall corporation (though also examining the classification of its individual establishments). Therefore, firms such as ADM, Cargill, Cardinal Health, and 3M with one or more "bioscience" establishments (locations), but within a corporate industry outside of the definition of bioscience sectors, are ***not*** included in the dataset. Ultimately, Battelle identified 649 public bioscience companies with reported fiscal year 2009 financial information to include in this analysis.

While each of the four bioscience subsectors had firms reporting positive net income and firms reporting negative net income, ***all four bioscience subsectors showed, on average, a positive net income in 2009***.

Bioscience Financial Performance by Subsector and Net Income, FY 2009

Bioscience Subsector	Net Income	Number of Public Firms in Dataset	FY 2009 Revenue		FY 2009 Net Income	
			$ Millions	% of Industry	$ Millions	% of Industry
Agricultural Feedstock & Chemicals	Positive	20	$116,711		$8,379	
	Negative	14	$3,531		$(645)	
Subsector Total		34	$120,242	21%	$7,734	10%
Drugs & Pharmaceuticals	Positive	98	$322,088		$66,343	
	Negative	285	$7,574		$(8,334)	
Subsector Total		383	$329,661	57%	$58,009	78%
Medical Devices & Equipment	Positive	84	$89,913		$11,897	
	Negative	98	$16,103		$(4,776)	
Subsector Total		182	$106,016	18%	$7,121	10%
Research, Testing, & Medical Laboratories	Positive	22	$20,152		$1,910	
	Negative	28	$1,278		$(231)	
Subsector Total		50	$21,430	4%	$1,680	2%
Total Biosciences	Positive	224	$548,863		$88,529	
	Negative	425	$28,485		$(13,985)	
Industry Total		649	$577,349	100%	$74,544	100%

Only in agricultural feedstock and chemicals did a majority of firms report a positive net income in fiscal year 2009. While drugs and pharmaceuticals account for 78 percent of the entire bioscience industry's net income, it also accounts for two-thirds of the firms with a negative net income (285 out of 425 or 67 percent). Many of the negative net-income firms in this subsector are much more aligned with a traditional R&D firm than they are with a pharmaceutical firm in that many had revenues at or near $0. Research, testing, and medical laboratories have a positive net income on average. Much of the revenue and net income attributed to this subsector, however, comes from large diagnostic laboratories (e.g., Quest Diagnostics, Laboratory Corporation of America) and contract research organizations (CROs) (e.g., Covance).

Given the inclusion of early-stage R&D firms (though still public companies) throughout many of these subsectors and their typically limited revenue potential, an additional analysis was developed based upon the revenue "size" of the firm.

Based upon this analysis, 85 percent of the bioscience industry's net income from public companies was generated by the largest 15 firms (those with $10 billion or more in fiscal year 2009 revenue). If considering all firms with $1 billion or more in revenue (79 firms), these firms account for 93 percent of all revenue earned and 109 percent of all net income earned (considering negative net income by many firms) by the bioscience industry.

Bioscience Financial Performance by Revenue Size Class, FY 2009

Revenue Size Class	Number of Public Firms in Dataset	FY 2009 Revenue		FY 2009 Net Income	
		$ Millions	% of Industry	$ Millions	% of Industry
$10 Billion +	15	$357,204	62%	$63,300	85%
$1–$9.99 Billion	64	$176,092	31%	$17,599	24%
$500–$999 Million	19	$12,062	2%	$808	1%
$250–$499 Million	42	$14,808	3%	$717	1%
$100–$249 Million	60	$9,147	2%	$(757)	-1%
$25–$99.9 Million	121	$6,427	1%	$(1,729)	-2%
$1–$24.9 Million	188	$1,587	0%	$(3,236)	-4%
>$0 to <$1 Million	57	$22	0%	$(1,048)	-1%
$0–No Revenue	83	$(0)	0%	$(1,111)	-1%
Industry Total	649	$577,349	100%	$74,544	100%

This analysis clearly shows that overall revenue size is the most predominant determiner of the financial performance of the bioscience industry in fiscal year 2009.

Key Findings: State Bioscience Initiatives

States continue to make investments designed to encourage the growth of the bioscience sector despite challenging state fiscal conditions. According to the National Association of State Budget Officers, the 50 states are facing the worst fiscal period since the Great Depression, with fiscal conditions deteriorating significantly in fiscal year (FY) 2009 and the trend expected to continue through FY 2010 and into FY 2011. Forty-three states reduced their enacted budgets in FY 2009 as tax revenues declined as a result of the national recession.[5] In response, however, some states are creating new initiatives aimed at growing the economy by investing in technology-based economic development. Many of these initiatives are targeted to the biosciences, which have continued to be a key driver of economic growth.

- The **Kansas Bioscience Authority (KBA)** is slated to receive $35 million in FY 2011. KBA was created in 2004 and is funded by a percentage of the increases in state taxes paid by bioscience companies. The Authority offers a comprehensive set of programs designed to attract and grow bioscience companies.
- **Maryland** continues to implement its BIO 2020 Initiative, a commitment to invest $1.1 billion to support the state's life-science industry over a 10-year period. The Maryland Biotechnology Center, designed to serve as a one-stop center for linking bioscience companies with a variety of services and programs, opened in 2009. The Governor's proposed budget for FY 2011 includes $43 million for BIO 2020.
- **Massachusetts** continued to support its Life Science Initiative, which was enacted in 2007. The state fully funded $25 million in tax credits for life science companies and provided $15 million for its Life Science Investment Fund, which makes investment to stimulate bioscience R&D in FY 2009. Another $15 million was appropriated for the Life Sciences Infrastructure Fund.
- **Ohio's** FY 2010 budget included $6.1 million in annual funding for the Third Frontier Initiative, a $1.6 billion, 10-year initiative launched in 2002 aimed at growing the state's technology industry sectors, including the biosciences.
- **Virginia's** FY 2010–2011 budget includes $3 million over the biennium to support biotechnology initiatives, including $1.5 million for a wet-lab program and funding for a Virginia Immunology Center research consortium.

States are actively promoting the growth of their agricultural biotechnology, bioenergy, and bioproducts industry subsectors. As discussed previously, the bioeconomy has arrived. Biobased materials and renewable products are becoming cost-effective alternatives to petroleum-based counterparts. States are actively supporting the development of this bioeconomy, using many of the same mechanisms and programs that are also used to support the biomedical sector. But, in addition, states are creating programs and partnerships that are targeted specifically to the bioagriculture, bioenergy, and biobased products industries. Examples of such initiatives include:

- **Iowa State University (ISU)** has created a **Bioeconomy Institute (BEI)** to focus the university's research on biorenewable resources as sustainable feedstocks for producing chemicals, fuels, materials, and energy. The BEI, which was created to encourage collaboration, has engaged 29 departments in all seven colleges and 20 research centers and institutes. ISU recently became the first university in the country to offer M.S. and Ph.D. degrees in biorenewable resources. The university's Biorenewables Research and Technology Program offers students advanced studies in the use of plant and crop-based resources for the production of biobased products.
- Michigan enacted legislation creating Centers of Energy Excellence in 2009 as part of the Governor's overall job creation and economic stimulus package. The Centers match companies

[5] National Governors Association and National Association of State Budget Officers, *Fiscal Survey of the States*, December 2009.

with universities, national laboratories, and training centers to accelerate next-generation research, workforce development, and technology commercialization. The initiative was funded at $45 million for FY 2008 and FY 2009, and an additional $30 million was authorized through FY 2011.[6]

- The Legislature created the **Biofuels Center of North Carolina** in 2007 with the mission of developing a statewide biofuels industry. The Center, which is a private, nonprofit organization, received an initial appropriation of $5 million and has continued to receive operating support from the state. The Center awards funds on a competitive basis to academic institutions, economic development organizations, and nonprofit organizations to identify and bridge gaps in knowledge and information, speed development of technology to industry, and create a seamless continuum from agriculture to transportation fuels.
- Ohio is actively pursuing the development of the state's bioproducts industry. In 2005, the Ohio Department of Development funded an **Ohio Bioproducts Innovation Center** under its Third Frontier Initiative. The Center, which received an $11.5 million Wright Centers of innovation Grant, is a partnership of academia and industry that is focused on the development of renewable specialty chemicals, polymer/plastics, and advanced materials. In 2010, Ohio became the first state in the nation to establish a bioproducts preferred purchasing program.
- The **Oklahoma Bioenergy Center** was created by the Legislature in 2007. The Center is a collaboration of the University of Oklahoma, Oklahoma State University, and the Samuel Roberts Noble Foundation, who are working together to advance the development of cellulosic ethanol from crops like switchgrass, sweet sorghum, and milo as well as research on biodiesel that is derived from natural oils, such as sunflower seeds and canola. The Center has secured 1,000 acres of production-scale demonstration fields for growing cellulosic energy crops.
- The **University of Tennessee Biofuels Initiative** is a state-sponsored initiative designed to jump-start the state's bioenergy industry by building and operating a pilot-scale cellulosic ethanol biorefinery in East Tennessee. The state made a $70 million, 5-year commitment with the Legislature appropriating $40.7 million in capital costs and $8.25 million for research, farmer incentives, and operating expenses in 2007. The pilot facility, which was built by the UT Research Foundation in partnership with DuPont Danisco Cellulosic Ethanol LLC, opened in January 2010. It is one of the first cellulosic ethanol plants in the country and the only one dedicated to converting both agricultural residue and bioenergy crops to ethanol.[7]
- Created in 2007 by University of Wisconsin-Madison College of Agricultural and Life Sciences, the **Wisconsin Bioenergy Initiative (WBI)** seeks to cultivate bioenergy expertise among UW-Madison, UW-System, and Wisconsin stakeholders. WBI is a university-based coalition that seeks to create, commercialize, and promote biobased solutions.

[6] SSTI, "Building Tech-based Economies: State Proposals and Actions," 03/05/2010.

[7] "DDCE and UT/Genera Energy Demonstration Plant Grand Opening," UT Press Release, 01/07/2010, http://www.tennessee.edu/media/releases/010710_grandopen.html.

Industrial Biotech: A Rapidly Expanding Bioscience Field With Demonstrated Economic Value

Industrial biotechnology uses biological tools, such as microbes and enzymes, to produce value-added products. Modern scientific knowledge has opened the book of life to new chapters in enzyme and microbiological resource discovery and development, and industrial biotechnologists are expanding the application and engineering of cell lines, microbes, and enzymes into a broad variety of industrial processes. Via fermentation, biosynthesis, biochemical-catalysis, and other "life" processes, industrial biotechnology leverages the complexity and refinement of the natural world, building upon biological structures and processes to create efficient, sustainable, and environmentally friendly manufacturing technologies.

Fundamental business principles are driving the increased application of biotechnology to industrial processes—the need to add value, increase process efficiency, reduce production costs, and introduce new and better products to the marketplace. Industrial biotechnology is proving to be a highly flexible, cost-effective, and sustainable tool for achieving these business goals and represents a key tool for modern economic growth and sustainable industrial and global development.

The range of industries using industrial biotechnology is broad and expanding. For example, key applications of biotech are seen in the production of the following:

- *Food and beverage products*
- *Vaccines*
- *Bulk chemicals and specialty chemicals*
- *Bio-based plastics and polymers*
- *Textiles*
- *Packaging materials*
- *Pharmaceuticals*
- *Vitamins*
- *Biofuels*
- *Pulp and paper*
- *Cosmetics and personal care products*
- *Environmental remediation technologies*

In addition to providing specialized production tools and technologies across a range of industries, industrial biotechnology is making possible a move into a new and sustainable biobased economy, as opposed to a nonsustainable petroeconomy. The United States' large landmass, in concert with very high levels of productivity in agriculture and forestry, provides the resources for a new biobased economy using domestically grown natural biomass resources. Agricultural biotechnology is increasing the production of biomass, while industrial biotechnology provides the tools to efficiently convert that biomass into energy, liquid fuels, plastics, materials, chemicals, fibers, and other high-value products, thereby building a new and sustainable platform for modern economic development and progress. Of particular interest to economic developers is the fact that this agricultural and industrial bioeconomy provides a model for development that is geographically dispersed (rather than focused in just a few technologically intensive cities). Value-added conversion of biobased resources (especially low-bulk density cellulosic biomass) into value-added products tends to occur close to the location in which the biomass is produced. Thus, the conversion of biological resources into value-added manufactured products represents a present and growing opportunity for every state in the United States and perhaps, for the first time in a long-time, a platform for the economic revitalization of rural and small town America.

Industrial biotechnology is providing the means to transform manufacturing via the application of biobased resources, technologies, and processes. Through the application of science and advanced technologies industrial biotechnologists are using the processes of life to make life better. Industrial biotechnology is a flexible, modern tool producing new products and enhancing industrial efficiency. The net result is the creation of new, high-quality jobs and economic development.

States continue to put in place new programs to build bioscience R&D capacity and to encourage the commercialization of new discoveries. Recognizing that a strong bioscience R&D base is a prerequisite to growing a robust bioscience industry cluster, states continue to create mechanisms designed to position universities to compete for bioscience R&D awards and to commercialize the results of research findings. Since 2008, the following programs have been implemented:

- Arkansas enacted legislation that created the **Arkansas Research Alliance**. The program, modeled after the Georgia Research Alliance, is a collaboration of research universities and private sector leaders whose mission is to create greater economic opportunities in Arkansas by advancing university-based innovation. The Alliance plans to raise funds that will be used to recruit Eminent Scholars in a number of scientific fields, including in the biosciences.

- The **Colorado Institute for Drug, Device and Diagnostic Development** was launched in 2009, with the mission of accelerating the commercialization of biomedical technologies. Partners in the Institute include the University of Colorado-Boulder, Colorado State University, Colorado Bioscience Association, Colorado Science + Technology Park at Fitzsimons, and the University of Colorado Denver.

- Four **Georgia** research and healthcare organizations, with support from the Georgia Research Alliance, have created a **Global Center for Medical Innovations** at Georgia Institute of Technology. The mission of the Center, which will contain a medical device prototyping center, is to accelerate the development and commercialization of next-generation medical devices and medical technology.

- **South Dakota** announced five new **2010 Research Centers** in 2008 and 2009, one of which is focused on translational cancer research. The Centers are aimed at growing the state's economy by targeting investments in specialized research at South Dakota public universities.

States continue to create programs to address the need for early-stage capital for bioscience companies. Venture capital firms invested **a**pproximately $7.7 billion in bioscience companies nationally in 2009, down from $11.4 billion and $11.6 billion in 2007 and 2008, respectively. In addition to the fact that there has been a decline in overall venture capital investing, only about 6 percent of the total dollars invested between 2004 and 2009 was invested in start-up bioscience companies, with another 17.7 percent in early-stage bioscience firms. Also, bioscience venture investing is geographically concentrated, with about 70 percent of the total being invested going to firms in just five states: California, Massachusetts, New Jersey, Pennsylvania, and Texas. As a result, states seeking to grow their bioscience industry continue to look for ways to help firms within their state access needed capital by investing in funds that agree to make in-state investments or locate offices in a particular state, helping companies tap the federal Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) and directly investing in companies. Examples of recent state efforts to increase access to early-stage capital include the following:

- In 2009, the **Kansas Bioscience Authority** invested $50 million in eight funds that committed to having an office in Kansas. Each fund has a focus in a specific area of the biosciences, such as human health, plant biology, bioenergy, and biomaterials. The funds must raise a minimum of $25 million each from private and institutional sources.[8]

- The **Michigan Retirement Fund** is seeking to leverage public assets to increase the amount of locally managed venture capital willing to make investments in Michigan companies at all stages, from

[8] Kansas Bioscience Authority, Press Release, 10/08/2009, http://www.kansasbioauthority.org/news/Detail.aspx?id=81.

microloans through later-stage venture capital and buyout funds. The Retirement Fund has allocated $300 million to two private equity partnerships that agreed to make in-state investments.[9]

- **Virginia** created a new program that provides **matching grants for SBIR awards.** The Omnibus Bioscience Bill, signed into law in April 2009, authorized matching grants for NIH SBIR/STTR awards.

States continue to use tax policies to support the bioscience industry. They provide tax credits for R&D expenditures and to encourage investment in both technology companies and funds that invest in technology companies. In some cases, these tax credits are exclusively targeted to bioscience companies. Recently enacted tax credits include the following:

- **Virginia's** Omnibus Bioscience Bill passed in 2009 replaced the state's Angel Investor Tax Credit with a **Bioscience Investment tax credit**. Fifty percent of the available credit is reserved for technology transfer spin-outs from Virginia universities. During the 2010 legislative session, the Virginia Innovation Investment Act was passed that excludes from taxes all capital gains on investments in advanced technology companies (with less than $3 million in annual revenue), including bioscience companies. The legislation has not yet been signed by the Governor.

- The **Colorado Innovation Investment Tax Credit** provides a state income tax credit for qualified investors that make investments during calendar year 2010 in small qualified Colorado businesses involved primarily in R&D or manufacturing of new technologies, products, or processes.

State R&D Tax Credits

Thirty-eight states reported offering R&D tax credits, an increasing number of which offer a larger credit if the research is conducted by an in-state university. In Nebraska, for example, the state offers a refundable R&D tax credit that is equal to 15 percent of the federal R&D credit. Legislation passed in 2009 increases the credit to 35 percent if the research is performed by a Nebraska university. R&D tax credits are refundable in seven states and transferable in four others (Table 1).

[9] InvestMichigan!, http://www.investmichiganfund.com/.

Table 1. State R&D Tax Credits

State	R&D Tax Credit	Transferable	Refundable	Comments
AR	●	●		
AZ	●			
CA	●			
CT	●		●	
DE	●			
GA	●			
HI	●		●	
ID	●			
IL	●			
IN	●			
IA	●		●	The refundable tax credit is equal to 6.5% of qualified expenditures, and it may be doubled for bioscience firms.
KS	●			
KY	●			
LA	●		●	
ME	●			
MD	●			
MA	●			
MI	●			
MN	●			
MS	●			R&D Jobs Credit
MT	●			
NE	●		●	
NH	●			
NJ	●	●		
NM	●			
NC	●			
ND	●			
NY	●		●	
OH	●			
OK	●	●		
OR	●			
PA	●	●		
RI	●			The R&D tax credit has a carry forward of 14 years
SC	●			
UT	●			
WA	●			Washington has no state income tax. Instead, a Business & Operating (B&O) tax is levied against businesses. The R&D tax credit can be taken against the levied B&O tax.
WV	●		●	Investment credit
WI	●			Effective 1/1/2011

State Tax Credits to Encourage Early-Stage Investment

States also use tax policies to encourage private investment in early-stage companies and/or in funds that make early-stage investments. Twenty states offer tax credits to angel investors who invest in technology companies, six of which are targeted specifically to angel investors who invest in bioscience companies. Twelve states reported providing tax credits to individuals who invest in early-stage venture funds. New Mexico, North Carolina and Wisconsin offer tax credits to those who invest in bioscience early-stage venture funds. Table 2 summarizes state capital tax credits to angel and bioscience angel investors and investors in early-stage and bioscience early-stage venture funds.

