



# The Economic Impact of the U.S. Biopharmaceutical Industry

Prepared by Battelle Technology Partnership Practice

Prepared for Pharmaceutical Research and Manufacturers of America (PhRMA)

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## Summary

The U.S. biopharmaceutical sector is one of the nation's most dynamic innovation and business ecosystems. A large part of the modern biomedical economy is built upon a robust foundation of biopharmaceutical companies that perform and support advanced biomedical and technological R&D and act as the funnel and distribution engine for getting life-saving and quality-of-life-improving therapeutics to the marketplace. The U.S. biopharmaceutical sector provides significant R&D investments yielding new treatments and potential cures that improve the health and well-being of individuals and reduce the socioeconomic burdens for society as a whole. In accomplishing the mission of bringing new medical treatments to patients, the biopharmaceutical sector sustains a large-scale supply chain—both in R&D and in support of the production and distribution of biopharmaceutical and biotechnological products.

PhRMA engaged Battelle's Technology Partnership Practice to develop this report which provides an independent estimate of the size and structure of the U.S. biopharmaceutical industry and its total economic impacts on the U.S. economy.

This examination is the first to fully consider the broad value chain of the biopharmaceutical industry sector from research and development to clinical testing to production of goods and services to final distribution. Moreover, this value chain continues to evolve, shaped by technological advances that open up opportunities for new biomedical goods and services, such as molecular diagnostics and medical informatics. The formation of new high growth potential businesses such as these remains a key means for bringing new innovations to the marketplace.

Key findings from this examination of the broad biopharmaceutical value chain include the following:

- The U.S. biopharmaceutical sector contributes substantially to national, state, and local economies. It directly and indirectly supported approximately 3.4 million U.S. jobs in 2011, including 813,523 direct jobs.
- For 2011, the 813,523 direct jobs generated \$89.9 billion in total personal income—averaging \$110,490 in wages and benefits per worker. The average compensation was twice the U.S. private sector compensation of \$54,455, an indication of the high-quality jobs the biopharmaceutical industry provides to U.S. workers.
- The overall economic impact of the biopharmaceutical sector on the U.S. economy is substantial. The biopharmaceutical industry accounted for \$789 billion in economic output, representing 2.9% of total U.S. output in 2011.
- The economic impact comprises \$375 billion in direct impact of biopharmaceutical businesses and \$414 billion in indirect and induced impacts.
- The biopharmaceutical industry also is an important generator of government tax revenues through the wages and benefits provided to its employees. The analysis shows that the incomes of workers whose employment is supported by the biopharmaceutical industry—directly and through its suppliers or other affected sectors—generated more than \$40 billion in federal, state, and local personal tax revenues in 2011.



## Introduction

The United States' innovative biopharmaceutical industry develops new medicines that save, sustain and improve lives. The U.S. biopharmaceutical research industry leads the world in the development of new medicines with more than 3,200 in development or under review by the Food and Drug Administration (FDA) review in the U.S. The sector also accounts for the single largest share of all U.S. business research and development (R&D), representing nearly 20% of all domestic R&D funded by U.S. businesses, according to the National Science Foundation.<sup>1</sup> Members of the Pharmaceutical Research and Manufacturers of America (PhRMA) alone invested an estimated \$48.5 billion in R&D in 2012, an indicator of the R&D intensity of this knowledge-based industry.<sup>2</sup> U.S.-based biopharmaceutical research makes important economic contributions to the U.S. economy—contributions likely to grow if the underpinning for large-scale R&D investment remain intact.

Biopharmaceutical R&D is one area where the U.S. is still the global leader in terms of R&D investment and number of new medicines. However, the economic contributions of industries involved in biomedical innovation, particularly biopharmaceutical R&D, is increasingly seen as an area of opportunity for other countries, particularly China and India which are investing billions to build an R&D infrastructure modeled after the U.S. system. At the same time that other countries are increasing R&D spending, overall R&D spend in the U.S. across the public and private sectors has remained level. Sustaining productivity in medical research is critical for the health of the economy as well as U.S. competitiveness in the global marketplace.

The biopharmaceutical industry is well recognized as a dynamic and innovative business sector generating high-quality jobs as well as powering economic output and exports for the U.S. economy. Recognizing the importance of the biopharmaceutical industry from both perspectives and the need for high-quality economic and social analysis to inform public policy discussions, PhRMA engaged Battelle's Technology Partnership Practice to develop an independent estimate of the size and structure of the U.S. biopharmaceutical industry and its total economic impacts on the U.S. economy.

This report quantifies the 2011 economic impact of the biopharmaceutical industry on the U.S. economy in terms of economic output and jobs (2011 is the most recently available year for the economic impact model data). Using input/output analysis, this report measures the direct and indirect impacts or ripple effect of the biopharmaceutical industry on the U.S. economy. This report employs refinements to the methodology used to develop prior job estimates for industry to more accurately capture how industry has evolved over time. Due to the methodological changes, the estimates in this report are not directly comparable to prior industry estimates supported by PhRMA.

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## The U.S. Innovative Biopharmaceutical Industry – Sustaining and Growing the Economy

