The Biopharmaceutical Sector's Impact on the U.S. Economy: Analysis at the National, State, and Local Levels

Executive Summary

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EXECUTIVE SUMMARY

In the last century, U.S. innovations in the automotive, aviation, telecommunications, and computer electronics industries were the primary drivers of economic growth and positioned the U.S. as the world's economic leader. Today, new fields are emerging that will define economic success for the country in the 21st century. Few sectors hold as much promise for providing future economic leadership for the U.S. as the research-intensive biopharmaceutical sector, which is responsible for the development of new medicines.

> **Bioscience is in many ways the key to unlocking our future economic potential as a state…** At the same time it allows us to offer moral leadership as we seek to extend healing and human compassion to our neighbors all around the globe.
>
> ***—Maryland Governor Martin O'Malley*** [1]

The 21st century holds tremendous promise for achieving significant advances in medical innovation. Today, scientists are in the early stages of translating knowledge gained from the mapping of the human genome into vast possibilities for improving and extending life. Complementary advances in the physical and information sciences may further expand the potential for dramatic steps forward in medical innovation. Such progress may bring about a future of increasingly personalized medicine, with therapies tailored to the needs of specific patient sub-groups that enable providers to select optimal treatments for individual patients.

In tandem with these developments, the U.S. will likely face the challenges associated with an aging population and an increasing prevalence of chronic disease. These challenges may drive an even greater need for new medicines to more effectively treat and prevent conditions such as cancer, Alzheimer's disease, and Parkinson's disease. Medical innovation has the potential to improve quality of life, extend life expectancy, reduce disability, and improve worker productivity, all of which are vital to the nation's continued prosperity.

Medical innovation also creates economic value. Biopharmaceutical advances support high-value jobs and help stimulate regional and national economic activity. For these reasons, industrialized nations around the world compete aggressively to attract biopharmaceutical investment and to create clusters of companies centered around the biopharmaceutical sector that will act as "innovation hubs" to drive sustained economic growth.

This report provides important new empirical evidence on the economic impact of the biopharmaceutical sector in the U.S.[2] The biopharmaceutical sector is composed of an extensive and diverse group of companies ranging in size from small start-up firms to multi-national, multi-billion dollar corporations. These companies provide the resources—both human and financial—that drive the discovery, development, testing, and production of new medical treatments.

This report focuses on the period from 1996 to 2006, and used the most recent data available at the time analyses were performed. The economic environment has changed since 2006, however, and the biopharmaceutical sector has not been immune to the global economic slowdown in the last year. This slowing economic activity, together with business restructuring to address the shifting scientific and market landscape,

has led to job reductions in a number of biopharmaceutical companies in the last 24 months. Now, with the nation's urgent need to stimulate economic activity and to assure the sustainable long-term competitiveness of the U.S. economy, this report's findings are particularly important.

To measure the sector's absolute economic impact in the United States, this study examined employment levels, wages and personal taxes, and dollar contribution to gross domestic product (GDP).[3] Results are presented at the national and state levels, as well as for 20 selected metropolitan statistical areas. In addition, as an indicator of the sector's potential for future economic activity, this study estimated the sector's domestic private investment into research and development and characterized the number and types of ongoing clinical trials. It did not attempt, however, to estimate the potential gains in health outcomes, productivity, or quality of life associated with the use of medicines developed by the biopharmaceutical sector. Other publications address these issues in detail.[4]

Highlights:

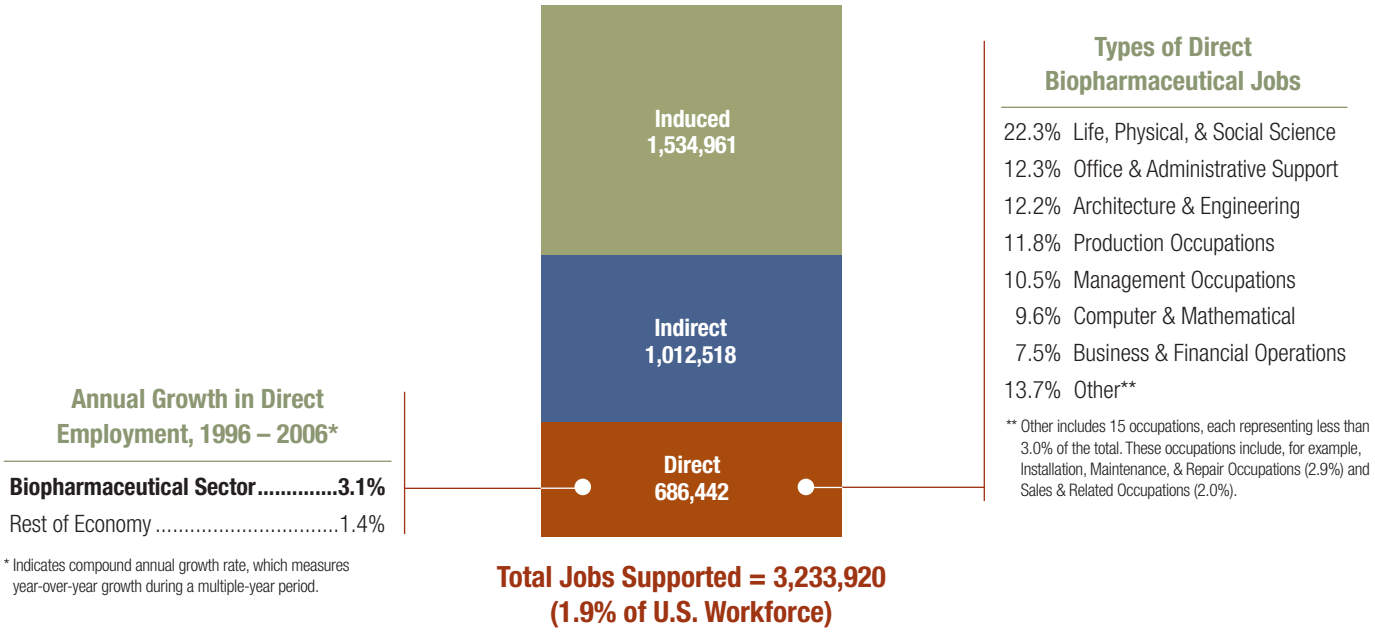
- **Broad and Deep Economic Footprint:** This sector provides jobs in all 50 states, Washington, D.C., and Puerto Rico. States in which the national biopharmaceutical sector supported the largest number of jobs in 2006 included California, New York, New Jersey, Pennsylvania, and Illinois.
- **High-value Jobs:** The biopharmaceutical sector directly provided 686,442 jobs in 2006 and supported an estimated 3.2 million jobs across the U.S. economy when accounting for its full ripple effect (i.e., direct, indirect, and induced jobs).
    - ***Ripple effect:*** Each direct job in the biopharmaceutical sector supported 3.7 other jobs in the U.S. in 2006. The ripple effect of the sector has increased since 1996, when each direct job supported 2.2 other jobs.
    - ***Average wage:*** On average, biopharmaceutical employees earned annual wages of $88,929 and paid approximately three times as much in federal (including Social Security) and state taxes as employees in the rest of the economy in 2006.
    - ***Tax revenue:*** Biopharmaceutical employees paid an average of $21,858 in federal taxes (including Social Security), compared to an average of $7,384 for employees in the rest of the economy, and an average of $3,271 in state taxes, compared to an average of $940 for employees in the rest of the economy.
- **Job Growth:** In approximately 80 percent of the locations studied, direct employment in the biopharmaceutical sector grew at a faster rate than employment in the rest of that location's economy grew between 1996 and 2006.
    - From 1996 to 2006, direct employment in the national biopharmaceutical sector grew more than twice as fast as employment in the rest of the U.S. economy, with compound annual growth rates of 3.1 percent and 1.4 percent, respectively.
- **Macroeconomic Impact:** The biopharmaceutical sector's direct contribution to GDP in 2006, $88.5 billion, was triple the average contribution for sectors that make up the rest of the economy. On a per employee basis, the sector's direct contribution to GDP was 71 percent more than the average contribution from sectors that make up the rest of the economy.
    - For every dollar that biopharmaceutical companies contributed to GDP in 2006, the ripple effect of that activity supported another $2.33 in contribution to GDP from other sectors. The impact of the sector's activity has increased since 1996, when each dollar of GDP contribution from the sector supported a contribution of $1.29 from other sectors.
- **Investment in R&D:** In 2006, U.S. biopharmaceutical companies invested $56.1 billion in research and development for new medicines, $44.9 billion of which was for research conducted in the U. S. This estimate represents an investment in U.S. research of $65,381 per direct employee, approximately eight times the published estimates of R&D spending per employee in all manufacturing industries between 2000 and 2004.[5]

Employment

The results of this analysis indicate that the biopharmaceutical sector was responsible for 686,442 direct jobs across the nation in 2006, representing a significant source of employment in the U.S. economy. Direct employment in the U.S. biopharmaceutical sector grew at more than twice the rate of employment growth in the rest of the economy between 1996 and 2006.[6]

Taking into account the ripple effect of jobs created in other sectors, biopharmaceuticals supported total employment of 3.2 million jobs in 2006 (Figure ES-1). This total employment estimate includes direct jobs as well as approximately 1.0 million indirect and 1.5 million induced jobs that were supported by the ripple effect of activity by biopharmaceutical companies and employees. Indirect jobs provide goods or services necessary to support biopharmaceutical companies. For example, the presence of a biopharmaceutical company in a local economy may indirectly support employment opportunities for accountants and tax professionals whose services are needed by the biopharmaceutical firm. Induced jobs are supported by the spending patterns of both direct and indirect employees of the biopharmaceutical sector. Induced employment includes, for example, jobs at a local day care facility that is primarily used by children of biopharmaceutical employees. In 2006, for every direct job, 3.7 indirect and induced jobs were supported by the sector.