Table 2. State Seed Capital Tax Credits

State	State Tax Credits Provided to:			
	Angel Investors	Bioscience Angel Investors	Investors in Early-Stage Venture Funds	Investors in Bioscience Early-Stage Venture Funds
AZ	●	●		
CO	●			
HI	●			
IN	●			
IA	●		●	
KS	●	●		
KY	●		●	
LA	●			
ME	●		●	
MD	●	●		
MI	●			
MT	●		●	
NM	●		●	●
NY	●			
NC	●	●	●	●
ND	●		●	
OH	●		●	
OK	●		●	
OR			●	
RI	●			
VA		●		
WV			●	
WI	●	●	●	●

State Tax Credits to Increase the Availability of Venture Capital

States also use tax credits to increase the availability of venture capital. They can create funds that invest directly in companies or invest in privately managed funds that agree to invest in in-state companies. They also can create a fund that, in turn, invests in private venture-capital funds, which is referred to as a "fund of funds" if it involves more than one fund. As of 2010, 13 states reported investing in a fund of funds, 10 states reported investing state dollars in private venture-capital firms, and 14 states reported making direct investments in bioscience companies (Table 3).

Table 3. State Investments to Increase the Availability of Locally Managed, Later-Stage Venture Capital, 2010

State	Invested in Fund of Funds	Invested in Private VC Firms	Invested in Bioscience Companies	Other
DE	●	●	●	
HI				Appropriated funds for contract with private nonprofit to provide funding for companies
IL	●	●	●	
IA	●			
KS			●	
KY	●	●	●	
MA			●	Through Massachusetts Technology Development Corporation
MI	●			
MT	●			
NJ	●	●	●	
NM	●	●	●	
NC	●	●		
OH	●	●	●	
OK	●		●	
OR	●			
PA		●	●	
RI			●	
SD			●	Provides financing for feasibility studies in the form of a forgivable loan
TN		●		
VA			●	
WI	●	●	●	

State Tax Credits to Support the Growth of Bioscience Companies

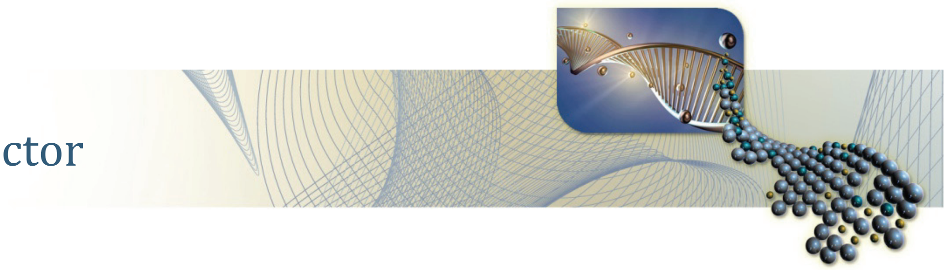
Thirty-four states reported exempting sales tax for equipment used in R&D, including equipment purchased for biomanufacturing, and 33 states reported exempting equipment purchased for biomanufacturing from sales tax. Seven states—Colorado, Missouri, New Jersey, New Mexico, North Carolina, Rhode Island, and Wisconsin—have sales tax exemptions specifically targeted to bioscience firms (Table 4).

Table 4. State Sales Tax Exemptions for Equipment and/or Bioscience Firms

State	Sales Tax Exemption for Equipment Used in R&D	Sales Tax Exemption Specifically Targeted to Bioscience	Sales Tax Exemption on Equipment Purchased for Biomanufacturing
CO	●	●	●
CT	●		●
DE	●		●
FL	●		●
GA	●		●
HI	●		●
IL	●		●
IN	●		●
IA	●		●
KS	●		●
KY	●		●
LA	●		●
ME	●		●
MD	●		●
MA	●		●
MI	●		●
MN	●		●
MS	●		●
MO	●	●	●
NE	●		●
NV	●		●
NJ	●	●	●
NM	●	●	●
NY	●		●
NC	●	●	●
ND	●		●
OH	●		●
PA	●		●
RI	●	●	●
SC	●		●
SD	●		●
VA	●		●
WA	●		●
WI*	●	●	

*Bioscience tax credit effective 1/1/2011

U.S. Bioscience Sector



Introduction

The bioscience industry sector, as this report has documented in prior editions, has consistently generated high-paying jobs across a varied set of value-adding niche components and geographies. As the national economy faced a severe recession in late 2007, the sector's resilience was tested. Analysis of the biosciences through the first year of the recession reveals a sector that has fared well. The industry that has continually outpaced job growth for the overall private sector during the economic expansion continued to add jobs in 2008 while national private sector employment declined. Performance has varied among the major subsectors of the industry, and even one subsector, drugs and pharmaceuticals, lost jobs in 2008. The diverse nature of the biosciences, however, has enabled states and localities to continue to rely on the industry and their own niches within the industry as a proven job and economic growth generator.

Defining the Biosciences

The biosciences represent a unique industry with impressive variety yet common threads. The industry includes a varied set of companies that span manufacturing, research activities, and services and a whole range of products and services classified among 27 individual industry segments. Much more than other sectors, the biosciences are dynamic and evolve with the latest research and scientific discoveries with tremendous widespread impact on food, medicine, and the environment. The common link among this diverse set of companies is an application of knowledge as to how living organisms function.

The biosciences transcend industry classification, making the sector difficult to define and track. The existing federal industry classification system does not identify one single industry code that encompasses all bioscience activities; therefore, defining the industry requires a careful examination of all industries engaged in bioscience-related activity. In its work with BIO and in assisting numerous states and regions in developing their bioscience industry base, Battelle has identified four major subsectors that represent the core of current and likely future bioscience economic activity. The four major subsectors of the biosciences include the following:

- **Agricultural feedstock and chemicals**—Firms engaged in agricultural production and processing, organic chemical manufacturing, and fertilizer manufacturing. The subsector includes the emerging industry activity in the production of ethanol and other biofuels.
- **Drugs and pharmaceuticals**—Firms that develop and produce biological and medicinal products and manufacture pharmaceuticals and diagnostic substances.
- **Medical devices and equipment**—Firms that develop and manufacture surgical and medical instruments and supplies, laboratory equipment, electromedical apparatus including MRI and ultrasound equipment, dental equipment and supplies, and ophthalmic products.
- **Research, testing, and medical laboratories**—Firms engaged in research and development in biotechnology and other life sciences, life science testing laboratories, and stand-alone medical laboratories and other diagnostic centers.

Research and economic activity within a fifth center of bioscience activity might include academic health centers, research hospitals, and other biomedical research-driven institutions. Many U.S. hospitals partner with universities and other research institutes to further advances in the biosciences with a particular focus on biomedical and healthcare applications. Unfortunately, current industrial classifications and available data do not allow for an isolation of these research-oriented establishments outside of the larger hospitals sector. Though it cannot be reliably quantified, the sector should be recognized as an important element of the bioscience industry cluster.

Table 5 presents the component industries that make up each of the four bioscience subsectors. This 2010 edition of the Battelle-BIO report now incorporates the updates and revisions to North American Industry Classification System (NAICS) classifications implemented in 2007. Highly relevant for this report is the incorporation of a new industry code, NAICS 541711, that for the first time isolates industry R&D activities specifically in "biotechnology."

Table 5. The Bioscience Subsector Industries

NAICS Code	NAICS Description
AGRICULTURAL FEEDSTOCK & CHEMICALS	
311221	Wet corn milling
311222	Soybean processing
311223	Other oilseed processing
325193	Ethyl alcohol manufacturing
325199	All other basic organic chemical manufacturing
325221	Cellulosic organic fiber manufacturing
325311	Nitrogenous fertilizer manufacturing
325312	Phosphatic fertilizer manufacturing
325314	Fertilizer (mixing only) manufacturing
325320	Pesticide and other agricultural chemical manufacturing
DRUGS & PHARMACEUTICALS	
325411	Medicinal and botanical manufacturing
325412	Pharmaceutical preparation manufacturing
325413	In-vitro diagnostic substance manufacturing
325414	Biological product (except diagnostic) manufacturing
MEDICAL DEVICES & EQUIPMENT	
334510	Electromedical apparatus manufacturing
334516	Analytical laboratory instrument manufacturing
334517	Irradiation apparatus manufacturing
339112	Surgical and medical instrument manufacturing
339113	Surgical appliance and supplies manufacturing
339114	Dental equipment and supplies manufacturing
339115	Ophthalmic goods manufacturing
339116	Dental laboratories
RESEARCH, TESTING, & MEDICAL LABORATORIES	
541380*	Testing laboratories
541711	R&D in biotechnology
541712*	R&D in the physical, engineering, and life sciences (except biotech)
621511	Medical laboratories
621512	Diagnostic imaging centers

*Includes only a portion of these industries engaged in relevant life-science research and testing activities

While extremely useful for identifying those firms classified in biotech, the new industry structure also includes related life sciences R&D in NAICS 541712, in addition to physical and engineering R&D activities. The inclusion of life sciences R&D in NAICS 541712 requires applying a sharing procedure implemented by Battelle in prior reports (to address virtually the same issue within R&D) in order to effectively isolate these additional key R&D activities from their non–life-science counterparts. The data and methodology section of this report discusses the relevant changes in NAICS and the comparability of figures in this report with those reported in prior editions.

Bioscience Employment Metrics

To measure the size, relative concentration, and overall employment impacts of the biosciences in the United States, Battelle tabulated employment, establishment, and wage data for each state, the District of Columbia, Puerto Rico, and every metropolitan statistical area (MSA). The data were calculated for each of the four bioscience industry subsectors for 2001 and 2008, the most current, detailed, and comparable annual data available.

The Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW) program data were used as the primary data source for this industry analysis. The QCEW provides the most accurate employment data for detailed industries at the sub-national level. The data represent a virtual "census" of workers covered under the Unemployment Insurance system, as reported by employers.

Metropolitan area data that measure relative employment concentration in this analysis are tabulated and presented in groups by the overall private sector employment level of the MSA. Each MSA is classified as either large, medium, or small with respect to private sector employment. A "large" MSA has total regional employment at or above 250,000. A "medium" MSA has total employment greater than or equal to 75,000, but less than 250,000. A "small" MSA has employment less than 75,000. By presenting key employment metrics among metro areas of a similar overall size, the data provide a more useful comparison.

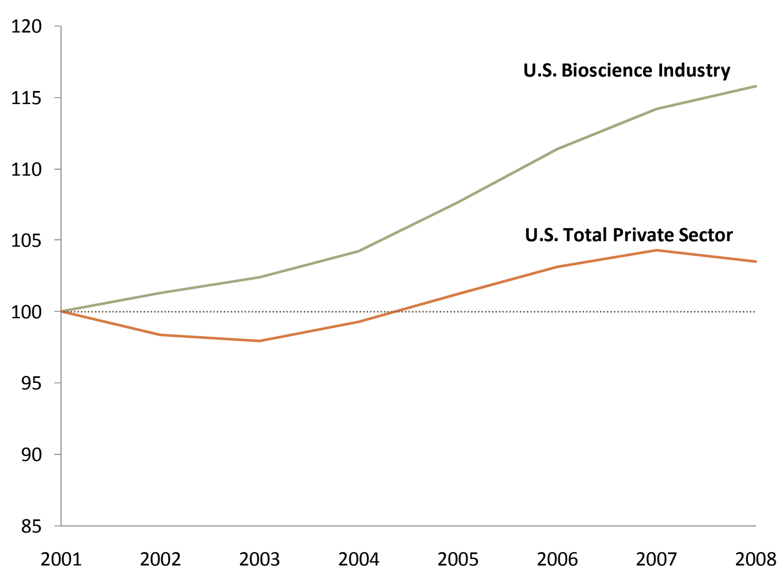
For a full discussion of the data and methodology used in this analysis, refer to the Appendix to this report.

The Size, Composition, Growth, and Impact of the U.S. Bioscience Sector

Overview

Employment in the bioscience sector reached 1.42 million in 2008 following strong job gains during the previous economic expansion and through the first year of the recent recession. Since 2001, U.S. bioscience firms have increased their employment by more than 193,000 jobs or 15.8 percent. This rapid rate of job growth was 4.5 times as much as the overall growth rate for the national private sector (Figure 1).

Figure 1. U.S. Bioscience and Total Private Sector Employment, 2001–08, Indexed (2001=100)



During the previous business cycle, from the economic peak of 2001 through that of 2007, the sector outpaced the overall private sector in terms of job growth by increasing 14.2 percent overall compared with 4.3 percent for the private sector. This relationship continued in 2008 when the biosciences again added jobs, increasing its base by 1.4 percent, and the total private sector contracted by 0.7 percent amid the recession.

The expanding economic footprint of the biosciences is not only evident through increased employment, but also through the number of individual business establishments across the United States. Bioscience companies now operate 47,593 establishments across the country. Establishment totals in the biosciences have steadily increased, with growth of more than 28 percent since 2001. Much of the gain in establishments has come in research, testing, and medical labs where firms tend to have smaller operations, on average, compared with the other manufacturing-oriented subsectors (Table 6).

Table 6. U.S. Bioscience Employment and Establishments, 2008, and Changes, 2001–08 and 2007–08

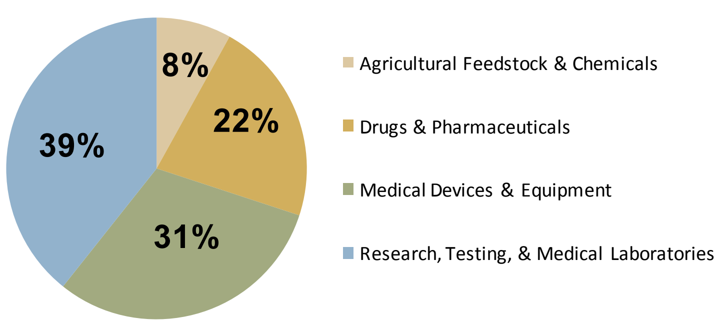
Bioscience Subsector	2008 Establishments	Change in Establishments, 2001–08	Change in Establishments, 2007–08	2008 Employment	Change in Employment, 2001–08	Change in Employment, 2007–08
Agricultural Feedstock & Chemicals	2,440	16.0%	6.4%	114,793	1.9%	4.6%
Drugs & Pharmaceuticals	2,771	6.4%	2.0%	311,882	2.3%	-2.3%
Medical Devices & Equipment	15,227	0.4%	1.6%	435,509	2.0%	2.4%
Research, Testing, & Medical Laboratories	27,154	57.7%	6.1%	558,140	46.1%	2.1%
Total U.S. Biosciences	**47,593**	**28.3%**	**4.4%**	**1,420,324**	**15.8%**	**1.4%**

Source: Battelle analysis of BLS, QCEW data from the Minnesota IMPLAN Group.

Research, testing, and medical labs represent the largest and fastest-growing subsector of the biosciences. The subsector employs more than 558,000 and spans more than 27,000 U.S. business establishments. It employs about 4 in 10 bioscience workers and, since 2001, has generated 9 of every 10 new bioscience jobs. Research, testing, and medical labs have continuously grown since 2001, adding more than 176,000 jobs or 46.1 percent to its employment base during the 7-year period. The subsector carried its strong growth trend into the first year of the recession, with 2.1 percent job growth in 2008.

Medical devices and equipment is the second-largest component of the U.S. bioscience sector, with 31 percent of employment (Figure 2). Subsector firms operate more than 15,000 establishments employing nearly 436,000 employees in 2008. After the 2001 recession and 3 years of job declines, the subsector has grown steadily since 2004, increasing its employment base by nearly 6 percent or an average annual growth rate of 1.5 percent. This recent growth includes expanded hiring during the first year of the recent recession, with subsector jobs increasing by 2.4 percent over 2008.

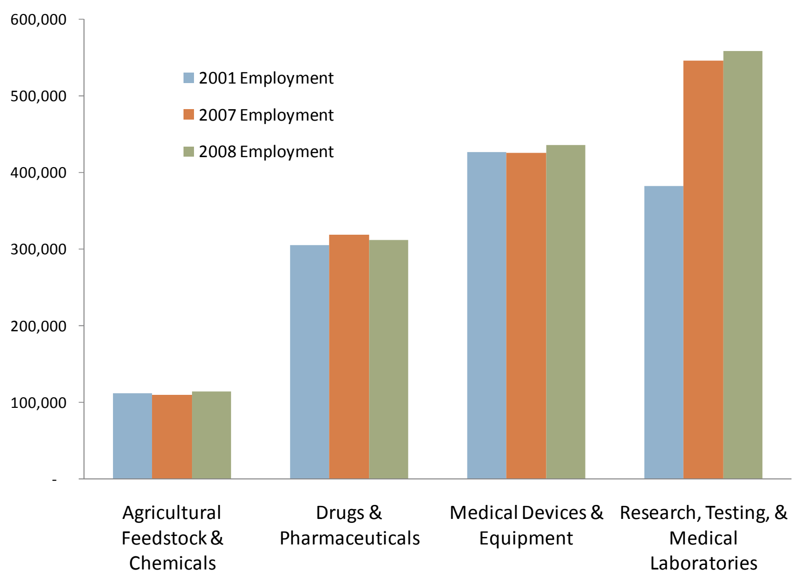
Figure 2. Employment Composition of the U.S. Bioscience Sector, 2008



The drugs and pharmaceuticals subsector began the recent recession, from 2007 to 2008, by shedding 2.3 percent of its employment base, which totaled nearly 312,000 by 2008 and spanned about 2,800 individual business establishments. During much of the economic expansion of the 2000s, employment in this bioscience subsector remained relatively flat, though it grew in both 2006 and 2007. Its rate of job loss was greater than that for the overall U.S. private sector in 2008, which declined by just 0.7 percent in the first year of the recession. As the only of the four bioscience subsectors to lose jobs in 2008, drugs and pharmaceuticals' share of national bioscience employment declined from 24 percent in 2006 to 22 percent in 2008.

The smallest of the major bioscience subsectors, agricultural feedstock and chemicals, employed nearly 115,000 or 8 percent of the national bioscience industry in 2008. Like much of the national bioscience sector, firms in agricultural feedstock and chemicals had strong momentum entering the recent recession and expanded their workforce even through the first year of the recession. After shedding jobs in 2006, the subsector resumed its job growth by adding jobs in both 2007 and 2008 (Figure 3). The subsector jobs total is up 1.9 percent overall since 2001.

Figure 3. U.S. Employment by Bioscience Subsector, 2001, 2007, and 2008



Broader Impacts of the Bioscience Industry: Employment Multipliers

The bioscience industry, with 1.42 million jobs and a high-skilled, high-wage workforce, directly accounts for a substantial national economic impact. The full impact of this high-value growth sector of the economy, however, goes well beyond the direct level of employment and earnings presented thus far in this report. The biosciences, like other industries, have interdependent relationships with suppliers of other goods and services. The sector both supports and depends upon other regional and national economic entities to supply everything from marketing or legal services to transportation or janitorial services to assist in running daily operations. As a result, the industry has a regional and national impact that is greater than its total direct employment or earnings might suggest.

State employment multipliers are used to measure the additional regional impact of adding bioscience jobs. Multipliers quantify the broad ripple effect outlined above where one industry (in this case, the biosciences) creates and supports additional economic activities. The Bureau of Economic Analysis (BEA) has developed regional factors to conduct this type of impact analysis using its Regional Input-Output Modeling System also known as RIMS II.[10]

Battelle has calculated state and national employment impact factors for each major bioscience subsector using the direct-effect employment multipliers provided by BEA.[11] The multipliers represent the total change in number of jobs in all industries (direct, indirect, and induced effects) that result from a change of one job in the corresponding industry sector. At the national level, the multipliers range from 3.3 for research, testing, and medical laboratories, to 11.3 for agricultural feedstock and chemicals.