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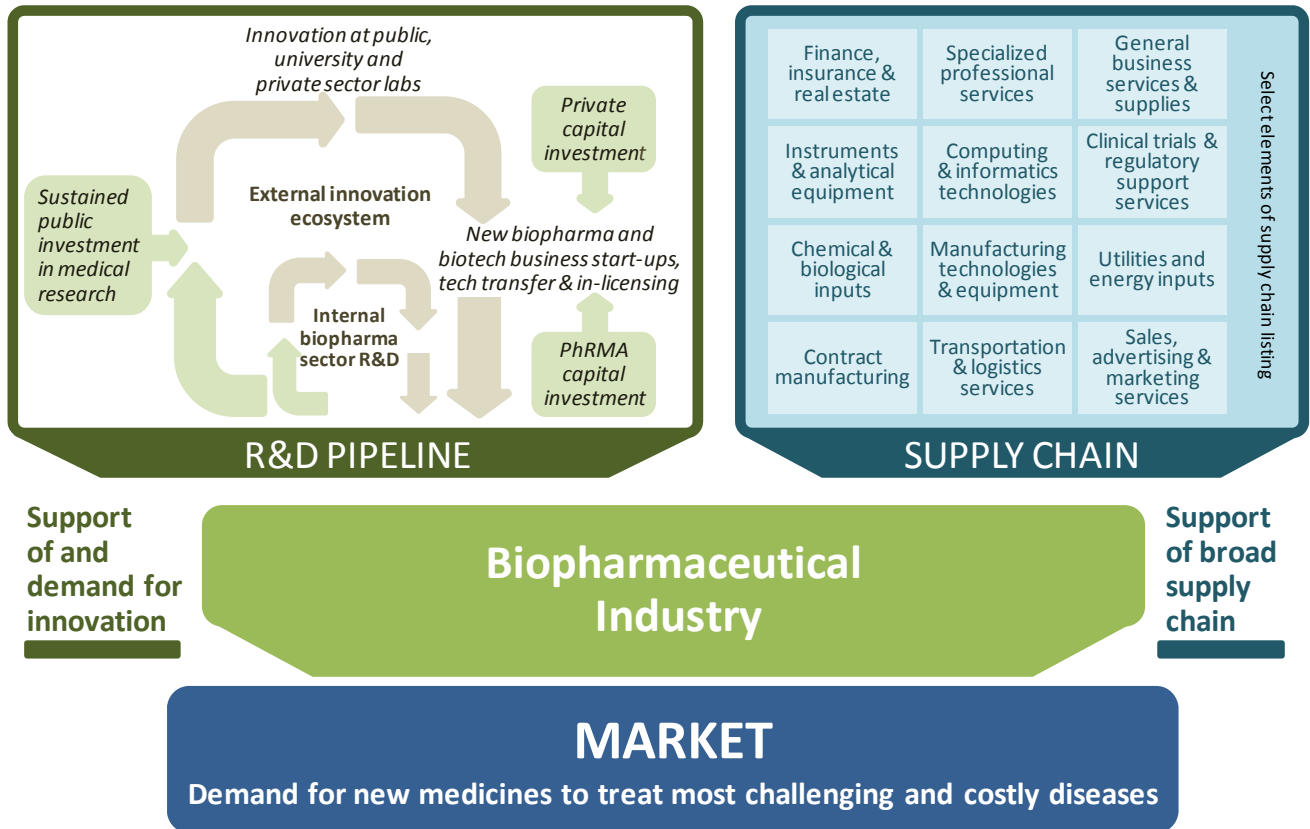
In 2011 the biopharmaceutical industry consisted of more than 813,000 direct jobs across a broad range of occupations—led by science-related occupations but a wide variety of technical support and production-related occupations. It is a high-wage industry, with an average annual personal income of more than \$110,000 which is two times more than the average across other sectors.

Beyond the direct employment in biopharmaceutical companies, however, the biopharmaceutical industry is the foundation upon which one of the United States' most dynamic innovation and business ecosystems is built. A large part of the modern biomedical economy is built upon a robust foundation of biopharmaceutical companies that perform and support advanced biomedical and technological R&D, and act as the driver for getting life-saving and quality-of-life-sustaining therapeutics to the marketplace. In accomplishing the mission of bringing new medical treatments and potential cures to patients, the biopharmaceutical industry sustains a very large-scale supply chain—both in R&D and in support of the production and distribution of biopharmaceutical and biotechnological products. This report also finds that the U.S. biopharmaceutical industry supports more than 2.55 million additional U.S. jobs through its varied supply base and from the additional economic impacts stemming from worker spending. In total, the biopharmaceutical industry accounts for \$789 billion in economic output, representing 2.9% of total U.S. output in 2011.

As Figure 1 (next page) illustrates, the innovative biopharmaceutical industry, which develops both large and small molecule drugs, is a foundational component of a broader biomedical ecosystem that includes such sectors as diagnostics and medical devices. Through its direct R&D activities, supply chain relationships, capital resources, and extensive market access and distribution system, the biopharmaceutical industry is of central importance to the much broader biomedical and life sciences economy.

Furthermore, in a 21st Century economy in which economic leadership is synonymous with leadership in technology and innovation, the biopharmaceutical industry is on the front lines in leveraging America's exceptional base of public and private R&D activity. Fueled by private investment capital, venture capital investments including venture capital funds established by innovative biopharmaceutical companies to support start-ups in the biosciences, and public and private collaborations, including partnerships between and enabled by the U.S. open market system, the nation has been able to advance biopharmaceutical innovation, which in turn has led to new start-ups, world leading multi-national companies, business growth and exports across the world.

**Figure 1: The Biopharmaceutical Sector – The Foundation of a Dynamic U.S. Innovation and Business Ecosystem**



# Measuring the Size and Structure of the Biopharmaceutical Industry

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## Components of the Biopharmaceutical Industry

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The U.S. biopharmaceutical industry is not only a world leader in the development new medicines to treat the most costly and challenging diseases and one of our nation’s top performing industry innovation drivers, but a highly valuable industry sector in terms of its economic contributions. The industry has developed a dynamic and broad biopharmaceutical-related value chain from R&D to clinical testing to production of goods and services to final distribution. Moreover, this value chain continues to evolve, shaped by technological and scientific advances that open up opportunities for new biomedical goods and services, such as molecular diagnostics and medical informatics as well as by industry restructuring in which contract research, manufacturing and distribution services are more prominent than in the past and the formation of new high-growth potential businesses help bring new medical advances to patients. This value chain concept can be applied broadly to understanding the context of the size and dimensions of industry sectors starting with the value-creating processes of suppliers and continuing all the way to the ultimate end-use product or service delivered into the consumers’ hands, in this case patients.

