An Economic Profile of the Biosciences Industry in West Virginia[1]

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[1] This research was conducted under contract with the Pharmaceutical Research and Manufacturers of America. The opinions expressed herein are the responsibility of the authors. Mr. Gregory is a graduate research assistant, Bureau of Business and Economic Research. Dr. Witt is a professor of economics and director, Bureau of Business and Economic Research. We appreciate the assistance of Amy Higginbotham and Randy Childs, BBER economists, in the preparation of the economic impacts reported in this study.

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Executive Summary

The West Virginia economy, along with many other states, has undergone significant changes in its overall economic structure. Manufacturing employment continues to decline while service related jobs continue to grow. As part of the process of identifying new opportunities to grow the state economy, policy makers and economists have identified industry clusters that have potential for advancing the state's economy. In recent years the bioscience industry has received increasing attention and study. For the purposes of this report this industry has four major subsectors: agricultural feedstock and chemicals, drugs and pharmaceuticals, medical devices and equipment, and research, testing and medical laboratories.

National studies by the Battelle Memorial Institute and the Milken Institute have identified the bioscience industry as an attractive target for states seeking to stimulate economic growth. This industry has strong job growth and wages well above the national private sector level. As a result, states have been fashioning their public policies to support the continued growth of this industry cluster.

This study estimates the economic impact (direct, indirect and induced, and total) of the West Virginia bioscience industry in 2006. The following table summarizes these impacts:

Economic Impact of West Virginia's Bioscience Industry, 2006
(millions of $)

	Direct	Indirect & Induced	Total
Business Volume	$3,374	$3,821	$7,195
Employment (Jobs)	6,912	15,023	21,935
Output	$3,374	$2,720	$6,094
Employee Compensation	$457	$499	$956
Value Added	$825	$1,053	$1,878
Assorted State Taxes	-	-	$56.8

Note: Totals may not sum due to rounding. Assorted state taxes include consumer sales, use, personal income, corporate net income and business franchise.

The report presents a detailed profile of the West Virginia bioscience industry over the period 2001-2006. Major findings include:

- Within the bioscience industry, the agricultural feedstock and chemical sub-sector as well as the drugs and pharmaceutical sub-sector have a greater concentration in West Virginia than the nation as a whole. The Charleston MSA has a relatively high concentration of agriculture feedstock and chemicals employment while the Morgantown MSA has a very high concentration of employment in the drugs and pharmaceutical sub-sector.

- West Virginia bioscience employment ranged from 6,928 in 2001 to 6,912 in 2006. Significant employment declines of 1,151 jobs in the All Other Basic Organic Chemical Manufacturing Sector were largely offset by employment gains in the other bioscience sectors.

- West Virginia bioscience average earnings in 2006 were $55,220 compared to statewide average earnings of $37,894.

- Bioscience employment was largely concentrated in the Charleston, Huntington and Morgantown Metropolitan Statistical Areas as well as Tyler County.

National studies on the bioscience industry acknowledge the importance of research undertaken in higher education; however, most studies do not estimate the economic impact of this research. University based research is a very important component for the development of human capital as well as the commercialization of research in the private sector. The following table summarizes the economic impact of the life sciences research undertaken at West Virginia University, Marshall University and the West Virginia School of Osteopathic Medicine during FY2007.

Economic Impact of West Virginia's Life Science Research at WVU, Marshall and WVSOM, FY 2007 (thousands of $)

	Direct	Indirect & Induced	Total
Business Volume	$99,760	$100,303	$200,063
Employment (Jobs)	872	712	1,584
Output	$99,760	$72,723	$172,483
Employee Compensation	$35,028	$16,817	$51,845
Value Added	$46,111	$39,520	$85,631
Assorted State Taxes	$1,568	$1,149	$2,716

Note: Totals may not sum due to rounding. Assorted state taxes include consumer sales, use, personal income, corporate net income and business franchise.

The study also reviews a variety of state level public policy measures critical to the growth and development of the industry. West Virginia has numerous efforts underway, as well as new initiatives that will create an environment more attractive and welcoming to the bioscience sector.

West Virginia is well positioned to grow its bioscience industry through investments in additional higher education research support along with support of current and new state and regional initiatives fostering additional investment and job creation in this industry.