The total indirect and induced employment impact of the 1.4 million U.S. bioscience jobs is an additional 6.6 million jobs throughout the remainder of the economy. Together, these direct, indirect, and induced

[10] For more information on the BEA RIMS II multipliers used in this report, refer to the Appendix.

[11] All state and national subsector multipliers and total employment impacts are presented in the State Profile tables within this report. Multipliers for Puerto Rico are not available from BEA.

bioscience impacts account for a total employment impact of 8.0 million jobs. This amounts to an overall bioscience direct-effect employment multiplier of 5.8.

Bioscience Wages

Bioscience workers continue to earn more, on average, than their counterparts in most other major industries. In 2008, U.S. bioscience workers earned an average annual wage of $77,595 (Table 7). These earnings are $32,000 greater, on average, than wages in the overall U.S. private sector. The wage premium in the biosciences reflects both the highly skilled makeup of its workforce, as well as the strong demand for these workers in the United States. Bioscience workers earn 1.72 times the private sector average (or 72 percent greater), a ratio that has increased from 1.61 (or 61 percent more) in 2001.

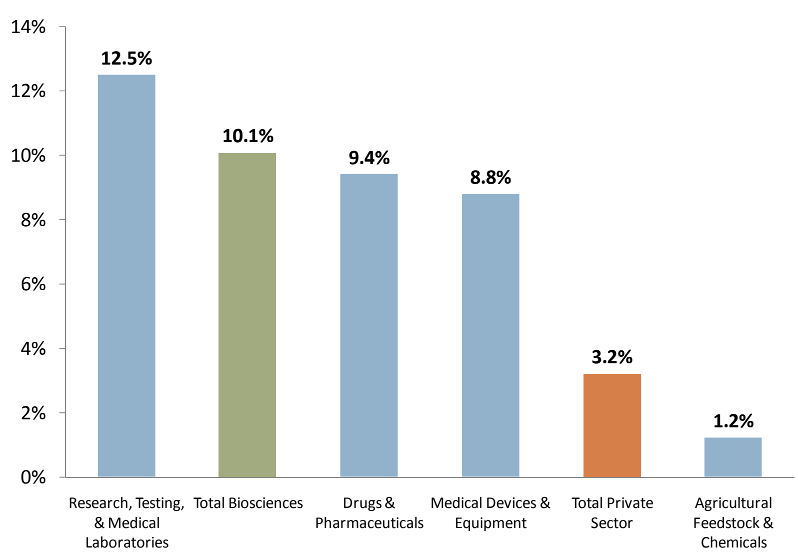
Table 7. Average Annual Wages in the Biosciences and Other Major Industries, 2008

U.S. Average Annual Wages per Employee, 2008		
Drugs & Pharmaceuticals	**$**	**93,378**
Finance and Insurance	$	85,274
Research, Testing, & Medical Laboratories	**$**	**80,785**
Total Biosciences	**$**	**77,595**
Professional, Scientific, and Technical Services	$	74,354
Agricultural Feedstock & Chemicals	**$**	**72,279**
Information	$	70,780
Medical Devices & Equipment	**$**	**63,606**
Manufacturing	$	54,392
Construction	$	49,014
U.S. Total Private Sector	**$**	**45,229**
Real Estate and Rental and Leasing	$	43,239
Transportation and Warehousing	$	42,969
Health Care and Social Assistance	$	42,150
Retail Trade	$	26,181

Source: Battelle analysis of BLS, QCEW data from the Minnesota IMPLAN Group.

Average wage growth in the biosciences continues to outpace that for the overall private sector. Since 2001, real (inflation-adjusted) earnings have increased by 10.1 percent, compared with 3.2 percent for the U.S. private sector (Figure 4). Among the subsectors, average wages in research, testing, and medical laboratories have risen significantly, and are up 12.5 percent since 2001. Workers in drugs and pharmaceuticals and in medical devices and equipment have seen their wages rise by an average of 9 percent.

Figure 4. Change in Real Average Annual Wages in the Biosciences and the Total Private Sector, 2001–08



The following section provides a more in-depth examination of employment trends among each of the four major bioscience subsectors. Data were tabulated for each state, the District of Columbia, Puerto Rico, and each MSA to determine the size and relative job concentration within each subsector. In addition, employment growth and loss were calculated to illuminate recent trends.

Employment size measures the absolute level of jobs within each region. To allow for meaningful comparisons across regions, the region's share of total U.S. employment was analyzed. States with more than 5 percent of national employment are labeled "large"; states with more than 3 percent but less than 5 percent are referred to as "sizable."

Employment concentration is a useful way in which to gauge a region's subsectors relative to the national average. State and regional location quotients (LQs) measure the degree of job concentration within the region relative to the nation.[12] States or regions with an LQ greater than 1.0 are said to have a concentration in the subsector. When the LQ is significantly above average, 1.20 or greater, the state is said to have a "specialization" in the industry.

The level of **employment growth or loss** during 2001 to 2008 provides a snapshot of recent progress in growing a state's bioscience sector. In this analysis, job growth or loss was measured by absolute employment gains or losses, as percentage changes may overstate trends in those states with a smaller subsector employment base.

[12] Location quotients (LQs) are a standard measure of the concentration of a particular industry in a region relative to the nation. The LQ is the share of total regional employment in the particular industry divided by the share of total industry employment in the nation. An LQ greater than 1.0 for a particular industry indicates that the region has a greater relative concentration, whereas an LQ less than 1.0 signifies a relative underrepresentation. An LQ greater than 1.20 denotes employment concentration significantly above the national average. In this analysis, regional specializations are defined by LQs of 1.20 or greater.

AGRICULTURAL FEEDSTOCK and CHEMICALS

The agricultural feedstock and chemicals subsector applies life sciences knowledge, biochemistry, and biotechnologies to the processing of agricultural goods and the production of organic and agricultural chemicals. The subsector also includes activities around the production of biofuels.

Examples of Products

Fertilizers, pesticides, herbicides, and fungicides

Corn and soybean oil

Ethanol and biodiesel fuels

Biodegradable materials synthesized from plant-based feedstock

Sustainable industrial oils and lubricants

Biocatalysts

Examples of Companies

Archer Daniels Midland

BASF Plant Science

Bayer CropScience

Bunge

Cargill

Dow AgroSciences

DuPont

Intrepid Potash

Monsanto

Scotts Miracle-Gro

Syngenta

States that are Both Large and Specialized*

Texas

Illinois

Iowa

Ohio

Tennessee

Metro Areas with the Largest Employment Levels*

Houston-Baytown-Sugar Land, TX

New York-Northern New Jersey-Long Island, NY-NJ-PA

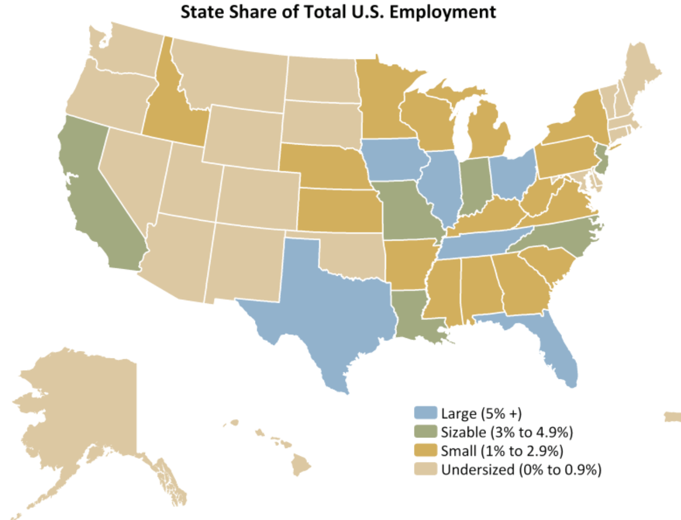
Decatur, IL

Indianapolis, IN

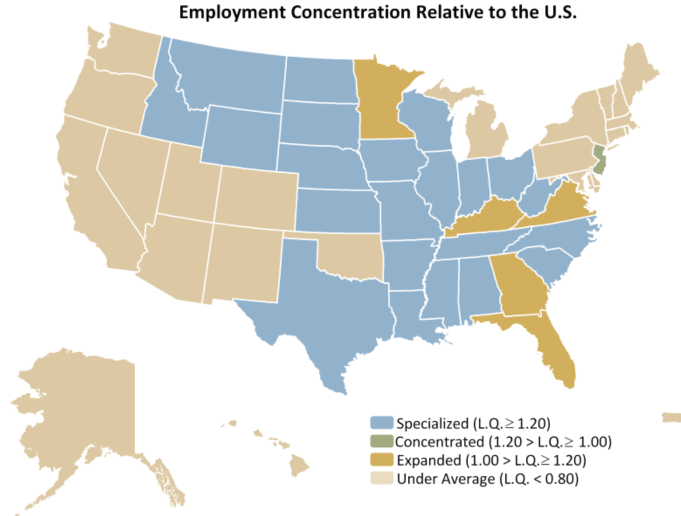
Memphis, TN-MS-AR

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

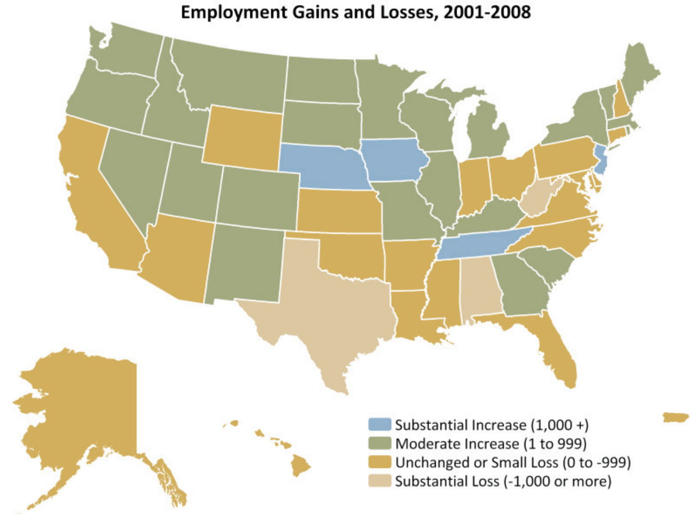
State Share of Total U.S. Employment



Employment Concentration Relative to the U.S.



Employment Gains and Losses, 2001-2008



Agricultural Feedstock and Chemicals

Overview

Agricultural feedstock and chemicals, representing 8 percent of the nation's bioscience jobs, has resumed job growth in recent years and added establishments. With primary components of what's often referred to as the "agbiosciences," it employed 114,793 in 2008 across 2,440 individual business establishments. Like much of the national bioscience sector, firms in agricultural feedstock and chemicals had strong momentum entering the recent recession and expanded their workforce even through the first year of the recession. After shedding workers in 2006, employers in the subsector added jobs in both 2007 and 2008, increasing their employment base by 8.5 percent or nearly 9,000 jobs over those 2 years. The subsector jobs total is up 1.9 percent overall since 2001.

The major components of the agricultural bioscience subsector consist of agricultural feedstock and organic and agricultural chemicals. The chemicals component is much larger and has been the recent driver of job gains, particularly in the production of ethanol and biofuels and in the catch-all component of "all other basic organic chemicals." Substantial investments in labor and capital in the ethanol industry have resulted in U.S. jobs in the sector growing steadily through the decade to 2008. In a sector that had a limited presence in the early 2000s, employment among ethanol producers has increased more than 180 percent to more than 9,000 jobs in 2008.

State Agricultural Feedstock and Chemicals Employment

Employment Size. The national subsector is widely distributed among states, with the largest 10 states accounting for just 57 percent of total employment.

Large States: Texas, Illinois, Iowa, Ohio, Tennessee, Florida[13]

Sizable States: Indiana, California, Missouri, Louisiana, North Carolina, New Jersey

Employment Concentration. Twenty-two states have a specialized agricultural bioscience subsector, more than for any of the four subsectors. These concentrations are generally in the Midwest and South.

Specialized States: Iowa, Nebraska, Idaho, Louisiana, South Dakota, Tennessee, West Virginia, Indiana, North Dakota, Illinois, Missouri, Arkansas, Alabama, Mississippi, Ohio, Kansas, Texas, Wyoming, South Carolina, Wisconsin, North Carolina, Montana

Concentrated States: New Jersey

Employment Growth. The net employment gain in agricultural feedstock and chemicals totaled 2,100 jobs during 2001 to 2008. Contributing to this increase in employment were just over half of all states. Twenty-three states experienced moderate job gains (increases of fewer than 1,000 jobs). Four states—Tennessee, Iowa, New Jersey, and Nebraska—were the only to experience large employment increases (more than 1,000 jobs).

Large and Specialized States. Five states have both a large employment base and a specialized concentration of jobs in agricultural feedstock and chemicals (Table 8).

[13] All state listings by employment size and concentration in this section are in descending order.

Table 8. States with Large and Specialized Employment in Agricultural Feedstock and Chemicals, 2008

State	Establishments 2008	Employment 2008	Location Quotient	Share of U.S. Employment
Texas	228	11,546	1.32	10.1%
Illinois	125	9,760	1.93	8.5%
Iowa	144	7,568	5.99	6.6%
Ohio	124	6,836	1.51	6.0%
Tennessee	46	5,980	2.57	5.2%

Source: Battelle analysis of BLS, QCEW data from the Minnesota IMPLAN Group.

Metropolitan Areas

Tables 9 and 10 present those MSAs with the overall largest employment levels (size) in agricultural feedstock and chemicals and those with the highest LQs (concentration) among their respective size categories.

Table 9. MSAs with the Largest Employment Levels in Agricultural Feedstock and Chemicals, 2008

Metropolitan Statistical Area	2008 Employment
Houston-Baytown-Sugar Land, TX	5,565
New York-Northern New Jersey-Long Island, NY-NJ-PA	4,480
Decatur, IL	4,326
Indianapolis, IN	2,791
Memphis, TN-MS-AR	2,571
Baton Rouge, LA	2,404
Lakeland, FL	2,194
Chicago-Naperville-Joliet, IL-IN-WI	1,763
Cincinnati-Middletown, OH-KY-IN	1,437
Cleveland-Elyria-Mentor, OH	1,432
Beaumont-Port Arthur, TX	1,337
Mobile, AL	1,260
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	1,241
Kansas City, MO-KS	1,188
St. Louis, MO-IL	1,151
Tampa-St. Petersburg-Clearwater, FL	1,137
Cedar Rapids, IA	1,106
Omaha-Council Bluffs, NE-IA	1,099
Peoria, IL	1,098
Knoxville, TN	1,056
Victoria, TX	1,010
Los Angeles-Long Beach-Santa Ana, CA	1,006
Champaign-Urbana, IL	1,003
Charleston, WV	974
Dallas-Fort Worth-Arlington, TX	945

Source: Battelle analysis of BLS, QCEW data from the Minnesota IMPLAN Group.

Table 10. MSAs with the Highest LQs in Agricultural Feedstock and Chemicals, 2008

Metropolitan Statistical Area	Location Quotient	2008 Employment
Large MSAs (Total Private Employment Greater than 250,000)		
Baton Rouge, LA	8.25	2,404
Memphis, TN-MS-AR	4.79	2,571
Knoxville, TN	3.69	1,056
Indianapolis, IN	3.63	2,791
Madison, WI	3.28	873
Omaha-Council Bluffs, NE-IA	2.78	1,099
Houston-Baytown-Sugar Land, TX	2.48	5,565
New Orleans-Metairie-Kenner, LA	1.91	828
Greensboro-High Point, NC	1.87	597
Dayton, OH	1.63	526
Cincinnati-Middletown, OH-KY-IN	1.61	1,437
Cleveland-Elyria-Mentor, OH	1.59	1,432
Richmond, VA	1.57	794
Buffalo-Niagara Falls, NY	1.45	650
Kansas City, MO-KS	1.39	1,188
Medium MSAs (Total Private Employment Between 75,000 and 250,000)		
Champaign-Urbana, IL	13.28	1,003
Lakeland, FL	12.27	2,194
Beaumont-Port Arthur, TX	9.62	1,337
Cedar Rapids, IA	9.06	1,106
Mobile, AL	8.27	1,260
Charleston, WV	8.14	974
Peoria, IL	6.55	1,098
Augusta-Richmond County, GA-SC	3.30	566
Charleston-North Charleston, SC	2.88	680
Kingsport-Bristol-Bristol, TN-VA	2.47	264
Stockton, CA	2.29	426
Sioux Falls, SD	2.27	277
Lubbock, TX	2.23	227
Waco, TX	2.01	175
Fayetteville, NC	1.94	181
Small MSAs (Total Private Employment Less Than 75,000)		
Decatur, IL	89.52	4,326
Victoria, TX	23.59	1,010
Blacksburg-Christiansburg-Radford, VA	16.37	790
Danville, IL	13.75	336
St. Joseph, MO-KS	10.69	524
Sioux City, IA-NE-SD	10.37	691
Pocatello, ID	9.86	279
Ames, IA	9.55	276
Decatur, AL	9.11	439
Kankakee-Bradley, IL	8.19	308
Johnson City, TN	7.57	489
Valdosta, GA	7.30	318
Lafayette, IN	6.92	463
Hanford-Corcoran, CA	4.80	145
Sheboygan, WI	4.67	264

DRUGS and PHARMACEUTICALS

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

Examples of Products

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

Examples of Companies

Abbott Laboratories
Amgen
Biogen Idec
Cornerstone Therapeutics
Eli Lilly & Co.
Merck & Co.
Mylan
Novartis
Pfizer
Roche Group – Genentech
Sanofi-Aventis/Sanofi Pasteur

States that are Both Large and Specialized*

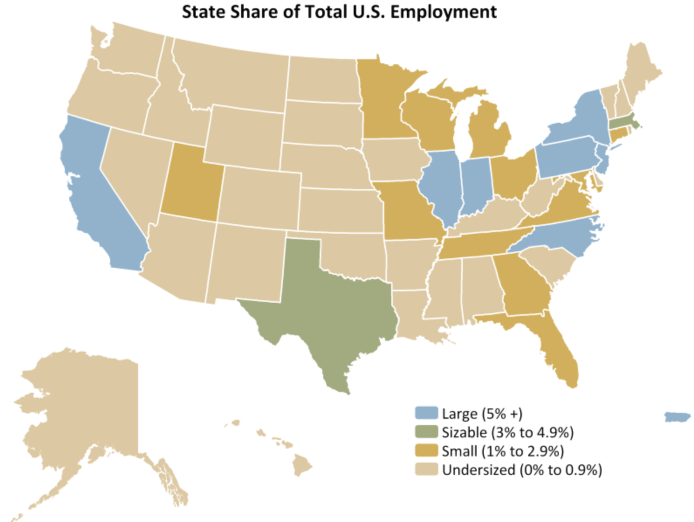
California
New Jersey
Puerto Rico
Pennsylvania
Indiana
North Carolina
Illinois

Metro Areas with the Largest Employment Levels*

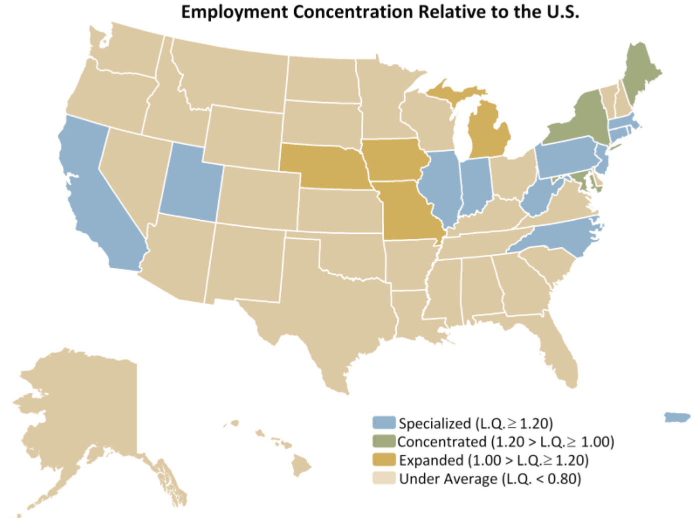
New York-Northern New Jersey-Long Island, NY-NJ-PA
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD
Chicago-Naperville-Joliet, IL-IN-WI
Indianapolis, IN
San Francisco-Oakland-Fremont, CA

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

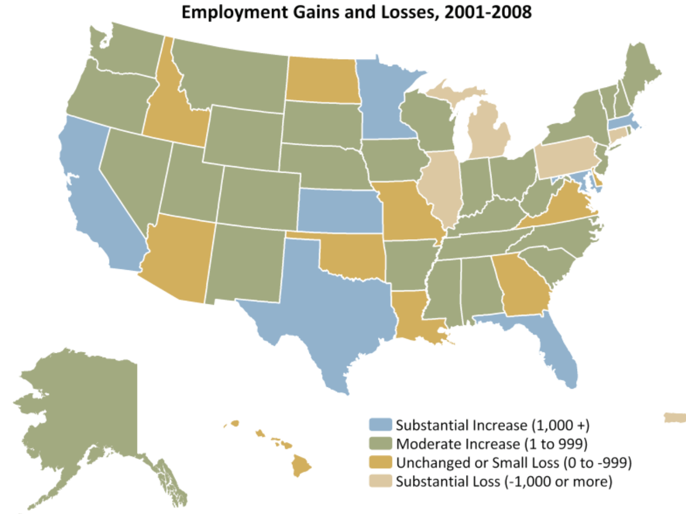
State Share of Total U.S. Employment



Employment Concentration Relative to the U.S.