The breadth of activities that occur within the progression of biopharmaceutical development from the “*lab to clinical trials to production to bedside*” incorporate all or parts of four “sectors” of the U.S. economy as defined by the federal government in the North American Industrial Classification System (NAICS; detailed in Table 1). These four sectors—pharmaceutical manufacturing, drug merchant wholesale, scientific R&D services, and management of companies/enterprises (including standalone corporate headquarters operations)—are each captured within U.S. federal data sources as distinct sectors. Therefore, to fully understand and capture the size, structure, and impacts of the biopharmaceutical industry, data for these four sectors need to be carefully developed, integrated and in some cases refined.

**Table 1. NAICS Structure Relevant to Biopharmaceutical Industry**

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### NAICS Codes Related to Biopharmaceutical Sectors

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**3254 Pharmaceutical and medicine manufacturing**

*325411 Medicinal and botanical manufacturing*

*325412 Pharmaceutical preparation manufacturing*

*325413 In-vitro diagnostic substance manufacturing*

*325414 Biological product (except diagnostic) manufacturing*

**4242 Drugs and druggists’ sundries merchant wholesalers**

*424210 Drugs and druggists’ sundries merchant wholesalers*

**5417 Scientific research and development (R&D) services**

*541711 R&D in biotechnology*

*541712 R&D in the physical, engineering, and life sciences (except biotech)*

**5511 Management of Companies and Enterprises**

*551114 Corporate, subsidiary, and regional managing offices*

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From these four industry components, the whole of NAICS 3254 pharmaceutical and medicine manufacturing is obviously included within the biopharmaceutical industry (even though establishments within this NAICS code may also produce, at some minor level, products that may not be considered drugs or medicines). The biopharmaceutical industry also includes significant employment and impact from within the scientific R&D sector, the sector that includes the vast majority of biotech and early stage drug development firms. Finally, due to the multi-national, corporate nature of key industry firms there also is industry employment captured within the corporate headquarters and managing offices NAICS classification.

Three detailed NAICS industries—424210 (Drugs and druggists' sundries merchant wholesalers), 541712 (R&D in the physical, engineering, and life sciences, except biotech), and 551114 (corporate, subsidiary, and regional managing offices)—contain elements and activities outside the scope of the biopharmaceutical sector. To determine the share of these sectors attributable to the biopharmaceutical industry, data from the most recent U.S. Economic Census (2007 data, released in 2010 and 2011) and from the U.S. Bureau of Labor Statistics were used to estimate biopharmaceutical-relevant activities within these NAICS codes. This information was additionally supplemented with data from Dun & Bradstreet regarding company-specific establishment locations and employment estimates. *For a more detailed discussion of this approach and methodology please see Appendix A.*

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## Source of Employment and Impact Data

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Employment and impact estimates of the biopharmaceutical industry were obtained and calculated using 2011 IMPLAN U.S. specific input-output (I/O) models generated by MIG, Inc. The IMPLAN model consists of a specialized software system for impact analysis and highly detailed data tables at the national and individual state levels. Battelle acquired the necessary data files for use with the IMPLAN system and developed a customized model to quantify the direct, indirect and induced impacts of the biopharmaceutical industry. The model incorporates employment and other details of the biopharmaceutical industry and its economic inter-relationships with more than 430 other individual sectors that cover the entire national economy. With these data, the analysis is able to show not only the overall impact on the U.S. economy, but impacts on specific sub-sectors of the economy that are strongly dependent on economic activity generated by the biopharmaceutical industry.

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## Employment in the Biopharmaceutical Industry

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To facilitate a comprehensive measurement of the employment size of the biopharmaceutical industry and its economic impacts on the U.S. economy, the sector employment metrics contained within the IMPLAN impact model are used to estimate and measure the biopharmaceutical industry's 2011 employment.

Of note, this industry relies on highly skilled talent across a range of occupational categories and educational levels, including those with skills, education, and training in science, technology, engineering, and math (STEM). An array of STEM-related jobs are required by this



industry and can range from those requiring college degrees such as advanced manufacturing jobs to blue collar positions such as highly skilled technicians and other production personnel.

Table 2 shows the IMPLAN sector employment that corresponds to the appropriate 4-digit NAICS code, the estimated share of employment within that sector that is attributed to the biopharmaceutical industry, the ultimate employment estimate, and the subsector's share of total biopharmaceutical industry employment.

**Table 2. Estimating the Employment Size of the Biopharmaceutical Industry, 2011**

NAICS Codes	Relevant IMPLAN Sectors	IMPLAN Total Sector Employment	Biopharmaceutical Share of Sector	Biopharmaceutical-Related Sector Employment	Share of Total Biopharmaceutical Employment
3254 Pharmaceutical and medicine manufacturing	132, 133, 134, 135	273,027	100.0%	273,027	33.6%
4242 Drug and druggist sundries wholesale	319	5,973,159	2.9%	170,521	21.0%
5417 Scientific research and development (R&D) services	376	969,366	35.0%	338,835	41.7%
5511 Management of companies and enterprises	381	2,058,156	1.5%	31,141	3.8%