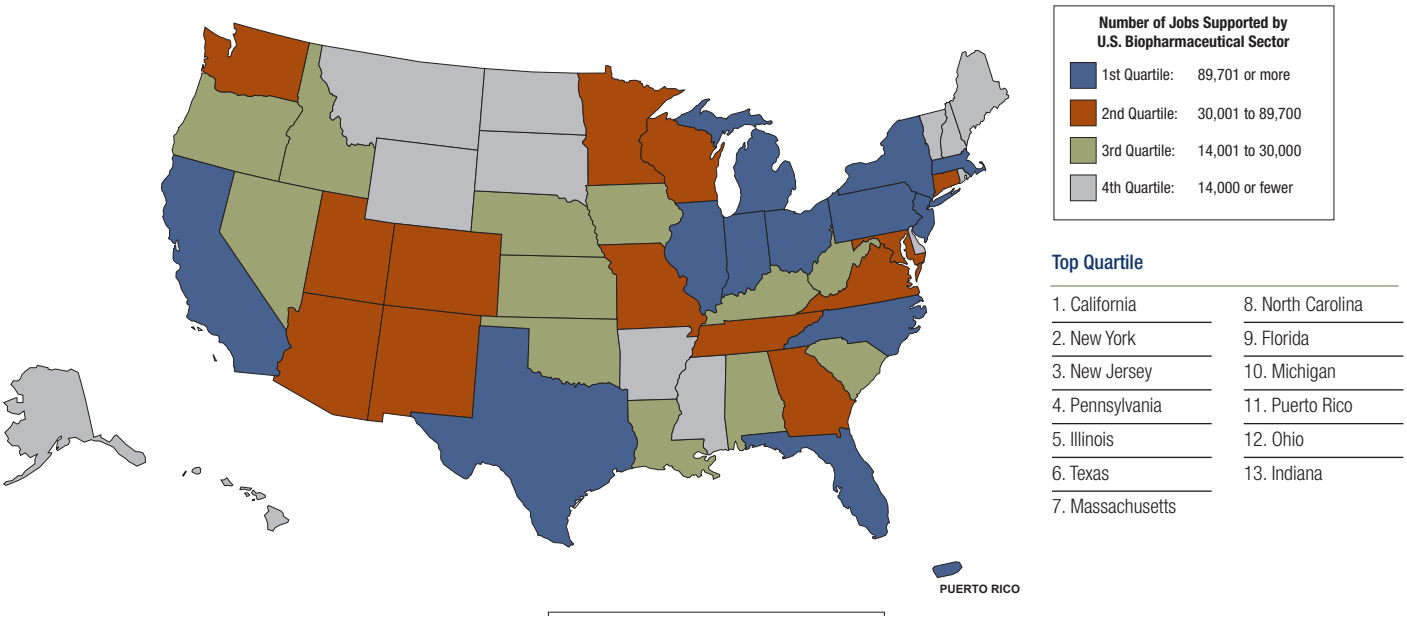
Figure ES-1: Employment Supported by U.S. Biopharmaceutical Sector (2006)



Source: Archstone Consulting Analysis, Minnesota IMPLAN Group, Inc., U.S. Bureau of Labor Statistics.[7]

In 2006, jobs supported by the national biopharmaceutical sector were spread across all 50 U.S. states, as well as Washington, D.C. and Puerto Rico. As shown in Figure ES-2, the states with the highest total number of jobs supported by the national biopharmaceutical sector were California, New York, New Jersey, Pennsylvania, and Illinois. Total employment in these five states ranged from 181,788 to 501,661 jobs per state.

Figure ES-2: Distribution of Total Employment Supported by U.S. Biopharmaceutical Sector (2006)



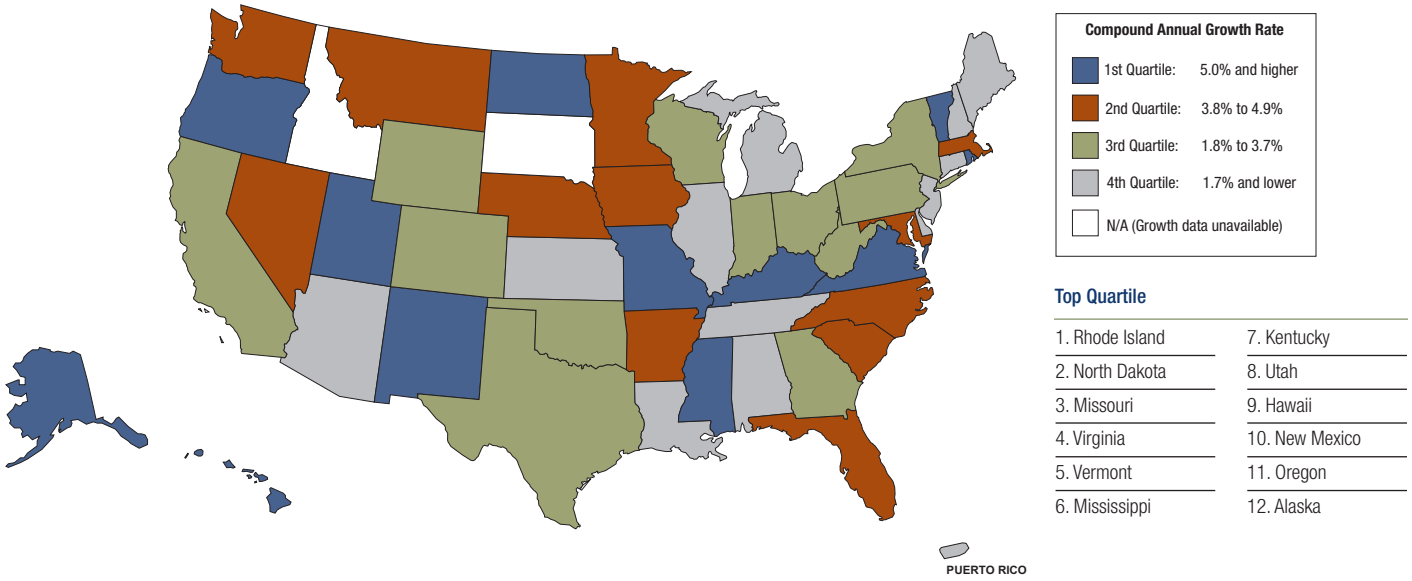
Top Quartile

1. California	8. North Carolina
2. New York	9. Florida
3. New Jersey	10. Michigan
4. Pennsylvania	11. Puerto Rico
5. Illinois	12. Ohio
6. Texas	13. Indiana
7. Massachusetts	