Employment Gains and Losses, 2001-2008



Drugs and Pharmaceuticals

Overview

The U.S. drugs and pharmaceuticals sector began the recent recession, from 2007 to 2008, by shedding 2.3 percent of its employment base, which totaled 311,882 by 2008. During much of the economic expansion of the 2000s, employment in this bioscience subsector remained relatively flat, though it grew in both 2006 and 2007. Its rate of job loss was greater than that for the overall U.S. private sector in 2008, which declined by just 0.7 percent in the first year of the recession. As the only of the four bioscience subsectors to lose jobs in 2008, drugs and pharmaceuticals' share of national bioscience employment declined from 24 percent in 2006 to 22 percent in 2008.

The majority of jobs in drugs and pharmaceuticals are in the large pharmaceutical preparation manufacturing industry. This component industry was the major contributor to the recent decline by decreasing about 2 percent in employment since 2006. Other smaller components of drugs and pharmaceuticals have, however, supported the overall sector by adding jobs in 2008—companies producing in-vitro diagnostics have increased employment by nearly 8 percent over the year and nearly 45 percent since 2001; companies manufacturing biological products have increased employment by more than 3 percent over the year and nearly 9 percent since 2001.

U.S. drug and pharmaceutical production spans 2,771 individual business establishments manufacturing an array of products from therapeutics and vaccines to new biologics. Production establishments in this subsector tend to be the largest in the bioscience industry in terms of employment—with an average of 113 employees. Another distinguishing characteristic of the subsector is its high wages, with firms paying its U.S. workers more than $93,000, on average, in 2008. This represents the highest average wage among the four major bioscience subsectors.

State Drugs and Pharmaceuticals Employment

Employment Size. Industrial activity in drugs and pharmaceuticals is more highly concentrated among fewer states than the other bioscience subsectors. The 10 states with the largest number of jobs account for 71 percent of national subsector employment. California and New Jersey, the largest two states, combine to make up more than one-quarter of national pharmaceutical employment.

Large States: California, New Jersey, Puerto Rico, Pennsylvania, New York, Indiana, North Carolina, Illinois

Sizable States: Texas, Massachusetts

Employment Concentration. Eleven states and Puerto Rico have a specialized concentration of jobs in production of drugs and pharmaceuticals.

Specialized States: Puerto Rico, New Jersey, Indiana, North Carolina, Connecticut, Utah, Pennsylvania, Illinois, Rhode Island, West Virginia, Massachusetts, California

Concentrated States: Maryland, New York, Maine

Employment Growth. The drugs and pharmaceuticals subsector, though it lost jobs in 2008, has seen overall job growth since 2001, up 2.3 percent. National job growth has been widespread, with 36 states increasing employment at some level. California leads in job growth, with state companies adding just fewer than 4,000 jobs since 2001.

Large and Specialized States. Seven states have both a large employment base and a specialized concentration of jobs in drugs and pharmaceuticals (Table 11).

Table 11. States with Large and Specialized Employment in Drugs and Pharmaceuticals, 2008

State	Establishments 2008	Employment 2008	Location Quotient	Share of U.S. Employment
California	395	43,038	1.21	13.8%
New Jersey	255	37,956	4.17	12.2%
Puerto Rico	74	22,556	11.50	7.2%
Pennsylvania	118	22,288	1.65	7.1%
Indiana	43	18,822	2.79	6.0%
North Carolina	80	18,787	2.04	6.0%
Illinois	117	18,533	1.35	5.9%

Source: Battelle analysis of BLS, QCEW data from the Minnesota IMPLAN Group.

Metropolitan Areas

Tables 12 and 13 present those MSAs with the overall largest employment levels (size) in drugs and pharmaceuticals and those with the highest LQs (concentration) among their respective size categories.

Table 12. MSAs with the Largest Employment Levels in Drugs and Pharmaceuticals, 2008

Metropolitan Statistical Area	2008 Employment
New York-Northern New Jersey-Long Island, NY-NJ-PA	49,752
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	17,584
Chicago-Naperville-Joliet, IL-IN-WI	17,029
Indianapolis, IN	12,396
San Francisco-Oakland-Fremont, CA	12,009
Los Angeles-Long Beach-Santa Ana, CA	11,318
Boston-Cambridge-Quincy, MA-NH	8,682
Durham, NC	6,755
Oxnard-Thousand Oaks-Ventura, CA	6,537
San Diego-Carlsbad-San Marcos, CA	4,673
Dallas-Fort Worth-Arlington, TX	4,208
Bridgeport-Stamford-Norwalk, CT	3,774
St. Louis, MO-IL	3,578
Washington-Arlington-Alexandria, DC-VA-MD-WV	3,478
Kalamazoo-Portage, MI	3,455
Raleigh-Cary, NC	3,431
Miami-Fort Lauderdale-Miami Beach, FL	3,250
Minneapolis-St. Paul-Bloomington, MN-WI	3,125
Baltimore-Towson, MD	2,738
New Haven-Milford, CT	2,373
Cincinnati-Middletown, OH-KY-IN	2,353
San Jose-Sunnyvale-Santa Clara, CA	2,190
Greenville, SC	2,094
Riverside-San Bernardino-Ontario, CA	1,908
Vallejo-Fairfield, CA	1,885

Table 13. MSAs with the Highest LQs in Drugs and Pharmaceuticals, 2008

Metropolitan Statistical Area	Location Quotient	2008 Employment
Large MSAs (Total Private Employment Greater than 250,000)		
Oxnard-Thousand Oaks-Ventura, CA	9.21	6,537
Indianapolis, IN	6.31	12,396
Bridgeport-Stamford-Norwalk, CT	3.82	3,774
Raleigh-Cary, NC	3.14	3,431
Greenville, SC	3.10	2,094
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	2.87	17,584
New Haven-Milford, CT	2.84	2,373
New York-Northern New Jersey-Long Island, NY-NJ-PA	2.70	49,752
San Francisco-Oakland-Fremont, CA	2.62	12,009
Madison, WI	2.58	1,750
Worcester, MA	1.87	1,317
Chicago-Naperville-Joliet, IL-IN-WI	1.71	17,029
San Diego-Carlsbad-San Marcos, CA	1.63	4,673
Boston-Cambridge-Quincy, MA-NH	1.58	8,682
Buffalo-Niagara Falls, NY	1.44	1,655
Medium MSAs (Total Private Employment Between 75,000 and 250,000)		
Durham, NC	11.74	6,755
Kalamazoo-Portage, MI	11.03	3,455
Vallejo-Fairfield, CA	7.17	1,885
Boulder, CO	4.91	1,737
Norwich-New London, CT	4.31	1,045
Trenton-Ewing, NJ	4.17	1,782
Lincoln, NE	3.86	1,311
Provo-Orem, UT	3.75	1,458
Evansville, IN-KY	3.58	1,429
Santa Cruz-Watsonville, CA	2.72	566
Waco, TX	2.31	516
Ogden-Clearfield, UT	2.24	889
Kingsport-Bristol-Bristol, TN-VA	2.19	600
Holland-Grand Haven, MI	2.11	526
Portland-South Portland-Biddeford, ME	1.78	1,028
Small MSAs (Total Private Employment Less Than 75,000)		
Morgantown, WV	13.87	1,595
Cleveland, TN	9.73	832
Bloomington, IN	7.17	1,048
St. Joseph, MO-KS	7.13	894
Greenville, NC	6.92	979
Kankakee-Bradley, IL	6.88	662
Harrisonburg, VA	5.94	786
Terre Haute, IN	5.94	878
Lebanon, PA	5.29	550
Lafayette, IN	5.10	872
Athens-Clarke County, GA	4.97	766
Logan, UT-ID	4.75	501
Columbus, IN	3.83	387
Napa, CA	3.20	492
Iowa City, IA	3.05	449

MEDICAL DEVICES and EQUIPMENT

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

Examples of Products

Bioimaging equipment
Surgical supplies and instruments
Orthopedic/prosthetic implants and devices
Laser eye surgery instruments
Automated external defibrillators (AEDs)
Vascular stents and other implantable devices
Dental instruments and orthodontics
Walkers, wheelchairs, and beds

Examples of Companies

Alcon
Becton, Dickinson and Co.
Boston Scientific Corp.
GE Healthcare
Medtronic
Roche Group – Ventana
Siemens Medical Solutions
STERIS
Stryker
Zimmer
3M Health Care

States that are Both Large and Specialized*

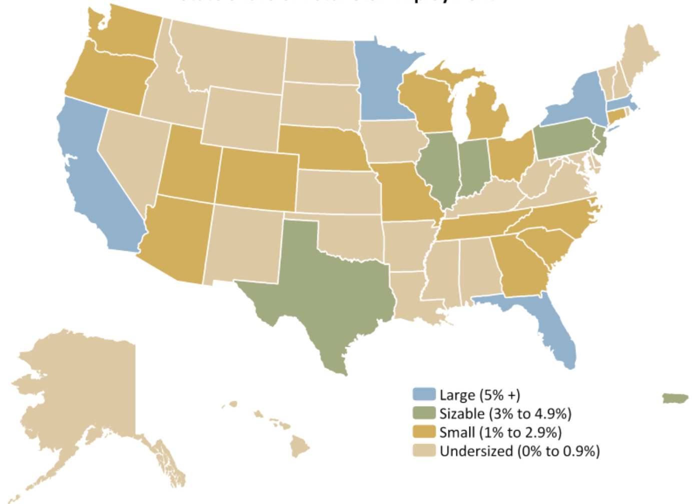
California
Minnesota
Massachusetts

Metro Areas with the Largest Employment Levels*

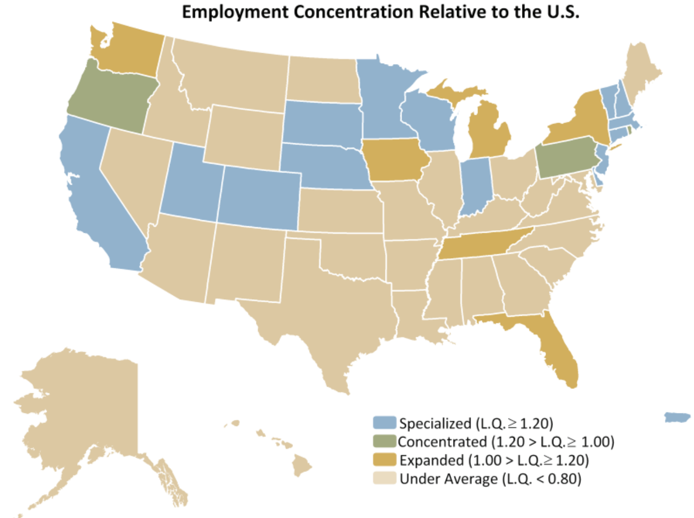
Los Angeles-Long Beach-Santa Ana, CA
Minneapolis-St. Paul-Bloomington, MN-WI
New York-Northern New Jersey-Long Island, NY-NJ-PA
Boston-Cambridge-Quincy, MA-NH
Chicago-Naperville-Joliet, IL-IN-WI

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

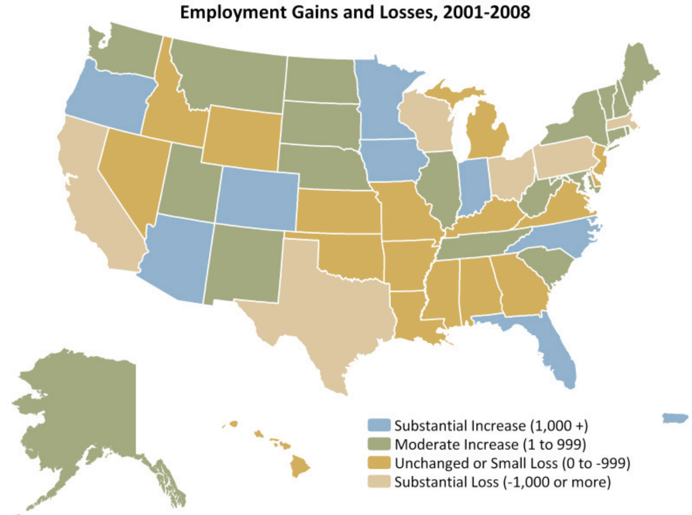
State Share of Total U.S. Employment



Employment Concentration Relative to the U.S.



Employment Gains and Losses, 2001-2008



Medical Devices and Equipment

Overview

The national medical devices and equipment subsector represents nearly one-third of U.S. bioscience employment in 2008, with 435,509 jobs spanning 15,227 individual establishments. After the 2001 recession and 3 years of job declines, the subsector has grown steadily since 2004, increasing its employment base by nearly 6 percent or an average annual growth rate of 1.5 percent. This recent growth includes expanded hiring in 2008 during the first year of the recent recession, with subsector jobs increasing by 2.4 percent over the year.

Among the component manufacturing industries in the medical devices and equipment subsector, surgical and medical instruments, surgical appliances and supplies, and electromedical apparatus producers have led job growth during the subsector's recent 4-year growth period. These represent not only the top growth components, but also the largest employer industries in the subsector. Other, smaller component industries had more modest job gains.

State Medical Devices and Equipment Employment

Employment Size. Medical device production is widespread, with establishments in every state, the District of Columbia, and Puerto Rico. The top 10 employer states account for 59 percent of the national subsector.

Large States: California, Minnesota, Florida, Massachusetts, New York

Sizable States: Indiana, Pennsylvania, Texas, Puerto Rico, New Jersey, Illinois

Employment Concentration. Fourteen states and Puerto Rico have a specialized concentration of jobs in medical devices. Puerto Rico continues to have the highest LQ.

Specialized States: Puerto Rico, Minnesota, Utah, Indiana, Delaware, Massachusetts, Connecticut, Nebraska, California, South Dakota, New Hampshire, Vermont, Colorado, Wisconsin, New Jersey

Concentrated States: Rhode Island, Pennsylvania, Oregon

Employment Growth. Medical devices and equipment has gained about 8,500 jobs or 2.0 percent since 2001, with steady growth since 2004. Employment gains have been widespread among the States, with 19 states experiencing moderate job gains over the 7-year period to 2008 and eight states—Minnesota, Indiana, Iowa, Florida, Oregon, North Carolina, Arizona, and Colorado—and Puerto Rico contributing large employment gains (more than 1,000 jobs).

Large and Specialized States. Three states have both a large employment base and a specialized concentration of jobs in medical devices and equipment (Table 14).

Table 14. States with Large and Specialized Employment in Medical Devices and Equipment, 2008

State	Establishments 2008	Employment 2008	Location Quotient	Share of U.S. Employment
California	2,023	73,344	1.47	16.8%
Minnesota	489	29,963	3.40	6.9%
Massachusetts	441	22,135	2.04	5.1%

Source: Battelle analysis of BLS, QCEW data from the Minnesota IMPLAN Group.

Metropolitan Areas

Tables 15 and 16 present those MSAs with the overall largest employment levels (size) in medical devices and equipment and those with the highest LQs (concentration) among their respective size categories.

Table 15. MSAs with the Largest Employment Levels in Medical Devices and Equipment, 2008

Metropolitan Statistical Area	2008 Employment
Los Angeles-Long Beach-Santa Ana, CA	31,488
Minneapolis-St. Paul-Bloomington, MN-WI	27,686
New York-Northern New Jersey-Long Island, NY-NJ-PA	19,592
Boston-Cambridge-Quincy, MA-NH	16,596
Chicago-Naperville-Joliet, IL-IN-WI	13,499
San Jose-Sunnyvale-Santa Clara, CA	10,413
San Francisco-Oakland-Fremont, CA	9,908
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	8,920
Miami-Fort Lauderdale-Miami Beach, FL	8,632
Salt Lake City, UT	7,264
Dallas-Fort Worth-Arlington, TX	7,143
San Diego-Carlsbad-San Marcos, CA	6,483
Tampa-St. Petersburg-Clearwater, FL	6,221
Milwaukee-Waukesha-West Allis, WI	6,037
Indianapolis, IN	5,890
Riverside-San Bernardino-Ontario, CA	5,826
Seattle-Tacoma-Bellevue, WA	5,502
Denver-Aurora, CO	5,154
Pittsburgh, PA	4,971
Cleveland-Elyria-Mentor, OH	4,651
New Haven-Milford, CT	4,621
Portland-Vancouver-Beaverton, OR-WA	4,350
Rochester, NY	4,245
Providence-New Bedford-Fall River, RI-MA	4,147
Memphis, TN-MS-AR	4,002

Source: Battelle analysis of BLS, QCEW data from the Minnesota IMPLAN Group.