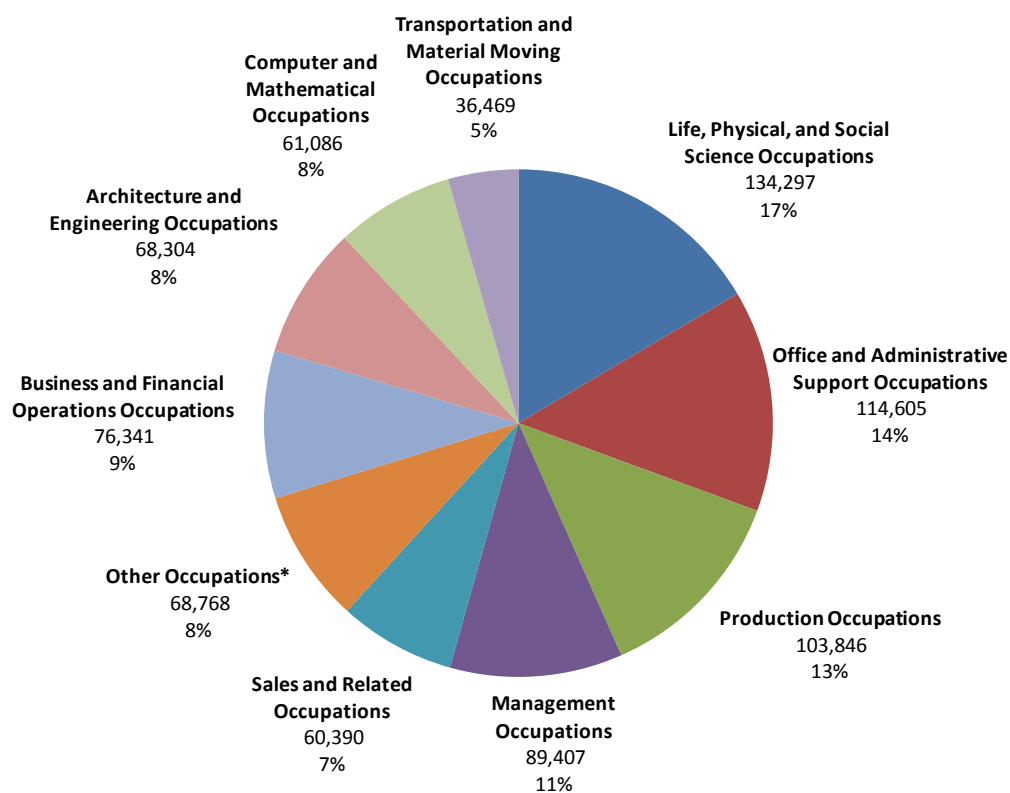
Source: Battelle data, calculations and analysis; IMPLAN 2011 U.S. model

This analysis includes the entirety of NAICS 3254, pharmaceutical and medicine manufacturing. A small portion of wholesale distribution was captured using detailed 6-digit NAICS code level QCEW data from IMPLAN. This allowed us to share the IMPLAN model-based employment data in a direct fashion of current (2011) drug and druggists' sundries merchant wholesale employment. Using an estimation procedure based upon the 2007 Economic Census, we estimate that 35% of NAICS 5417 Scientific R&D services are related to and included within the biopharmaceutical industry. Estimates by other third parties have varied in terms of the percentage of code attributable to the biopharmaceutical estimate with estimates by some including a higher percentage and thus this may be considered a conservative estimate by some. This percentage captured includes employment involved in biotechnology activities, pharmaceutical sciences research, and other medical and health related R&D. Finally, it is estimated that 31,141 jobs in NAICS 5511 are related to corporate headquarters or other specific management establishments. *For more detail on the methodology used to develop these estimations please see Appendix A. Based upon these data the total employment size of the biopharmaceutical industry in 2011 was 813,523 jobs.*<sup>3</sup>

## Occupational Structure of the Biopharmaceutical Industry

To better understand the key job functions within the overall biopharmaceutical industry, a separate analysis was performed to estimate the current occupational structure of the industry, using the same industry definition described above. Using U.S. Bureau of Labor Statistics Occupational Employment by Industry data and the individual biopharmaceutical sector employment totals, weighted shares of U.S. total sector occupational employment are developed. These sector-level occupational values are then combined to describe the total biopharmaceutical industry occupational mix as shown in Figure 2.

**Figure 2. Overview of Occupations in the Biopharmaceutical Industry (Number and Percent of Jobs)**



**Source:** U.S. Bureau of Labor Statistics (BLS) Occupational Employment by Industry for the U.S., 2012, and Battelle estimations. Note that these data are for 2012, while the economic impact data included throughout this report are for 2011. BLS occupational data are released earlier than the IMPLAN data used for the economic impact estimates, allowing more recent occupation data to be included in this report.

\***Other Occupations** include areas such as Installation, Maintenance, & Repair (2%), Healthcare Practitioners (2%), Arts, Design, and Media (1%), and Building and Grounds Maintenance (1%) among others.

Within the occupational structure of the biopharmaceutical industry approximately one out of every six workers (17%) are in the life, physical and social science occupations. Production occupations, occurring primarily within the drugs and pharmaceutical manufacturing subsector, account for 13% of the industry's total employment.

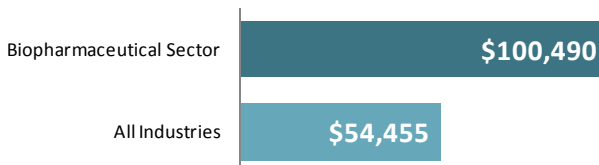
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## Personal Income within the Biopharmaceutical Industry

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The biopharmaceutical industry, whether in its manufacturing, R&D, or corporate headquarters and management functions, is a generator of high-quality jobs for Americans. The IMPLAN model used to develop the overall employment figure also provides an estimate of the total personal income of employees (i.e., wages and benefits) in the industry. **For 2011, the 813,523 direct jobs generated \$89.9 billion in personal income—averaging \$110,490 in personal income per worker.** (Figure 3) This is more than twice the national average personal income per worker of \$54,455, a strong indication of the quality of jobs that the biopharmaceutical industry provides to U.S. workers, and of the high value-adding activities within the industry.

**Figure 3: Average Annual Employee Compensation, Biopharmaceutical Industry versus National Average (All Industries)**



# Expenditure Impacts of the Biopharmaceutical Industry

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## The Structure of Biopharmaceutical Industry Impacts

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Industry impacts may be logically segmented into “expenditure impacts” (also known as backward-linkage economic impacts) and “functional impacts” (sometimes referred to as forward-linkage impacts). Backward-linkage expenditure impacts of the biopharmaceutical industry are the impacts typically measured in an economic impact study, quantifying direct and indirect job creation, associated personal incomes, business output, and associated revenues to federal, state and local taxing jurisdictions. These impacts are measured using the well-established regional economic analysis technique of input/output analysis (I/O) which tracks the revenues of a sector and the related economic activity of suppliers to the sector and its personnel. Battelle’s analysis thus quantifies, using input/output (I/O) analysis, the economic impacts of the biopharmaceutical industry on output in the U.S. economy, on jobs, personal income, and federal, state and local tax revenues.