Source: Archstone Consulting Analysis, Minnesota IMPLAN Group, Inc., U.S. Bureau of Labor Statistics.[8]

Nationally, direct employment in the biopharmaceutical sector grew at a compound annual rate of 3.1 percent from 1996 to 2006, compared to 1.4 percent in the rest of the U.S. economy. This pattern was reflected in state economies as well; this analysis found that in 80 percent of the locations studied,[9] direct employment in the biopharmaceutical sector grew at a faster rate than employment in the rest of that location's economy during this time period. Some states experienced particularly rapid growth in sector employment. As shown in Figure ES-3, the states with the highest rate of direct employment growth between 1996 and 2006 included several states, such as North Dakota and Missouri, that are not traditionally known for having a biopharmaceutical sector presence. High employment growth in these states during this timeframe may be attributable to state policies and initiatives that were designed to attract and grow the biopharmaceutical sector. For example, North Dakota established the Red River Valley Research corridor in 2002 in an effort to attract research investment to the state.[10]

Figure ES-3: Distribution of Direct Employment Growth in U.S. Biopharmaceutical Sector (1996 – 2006)



Top Quartile

1. Rhode Island	7. Kentucky
2. North Dakota	8. Utah
3. Missouri	9. Hawaii
4. Virginia	10. New Mexico
5. Vermont	11. Oregon
6. Mississippi	12. Alaska

Source: Archstone Consulting Analysis, U.S. Bureau of Labor Statistics, Minnesota IMPLAN Group, Inc.[11]

Because the biopharmaceutical sector is research-intensive, nearly one out of every four direct jobs at biopharmaceutical companies is classified as a life, physical, or social sciences occupation (Figure ES-1). The sector's large and highly-educated workforce receives wages commensurate with skill level and generates significant tax revenues for federal and state governments. In 2006, direct employees of the U.S. biopharmaceutical sector received wages totaling $61.0 billion and paid federal taxes (including Social Security) totaling $15.0 billion. In 2006, on average, U.S. biopharmaceutical employees earned $88,929 (excluding benefits) and paid $21,858 in federal taxes (including Social Security) and $3,271 in state taxes, or approximately three times the average amount paid by U.S. workers in the rest of the economy.

Table ES-1: Wages Earned and Taxes Paid in the U.S. (2006)

	Wages	Federal Taxes	State Taxes
All Direct Biopharmaceutical Employees	$61.0 billion	$15.0 billion	$2.0 billion
Average per Direct Biopharmaceutical Employee	$88,929	$21,858	$3,271
Average per Employee in Rest of Economy	$42,067	$7,384	$940

Note: Federal taxes include both income and Social Security taxes; state taxes include income taxes only.
Source: Archstone Consulting Analysis, U.S. Bureau of Labor Statistics, National Bureau of Economic Research, Minnesota IMPLAN Group, Inc.[12]

Economic Impact

To assess the absolute economic impact of the biopharmaceutical sector, this study measured the sector's dollar contribution to GDP at the national level as well as its dollar output at the state level. GDP is the commonly accepted measurement of a nation's aggregate economic activity. A sector's contribution to GDP represents the sector's net effect on the economy. A sector's output, by contrast, is the value of all sales generated by companies in a sector and is a more appropriate measure to use than contribution to GDP when examining employment at the local level as it includes all activities requiring jobs. Each total measurement is comprised of direct, indirect, and induced components. For every one dollar of direct sector contribution to GDP or output, indirect and induced dollars can be attributed to companies that support the biopharmaceutical sector and its employees.

The biopharmaceutical sector generated a substantial contribution to the nation's GDP, with a dollar contribution larger than the average contribution from sectors in the rest of the economy and a compound annual growth rate that exceeded this rate for the rest of the economy between 1996 and 2006. In 2006, biopharmaceuticals represented approximately 1.0 percent of the nation's GDP, with a direct contribution of approximately $88.5 billion. The sector's direct contribution was more than three times the average contribution from sectors in the rest of the economy, which averaged a contribution of $26.1 billion per sector. Per direct employee, this contribution was $128,925, or 71 percent more than the average contribution per employee in the rest of the economy. When the sector's total impact is considered, biopharmaceuticals represented 2.2 percent of the nation's GDP, with a total contribution of $294.6 billion.

Figure ES-4: Contribution to GDP Supported by U.S. Biopharmaceutical Sector (2006)

Total Contribution Supported = $294.6 billion (2.2% of U.S. GDP)