Table 16. MSAs with the Highest LQs in Medical Devices and Equipment, 2008

Metropolitan Statistical Area	Location Quotient	2008 Employment
Large MSAs (Total Private Employment Greater than 250,000)		
Minneapolis-St. Paul-Bloomington, MN-WI	4.87	27,686
New Haven-Milford, CT	3.85	4,621
Salt Lake City, UT	3.68	7,264
San Jose-Sunnyvale-Santa Clara, CA	3.35	10,413
Madison, WI	2.84	2,768
Worcester, MA	2.76	2,790
Rochester, NY	2.72	4,245
Syracuse, NY	2.46	2,318
Milwaukee-Waukesha-West Allis, WI	2.19	6,037
Boston-Cambridge-Quincy, MA-NH	2.10	16,596
Indianapolis, IN	2.09	5,890
Memphis, TN-MS-AR	2.03	4,002
Grand Rapids-Wyoming, MI	1.93	2,465
Providence-New Bedford-Fall River, RI-MA	1.88	4,147
Bridgeport-Stamford-Norwalk, CT	1.83	2,608
Medium MSAs (Total Private Employment Between 75,000 and 250,000)		
Boulder, CO	5.15	2,618
Kalamazoo-Portage, MI	4.32	1,947
Santa Rosa-Petaluma, CA	3.42	2,097
Reading, PA	3.24	1,784
Santa Barbara-Santa Maria-Goleta, CA	3.20	1,851
Scranton--Wilkes-Barre, PA	3.13	2,609
Ogden-Clearfield, UT	2.85	1,631
Gainesville, FL	2.30	780
Rochester, MN	2.19	757
Utica-Rome, NY	2.18	771
Huntington-Ashland, WV-KY-OH	2.17	759
Burlington-South Burlington, VT	2.16	763
St. Cloud, MN	2.10	674
Manchester-Nashua, NH	2.08	1,369
Deltona-Daytona Beach-Ormond Beach, FL	1.85	978
Small MSAs (Total Private Employment Less Than 75,000)		
Bloomington, IN	15.63	3,289
Glens Falls, NY	14.05	2,273
Flagstaff, AZ	10.81	1,761
Niles-Benton Harbor, MI	9.40	1,901
Corvallis, OR	9.32	919
Sumter, SC	6.68	757
State College, PA	5.56	909
Iowa City, IA	4.07	860
Elmira, NY	3.68	443
Logan, UT-ID	3.03	459
Jackson, MI	2.55	444
Michigan City-La Porte, IN	2.08	291
Gainesville, GA	2.01	487
Racine, WI	1.68	416
Saginaw-Saginaw Township North, MI	1.67	453

RESEARCH, TESTING, and MEDICAL LABORATORIES

The research, testing, and medical laboratories subsector includes a range of activities; from highly research-oriented companies working to develop and commercialize new drug discovery/delivery systems, and gene and cell therapies, to more service-oriented firms engaged in medical and other life sciences testing services.

Examples of Products

Preclinical drug development
Drug delivery systems
Diagnostic imaging and testing
Stem cell/regenerative research
Biomarkers
Research/laboratory support services

Examples of Companies

Albany Molecular Research
Celera
Charles River Laboratories
Covance
Laboratory Corp. of America
NeoGenomics
Orchid Cellmark
Pacific Biomarkers
Pharmaceutical Product Development
Quest Diagnostics

States that are Both Large and Specialized*

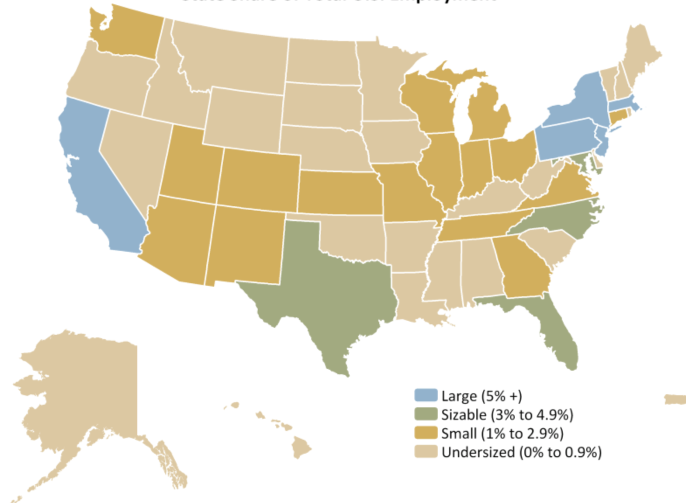
California
Massachusetts
Pennsylvania
New Jersey

Metro Areas with the Largest Employment Levels*

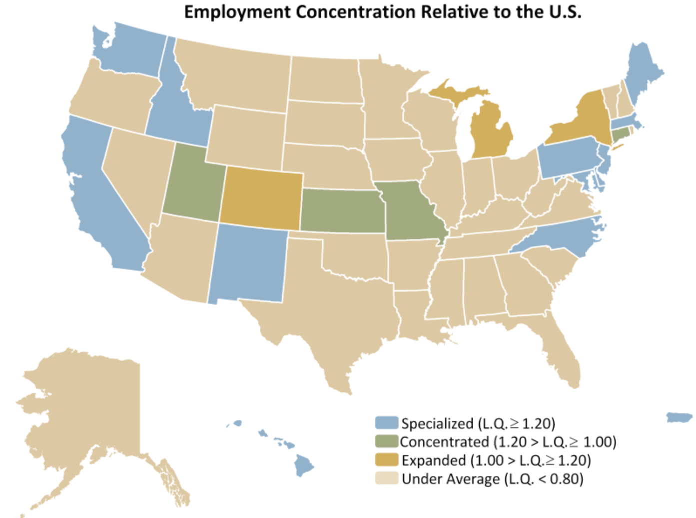
New York-Northern New Jersey-Long Island, NY-NJ-PA
Boston-Cambridge-Quincy, MA-NH
Los Angeles-Long Beach-Santa Ana, CA
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD
San Francisco-Oakland-Fremont, CA

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

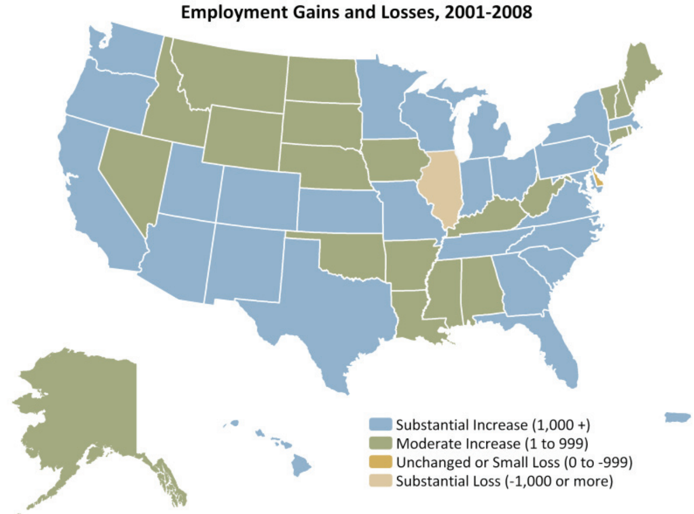
State Share of Total U.S. Employment



Employment Concentration Relative to the U.S.



Employment Gains and Losses, 2001-2008



Research, Testing, and Medical Laboratories

Overview

Research, testing, and medical laboratories, with rapid job growth in recent years, has firmly established itself as the largest among the four U.S. bioscience subsectors. It has continuously grown since 2001, adding more than 176,000 jobs or 46.1 percent to its employment base during the 7-year period. The subsector that now employs about 4 in 10 U.S. bioscience workers carried its strong growth trend into the first year of the recession, with 2.1 percent job growth in 2008. Like employment, research, testing, and medical lab establishments have also grown rapidly and totaled 27,154 in 2008. Subsector establishments tend to be the smallest in the biosciences, in terms of employment, averaging about 21 employees per site compared with an industry-wide average of 30 employees per establishment.

Compared with the other bioscience subsectors, this subsector is unique in that its firms do not engage in manufacturing specific products. Companies in the biosciences that provide R&D and lab services play a critical role in breakthrough research and the development of new products, in addition to administering biomedical diagnostic and lab services. When products like new therapeutics, for example, are developed and successfully commercialized by these biotechnology companies, they often move out of the subsector by classification and into drugs and pharmaceuticals.

The biotechnology and other life sciences R&D component of the subsector has experienced the most rapid growth and now accounts for 60 percent of subsector employment. While employment in the medical laboratories and diagnostic imaging component has also seen growth, it makes up a smaller share of subsector jobs than in the recent past and now stands at 38 percent. Life sciences testing labs make up the remaining 2 percent.

State Research, Testing, and Medical Laboratories Employment

Employment Size. The largest of the bioscience subsectors, research, testing, and medical laboratories employment is widespread and rapidly growing. Similar to other subsectors, the 10 largest states account for 63 percent of national jobs. California, with just over 100,000 jobs, is by far the largest state in the subsector, followed by Massachusetts and Pennsylvania.

Large States: California, Massachusetts, Pennsylvania, New Jersey, New York

Sizable States: Texas, Florida, Maryland, North Carolina

Employment Concentration. Twelve states, the District of Columbia, and Puerto Rico have specialized employment concentrations relative to the national average in research, testing, and medical laboratories.

Specialized States: Massachusetts, Maryland, District of Columbia, New Mexico, New Jersey, Delaware, Idaho, California, Pennsylvania, Puerto Rico, North Carolina, Hawaii, Washington, Maine

Concentrated States: Missouri, Utah, Kansas, Connecticut

Employment Growth. Rapid national growth among firms in research, testing, and medical laboratories has been geographically widespread, with 48 states and Puerto Rico adding some level of jobs in the subsector since 2001. Among these growth states are an impressive 27 states and Puerto Rico that have grown their job base by 1,000 jobs or more.

Large and Specialized States. Four states have both a large employment base and a specialized concentration of jobs in research, testing, and medical laboratories (Table 17).

Table 17. States with Large and Specialized Employment in Research, Testing, and Medical Laboratories, 2008

State	Establishments 2008	Employment 2008	Location Quotient	Share of U.S. Employment
California	3,485	100,132	1.57	17.9%
Massachusetts	1,184	40,281	2.90	7.2%
Pennsylvania	1,130	37,007	1.53	6.6%
New Jersey	1,127	31,723	1.95	5.7%

Source: Battelle analysis of BLS, QCEW data from the Minnesota IMPLAN Group.

Metropolitan Areas

Tables 18 and 19 present those MSAs with the overall largest employment levels (size) in research, testing, and medical laboratories and those with the highest LQs (concentration) among their respective size categories.

Table 18. MSAs with the Largest Employment Levels in Research, Testing, and Medical Laboratories, 2008

Metropolitan Statistical Area	2008 Employment
New York-Northern New Jersey-Long Island, NY-NJ-PA	43,670
Boston-Cambridge-Quincy, MA-NH	36,158
Los Angeles-Long Beach-Santa Ana, CA	29,375
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	29,163
San Francisco-Oakland-Fremont, CA	22,446
Washington-Arlington-Alexandria, DC-VA-MD-WV	21,095
San Diego-Carlsbad-San Marcos, CA	19,114
San Jose-Sunnyvale-Santa Clara, CA	14,723
Chicago-Naperville-Joliet, IL-IN-WI	12,751
Baltimore-Towson, MD	11,205
Detroit-Warren-Livonia, MI	10,253
St. Louis, MO-IL	9,658
Miami-Fort Lauderdale-Miami Beach, FL	8,953
Seattle-Tacoma-Bellevue, WA	8,801
Houston-Baytown-Sugar Land, TX	8,338
Durham, NC	8,270
Dallas-Fort Worth-Arlington, TX	7,488
Kansas City, MO-KS	7,019
Pittsburgh, PA	6,824
Atlanta-Sandy Springs-Marietta, GA	5,775
Phoenix-Mesa-Scottsdale, AZ	5,603
Sacramento--Arden-Arcade--Roseville, CA	5,101
Tampa-St. Petersburg-Clearwater, FL	4,954
Albany-Schenectady-Troy, NY	4,755
Salt Lake City, UT	4,602

Table 19. MSAs with the Highest LQs in Research, Testing, and Medical Laboratories, 2008

Metropolitan Statistical Area	Location Quotient	2008 Employment
Large MSAs (Total Private Employment Greater than 250,000)		
San Jose-Sunnyvale-Santa Clara, CA	3.51	14,723
San Diego-Carlsbad-San Marcos, CA	3.45	19,114
Boston-Cambridge-Quincy, MA-NH	3.40	36,158
Albany-Schenectady-Troy, NY	2.89	4,755
San Francisco-Oakland-Fremont, CA	2.53	22,446
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	2.46	29,163
Madison, WI	2.26	2,968
Baltimore-Towson, MD	2.13	11,205
Albuquerque, NM	2.00	3,094
Washington-Arlington-Alexandria, DC-VA-MD-WV	1.86	21,095
Raleigh-Cary, NC	1.76	3,718
Salt Lake City, UT	1.73	4,602
New Haven-Milford, CT	1.67	2,701
Kansas City, MO-KS	1.66	7,019
St. Louis, MO-IL	1.66	9,658
Medium MSAs (Total Private Employment Between 75,000 and 250,000)		
Durham, NC	7.42	8,270
Kennewick-Richland-Pasco, WA	6.04	2,568
Trenton-Ewing, NJ	4.88	4,044
Wilmington, NC	4.41	2,626
Rochester, MN	3.65	1,701
Norwich-New London, CT	3.38	1,588
Boulder, CO	3.18	2,179
Ann Arbor, MI	2.80	1,730
Barnstable Town, MA	2.35	918
Kalamazoo-Portage, MI	2.13	1,291
Spokane, WA	1.54	1,355
Peoria, IL	1.48	1,228
Santa Cruz-Watsonville, CA	1.47	591
South Bend-Mishawaka, IN-MI	1.46	860
Oshkosh-Neenah, WI	1.46	591
Small MSAs (Total Private Employment Less Than 75,000)		
Hinesville-Fort Stewart, GA	5.77	333
Burlington, NC	3.18	846
Muncie, IN	1.99	384
Mount Vernon-Anacortes, WA	1.91	362
Bloomington, IN	1.89	535
Santa Fe, NM	1.69	401
Columbia, MO	1.67	501
Bangor, ME	1.60	469
Ames, IA	1.51	215
Monroe, MI	1.42	248
Corvallis, OR	1.38	184
State College, PA	1.24	273
Coeur d'Alene, ID	1.20	280
Lima, OH	1.19	274
Valdosta, GA	1.19	256

Industry Summary and Conclusion

The U.S. bioscience sector has established itself as a proven driver of regional job growth across a set of varied industries. The industry has continued to generate high-quality jobs and outperform job and establishment growth in the national private sector. By 2008, with the U.S. economy in the midst of a recession, the biosciences added jobs while national employment contracted. The sector reached 1.42 million jobs with firms operating nearly 48,000 establishments. While data are not yet available for the detailed bioscience industries through 2009 and the full impact of the recession cannot yet be gauged on the industry, it is clear the sector has fared better than most, with strong momentum through the first year of the economic downturn.

Bioscience employment has maintained a steady growth trajectory since 2001 and through the first year of the recession in 2008. During the previous business cycle, from 2001 through 2007, the biosciences added 14.2 percent to its job base overall, compared with 4.3 percent net growth for the overall private sector. From 2007 to 2008, sector jobs rose 1.4 percent while the private sector declined by 0.7 percent. Three of the four major bioscience subsectors—research, testing, and medical labs; medical devices and equipment; and agricultural feedstock and chemicals—had job growth from 2007 to 2008, with drugs and pharmaceuticals experiencing a decline.

The research, testing, and medical labs subsector has been the primary driver of bioscience job gains. The largest of the major subsectors, it is also the fastest growing, with 46.1 percent job growth since 2001. This represents 9 of every 10 new bioscience jobs over the 7-year period.

After the 2001 recession and 3 years of job declines, medical devices and equipment has grown steadily since 2004, increasing its employment base by nearly 6 percent or an average annual growth rate of 1.5 percent.

A wage premium paid to bioscience workers is evidence of the depth of the industry talent pool and the increasing demand for these workers. In 2008, the average bioscience worker earned about $77,600, 72 percent more than their counterparts across the private sector where average wages were just over $45,000.

Despite the recent recession, employment growth in the national bioscience sector is projected to continue. The overall bioscience average annual growth rate will be 1.5 percent, exceeding the 1.0 percent annual rate projected for the overall private sector through 2016, according to the latest BLS industry employment projections for the 10-year period ending in 2018.

Bioscience firms conduct business in all 50 states, the District of Columbia, and Puerto Rico. The distribution is widespread, with numerous states developing strong niches in certain specializations. While some states are deeply involved in a number of industry subsectors, no one state has a large employment base in every one.

Highlights from the state-by-state industry employment analysis include the following:

- In size, 14 states and Puerto Rico have a large employment base (5 percent or more of national employment) in at least one of the four bioscience subsectors. Seven of those states—California, Florida, Illinois, Massachusetts, New Jersey, New York, and Pennsylvania—have a large base in at least two subsectors. Only two of those states—California and New York—are classified as having a large job base in three of the four subsectors. No states are classified as having a large job base in all four subsectors.

- In employment concentration, 39 states, the District of Columbia, and Puerto Rico have an employment specialization in at least one of the four bioscience subsectors. This total has increased from the 2008 report, with four additional states—Montana, South Carolina, Vermont, and Wyoming—adding a specialized subsector. Fifteen states and Puerto Rico are specialized in two or more industry subsectors. California, Indiana, Massachusetts, New Jersey, North Carolina, and Puerto Rico have a specialization in three of four subsectors. No state is specialized in all four.
- Twelve states and Puerto Rico have both a large and specialized bioscience base in at least one of the four bioscience subsectors (Table 20). That is, they have an employment level that represents at least 5 percent of the U.S. total and they have an LQ that meets or exceeds 1.20. Four states—Illinois, Massachusetts, New Jersey, and Pennsylvania—are both large and specialized in two of the subsectors. California is the only state both large and specialized in three of the four subsectors.

Table 20. States with Both Large and Specialized Bioscience Subsectors, 2008

States	Agricultural Feedstock & Chemicals	Drugs & Pharmaceuticals	Medical Devices & Equipment	Research, Testing, & Medical Laboratories
California		●	●	●
Illinois	●	●		
Indiana		●		
Iowa	●			
Massachusetts			●	●
Minnesota			●	
New Jersey		●		●
North Carolina		●		
Ohio	●			
Pennsylvania		●		●
Puerto Rico		●		
Tennessee	●			
Texas	●			

Source: Battelle analysis of BLS, QCEW data from the Minnesota IMPLAN Group.

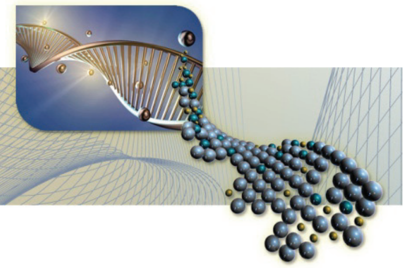
As the national and state bioscience sectors grow, local areas are expanding and refining their own niche in the biosciences. Metropolitan areas both large and small are supporting the biosciences and reaping the economic and social benefits of fostering a local bioscience cluster or individual subsector. Hundreds of metropolitan areas throughout the United States are engaged in some commercial or research endeavors in the biosciences.

Of the nation's 361 MSAs, 190 have an employment specialization in at least one of the four bioscience subsectors in 2008. This total has dropped slightly from 202 MSAs in the previous Battelle-BIO report (using 2006 data).

Fifteen regions have a specialized employment concentration in three of the four bioscience subsectors, including the following:

- Ames, IA
- Boston-Cambridge-Quincy, MA-NH
- Boulder, CO
- Buffalo-Niagara Falls, NY
- Cleveland, TN
- Durham, NC
- Gainesville, GA
- Indianapolis, IN
- Iowa City, IA
- Kalamazoo-Portage, MI
- Lafayette, IN
- New Haven-Milford, CT
- San Diego-Carlsbad-San Marcos, CA
- San Francisco-Oakland-Fremont, CA
- Worcester, MA

Bloomington, Indiana and Madison, Wisconsin, are the only metropolitan areas with a specialized employment concentration in all four bioscience subsectors in 2008. In the previous version of this report using 2006 data, Madison also achieved this distinction in broad but deep industry concentration.