### Direct, Indirect, and Induced Impacts of the Biopharmaceutical Industry

The Battelle impact analysis for the U.S. biopharmaceutical industry uses a custom IMPLAN I/O model quantifying the interrelationships between economic sectors in the economy of the United States. The model’s data matrices track the flow of commodities to industries from producers and institutional consumers within the nation. The data also model consumption activities by workers, owners of capital, and imports. The inter-industry trade flows built into the model permit estimating the impacts of one sector on all other sectors with which it interacts.

Economic impacts consist of three types: **direct impacts** (the specific impact of biopharmaceutical industry expenditures in the first round of spending), **indirect impacts** (the impact of expenditures by suppliers to the biopharmaceutical industry), and **induced impacts** (the additional economic impact of the spending of biopharmaceutical industry employees and suppliers’ employees in the overall economy that can be attributed to the direct biopharmaceutical industry expenditures). Taken together, these three impacts combine to form the **total impacts**. In other words, I/O analysis models the total economic activity that originates from direct biopharmaceutical industry expenditures in the economy, flows through industry suppliers, and the ongoing ripple (multiplier) effect of these expenditures. In other words, this “multiplier

#### Functional Impacts

*While the expenditure or “backward-linkage” economic impacts are the focus of this report, functional or “forward-linkage” impacts are what make a sector unique and can be just as important.*

*The biopharmaceutical industry exists to make useful, and in many cases crucial, life-saving new medicines for patients. The output of the biopharmaceutical industry is highly valued by society because the industry develops and manufactures a broad range of unique products to prevent and treat diseases and conditions that can negatively impact quality of life, health outcomes, and productivity. In many instances, biopharmaceuticals are central to helping to prevent and treat a range of diseases and conditions that have substantial socioeconomic costs.*

effect” represents the concept that every dollar spent in the economy may be partially re-spent (or re-circulated) in the economy through purchases or wages, thereby generating additional economic activity and impact. I/O analysis represents the generally accepted standard for measurement of economic impacts.

## Economic Impacts of U.S. Biopharmaceutical Industry Employment and Spending

Table 3 presents the findings from Battelle’s I/O analysis of the U.S. biopharmaceutical industry for 2011 (the most current year for which complete I/O tables are available). As noted in the table:

- **The overall economic impact of the biopharmaceutical industry on the U.S. economy (as measured by “output” and most typically presented as the “economic impact” of an impact study) totals nearly \$789 billion on an annual basis.**
- **This impact comprises \$375 billion in direct impact of biopharmaceutical businesses and \$413 billion in indirect and induced impacts—meaning that every \$1 dollar in output generated by the biopharmaceutical industry generates an additional \$1.10 in output in other sectors of the economy.**

This significant multiplier is due to the high value-added nature of the industry, its extensive supply chain relationships, and the industry’s higher wage jobs.

**Table 3: Economic Impacts of the U.S. Biopharmaceutical Industry, 2011 (\$ in billions)**

Impact	Employment	Personal Income	Value Added	Output	State/Local Personal Tax Revenue	Federal Personal Tax Revenue
<b>Direct Effect</b>	813,523	\$89.9	\$159.5	\$375.3	\$2.4	\$14.6
<b>Indirect Impacts</b>	1,021,841	\$64.8	\$99.5	\$192.1	\$1.7	\$10.4
<b>Induced Impacts</b>	1,527,983	\$70.2	\$124.6	\$221.4	\$1.9	\$11.4
<b>Total Impact</b>	3,363,347	\$224.9	\$383.6	\$788.8	\$6.0	\$36.3
<b>Impact Multiplier</b>	4.13	2.50	2.40	2.10		

Source: Battelle data, calculations and analysis; IMPLAN 2011 U.S. model

### Definition of Impact Variables

**Employment:** The number of individuals whose employment is due, totally (direct employment) or in part (indirect or induced employment) to the economic effects of the industry.

**Personal Income:** Measures cash, benefits and non-cash payments received by individuals in the economy.

**Value-Added:** The difference between an industry’s or an establishment’s total output and the cost of its intermediate inputs; sometimes referred to as an industry’s “Contribution to GDP”.

**Output:** The dollar value of production (i.e., sales).

**Personal Tax Revenue:** The dollar value of taxes generated due to the creation of personal income; includes company paid portion of social security taxes.

Other key findings included in the table include:

- **The biopharmaceutical industry is responsible for supporting nearly 3.4 million jobs in the U.S. economy (more than 813,000 direct jobs and an additional 2.5 million indirect and induced jobs) in 2011.**
- **Together, the biopharmaceutical industry and the workforce of its suppliers and other impacted segments of the economy received \$225 billion in wages and benefits in 2011.**
- **The biopharmaceutical industry also is an important generator of federal, state and local government revenues through the wages and benefits provided to its employees. The analysis shows that the incomes of biopharmaceutical industry employees, directly and through the multiplier effect, generated more than \$42 billion in personal tax revenues—\$6 billion in state and local personal tax revenue and more than \$36 billion in federal personal tax revenues in 2011.**

### **The Biopharmaceutical Industry Supply-Chain and Breadth of Impacts**

The multiplier effects of the biopharmaceutical industry (indirect and induced impacts) are of benefit to, and interrelated with, a broad range of U.S. economic sectors. The I/O analysis gauges the impact of the biopharmaceutical industry on every other sector in the economy.

From an industrial perspective it is important to understand the key industry suppliers to the biopharmaceutical industry. Table 4 identifies the top 20 supplier sectors to the U.S. biopharmaceutical industry as determined by the size of the *indirect output impacts*. For example, the biopharmaceutical industry purchased \$18.2 billion in output from the non-biopharmaceutical wholesale trade sector (which includes a wide variety of **inputs** used in biopharmaceutical production). These purchases also generate an indirect employment impact of more than 87,000 wholesale trade jobs. These twenty supplier sectors alone account for nearly 63% of all the indirect output effects and more than 57% of all the indirect employment effects of the biopharmaceutical industry.