Direct Contribution to GDP per Direct Employee, 2006

Biopharmaceutical Sector.....$128,925

Rest of Economy.....$75,307

Annual Growth in Direct Contribution to GDP, 1996 – 2006*

Biopharmaceutical Sector.....3.1%

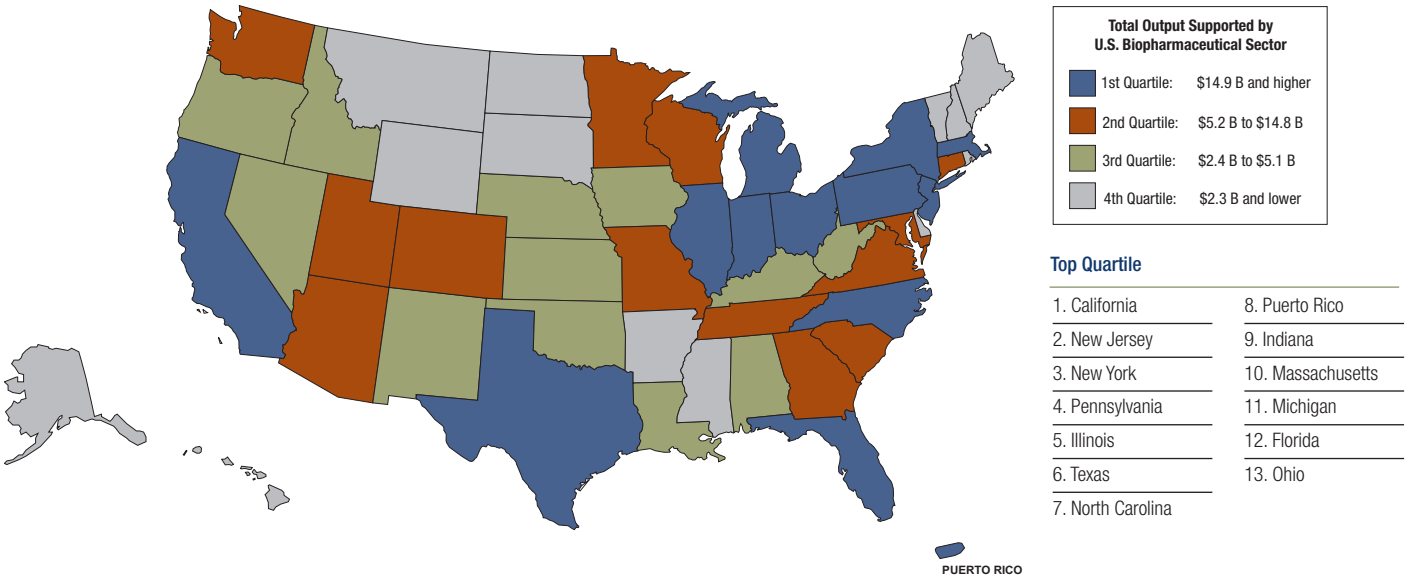
Rest of Economy.....2.9%

* Indicates compound annual growth rate, which measures year-over-year growth during a multiple-year period.

Source: Archstone Consulting Analysis, Minnesota IMPLAN Group, Inc.[13]

To assess the breadth and reach of the sector's economic impact at the state level, total output was calculated for all states. In 2006, the states with the highest total output supported by the national biopharmaceutical sector included California, New Jersey, New York, Pennsylvania, and Illinois, with total output ranging from $37.9 to $100.9 billion per state.

Figure ES-5: Distribution of Total Output Supported by U.S. Biopharmaceutical Sector (2006)



Top Quartile

1. California	8. Puerto Rico
2. New Jersey	9. Indiana
3. New York	10. Massachusetts
4. Pennsylvania	11. Michigan
5. Illinois	12. Florida
6. Texas	13. Ohio
7. North Carolina	

Source: Archstone Consulting Analysis, Minnesota IMPLAN Group, Inc., U.S. Bureau of Labor Statistics.[14]

The relatively high number of indirect and induced jobs and the high level of economic activity supported by the sector may be an indicator of clustering of interrelated life sciences organizations in particular geographic areas. Such clusters have the potential to transform local economies by drawing highly-educated labor, attracting and enhancing research and educational institutions, and fostering local economic development. In recent years, many states and localities have launched or begun planning initiatives to attract, maintain, or grow the presence of the biopharmaceutical sector. These efforts aim to leverage the presence of biopharmaceutical companies, in order to help attract local investment by other firms, academic institutions, and research facilities that want to capitalize on existing infrastructure and human capital. Clusters of biopharmaceutical and bioscience activity include, for example, Frederick, Maryland and Madison, Wisconsin.

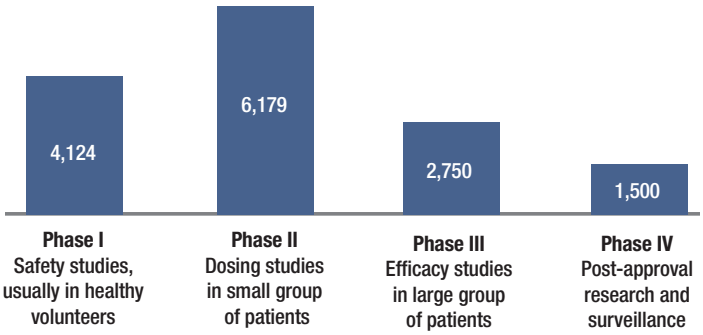
Research and Development

The discovery and development of new medicines is a research-intensive, costly, and high-risk venture. The estimated cost to develop an approved medicine rose from approximately $800 million in 2000 to over $1.2 billion in 2005.[15] Because many drugs in the pipeline do not succeed in gaining FDA approval and eight in ten medicines earn less in sales than the average cost to develop a new medicine,[16] earnings from the relatively few successful medicines are relied upon to support companies' ability to invest in research.

The level of R&D activity in the biopharmaceutical sector is one indicator of its future potential for growth. From 1999 to 2007, the number of compounds in the development pipeline for the U.S. market steadily grew from 1,756 to 2,742 at a compound annual growth rate of 5.7 percent.[17] Between 2005 and 2007, 1,251 new compounds were introduced to the development pipeline, which was nearly double the number of new compounds introduced between 1997 and 1999.[18] An estimated 21,795 active clinical trials were taking place in the U.S. in 2008, targeting a wide range of conditions including cancer, rare diseases, and behavioral and mental disorders.