Bioscience Performance Metrics

Beyond Employment

As state, regional, and local stakeholders strive for economic development gains in the biosciences in terms of jobs, establishments, and income, many other factors play into the success, health, and robustness of a region's bioscience industry. Though a full examination of many of these factors (e.g., regional bioscience core competencies, corporate business models, regional networks, and supplier relationships) is beyond the scope of this report, additional analysis of a variety of secondary data sources can provide key insights, both directly and comparatively, into the status of state bioscience performance.

The following section provides an analysis of seven additional metrics of U.S. bioscience performance beyond industry employment—looking first at a national perspective, then providing information on leading states both in total magnitude and in more comparable ratios relative to population.[14] The metrics include academic bioscience R&D expenditures, total NIH funding, clinical trial activities, occupational employment in select bioscience-related fields, degrees awarded by higher education institutions in bioscience-related fields, venture capital investments in bioscience companies, and bioscience-related patents "invented" within the state.[15] Like the industry-based definition of the biosciences described in the previous section, the biosciences in this context do not include healthcare services. Therefore, for two bioscience metrics—occupational employment and degrees—healthcare occupations and degrees are not included in the analysis. It is important to note that some of these data sources extend through 2009 and therefore more fully reflect trends in the biosciences through the recent recession in 2008 and 2009.

As expected, California, due to its sheer size and overall bioscience involvement, leads in each of the seven metrics on a "total" basis. However, as shown in the following discussion, bioscience performance can also be driven by local academic and industrial characteristics and, when controlling for population size, other states also emerge as leaders in the biosciences.

Key Bioscience Performance Metrics

- Academic Bioscience R&D Expenditures
- NIH Funding
- Clinical Trials
- Bioscience Occupational Employment
- Bioscience Degrees Granted
- Bioscience Venture Capital Investments
- Bioscience-Related Patents

[14] For comparability, the various metrics are converted into a per-capita measure (or into a "per 1 million population" metric) in the tables in this section. In some instances, when a state's population is less than 1 million, the number shown in the table may be greater than the actual magnitude of the metric.

[15] For a detailed description of the data used, refer to the Data and Methodology Appendix.

Academic Bioscience R&D Expenditures

Academic institutions are a significant driver of bioscience development in most areas of the country. Bioscience R&D expenditures accounted for nearly $32 billion in FY 2008. This represents more than 60 percent of all U.S. academic R&D, with many individual states significantly exceeding that share. At a national level, this amounts to $104.54 per U.S. citizen spent by the nation's academic institutions on bioscience-related research. Academic bioscience R&D has steadily increased from FY 2004 to FY 2008, as shown in Figure 5, growing by 22.3 percent over the period. This rate is substantially lower than the 5-year FY 2002 to FY 2006 growth rate reported in the Battelle-BIO 2008 report, primarily reflecting the removal of the last 2 years (FY 2002 and FY 2003) of the NIH "doubling" from the 5-year range reported here. The 22.3 percent bioscience R&D growth rate is still higher than the 17.3 percent growth rate of overall academic R&D during FY 2004 to FY 2008.

Figure 5. U.S. Academic Bioscience R&D Expenditures, FY 2004–FY 2008

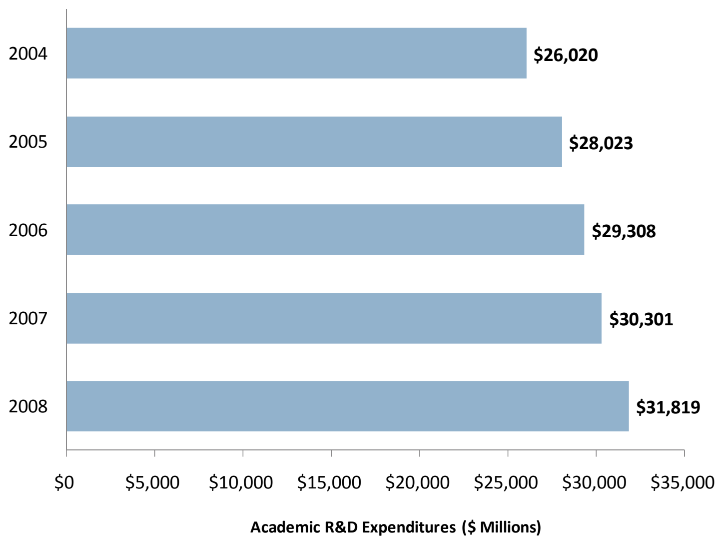


Figure 6. U.S. Academic Bioscience R&D Expenditures by Field, FY 2008

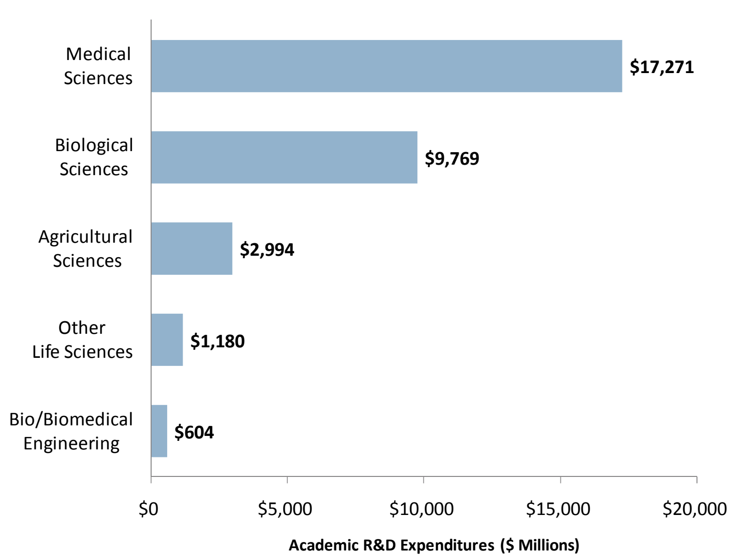


Figure 6 shows that medical sciences research, at more than $17 billion, accounts for the majority of the bioscience research performed at higher education institutions (54 percent) and, in fact, accounts for one-third of all academic R&D in the United States.

As shown in Table 21, the states with larger populations and those with large, multi-institution academic infrastructures lead in total academic bioscience R&D. However, on a per-capita basis, the District of Columbia (with significant levels of bioscience R&D at Georgetown University and George Washington University) leads the nation. Other states, especially smaller states with a single, very strong institution in bioscience R&D, are seen to be research leaders as well.

Of note, while many states had double-digit growth rates in academic bioscience R&D from FY 2004 to FY 2008, five states—Alaska, Idaho, Iowa, Nevada, Vermont—and Puerto Rico experienced actual declines in the amount of academic bioscience R&D performed.

Table 21. Leading States—Academic Bioscience R&D Expenditures, FY 2008

Academic Bioscience R&D Expenditures			
Leading States	**Total in $ Thousands**	**Leading States**	**$ Per Capita**
California	$4,395,602	District of Columbia	$354.73
New York	$2,677,763	Maryland	$240.23
Texas	$2,449,890	Massachusetts	$178.14
Pennsylvania	$1,614,981	Connecticut	$169.72
North Carolina	$1,517,418	North Carolina	$164.10
Maryland	$1,359,357	Vermont	$156.38
Illinois	$1,283,347	Nebraska	$141.09
Massachusetts	$1,165,655	New York	$137.55
Ohio	$1,162,471	Wisconsin	$135.02
Michigan	$950,939	Missouri	$132.99

Source: Battelle calculations based on National Science Foundation (NSF) data and U.S. Census Bureau population estimate.

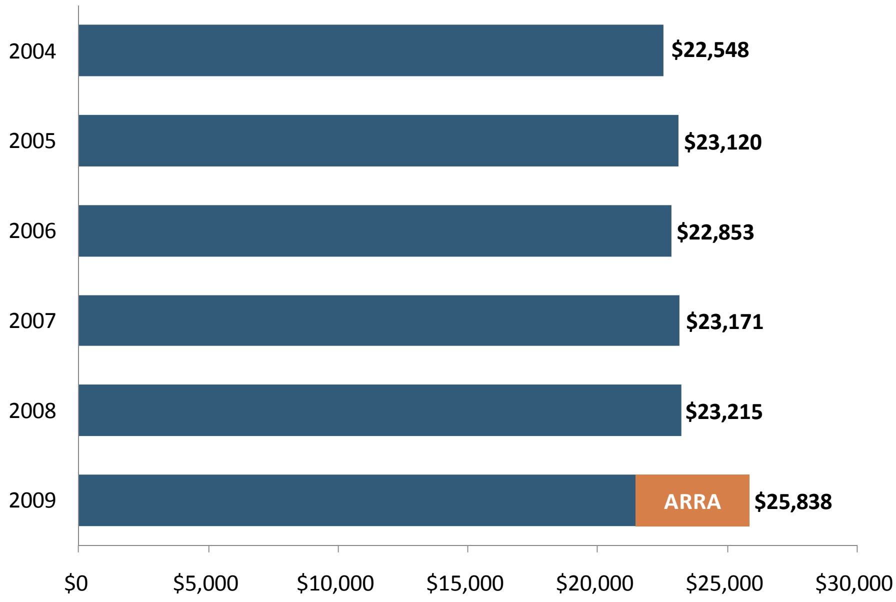
NIH Funding

A variety of federal agencies fund bioscience-related R&D, yet the NIH is considered to be the "gold standard" of biomedical research funding and therefore warrants a closer examination.[16] NIH funding constitutes a significant component of academic medical sciences research and is ultimately included in the academic bioscience R&D expenditures data above. However, NIH also funds research and educational initiatives within non–university-affiliated medical research institutions, hospitals, and other healthcare-related organizations.

In 2009, NIH announced awards of nearly $26 billion in extramural U.S.-based medical research and education. This amount included FY 2009 baseline NIH funding of $21.5 billion. This level continues what can best be described as flat growth since the end of the NIH "doubling" period in FY 2003.[17] In FY 2009, additional resources to NIH, provided through the American Recovery and Reinvestment Act (ARRA) or "economic stimulus," funded an additional $4.4 billion of research. As shown in Figure 7, baseline NIH funding slightly decreased (4.7 percent) from FY 2004 to FY 2009, while overall NIH funding (including ARRA resources) increased by 14.6 percent over FY 2004 levels.

[16] Bioscience-related R&D is also funded by the Department of Agriculture, Department of Defense, the Veterans Administration, NSF, and NASA, as well as other federal departments and agencies.
[17] From FY 1998 through FY 2003, Congressional appropriations for the NIH were purposefully "doubled" from $13.7 billion to $27.1 billion to dramatically increase the level of federal support to biomedical research.

Figure 7. U.S. Extramural NIH Funding, FY 2004–FY 2009



As with academic bioscience R&D, Table 22 shows the larger states capturing the largest amounts of NIH funding (which in fact drives much of the overall academic bioscience R&D performance discussed previously). On a per-capita basis, however, extramural NIH funding amounts to $84.16 per person nationally, with Massachusetts' significant biomedical strengths demonstrated by exceeding five times this amount, reaching nearly $430 per capita. Other smaller states similarly show relative biomedical strength as the District of Columbia, Rhode Island, Connecticut, and Vermont all significantly exceed the national per-capita average.

Table 22. Leading States—NIH Funding, FY 2009

NIH Funding			
Leading States	Total in $ Thousands	Leading States	$ Per Capita
California	$3,852,298	Massachusetts	$429.80
Massachusetts	$2,833,927	District of Columbia	$374.76
New York	$2,318,843	Maryland	$207.24
Pennsylvania	$1,658,949	Rhode Island	$167.52
Texas	$1,283,792	Connecticut	$155.22
Maryland	$1,181,164	Washington	$143.11
North Carolina	$1,141,200	Pennsylvania	$131.61
Washington	$953,722	North Carolina	$121.65
Illinois	$884,277	New York	$118.66
Ohio	$768,868	Vermont	$118.55

Source: Battelle calculations based on NIH data and U.S. Census Bureau population estimates.

From a state-level growth perspective, the additional ARRA funding caused many states to exceed a 25 percent growth rate from FY 2004 to FY 2009. Of the leading states in total funding shown in Table 22, seven states would have seen declines in NIH funding from FY 2004 to FY 2009 before the impact of the additional ARRA funding. When including these "stimulus" funds, only Maryland still saw an actual decline in total NIH funding among these leading states.

Of those states that had at least $200 million in NIH funding in FY 2004, five states—Georgia, Tennessee, Florida, Michigan, and Oregon—had growth rates of 30 percent or greater from FY 2004 to FY 2009.

Clinical Trials

To further understand the biomedical research capacity of the United States overall and individual states, an examination of recent clinical trial activities has been developed. The NIH-sponsored Web site, ClinicalTrials.gov, a registry of federally and privately supported clinical trial activities, provides a mechanism for healthcare professionals, researchers, and the general public to look for details and participation criteria regarding specific clinical trials related to a host of conditions. The data contained in this registry are also useful for examining the progression of biomedical research and understanding the key areas of emphasis. It is important to understand that ClinicalTrials.gov provides information on locations that are participating in the studies, not just the location of the key institution or researcher leading the study.

What is a clinical trial?
Although there are many definitions of clinical trials, they are generally considered to be biomedical or health-related research studies in human beings that follow a pre-defined protocol.

Source: ClinicalTrials.gov

Data was collected on nearly 5,300 clinical trials activities initiated in the United States in 2009. Figure 8 provides a snapshot of this clinical trial activity by phase (for descriptions of the "phases" of clinical trials, please see the adjacent text box).[18] It shows that Phase II studies currently represent the largest type of clinical trial, accounting for approximately 37 percent of the clinical trials. Phase I trials are only slightly behind, accounting for nearly 34 percent of United States clinical trials.

Based upon a category and keyword search, these clinical trials were classified into seven disease areas ranging from "cancer" to "nutritional and metabolic" and including an "other" classification to account for the remaining clinical trial activities, with some clinical trials associated with more than one disease area (e.g., cancer and heart disease). As shown in Figure 9, clinical trials related to cancer far exceed any other single disease area. The prevalence of heart disease in the United States leads this to be the second-largest area of clinical trial activities, with activities related to neurologic diseases the third largest specific disease area examined.

What are the phases of clinical trials?
Clinical trials are conducted in phases. The trials at each phase have a different purpose and help scientists answer different questions:

In **Phase I** trials, researchers test an experimental drug or treatment in a small group of people (20–80) for the first time to evaluate its safety, determine a safe dosage range, and identify side effects.

In **Phase II** trials, the experimental study drug or treatment is given to a larger group of people (100–300) to see if it is effective and to further evaluate its safety.

In **Phase III** trials, the experimental study drug or treatment is given to large groups of people (1,000–3,000) to confirm its effectiveness, monitor side effects, compare it to commonly used treatments, and collect information that will allow the experimental drug or treatment to be used safely.

In **Phase IV** trials, post marketing studies delineate additional information including the drug's risks, benefits, and optimal use.

Source: ClinicalTrials.gov

[18] About 36 percent of the clinical trials records did not contain phase information, and hence the numbers in Figure 8 will not sum to the U.S. total. Additionally, some clinical trials are cross-listed in more than one phase (e.g., Phase II/Phase III). In these instances, the lower phase number is used to categorize the clinical trial for this analysis to avoid double-counting. Finally, while clinical trials can occur over many states, with each state receiving credit for its participation, these trials are counted only once at the national level.

Figure 8. U.S. Clinical Trials by Phase, 2009

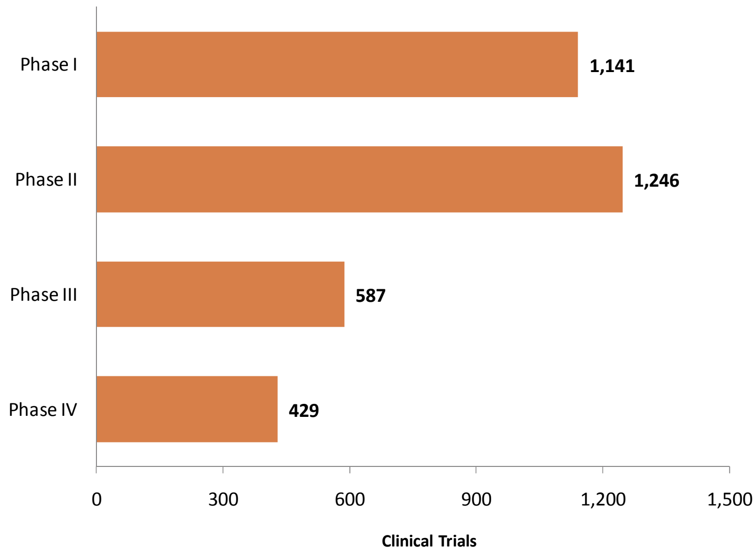
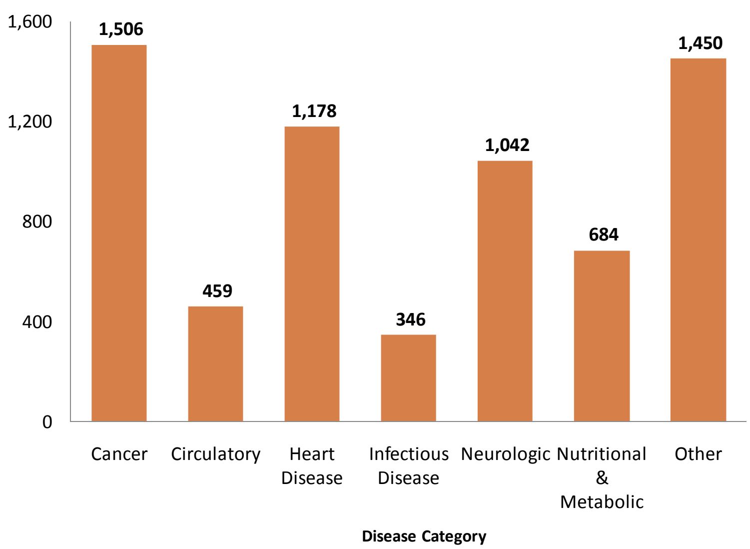


Figure 9. U.S. Clinical Trials by Selected Disease Areas, 2009



Examining the clinical trial activities within the states (Table 23) yields some predictable results in terms of leading states by total number of active clinical trials—corresponding fairly close to population size. When accounting for population size, the District of Columbia and many smaller and more rural states (often with unique demographic and population characteristics) demonstrate important involvement in clinical trial activities.