**Table 4: Key (Top 20) Supplier Sectors to the U.S. Biopharmaceutical Industry, 2011**

Sector	Sector <i>Indirect Output Impacts</i> (\$ billions)	Sector <i>Indirect Employment Impacts</i> (No. of Jobs)
Non-Biopharma Scientific R&D Services	\$18.2	97,482
Non-Biopharma Wholesale Trade (Production Inputs)	\$15.9	87,218
Petroleum Refineries	\$12.1	1,063
Other Basic Organic Chemical Manufacturing	\$8.7	5,464
Management, Scientific, and Technical Consulting	\$6.7	53,868
Petrochemical Manufacturing	\$6.5	686
Real Estate	\$5.7	37,541
Maintenance and Repair Construction	\$5.2	51,671
Advertising and Related Services	\$4.9	28,456
Telecommunications	\$4.4	8,006
Commercial Banking	\$4.3	11,755
Oil and Natural Gas Production	\$4.2	8,388
Legal Services	\$3.5	21,881
Electric Power	\$3.5	3,924
Non-Biopharma Corporate Offices & Holding Companies	\$3.2	15,570
Building Services	\$3.2	57,858
Truck Transport	\$2.7	20,279
Plastics Material and Resin Manufacturing	\$2.7	1,642
Employment Services	\$2.5	61,508
Other Miscellaneous Professional and Technical Services	\$2.3	10,147

Source: Battelle data, calculations and analysis; IMPLAN 2011 U.S. model

Table 5 (next page) examines the sector-based economic impacts further, by showing the top 20 sectors in terms of **total economic impacts** stemming from the biopharmaceutical industry. This table takes into account the significant purchasing activities of biopharmaceutical industry workers within their economies. The presence of some consumer-driven sectors in this list show the extent to which the high personal income from this sector leads to significant economic impacts within the U.S. economy.

**Table 5: Key Sectors Impacted by the U.S. Biopharmaceutical Industry, 2011**

<b>Sector</b>	<b>Sector Total Output Impacts (\$ billions)</b>	<b>Sector Total Employment Impacts (No. of Jobs)</b>
Non-Biopharma Wholesale Trade (Production Inputs)	\$24.8	135,808
Non-Biopharma Scientific R&D Services	\$19.1	102,024
Petroleum Refineries	\$18.6	1,624
Real Estate	\$17.1	112,663
Commercial Banking	\$12.6	34,080
Restaurants and Drinking Places	\$9.8	172,635
Telecommunications	\$9.6	17,522
Other Basic Organic Chemical Manufacturing	\$9.1	5,697
Investment Banking	\$8.8	50,222
Private Hospitals	\$8.5	63,540
Doctor and Dentist Offices	\$8.1	66,203
Management, Scientific, and Technical Consulting	\$7.9	63,598
Petrochemical Manufacturing	\$7.5	789
Insurance	\$7.4	26,161
Electric Power	\$7.2	8,160
Maintenance and Repair Construction	\$6.7	66,976
Oil and Natural Gas Production	\$6.5	13,159
Legal Services	\$6.2	38,807
Advertising and Related Services	\$6.1	35,468
Non-Biopharma Corporate Offices & Holding Companies	\$3.2	27,419

Source: Battelle data, calculations and analysis; IMPLAN 2011 U.S. model

### Recent Trends in Biopharmaceutical Industry Impacts

Because this report is the first to approach an economic impact analysis of the biopharmaceutical industry by fully considering its broad value chain, the impact estimates cannot be directly compared to previously reported estimates. We therefore provide a comparison of the 2011 values to the two previous years using this methodology (Table 6, next page). As shown, direct biopharmaceutical sector jobs remained essentially flat between 2009 and 2011, while there was a more marked decline in the multiplier resulting in a more substantial decline in the overall number of jobs supported by the industry. This in part reflects a broader trend in U.S. manufacturing over the period; the employment multiplier for U.S. manufacturing as a whole dropped 9% during this period. The biopharmaceutical industry experienced a greater decrease due to the unique challenges it faced during the period, including the loss of revenues following the introduction of generic versions of several blockbuster medicines. Despite the challenging business environment, biopharmaceutical manufacturing remains a high-multiplier activity. The manufacturing component of the biopharmaceutical industry had an employment multiplier of 7.2 in 2011, compared to 5.9 for U.S. manufacturing overall.



**Table 6: Employment Impacts of the U.S. Biopharmaceutical Industry, 2009–2011**

<b>Impact</b>	<b>2009</b>	<b>2010</b>	<b>2011</b>
Direct Effect	815,782	818,711	813,523
Indirect Impacts	1,551,153	1,252,763	1,021,841
Induced Impacts	2,105,432	1,948,601	1,527,983
Total Impact	4,472,368	4,020,075	3,363,347
Impact Multiplier	5.48	4.91	4.13

**Source:** Battelle data, calculations and analysis; IMPLAN 2009, 2010, and 2011 U.S. models

## Conclusions

The U.S. biopharmaceutical industry is a robust and vibrant component of the U.S. economy with a varied occupational base and extensive supply chain that yields significant impacts throughout the U.S. With more than 813,000 workers and a substantial employment multiplier of 4.13, the U.S. biopharmaceutical industry supports more than 2.5 million additional U.S. jobs for a total of 3.4 million jobs supported in 2011. At an average personal income of more than \$110,000—about twice as much as the average across industries, biopharmaceutical industry jobs are both high-wage and high-quality. The biopharmaceutical industry exceeded \$375 billion in direct output in 2011, and through the ripple effect of this production throughout the U.S. economy an additional \$413 billion in output was generated by suppliers and other sectors of the economy. **Combined, the total output impact of the U.S. biopharmaceutical industry is \$789 billion—representing more than 2.9% of the total U.S. output in 2011.**

Given the characteristics of the U.S. biopharmaceutical industry, it is not surprising that as reported in a previous report by Battelle that a range of countries are seeking to attract and grow their own innovative biopharmaceutical sector.<sup>4</sup> Battelle found that biopharmaceuticals and related industries, including biotechnology and the life sciences, are frequently the focus of economic development, innovation, and science and technology strategic plans in countries across the globe. This growing global focus is being driven by the recognition that these research-intensive, knowledge-based industry sectors produce important new treatments to fight the most costly and challenging diseases, generate high-quality and high-wage jobs, contribute to economic sustainability and growth, and generate exports for the countries where these companies' R&D and manufacturing facilities are located.