Figure ES-6: Active U.S. Clinical Trials by Phase and Condition (2008)

Active U.S. Clinical Trials by Phase, 2008



Total Active Trials = 21,795

Note: Values do not add to total number of trials due to omission of trials listed as Phase 0 (exploratory, first in-human studies) and those with no phase specified.

Active U.S. Clinical Trials by Selected Condition, 2008

Selected Conditions	Number of Active Trials
Cancers and Other Neoplasms	6,956
Rare Diseases	2,762
Behavioral and Mental Disorders	1,479
Heart Disease	1,017
HIV/AIDS	704
Respiratory Tract Diseases	646
Diabetes	355
Parkinson's Disease	129
Alzheimer's Disease	81

Note: Some compounds may be studied for more than one condition. Listed conditions represent only a portion of all clinical trials active in the country.

Source: The Lewin Group Analysis, National Institutes of Health (clinicaltrials.gov).[19]

Biopharmaceutical sector companies invest significant resources annually to support research pipelines aimed at developing new medicines. In 2006, U.S. biopharmaceutical companies invested approximately $56.1 billion in research and development, $44.9 billion of which was for research conducted in the United States.[20] Based on this study's estimate of sector employment, this figure represents an average investment in U.S. research of $65,381 per direct employee in 2006. This estimate is approximately eight times other published estimates of R&D spending per employee in all manufacturing industries between 2000 and 2004.[21] Similarly, the Congressional Budget Office (CBO) reports that biopharmaceutical companies invest as much as five times the amount on R&D, relative to sales, as the average manufacturing company invests.[22]

Table ES-2: U.S. Biopharmaceutical Company Expenditures on Research & Development (2006)

Total R&D Spend	$56.1 billion
Total R&D Spend in U.S.	$44.9 billion
Average R&D Spend in U.S. per Direct Employee	$65,381

Source: Archstone Consulting Analysis, PhRMA 2008 Pharmaceutical Industry Profile (Burrill & Company Analysis), Minnesota IMPLAN Group, Inc.[23]

Biopharmaceutical research requires many types of organizations to work together to create an environment that fosters innovation. In addition to the substantial investment by biopharmaceutical companies, a wide range of other organizations play important roles including the National Institutes of Health (NIH), National Science Foundation, venture capital firms, academic institutions, and private foundations. In 2006, for example, the NIH awarded over $22.8 billion in grants to support scientific research and discovery initiatives. Venture capital firms are a particularly important source of capital and resources for biotechnology efforts of entrepreneurs and scientists.

Conclusion

Between 1996 and 2006, the biopharmaceutical sector had a substantial impact on job growth and, on average, these jobs contributed more to U.S. GDP than jobs in other sectors of the rest of the economy.

> "…over the long run, few issues are as important to a nation's long-term economic security and global standing as being a leader in moving life sciences forward."
>
> ***—Larry Summers, Financial Times, January 2007***[28]

The decade between 1996 and 2006, the period studied in this report, was one of dramatic change for U.S. biopharmaceutical companies. Scientific advances in the understanding of diseases at the genetic and molecular levels suggest that a new wave of medical discoveries may be on the horizon. At the same time, changes in the market environment have created challenging financial pressure: rising cost and complexity of drug discovery and development, intensification of competition within therapeutic categories, significant changes in insurance coverage and reimbursement, and rising utilization of generic drugs. During the latter part of this 10-year period, these challenges were reflected by a reduction in the number of new drug approvals and a sharp decline in prescription drug spending growth.[24] The recent downturn in the economy has further contributed to slowing growth in the use of prescription drugs (IMS Health projects only 1-2 percent growth in sales for 2008)[25] and decreased access to capital for smaller companies.[26]

Despite this shifting landscape, the U.S. continues to be the largest and most attractive market for prescription medicines in the world, with strong intellectual property incentives and market competition. In addition, national and state polices have fostered U.S. investment in academic and non-commercial research and facilitated partnerships and knowledge-sharing among universities, government entities, and biopharmaceutical companies. Even with increasingly aggressive competition for private investment and R&D activities not only in the advanced industrial countries, but also in the rapidly growing economies of China, India, and the developing world, U.S. investment in R&D continues to rise. In 2008, biopharmaceutical investment in R&D rose to $65.2 billion.[27] This level of investment, together with increases in the number of compounds in clinical testing, offers hope for the resumption of growth of its economic contribution as the current economic downturn ends and new scientific opportunities are brought to fruition.