Introduction and Overview

The West Virginia economy, along with many other states, has undergone significant changes in its overall structure. Following the national trend, manufacturing employment continues to decline while service related jobs continue to grow. While there has been a recent upturn in West Virginia energy employment due to rising coal and natural gas prices, there has been a long term decline in energy employment. The loss of high wage employment and relatively low levels of educational attainment statewide have led to a per capita income of $28,067 in 2006, which was 77 percent of the national average of $36,629.[2]

In the last twenty years, West Virginia policy makers and economists have identified industry clusters that had the potential for advancing the state's economy. The Bureau of Business and Economic Research at West Virginia University has issued comprehensive reports on two such clusters—chemicals and polymers, along with recommendations for public policies to support the growth of these sectors.[3]

In the last several years the bioscience industry has received increasing attention in the United States. This industry has four major subsectors: agriculture feedstock and chemicals, drugs and pharmaceuticals, medical devices and equipment, and research, testing, and medical laboratories. All these sectors have shown considerable growth nationally.

This report reviews national studies on the bioscience industry and their implications for West Virginia. The report also includes a comprehensive profile of the bioscience industry in West Virginia as a whole and by county. Major economic indicators such as employment, earnings, and number of establishment are reviewed. Based upon the economic information in 2006 the economic impact of the industry is estimated and put in context with other major sectors.[4] The report concludes with a review of state policies promoting the growth of this industry and updates West Virginia's efforts.

National Studies on the Bioscience Industry and Their Implications for West Virginia

Over the past several years both the Battelle Memorial Institute and the Milken Institute have released major studies on the bioscience industry.[5] With a promising future ahead, the bioscience sector is an attractive target for states seeking to stimulate economic growth. The sector encompasses a group of industries and activities, linked by the application of knowledge of the way in which plants, animals, and humans function, that stem from the convergence of the biological sciences, engineering, and information technology. Due to strong job growth and wages which are typically well above the national private sector

[2] Source: Bureau of Economic Analysis, U.S. Department of Commerce, BEARFACTS, http://bea.gov/regional/bearfacts.

[3] See David Greenstreet, *Overview of Economic Aspects of the Polymer Alliance Zone*, BBER, 1996 and David Greenstreet, *Economic Prospects of the Central West Virginia Chemical Industry with Recommendations Regarding a Potential Chemical Alliance Zone*, BBER, 1998.

[4] Definitions of various types of economic impacts examined in this report can be found in Appendix A Table 7.

[5] Battelle Technology Partnership Practice and SSTI, *Growing the Nation's Bioscience Sector: State Bioscience Initiatives 2006*, prepared for the Biotechnology Industry Organization, April 2006, available at www.bio.org. Milken Institute, *Biopharmaceutical Industry Contributions to State and U.S. Economies*, October 2004, available at www.milkeninstitute.org.

average, the competition among states and regions to attract bioscience firms is intense. State-based initiatives are wide-ranging in their focus and funding levels, and will be covered below.

Within biosciences, the Battelle report identified four subsectors: agriculture feedstock and chemicals, drugs and pharmaceuticals, medical devices and equipment, and research, testing, and medical laboratories. A detailed listing of these sectors is provided in Table 1. As a note, academic institutions with major life sciences research (includes bioscience) were not included in the Battelle Memorial Institute study due to data restraints.

The Battelle report indicates that in 2004 total employment in the bioscience sector reached 1.2 million nationally, with medical devices and equipment, and research, testing, and medical laboratories each accounting for 33 percent of the total, and drugs and pharmaceuticals holding a 25 percent share.[6] Bioscience sector employment increased by just over 1 percent between 2001 and 2004, whereas overall U.S. employment decreased by 0.7 percent. Within biosciences, research, testing, and medical laboratories registered the fastest employment growth, at 8 percent between 2001 and 2004, with drugs and pharmaceuticals registering 3 percent growth. Agricultural feedstock and chemicals, and medical devices and equipment each showed declines during the period. Overall, the bioscience sector accounted for about 1.1 percent of U.S. employment during 2004.

As could be expected, the 1.2 million jobs attributed to the bioscience sector nationally have both directly and indirectly spurred other job opportunities.[7] Using RIMS II economic multipliers[8], a methodology permitting the tracing of the interrelationships between expenditures in the bioscience sector and other parts of the economy, the Battelle Memorial Institute attributed an additional 5.8 million jobs to suppliers and other firms, for a total impact of 7.0 million jobs. Along with this job creation, another primary attraction of the bioscience sector involves the relatively high wages paid to workers in the industry. The average annual wage of bioscience workers in the U.S. was $65,775 in 2004, nearly $26,000 higher than the average private sector annual wage in the U.S. Furthermore, real earnings increased by 6.4 percent between 2001 and 2004, compared to a 1.4 percent increase for the average private sector worker.