Biopharmaceutical development and manufacturing is clearly a major economic driver, but beyond that is a truly innovative industry positioned for breakthroughs and enormous societal impact into the future. Demand for new and improved therapeutics will not abate given the millions of people suffering or likely to suffer from diseases and disorders for which treatments have not yet been found or are currently insufficient. New areas of research are continually opening up, particularly with major advancements in our understanding of molecular biology and genomics. The challenges are large, but so too, are the opportunities.

These characteristics reinforce the importance of fostering an environment that will improve the private sectors' ability to *harness research innovations to meet health challenges and continue to create high-wage, high-skill jobs*. America's innovative biopharmaceutical companies face increasing challenges ranging from the increased costs and complexity of bringing new medicines to patients, the prospect of attracting and sustaining the capital needed to develop tomorrow's new treatments and cures, the increasing uncertainty related to coverage and payment of innovative medicines, and intensifying competition from other countries. Continued innovation is fundamental to U.S. economic well-being. A long-term commitment to science, technology, and innovation is vital to enabling U.S. biopharmaceutical companies to improve health outcomes and establish the foundation for economic growth and jobs of the future.

## Appendix A – Methodology

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### The Size and Structure of the Biopharmaceutical Industry

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The principal methodological challenge for this analysis is to estimate and establish the size and structure of the total biopharmaceutical industry. The requirement for a “high confidence” estimate of the biopharmaceutical R&D component of the industry drove much of the data development and analytical methodology. Additionally, the size and impact of employment with biopharmaceutical corporate or headquarters operations (non-manufacturing locations) requires special estimation efforts to assess these locations’ impacts. Finally, the increasing importance of firms involved in the logistics and distribution of biopharmaceutical products in terms of both overall supply chains as well as these firms being a source for industry innovation is acknowledge through their inclusion in this new “value-chain” approach to estimating the size and impacts of the biopharmaceutical industry.

An important consideration in the development of this overall methodology was to develop an approach that could estimate state-level employment within the biopharmaceutical industry in a similar and successful manner as well.<sup>5</sup>

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### Use of IMPLAN Impact Model Employment

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The principal data used for the estimations of biopharmaceutical industry employment and to drive the impact analysis are the 2011 employment estimates generated by the IMPLAN impact model (the most recently available U.S. IMPLAN impact model). This employment consists of either baseline employment data built into the model (referred to as “study area data” within IMPLAN) or is generated when driving the model with an economic measure—typically a regional “output” measure is used to generate a corresponding employment level. For the four component sectors of biopharmaceutical manufacturing, the U.S. data are used and reported directly from the IMPLAN model.

Economic impact models are designed around “full economy” reporting. Therefore, IMPLAN supplements the core U.S. Bureau of Labor Statistics Quarterly Census of Employment and Wages (QCEW) data with additional employment data to capture this additional economic activity (discussed further below). It should be noted that job totals within IMPLAN impact model employment are in “positions” not full-time employment (e.g., 10 faculty members doing outside consulting for 4 hours a month, would count as 10 jobs in the “university” faculty context and count again as 10 “jobs” in research, consulting or other field).

It is important to note that the IMPLAN model sector scheme only has a single sector, Sector 376 – Scientific research and development services that covers the entire spectrum of R&D activities including both life science and non-life science related research. This requires that any specific inclusion of Biotech or other Life Sciences R&D in the Biopharmaceutical sector to be further estimated outside of this specific model-based employment approach.

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## Estimating Biopharmaceutical R&D Output and Employment: Use of U.S. 2007 Economic Census Data

Every five years the U.S. Census Bureau performs a national “Economic Census” to examine the detailed economic activities of U.S. industry. The most recent year of the Economic Census is 2007 (capturing data from 2007 with the final national data released in 2010). These data provide unique “product-level” detail across a variety of industries. Of importance for the analysis of the biopharmaceutical industry are the details regarding the receipts generated by various activities within NAICS 5417 R&D in the physical, engineering, and life sciences (Table A-1). Table A-2 details what NAICS-level data is available from the Economic Census within the broader NAICS 5417 context.

**Table A-1. Key R&D-related Product Codes, Establishments, and Receipts, 2007**

Key Product Codes and Descriptions (Major and <i>Subcategories</i> ) of NAICS 5417	Estabs., 2007	Receipts 2007 (\$1,000)
<b>30000</b> Industry total	16,169	94,517,652
<b>39020</b> Testing svcs (physical/product), excl medical & veterinary svcs	134	39,184
<b>39160</b> Basic/applied research in the physical & engineering sciences	5,780	33,938,782
<b>39170</b> Basic/applied research in biotechnology	2,235	8,230,497
<b>39180</b> Basic/applied research in the life sciences, excl biotechnology	4,292	19,406,190
<b>39181</b> <i>Basic/applied research life sciences, excl biotech - Pharma science</i>	1,655	10,775,256
<b>39182</b> <i>Basic/applied research in the life sciences - Med/health sciences</i>	1,861	7,130,856
<b>39183</b> <i>Basic/applied research in the life sciences - Biological science</i>	465	633,177
<b>39184</b> <i>Basic/applied research life sciences, excl biotech - Ag, forestry</i>	315	249,138
<b>39185</b> <i>Basic/applied research - Animal prod, fisheries, &amp; vet science</i>	110	126,714
<b>39186</b> <i>Basic/applied research in the life sciences - Other life science</i>	204	491,049
<b>39190</b> Basic/applied research in the social sciences & humanities	1,478	3,583,179
<b>39210</b> Development services for goods	758	3,136,040
<b>39220</b> Development services for processes, systems, or methods	549	697,749
<b>39250</b> Outright sale of original works of intellectual property	145	439,321
<b>39260</b> Advisory & consulting svcs for research & development activities	1,821	420,692
<b>39280</b> Engineering services	1,447	665,603
<b>39400</b> Licensing of rights to use intellectual property	756	8,092,628
<b>39600</b> Resale of merchandise	1,677	1,368,900
<b>39700</b> All other operating receipts	2,213	5,332,566
<b>39900</b> Contributions, gifts, & grants - Government	887	4,903,200
<b>39910</b> Contributions, gifts, & grants - Private	1,243	2,606,627
<b>39920</b> Investment income, including interest & dividends	1,185	681,414
<b>39930</b> Gains (losses) from assets sold	227	268,486
<b>39960</b> All other revenue	636	706,594

**Source:** U.S. Bureau of the Census, Economic Census 2007

**Notes:** Establishments can be counted in more than one product code. Not all product codes are shown in this table. Receipts within subcategories sum to the Major Product Code.