Table 23. Leading States—Clinical Trials, 2009

Clinical Trials			
Leading States	**Total Clinical Trials**	**Leading States**	**Clinical Trials Per 1 M Population**
California	1,353	District of Columbia	307
Texas	1,213	Rhode Island	138
New York	1,008	Nebraska	136
Florida	895	Maryland	126
Pennsylvania	843	Vermont	122
Ohio	735	North Dakota	117
North Carolina	732	Montana	101
Maryland	717	Massachusetts	99
Illinois	661	Utah	97
Massachusetts	650	Kansas	96

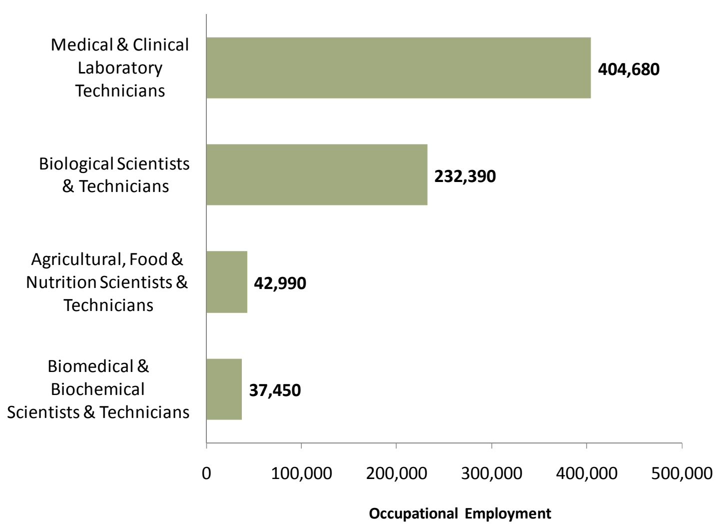
Source: Battelle calculations based on NIH data and U.S. Census Bureau population estimates.

Bioscience Occupational Employment

An additional metric that provides insight into national and state bioscience development is the size and nature of a region's bioscience workforce. Occupational employment provides a perspective of a region's bioscience economy not constrained by industrial classifications and focused on job functions that are unique to the biosciences. This analysis considers only those occupations that are more firmly rooted in commercial and industrial applications and does not include the vast majority of healthcare workers (e.g., doctors and nurses) where population size would be the principal driver of the size of these occupations in a region.

In total, the United States employed 717,510 workers in the occupational areas covered in this analysis. As shown in Figure 10, the majority (56 percent) are employed as medical and clinical laboratory technicians, with an additional 32 percent employed as biological scientists and technicians. Within this broad biological scientists and technicians "field," medical scientists account for nearly 100,000 of the more than 230,000 workers.

Figure 10. U.S. Bioscience Occupational Employment by Field, 2008



The leading states in terms of total occupational employment in Table 24 show that, even while removing the impact population would have on the numbers if healthcare workers were included, California accounts for nearly twice the bioscience occupational employment than the next highest state, Texas, generally revealing that bioscience occupational employment is still relatively tied to population size. States with stronger industrial bioscience sectors, especially those with significant R&D activities occurring in the state, are somewhat elevated in the standings. When controlling for population size, a number of smaller states emerge with respect to their well-concentrated bioscience workforce.

Table 24. Leading States—Bioscience Occupational Employment, 2008

Bioscience Occupational Employment			
Leading States	**Total Occ. Employment**	**Leading States**	**Per 1 M Population**
California	91,670	Massachusetts	5,887
Texas	49,160	District of Columbia	4,237
Pennsylvania	40,070	Maryland	3,572
New York	38,910	Minnesota	3,363
Massachusetts	38,520	Utah	3,362
Florida	27,960	Pennsylvania	3,189
North Carolina	23,630	South Dakota	3,170
New Jersey	22,530	Delaware	3,081
Illinois	22,310	Iowa	2,993
Ohio	21,820	Connecticut	2,938

Source: Battelle calculations based on BLS data and U.S. Census Bureau population estimates.

Bioscience Degrees Granted

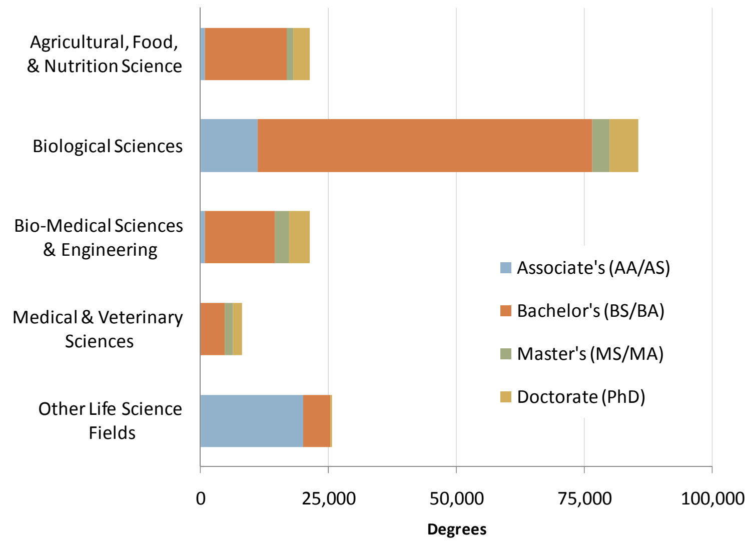
In the 2008 academic year (AY), U.S. higher education institutions granted bioscience-related degrees (ranging from associate's to doctorate degrees) to nearly 162,000 students, accounting for approximately 5 percent of all higher education degrees awarded in 2008.[19] This total is up nearly 13 percent from the 143,000 bioscience degrees awarded in AY 2006.

Figure 11 details the AY 2008 degrees by bioscience discipline and type. Of note is the sheer magnitude of biological sciences bachelor's degrees produced on an annual basis—more than 65,000 in 2008 and accounting for 40 percent of all bioscience degrees awarded. From a workforce development perspective, only in the category "other life science fields" do associate's degrees account for the majority of the awards.[20]

[19] As with the bioscience occupational analysis, this analysis of degrees does not include healthcare-specific fields and degrees (e.g., nursing, MD, DVM, etc.).

[20] It is important to note that, in a mapping of degrees to occupations, this "other life science fields" category maps almost completely to the largest bioscience occupational employment category of medical and clinical laboratory technicians.

Figure 11. U.S. Higher Education Bioscience Degrees by Discipline, AY 2008



While population size has a direct impact on the overall number of bioscience degrees awarded by the states (Table 25), when controlling for population, states with institutions having significant educational programs, often in specialized or agriculture-oriented biological sciences, emerge as key sources of the future bioscience workforce.

Table 25. Leading States—Bioscience Higher Education Degrees, AY 2008

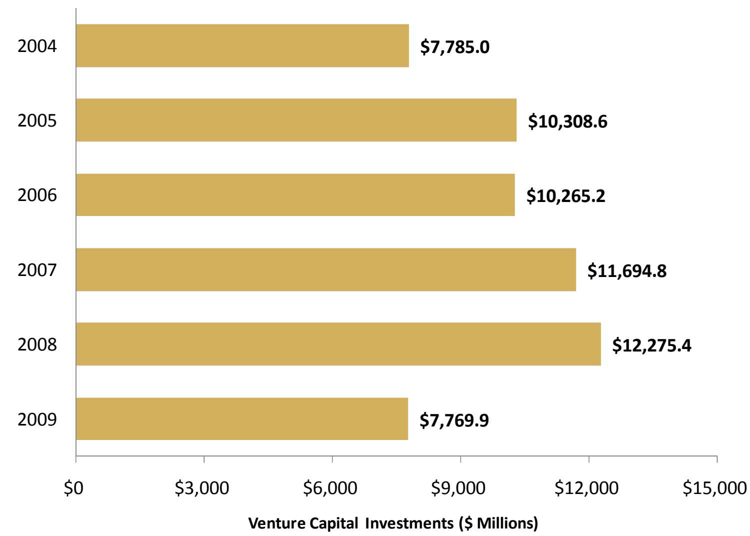
Bioscience Higher Education Degrees			
Leading States	**Total Degrees**	**Leading States**	**Per 1 M Population**
California	19,999	District of Columbia	1,824
Texas	10,504	North Dakota	926
Illinois	10,355	Nebraska	813
New York	9,630	Illinois	806
Pennsylvania	8,390	Rhode Island	785
Florida	6,886	South Dakota	779
Ohio	6,206	Vermont	773
Michigan	5,548	Massachusetts	751
Massachusetts	4,916	Wisconsin	728
North Carolina	4,473	Utah	721

Source: Battelle calculations based on National Center for Education Statistics (NCES-) Integrated Postsecondary Education Data System (IPEDS) data and the U.S. Census Bureau population estimates.

Bioscience Venture Capital Investments

In entrepreneurial development and business formation, venture capital investment is seen as a significant indicator of a region's bioscience performance and success. From 2004 through 2008, bioscience-related venture capital investments showed a steady increase, reaching $12.3 billion in 2008 (Figure 12). Given the severe economic downturn lasting throughout much of 2009, bioscience venture capital investments declined by 36.7 percent from 2008, reaching only $7.8 billion in 2009—slightly less than the amount invested in 2004. Comparatively, overall U.S. venture capital investments also declined—by 33.9 percent from 2008 to 2009.

Figure 12. U.S. Bioscience Venture Capital Investments, 2004–2009



Among the major segments, human biotechnology accounted for the largest share (more than 29 percent) of bioscience venture capital investments during 2004 to 2009. Medical therapeutics and pharmaceutical are the next largest segments, accounting for 20.6 percent and 18.0 percent, respectively (Figure 13).

Figure 13. U.S. Bioscience Venture Capital Investments by Segment, 2004–2009

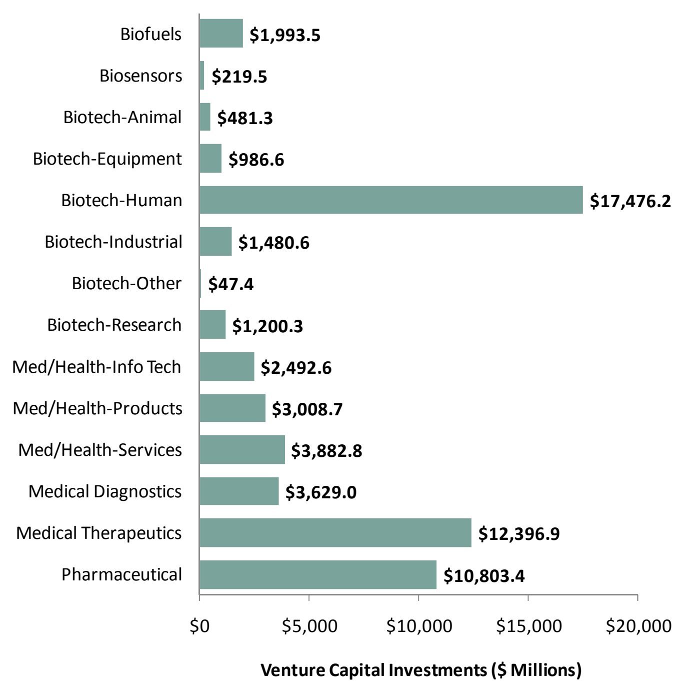


Table 26 provides details regarding U.S. bioscience venture capital investments by company stage. Across all investments, the average bioscience deal is for $8.56 million. The biosciences, like other industries, see a small share of investments going toward start-up/seed-stage efforts—approximately 6 percent of the venture capital investments in the biosciences went toward these deals. Early-stage investments account for the largest number of deals and the number of companies involved. Later-stage investments, however, account for the largest amount of total investment.

Table 26. U.S. Bioscience Venture Capital Investments by Stage, 2004–2009

Stage	Number of Deals	Number of Companies	Total VC Investments	Average Per Deal in $ Millions	Average Investment Per Company in $ Millions
Start-Up/Seed	838	613	$3,520	$4.20	$5.74
Early Stage	1,598	1,026	$10,591	$6.63	$10.32
Expansion	1,577	1,008	$16,053	$10.18	$15.93
Later Stage	1,534	771	$18,253	$11.90	$23.68
Buyout or Acquisition	289	248	$7,573	$26.21	$30.54
Other	1,188	691	$4,107	$3.46	$5.94
Grand Total	7,024	4,357	$60,099	$8.56	$13.79

Source: Battelle calculations based on Thomson Reuters VentureXpert data.

Among the states, California companies account for 38 percent of all bioscience venture capital invested during 2004 to 2009, with Massachusetts accounting for an additional 14 percent (Table 27). It is interesting to note that, when controlling for population size, even though Massachusetts' second-ranked total is more than $14 million less than California's total, on a per 1 million population basis, Massachusetts' level doubles that of California. South Dakota's presence on the per-capita leading states list stems from significant biofuels-related venture investments during the period.

Table 27. Leading States—Bioscience Venture Capital Investments, 2004–2009

Bioscience Venture Capital Investment			
Leading States	**Total in $ Millions**	**Leading States**	**$ Per 1 M Population**
California	$22,912	Massachusetts	$1,238
Massachusetts	$8,161	California	$620
New Jersey	$4,108	New Jersey	$472
Pennsylvania	$2,953	South Dakota	$347
Texas	$2,267	Minnesota	$313
Washington	$1,877	Maryland	$303
New York	$1,845	Colorado	$291
North Carolina	$1,757	Washington	$282
Maryland	$1,727	Connecticut	$282
Minnesota	$1,648	District of Columbia	$255

Source: Battelle calculations based on Thomson Reuters VentureXpert data and U.S. Census Bureau population estimate.

Table 28 provides details of leading states (top five) by bioscience venture capital segments in terms of total dollars invested during 2004 to 2009. California's overall venture capital dominance is reiterated in that it is a top-five player in 13 of the 14 segments. Massachusetts follows with top-five status in 12 of the 14 segments, and Pennsylvania is a top-five state in 6 of the 14 bioscience segments. Overall, 23 states achieve top-five investment totals in one or more bioscience segments.

Table 28. Top-Five States—Bioscience Venture Capital Investments by Segment, 2004–2009

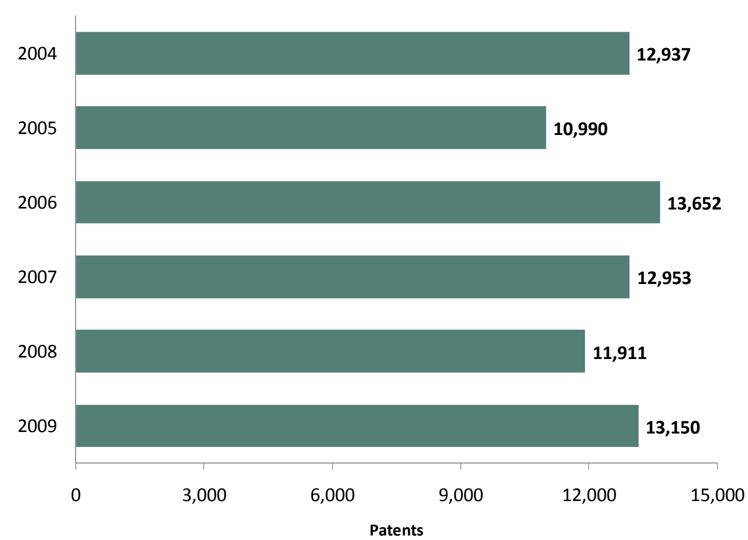
			BIOTECH						MED/HEALTH					
State	Biofuels	Biosensors	Animal	Equipment	Human	Industrial	Other	Research	IT/Software	Products	Services	Medical Diagnostics	Medical Therapeutics	Pharmaceutical
CA	●	●	●	●	●	●		●	●	●	●	●	●	●
CO	●					●								
CT									●					
FL											●			
HI							●							
IA	●													
IL			●											
MA	●		●	●	●	●	●	●	●	●		●	●	●
MD		●				●								●
MN										●			●	
NC		●		●	●		●	●						
NJ			●		●								●	●
NM		●												
NY				●						●		●	●	
OH												●		
PA		●			●		●	●			●			●
RI								●						
SD	●													
TN									●		●			
TX						●					●			
VA									●	●				
WA			●	●								●		
WI							●							

Source: Battelle calculations based on Thomson Reuters VentureXpert data.

Bioscience-Related Patents

The number of bioscience-related patents issued also provides an indicator of the relative strength and innovation of the U.S. bioscience industry. Bioscience-related patent numbers reached 75,593 over the 6-year, 2004-to-2009 period.[21] Bioscience-related patents reached 13,150 in 2009, the second-largest yearly total of the period (Figure 14).

Figure 14. U.S. Bioscience-Related Patents by Year, 2004–2009



[21] This figure counts each patent once for the United States. Adding together each state's patent figures would yield a total of 96,948 as many patents have inventors located in more than one state, with each state receiving credit for the patent, and hence leading to a level of double-counting when adding individual state totals together.

Three areas or patent class groups—surgical and medical instruments, drugs and pharmaceuticals, and biochemistry—account for the vast majority of bioscience-related patents, at 25.5, 24.6, and 22.6 percent of all bioscience patents, respectively (Figure 15).

Figure 15. U.S. Bioscience-Related Patents by Class Group, 2004–2009

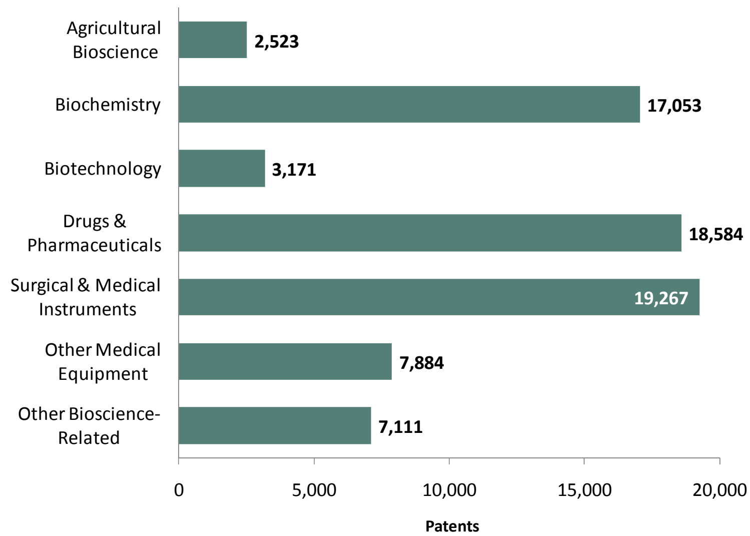


Table 29 shows that six of the leading states in terms of total patents also make the leading list when controlling for population—Massachusetts, Minnesota, New Jersey, California, Maryland, and Pennsylvania. The comparative strength of a number of smaller states is also apparent, as Connecticut, New Hampshire, and Iowa are all top-10 states in bioscience patents per 1 million population.

Table 29. Leading States—Bioscience-Related Patents, 2004–2009

Bioscience-Related Patents			
Leading States	**Total Patents**	**Leading States**	**Per 1 M Population**
California	23,162	Delaware	1,132
Massachusetts	7,250	Massachusetts	1,100
New Jersey	5,790	Minnesota	875
Pennsylvania	5,041	Connecticut	743
New York	4,975	New Jersey	665
Minnesota	4,608	California	627
Maryland	3,554	Maryland	624
Florida	3,141	New Hampshire	475
Texas	3,047	Iowa	454
Illinois	2,904	Pennsylvania	400

Source: Battelle calculations based on United States Patent and Trademark Office (USPTO)/Delphion data and U.S. Census Bureau population estimate.

Table 30 shows the “top-five” states for each of the seven bioscience-related patent class groups. Texas holds a unique and diverse position as it is among the top 10 in total bioscience-related patents, yet it does not make the top-five list in any single bioscience patent class group.