The four sub-sectors of biosciences encompass a wide range of activities, offering states an opportunity to capitalize on sector growth in several different areas. Agricultural feedstock and chemicals includes the production and processing of organic and agricultural chemicals and feedstock. Companies such as Archer Daniels Midland, Bayer CropScience, Cargill, Dow, DuPont, Monsanto, and others in this sector focus on the production of biodiesel fuels, plantbased biodegradable materials, fertilizers and pesticides, sustainable oils and lubricants, biocatalysts, and food and feed additives and ingredients.

[6] The Battelle report used data provided by the Minnesota Implan Group, Inc. (www.implan.com). The data on employment, earnings and established by industry is based upon the North American Industrial Classification System (NAICS), which is the standard established by the federal government for the classification of industries.
[7] Appendix A Table 7 provides a definition of the economic impact concepts covered in this report.
[8] The RIMS II economic multipliers were prepared by the Bureau of Economic Analysis, U.S. Department of Commerce. For further information see http://www.bea.gov/bea/regional/rims.

Table 1 Bioscience Sectors by NAICS Code

NAICS Code	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	Phospatic 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	Other Biological Product Manufacturing
Medical Devices & Equipment	
334510	Electromedical Apparatus Manufacturing
334516	Analytical Laboratory Instrument Manufacturing
334517	Irradiation Apparatus Manufacturing
339111	Laboratory Apparatus and Furniture 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
541710	Physical, Engineering, and Biological Research
621511	Medical Laboratories
621512	Diagnostic Imaging Centers
Sectors are grouped as in *Growing the Nation's Bioscience Sector: State Bioscience Initiatives 2006*, Battle Memorial Institute	

In order to assess whether the agricultural feedstock and chemicals sub-sector is concentrated in West Virginia, or if it is relatively under-represented compared to the nation as a whole, a location quotient is used. The location quotient is derived by dividing the share of employment of a particular industry in a location by the share of employment of the same industry in a comparison region such as the nation. If the location quotient is above 1, the industry is relatively concentrated in that location; if it is less than 1, there might be opportunities for industry expansion. For West Virginia, the agricultural feedstock and chemicals sub-sector has a location quotient of 1.2, indicating a 20 percent greater concentration of agricultural feedstock and chemicals employment than the national average. Moreover, at a more specific geographic level, the Charleston Metropolitan Statistical Area (MSA) is noted as having a relatively high concentration of agriculture feedstock and chemicals employment than is found nationally.

The drugs and pharmaceuticals sub-sector was one of two bioscience sub-sectors that registered positive employment growth nationally between 2001 and 2004. Composed of therapeutic and diagnostic substances, sub-sector activities include the production of vaccines, oncology, neurology and cardiology treatments, herbal supplements and vitamins, tissues and cell culture media, and dermatological and topical treatments. Leading companies include Abbot, Amgen, Biogen, Genentech, MedImmune, Merck, Novartis, Pfizer, Roche, and Sanofi-Aventis. Here again, West Virginia has a larger share of its employment in this sub-sector than the nation, with a location quotient between 1.00 and 1.20. Also, the Morgantown MSA stands well above many similar sized MSAs, with a location quotient of 15.26 and 1,553 drugs and pharmaceuticals employees in 2004.

The medical devices and equipment sub-sector accounted for close to one-third of total bioscience sector employment in 2004. Focused on medical supplies, devices, and equipment, this sub-sector encompasses bio-imaging equipment, orthopedic and prosthetic implants and devices, dental instruments and orthodontics, laser eye surgery instruments, automated external defibrillators, vascular stents and other implantable devices. Bausch & Lomb, Boston Scientific, Ethicon, GE Healthcare, Medtronic, Siemens Medical Solutions, Stryker, and 3M Health Care are the major players within medical devices and equipment. The sub-sector is not well represented in West Virginia, however, with a location quotient below 0.80. The Parkersburg-Marietta MSA does have a location quotient of 2.06 and employment of 448, indicating a concentration in this metro area above the national level.