Table ES-3: Economic Impact of U.S. Biopharmaceutical Sector

	Direct Biopharmaceutical Employment (2006)	Total Employment Supported by Biopharmaceutical Sector (2006)	Average Wage per Direct Biopharmaceutical Employee (2006)	Total Output Supported by Biopharmaceutical Sector (in U.S. $, Millions, 2006)	R&D Expenditure by Biopharmaceutical Companies (in U.S. $, Millions, 2006)	Total Active Clinical Trials (2008)
Alabama	4,804	28,189	$72,272	$4,200.6	$372.1	1,725
Alaska	570	3,747	$45,642	$511.4	$2.6	145
Arizona	4,045	35,373	$69,818	$5,300.0	$173.0	1,753
Arkansas	1,052	13,716	$46,885	$1,929.3	$17.4	954
California	120,134	501,661	$102,255	$100,901.2	$8,568.4	5,631
Colorado	13,647	57,191	$98,478	$9,698.5	$329.3	1,823
Connecticut	10,653	53,584	$113,722	$14,177.3	$3,889.4	1,352
Delaware	3,564	11,672	$98,022	$2,211.7	$67.7	499
Florida	12,417	112,041	$68,910	$15,339.7	$657.8	3,471
Georgia	5,612	56,879	$75,717	$10,197.0	$425.9	2,314
Hawaii	2,114	10,211	$71,893	$1,202.8	$38.2	432
Idaho	6,680	20,549	$72,782	$2,454.6	$28.6	401
Illinois	37,141	181,788	$106,296	$37,874.8	$2,009.4	3,286
Indiana	15,306	89,763	$91,660	$22,707.1	$1,692.7	1,922
Iowa	3,019	24,687	$51,366	$4,576.5	$35.3	1,143
Kansas	1,847	18,463	$56,523	$3,429.2	$50.4	1,143
Kentucky	2,012	23,227	$62,533	$3,776.8	$16.8	1,274
Louisiana	963	19,098	$57,137	$4,222.4	$29.7	1,306
Maine	2,571	12,341	$52,880	$2,066.0	$47.0	420
Maryland	28,065	89,675	$81,137	$14,431.0	$1,204.6	3,820
Massachusetts	39,900	127,472	$99,271	$22,619.7	$3,018.3	3,308
Michigan	23,859	106,846	$91,188	$19,925.1	$925.6	2,606
Minnesota	7,809	49,105	$74,134	$8,219.4	$218.4	2,205
Mississippi	1,229	13,539	$45,528	$2,256.6	$42.0	621
Missouri	10,884	65,192	$92,606	$11,107.6	$368.8	2,397
Montana	908	6,041	$49,463	$764.9	$17.3	570
Nebraska	2,532	17,486	$55,602	$3,189.6	$70.6	1,134
Nevada	4,758	21,895	$83,677	$2,984.2	$36.1	781
New Hampshire	2,052	11,213	$89,570	$1,867.9	$69.7	1,102
New Jersey	48,817	211,287	$118,993	$58,878.8	$7,863.6	2,016
New Mexico	16,945	43,029	$74,829	$5,147.7	$164.5	693
New York	55,446	215,729	$68,272	$44,564.8	$1,846.4	5,053
North Carolina	26,082	118,285	$80,053	$25,744.5	$1,459.2	3,121
North Dakota	576	4,298	$40,756	$488.7	$5.0	460
Ohio	15,992	91,750	$72,393	$14,904.0	$636.8	3,460
Oklahoma	2,149	20,758	$53,232	$3,352.6	$15.1	1,148
Oregon	4,451	27,115	$64,414	$3,711.5	$73.2	1,490
Pennsylvania	39,494	190,151	$92,505	$39,622.6	$4,256.5	3,785
Rhode Island	2,012	10,063	$75,883	$2,259.0	$24.4	769
South Carolina	4,093	28,800	$56,842	$5,204.5	$48.7	1,601
South Dakota	290	4,525	$48,415	$568.6	$4.2	466
Tennessee	10,603	53,852	$70,368	$8,380.4	$80.6	2,232
Texas	24,808	165,982	$80,096	$35,660.9	$660.3	4,777
Utah	6,351	34,016	$55,811	$6,290.2	$111.7	1,076
Vermont	546	4,043	$57,699	$495.4	$11.7	537
Virginia	19,942	79,986	$88,330	$12,644.9	$1,337.3	1,875
Washington	19,291	67,606	$81,499	$10,472.1	$916.5	2,191
Washington D.C.	10,599	20,681	$85,300	$3,292.6	$46.4	1,253
West Virginia	2,612	14,293	$67,556	$3,094.3	$125.5	439
Wisconsin	4,914	41,979	$71,721	$7,160.5	$99.0	1,608
Wyoming	285	3,047	$35,416	$530.3	$2.5	176
Puerto Rico	24,267	94,217	$51,887	$23,641.2	Not Available	425
United States	**686,442**	**3,233,920**	**$88,929**	**$626,612.0**	**$44,880.0**	**21,795**

Source: Archstone Consulting Analysis, Minnesota IMPLAN Group, Inc., U.S. Bureau of Labor Statistics, PhRMA 2008 Pharmaceutical Industry Profile (Burrill & Company Analysis), National Institutes of Health (The Lewin Group Analysis of clinicaltrials.gov).

Endnotes

[1] L. Smitherman. (2008). MD Joins Sprint to Lead in Biotechnology. *Baltimore Sun*. Baltimore, MD: The Baltimore Sun Company.

[2] For the purposes of this report, the biopharmaceutical sector includes companies in the following sub-sectors: medicinal botanical manufacturing, pharmaceutical preparation manufacturing, in-vitro diagnostic substance manufacturing, biological product manufacturing, life sciences research, and biotechnology research. This analysis makes corrections to attempt to avoid counting economic activity generated from medical products and equipment, personal care products, and agricultural and industrial biotechnology. Over-the-counter therapies are included in this analysis as they are a part of the definition of biopharmaceuticals.