Table 30. Top-Five States—Bioscience-Related Patents by Class Group, 2004–2009

State	Agricultural Bioscience	Biochemistry	Biotechnology	Drugs and Pharmaceuticals	Surgical and Medical Instruments	Other Medical Devices and Equipment	Other Bioscience-Related
CA	●	●	●	●	●	●	●
FL	●				●	●	
GA	●						
IA			●				
IL			●				
IN			●				
MA		●		●	●	●	●
MD		●					
MN			●		●		
NC	●						
NJ				●		●	●
NY		●		●	●	●	●
OR	●						
PA		●		●			●

Source: Battelle calculations based on USPTO/Delphion data.

Summary

This examination of bioscience performance metrics suggests that the nation continues to perform well although there are some signs of threats to future bioscience industry development. In terms of the nation's bioscience R&D base, U.S. academic bioscience R&D expenditures have increased steadily from FY 2004 through FY 2008 but the rate of increase slowed substantially from the FY 2002 to FY 2006. Bioscience R&D expenditures accounted for nearly $32 billion in FY 2008, accounting for more than 60 percent of all U.S. academic R&D, with many individual states significantly exceeding that share. At the same time, however, NIH funding has been flat since FY 2003 and would have declined in FY 2009 if not for the addition of ARRA funding.

The relative strength and innovation of the U.S. bioscience sector is reflected in the number of clinical trials underway and the number of bioscience patents issued. Nearly 5,300 clinical trials were underway in 2009. Bioscience-related patent reached 13,150 in 2009, the second-largest yearly total during the 2004 to 2009 time period. Venture capital investment, however, is a concern. Venture capital investments in bioscience companies fell 36.7 percent between 2008 and 2009, from $12.275 billion to $7.770 billion. In 2009, bioscience venture capital stood below levels recorded back in 2004.

Lastly, there is a mixed picture with regards to bioscience talent. While post-secondary bioscience graduates at all levels (associates, bachelor's, master's and doctorate) grew from 2006 to 2008 by a robust 12.8 percent, there is still concern that at the K-12 level the United States is continuing to fall behind in math and science education and may have trouble meeting the needs of bioscience companies for skilled, technical workers. The study, *Taking the Pulse of Bioscience Education in America: A State by State Analysis,* conducted by Battelle, BIO, and the Biotechnology Institute in 2009 concluded that states are not measuring up in terms of K-12 bioscience education and that wide disparities exist among states in student performance in the biosciences and broader sciences.

Conclusion

The bioscience industry is an extremely important and rapidly growing sector of national, state and regional economies in the U.S. The total employment impact of the industry is 8 million jobs taking into account the additional jobs created in the economy as a result of the sector's 1.4 million direct jobs in 2008. The biosciences industry continued to grow in employment, even through the first year of the recession, and the financial performance of public biosciences companies through the end of 2009 was positive. Looking toward the future, the biosciences are positioned for continued growth. The Bureau of Labor Statistics projects that the sector will grow at an annual rate of 1.5 percent between 2008 and 2018, making it one of the fastest growing industry sectors.

States and regions throughout the U.S. are targeting the bioscience sector because it is a source of high-wage, high-skilled jobs. The industry is diverse and becoming more so and more and more states are developing niches in specific areas of the biosciences. But state policymakers also realize that biosciences development is not simply about generating economic returns. The great promise of biosciences is its ability to address global problems from human health to food generation and security to environmental sustainability and clean energy. Biosciences development pays huge social and quality of life dividends for the U.S. and the world.

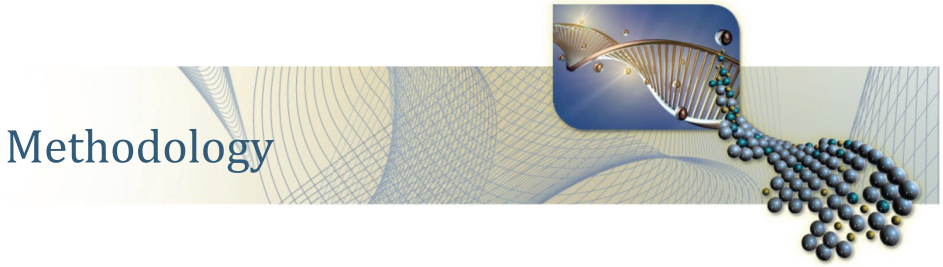
State governments, despite facing extremely challenging fiscal conditions, are continuing to implement policies and programs to support bioscience development. States are:

- Investing in major bioscience development initiatives
- Focusing on the agricultural biotechnology, bioenergy and bioproducts industry subsectors
- Implementing new programs to build R&D capacity and advance commercialization of research discoveries
- Continuing to address bioscience companies' needs for early-stage capital
- Enacting tax policies that are supportive of bioscience companies.

But continued biosciences development is not guaranteed. States will continue to face difficult fiscal times for the next several years that may cause them to roll-back many of the key economic development programs that were put in place over the past decade. Federal fiscal woes threaten NIH funding, a key generator of the U.S. leadership in basic research. The recent recession and its impact on capital markets have created a very sharp decline in venture capital for biosciences, which is critical to advancing biosciences innovation into the marketplace. And, in the long-term, the talent pipeline in the biosciences remains an area of significant concern. State and national policymakers have a key role to play in ensuring that these challenges are addressed in order to allow the U.S. to continue to be a world leader in the biosciences.

Bioscience employment and performance metrics data for each state, the District of Columbia and Puerto Rico can be found on the enclosed CD or downloaded from the BIO website, www.bio.org.

Appendix: Data & Methodology



Industry Employment, Establishments, and Wages

The bioscience industry employment analysis in this report examines national, state, and metropolitan area data and corresponding trends in the biosciences from 2001 through 2008. For employment analysis, Battelle used the Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW) data. The QCEW data (formerly known as the ES-202 program) provide the most current, detailed industry employment, establishment, and wage figures available at both a national and subnational level.[22] Battelle receives an enhanced version of these data from a private vendor, the Minnesota IMPLAN Group, Inc.

The QCEW program is a cooperative program involving BLS and the State Employment Security Agencies (SESAs). The QCEW program produces a comprehensive tabulation of employment and wage information for workers covered by state unemployment insurance (UI) laws and federal workers covered by the Unemployment Compensation for Federal Employees (UCFE) program. Publicly available files include data on the number of establishments, monthly employment, and quarterly wages, by NAICS (North American Industry Classification System) industry, by county, and by ownership sector, for the entire United States. These data are aggregated to annual levels, to higher industry levels (NAICS industry groups, sectors, and supersectors), and to higher geographic levels (national, state, and metropolitan statistical area [MSA]).[23]

Since 2001, the QCEW has been producing and publishing data according to the NAICS. Federal statistical agencies have a mandate to publish industry data according to this improved classification system. Compared with the prior classification system—the 1987 Standard Industrial Classification (SIC) system, NAICS better incorporates new and emerging industries. Employment, establishment, and wage data produced by the QCEW program for 2001 to present are not comparable with SIC-based industry data from prior years. This limits the ability to construct a longer time series for data analysis; however, 8 years of NAICS-based data (2001-2008) are now available.

Twenty-seven NAICS industries at the most detailed (6-digit) level make up the Battelle definition of the biosciences and its subsectors (Table 5 in this report). These detailed industries are aggregated up to four major subsectors of the bioscience industry. Two of the detailed NAICS industries, Testing Laboratories (NAICS 541380) and R&D in the Physical, Engineering, and Life Sciences (NAICS 541712), are adjusted in this analysis

[22] In general, QCEW monthly employment data represent the number of covered workers who worked during, or received pay for, the pay period that included the 12th day of the month. Virtually all workers are reported in the state in which their jobs are located. Covered private-industry employment includes most corporate officials, executives, supervisory personnel, professionals, clerical workers, wage earners, piece workers, and part-time workers. It excludes proprietors, the unincorporated self-employed, unpaid family members, and certain farm and domestic workers. An establishment is an economic unit such as a farm, mine, factory, or store that produces goods or provides services. It is typically at a single physical location and engaged in one, or predominantly one, type of economic activity for which a single industrial classification may be applied. Total wages: Covered employers in most states report total compensation paid during the calendar quarter, regardless of when the services were performed. A few state laws, however, specify that wages be reported for or be based on the period during which services are performed, rather than for the period during which compensation is paid. Under most state laws or regulations, wages include bonuses, stock options, severance pay, the cash value of meals and lodging, tips and other gratuities, and—in some states—employer contributions to certain deferred compensation plans such as 401(k) plans.

[23] Major exclusions from UI coverage, and thus from the QCEW data, include self-employed workers, some wage and salary agricultural workers, unpaid family workers, railroad workers, and some state and local government workers.

by Battelle to include only the share of these industries directly involved in biological or other life science activities. To isolate these relevant life science components, Battelle used information and data from the U.S. Census Bureau's Economic Census.

National, state, and MSA data were tabulated and presented in both summary analytical and state profile tables. Data for Puerto Rico and the District of Columbia are included in this report at both the "state" and national level. U.S. employment, establishment, and wage totals in this report reflect the sum of all state data and include both Puerto Rico and DC. All state and DC data are from the Minnesota IMPLAN Group; data for Puerto Rico are directly from BLS. Metropolitan area data do not include estimates for Puerto Rico as they are generally not disclosed at the 6-digit NAICS level of detail by BLS.

Data for 361 U.S. MSAs with bioscience employment activity were tabulated for this report. To best analyze location quotients (LQs) for MSAs, the areas were sorted by their total private sector employment base and designated as large, medium, or small metro areas. A "large" MSA has total employment at or above 250,000. A "medium" MSA has employment greater than or equal to 75,000, but less than 250,000. A "small" MSA has employment less than 75,000. Within each size classification, the metropolitan areas are then ranked by their LQ. Employment growth rates for MSAs were not included in this analysis because the relatively small bioscience employment bases in most metropolitan areas tend to result in large percentage changes in either direction that appear to overstate gains or losses among smaller MSAs and understate gains or losses among larger MSAs.

This 2010 edition of the Battelle-BIO report now incorporates the updates and revisions to NAICS industry classifications implemented with 2007 data. Highly relevant for this report is the incorporation of a new industry code, NAICS 541711, "Research and Development in Biotechnology," that for the first time isolates industry R&D activities specifically in "biotechnology." While extremely useful for identifying those firms classified in biotech, the new industry structure also includes related life sciences R&D in NAICS 541712 in addition to physical and engineering R&D activities. The inclusion of life sciences R&D in NAICS 541712 requires applying the sharing procedure mentioned above and implemented by Battelle in prior reports (to address virtually the issue within R&D) in order to effectively isolate these additional key R&D activities from their non-life science counterparts.

In addition to the changes affecting the life sciences research and development NAICS codes, the revision to the NAICS classification structure eliminated a previously used NAICS code from the medical device and equipment subsector of the biosciences—NAICS 339111, "Laboratory Apparatus and Furniture Manufacturing." Employment and establishment data from this industry were dispersed among several other industries, although the majority (roughly two-thirds) were added directly to another industry code in the Battelle-BIO definition for the medical device subsector, NAICS 339113, "Surgical Appliances and Supplies Manufacturing." With most of the employment and establishment data still accounted for and captured in another industry component, Battelle did not make adjustments to the medical device and equipment subsector to specifically address this change. Those jobs that once were counted in medical devices and now reside outside of the industry scope are estimated by Battelle at only about 5,000 or approximately one percent of the entire medical device and equipment subsector employment total.

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

Employment multipliers from the Bureau of Economic Analysis (BEA) were used to estimate the employment impact on all other industries of adding bioscience jobs at both the state and national levels. BEA's Regional Input-Output Modeling System (RIMS II) is based on an Input-Output (I-O) table in an accounting framework. I-O tables are calculated for each industry and show the distribution of inputs purchased and outputs sold. These tables are derived from two major data sources: BEA's national I-O table for almost 500 U.S. industries and BEA's regional economic accounts used to adjust the data for a region's industrial structure and trading patterns. It is important to note that, like all impact models, RIMS provides an approximate order-of-magnitude estimate of impacts, and the multipliers are best used to estimate impacts of small changes on a regional economy.

Multipliers and the resulting employment impacts are shown in each state profile table, for each major bioscience subsector. BEA does not provide employment multipliers for Puerto Rico.

For more information on the Bureau of Economic Analysis RIMS II Multipliers, see http://www.bea.gov/regional/rims/index.cfm.

In the time series analysis of earnings estimates in this report, the Consumer Price Index for All Urban Consumers (CPI-U) was used to adjust for inflation. The Consumer Price Index is a measure of the average change in prices over time of goods and services purchased by households.

Additional Bioscience Performance Metrics Data

At the national level and for each of the state profiles, additional key bioscience performance metrics provide further insights into the current structure, recent performance, and capacity of the state's bioscience infrastructure. These metrics and their data sources are briefly described in the following paragraphs.

Bioscience Academic R&D Expenditures

Based upon data from the National Science Foundation (NSF) Survey of R&D Expenditures at Universities and Colleges, national and state totals (summation of all state's responding institutions) are calculated for FY 2008 (most current year available). Data are provided for total R&D expenditures (including per capita measures) as well as in chart form for the bioscience fields including Medical Sciences, Biological Sciences, Agricultural Sciences, Bio/Biomedical Engineering, and Other Life Sciences.

For more information on the NSF Survey of R&D Expenditures at Universities and Colleges, see http://www.nsf.gov/statistics/nsf10311/.

National Institutes of Health (NIH) Support to Institutions

Using data from the NIH Awards to Institutions and Higher Education (NIH Office of Extramural Research), total and per capita measures are calculated for FY 2009 (most current year available).

For more information on the NIH Awards data, see http://report.nih.gov/award/trends/State_Congressional/StateOverview.cfm.

For more information on the additional grants awarded by NIH using funding made available through the American Recovery and Reinvestment Act (ARRA), see http://report.nih.gov/recovery.

Clinical Trials

Information regarding state involvement in clinical trials activities initiated in 2009 were obtained from the Web site ClinicalTrials.gov. The ClinicalTrials.gov database provides information for locating federally and privately supported clinical trials for a wide range of diseases and conditions. Sponsored by the U.S. National Institutes of Health (NIH), other federal agencies, and private industry, studies listed in the database are conducted in all 50 States and in 172 countries. Counts of clinical trials by phase will not sum to total trials as more than one-third of the trials did not include a specific "phase" reference. Additionally, some trials are classified by ClinicalTrials.gov as being involved in two phases (e.g., Phase I/II trials). In these instances the trial was classified by Battelle into the earlier phase for tabulation purposes. Individual clinical trial records were also classified using keywords into seven disease areas by Battelle.

For more information on Clinical Trials data, see http://www.clinicaltrials.gov/.

Bioscience-related Occupational Employment

The Bureau of Labor Statistics Occupational Employment Statistics (OES) program produces employment and wage estimates for more than 800 occupations.[24] From these specific occupations, OES data from May 2008 were used to construct and calculate occupational employment totals for four bioscience-related occupational groupings: Agricultural, Food, and Nutrition Scientists and Technicians; Biological Scientists and Technicians; Biomedical and Biochemical Scientists and Engineers; and Medical and Clinical Laboratory Technicians.

For more information on the BLS Occupational Employment Statistics program, see http://www.bls.gov/oes/home.htm.

Bioscience-related Degrees from Academic Institutions

Data from the U.S. Department of Education's National Center for Educational Statistics (NCES) were used to construct and calculate five bioscience-related degree categories, each consisting of a number of individual Classification of Instructional Program codes (CIP codes). These categories include the following: Agricultural, Food, and Nutrition Science; Biological Science; Biomedical Sciences and Engineering; Medical and Veterinary Sciences; and Other Life Science Clinical/Technical Fields. Charts are provided that examine the numbers of associate's, bachelor's, master's, and doctorate (Ph.D.) degrees by each degree category.

Given the emphasis on bioscience-related research and development activities, educational programs primarily designed to develop clinical practitioners (e.g., doctors, dentists, nurses) are not included in these categories. However, some instructional areas that provide degrees used in both clinical and research settings are included.

The data come from the Integrated Postsecondary Education Data System (IPEDS) and are described on the NCES website (http://nces.ed.gov/IPEDS/about/):

"IPEDS is the core postsecondary education data collection program for NCES. Data are collected from all primary providers of postsecondary education in the country in areas including enrollments, program

[24] The OES survey covers all full-time and part-time wage and salary workers in nonfarm industries (both public and private sectors). Surveys collect data for the payroll period including the 12th day of May. The survey does not cover the self-employed, owners and partners in unincorporated firms, household workers, or unpaid family workers.

completions, graduation rates, faculty, staff, finances, institutional prices, and student financial aid. These data are made available on our website to students, researchers and others."

Graduate data for Academic Year (AY) 2008 were used as the most recent year available.

Bioscience Venture Capital Investments

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

Venture capital data were collected using the Thomson-Reuters VentureXpert venture capital database and include all venture capital deals from January 1, 2004 through December 31, 2009 (as reported to Thomson-Reuters as of January 15, 2009). The analysis includes all investments categorized in VentureXpert in the Medical/Health/Life Sciences major category and four subcategories within the Information Technology major category that capture medical/health-related information technology applications (e.g., software, e-commerce, internet content, and internet services). Additionally, beginning with this report, investments in venture capital deals related to ethanol/biofuel/biodiesel-related companies were included from the Other Renewable Energy category maintained by VentureXpert.

Bioscience Patents

The use of patent data provides a surrogate (though not perfect) approach to understanding those innovations that bioscience-related industrial organizations, research institutions, and general inventors deem significant enough to register and protect and provide some measure of comparability among regions in one facet of innovation. Furthermore, examining recent patent activity provides some insight into firms' recent R&D areas, and hence, potential future lines of business. Three types of patents are defined by the U.S. Patent and Trademark Office (USPTO):

- **Utility** patents, which may be granted to anyone who invents or discovers any new and useful process, machine, article of manufacture, or composition of matter, or any new and useful improvement thereof.
- **Design** patents, which may be granted to anyone who invents a new, original, and ornamental design for an article of manufacture.
- **Plant** patents, which may be granted to anyone who invents or discovers and asexually reproduces any distinct and new variety of plant.

Additionally, patents have two geographic bases—the location of the inventors and the location of the assignee. For this analysis Battelle uses the location of the named inventor(s) as the geography of record. Hence, if a bioscience patent is invented by individuals in two states, each state will receive "credit" for the patent, but at a national level the patent is counted only once. Similarly, when two or more named inventors are from the same state the patent only gets counted once.

USPTO assigns each patent with a specific numeric major patent "class" as well as supplemental secondary patent classes. By combining relevant patent classes across the wide array of bioscience-related activity, these class designations allow for an aggregation specific to the biosciences. Battelle has grouped these relevant patents into broader patent class groups for this analysis.

Patent data were collected using the Thomson-Reuters Delphion patent analysis database and includes all published patents from January 1, 2004 through December 31, 2009.

Comparability with the 2008 Battelle-BIO Report

With the changes in NAICS codes implemented with 2007 data, industry employment data for the research, testing, and medical laboratories subsector presented in prior reports are no longer directly comparable with data presented in this report. Battelle has revised data in this subsector for prior years in its analysis of recent trends in the overall bioscience industry as well as the research, testing, and medical laboratories subsector. It is important to be aware, also, that industry employment data from the QCEW program are subject to revision. Some data presented in the 2008 report were ultimately revised and therefore may not match updated estimates from the same data source.

Other than these changes to industry employment metrics and the inclusion of ethanol/biofuels/biodiesel venture capital information, data presented in this report are, in general, completely comparable with those presented in the previous Battelle-BIO publication *Technology, Talent and Capital: State Bioscience Initiatives 2008*.

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