**Table A-2. Overview of NAICS-level detail within Economic Census, Total Establishments, and Receipts, 2007**

NAICS Code and Description		Industry Total Estabs., 2007	Industry Total Receipts 2007 (\$1000)
5417	Scientific research and development services	16,169	94,517,652
54171	Physical, engineering, and biological research	14,457	89,413,114
541711	Research and development in biotechnology	2,483	17,446,939
541712	Other physical and biological research	11,974	71,966,175
5417121	Research & development in the physical & engineering sciences	6,978	45,740,991
5417122	Research and development in other life sciences	4,996	26,225,184
54172	Research and development in the social sciences and humanities	1,712	5,104,538

Source: U.S. Bureau of the Census, Economic Census 2007

Using these Economic Census data and similar data for the more detailed NAICS codes allows for the development of estimations of the share of NAICS 5417 (and ultimately, IMPLAN Sector 376) output related to the biopharmaceutical industry. Through discussions with PhRMA it was determined that the primary drivers of the estimation methodology that best reflected the industry would be the basic and applied research performed in the biotechnology product code (39170), the basic and applied research performed in pharma science product code (39181), and a share of the basic and applied research performed in the medical/health product code (39182). The determination of this combined share of R&D to be considered “biopharmaceutical-related” would then be applied to other receipt based product codes (e.g., 39400, licensing of rights to use intellectual property), to capture a portion of these receipts as related to the biopharmaceutical R&D function.

Using these estimated 2007 biopharmaceutical R&D receipts data, as a proxy for output, an additional estimation process was used to translate this information into the scale and structure of the 2007 IMPLAN U.S. model output. At this point these data were updated to 2011 by using year-to-year changes in the IMPLAN U.S. model’s Sector 376 (NAICS 5417) from 2007 through 2011 to develop a 2011 IMPLAN U.S. “model-based estimate” of biopharmaceutical R&D output and ultimately the model-derived employment to produce that level of biopharmaceutical R&D output. Though, basing the 2011 figures on 2007 Economic Census data has some potential to distort the 2011 estimate, it is the only process that allows for making some assessment of the unique size and structure of biopharmaceutical R&D at the national level, within the construct of the overall IMPLAN model.

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### **Estimating Biopharmaceutical Headquarter Employment: Use of Dun & Bradstreet Data**

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Based upon feedback received by PhRMA from some of its members, there was concern that prior methodological approaches did not adequately capture management and other key jobs located in companies’ headquarters. It was determined that an important amount of biopharmaceutical industry employment, based within headquarters and other management offices, was being missed within the traditional pharmaceutical manufacturing and biopharmaceutical R&D sectors. With specific corporate examples to work from, Battelle

examined individual biopharmaceutical-related Dun & Bradstreet (D&B) establishment records identified as “headquarters” to ascertain whether any significant manufacturing or R&D activities were occurring within these establishments that would allow these locations to be classified by public sector data collection agencies as either NAICS 3254 – Pharmaceutical and medicine manufacturing; or NAICS 5417 – Scientific research and development (R&D) services. For those establishments that appeared to be dedicated to management activities only, additional work was performed including examination of corporate websites for additional location information, to determine if this employment would most likely be classified in NAICS 5511 – Management of companies and enterprises by public sector data collection agencies. Based upon this analysis, employment was estimated for a number of key establishments and locations, for inclusion as part of the overall biopharmaceutical industry.

In the context of including biopharmaceutical distribution subsector as part of the broader “value chain” approach to estimating the size of the biopharmaceutical industry, the headquarters employment for key firms in this subsector were also estimated in this fashion.

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### **Estimating Biopharmaceutical Distribution Employment: Use of Detailed QCEW Data**

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Similar to the Scientific research and development services sector, the IMPLAN model only includes a single, broad modeling sector to represent all wholesale/distribution activities—Sector 319 – Wholesale trade business. To estimate the size and impacts of the biopharmaceutical distribution subsector, the Battelle team used 2011 enhanced QCEW data, provided by IMPLAN, to develop the share of total wholesale employment that is related to biopharmaceutical wholesale/distribution. This was accomplished by calculating the specific share that NAICS 42421 – Drugs and druggist sundries wholesale is of total wholesale employment captured in NAICS 42 – Wholesale, and then applying this share to the 2011 IMPLAN model’s Sector 319 employment.

## ENDNOTES

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<sup>1</sup> National Science Board, 2012, "Science and Engineering Indicators 2012," Arlington VA: National Science Foundation (NSB 12-01).

<sup>2</sup> Pharmaceutical Research and Manufacturers of America, PhRMA Annual Member Survey, Washington, DC: PhRMA 2013.

<sup>3</sup> While similar in size, due to changes in underlying data and methodology this number is not directly comparable to biopharmaceutical industry employment estimates made previously for PhRMA by both Archstone Consulting or Battelle.

<sup>4</sup> Battelle Technology Partnership Practice, *The Biopharmaceutical Research and Development Enterprise: Growth Platform for Economies Around the World*, May 2012.

<sup>5</sup> The inclusion of the wholesale distribution is consistent with similar efforts Battelle has undertaken to measure the entire life sciences industry for the Biotechnology Industry Organization (BIO).