[3] The analytics performed in this report attempt to quantify the absolute impact of the biopharmaceutical sector on the economy, rather than its marginal impact. An absolute approach considers all economic activity (direct, indirect, and induced) that is attributable to the sector's presence; by contrast, a marginal approach acknowledges that a certain portion of this economic activity would still exist in the absence of the sector, and thus only measures the additional economic activity that is unique to the sector's presence in a given area. The absolute impact is a measure of the economic loss that would occur if the sector were to disappear and were not to be replaced by another sector, while the marginal impact is a measure of the economic loss that would result if the sector were to disappear but were to have its labor and capital redeployed to other sectors. This analysis reflects the economic activity associated with biopharmaceutical companies in 1996 and 2006, using inflation-adjusted 2006 dollar amounts for monetary assessments.

[4] See, for example, D. Cutler, G. Long, E. Berndt, J. Royer, A. Fournier, A. Sasser and P. Cremieux. (2007). The Value of Antihypertensive Drugs: A Perspective on Medical Innovation. *Health Affairs*, *26,1*, 97-110.; R. Devol and A. Bedroussian. (2007). An Unhealthy America: Economic Burden of Chronic Disease. Santa Monica, CA: Milken Institute.; C.W. Cranor, D. Bunting and D. Christensen. (2003). The Asheville Project: Long-Term Clinical and Economic Outcomes of a Community Pharmacy Diabetes Care Program. *Journal of the American Pharmaceutical Association*, *43, 2*, 173-184.; N. Choudhry, A. Patrick, E. Antman, J. Avorn and W. Shrank. Cost-Effectiveness of Providing Full Drug Coverage to Increase Medication Adherence in Post Myocardial Infraction Medicare Beneficiaries. (2008). *Circulation, 117*, *10*, 1261-1268.; J.B. Wong, G. Singh and A. Kavanaugh. (2002). Estimating the Cost-Effectiveness of 54 Weeks of Infliximab for Rheumatoid Arthritis. *American Journal of Medicine*, *113, 5*, 400-408.; M.C. Sokol, K. McGuigan, R. Verbrugge and R. Epstein. (2005). Impact of Medication Adherence on Hospitalization Risk and Healthcare Cost. *Medical Care, 43, 6*, 521-530.; O.L. Lopez, J.T. Becker, J. Saxton, R.A. Sweet, W. Klunk and S.T. DeKosky. (2005). Alteration of a Clinically Meaningful Outcome in the Natural History of Alzheimer's Disease by Cholinesterase Inhibition. *Journal of the American Geriatric Society*, *53,1*, 83-87.; The Lewin Group. (2004). Saving Lives. Saving Money: Dividends for Americans Investing in Alzheimer Research. Available at: http://www.alz.org/national/documents/report_savinglivessavingmoney.pdf. Falls Church, VA: The Lewin Group; and K.M. Murphy and R.H. Topel (Eds.). (2003). Measuring the Gains from Medical Research: An Economic Approach. Chicago, IL: University of Chicago Press.

[5] R.J. Shapiro and N.D. Pham. (2007). Economic Effects of Intellectual Property-Intensive Manufacturing in the United States. Available at: www.the-value-of-ip.org (Accessed October, 2008). Arlington, VA: World Growth.

[6] This analysis compares the biopharmaceutical sector to 503 other sectors in the economy (i.e., "the rest of the economy") as primarily defined in IMPLAN software (e.g., air transportation, radio and television broadcasting). As a point of reference regarding the data used for this report, for 2006, the 504 sectors combined resulted in a total U.S. employment of 174.7 million, GDP of $13.2 trillion, and output of $24.8 trillion. Data for Washington, D.C. is included in these figures but data for Puerto Rico is not included. Growth rate used in this comparison is a compound annual growth rate from 1996 to 2006.

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[9] Locations studied were the 48 states for which growth data was available, Washington D.C., and Puerto Rico.

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[12] U.S. Department of Labor (U.S. Bureau of Labor Statistics). (2008). *BLS Quarterly Census of Employment and Wages* [database], *2006 data*. Available at: www.bls.gov/cew/#databases (Accessed: October, 2008). Washington, DC: BLS.; Minnesota IMPLAN Group, Inc. (1997). IMPLAN System (2006 data and software version 2.0). In *IMPLAN State Totals Package* [data files] (www.implan.com). Stillwater, MN: Minnesota IMPLAN Group, Inc.; and National Bureau of Economic Research. (2008). *Internet TAXSIM Version 8.0* [tax simulator] (D. Feenberg, Ed.). Available at: www.nber.org/~taxsim/ (Accessed: November, 2008). Cambridge, MA: NBER.

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Note: 2007 data was the most recent data available at the time analyses were performed and was available in a readily accessible and de-duplicated format. To reduce the burden of analysis, alternating years were included.

[18] Ibid.

[19] United States Department of Health & Human Services (National Institutes of Health). (2008). National Library of Medicine (The Lewin Group Analysis). In *Analysis of Clinicaltrials.gov* [data file provided by The Lewin Group] (www.clinicaltrials.gov).

[20] Venture capital dollars may be captured in this figure as start up and smaller biopharmaceutical firms that may not have any approved medicines on the market are highly reliant on investment from venture capital firms.

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Note: Total 2006 Biopharmaceutical R&D figures were adjusted, with guidance from Burrill & Company, to estimate only that portion of R&D investment taking place in the U.S. Total R&D includes spending by U.S.–owned and U.S. divisions of foreign–owned biopharmaceutical companies.

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Note: New data released following the completion of this analysis show that U.S. biopharmaceutical sector investment, including U.S. investment for R&D conducted domestically and abroad, was $65.2 billion in 2008; of this amount, $49.8 billion was invested in R&D conducted within the U.S. in 2008.

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