Research, testing, and medical laboratories not only accounted for another one-third of total bioscience sector employment, but it also registered strong job gains between 2001 and 2004. Activities in this sub-sector include functional genomics and drug discovery techniques, diagnostic testing, preclinical drug therapeutics, protein receptors, drug delivery technology, research models and laboratory support services. Sub-sector leaders include Cellomics, Charles River Labs, Diversa, Invitrogen, Laboratory Corp. of America, Pharmacopeia Drug Discovery, Quest Diagnostics, and ViaCell. West Virginia is under-represented in this sub-sector, with a location quotient below 0.80.

Similar to the bioscience sector described above, the biopharmaceutical industry holds the promise of growing companies and an increasing number of well-paying jobs, according to the

Milken Institute Study in 2004. The biopharmaceutical industry is an outgrowth of interdisciplinary research in molecular biology, immunology, and biochemistry and should be viewed as part of the bioscience sector. Recent biopharmaceutical growth stems from many traditional pharmaceutical firms seeking to supplement their product pipelines through external acquisitions or development of internal biotechnology divisions. In order to attract the attention of these firms and the industry itself, states are competing to offer a favorable and attractive environment. Moreover, the Milken Institute study pegged West Virginia as a state that has the potential to capitalize on the expanding biopharmaceutical industry.

The Milken Institute study indicated that in 2003 the biopharmaceutical industry directly employed 406,700 people in the U.S and was responsible for a total of 2.7 million jobs including the indirect and induced impacts.[9] Average annual wage for biopharmaceutical employees was $72,600, and the industry accounted for $63.9 billion in real output directly and $172.7 billion indirectly. The Milken Institute provides a 10-year projection for the industry, forecasting an increase in direct employment from 413,800 in 2004 to 536,300 in 2014. Moreover, total employment attributed to the biopharmaceutical industry is expected to grow to 3.6 million jobs over the same time period. Along with several other states, West Virginia is expected to exhibit job growth above the national average between 2004 and 2014.

Biopharmaceutical companies are characterized by their high levels of research and development, typically at least 20 percent of their overall sales, making them the most research-intensive sectors in the U.S. economy. Moreover, firms in this industry demand a skilled, welleducated labor force, access to research and risk capital funding, and an environment which encourages innovation. In order to be competitive in attracting biopharmaceutical companies, it is imperative that states enhance their research, financial and human capital infrastructures.

Hubs of biopharmaceutical activity are located in New England, the New Jersey-New York-Pennsylvania region, and in several Midwest states. While the clustering of firms is apparent in some areas, the overall growth of the industry has lead many states to register favorable biopharmaceutical growth in recent years. In the South Atlantic region, as defined by the Milken Institute and which includes West Virginia, North Carolina and Maryland dominate in terms of industry employment and output, while Delaware and the District of Columbia are also noted for their activity. As a whole, the region has outperformed the rest of the nation in terms of biopharmaceutical employment growth between 1983 and 2003. Perhaps most interesting, West Virginia led the region in terms of both employment growth (106.1 percent) and real output growth (214.2 percent) between 1993 and 2003. Real output per employee in West Virginia ($169,400) was third highest among the nine states in the region and wages per employee were the fifth highest ($56,800).

On a national scale, West Virginia's 106.1 percent employment growth rate in the biopharmaceutical industry between 1993 and 2003 ranks as the seventh-highest in the nation, while the real output growth rate during the same period (214.2 percent) is the fifth-highest in the U.S. The majority of West Virginia's biopharmaceutical employment is

[9] The Milken Institute study also used the RIMS II multipliers for the NAICS sectors examined.

concentrated in pharmaceutical and medicine manufacturing activity, relative to research and development (R&D) employment in the life sciences.

The Milkin Institute report provides detailed biopharmaceutical data along with economic and tax impacts for every state in the country. In 2003 West Virginia's biopharmaceutical industry directly employed 1,879 people and provided $106.8 million in earnings. Including multiplier effects, the total number of jobs generated by the industry swells to 5,833 with $219.2 million in total earnings. The industry registered a total real output (measured in 1996 dollars) of $521.7 million in 2003, with 61 percent ($318.3 million) directly attributable to biopharmaceutical firms and $203.4 million in indirect and induced impacts. The industry had a total federal and state tax liability of $87 million, of which $69.9 million was due to personal income tax revenues, $2.2 million attributed to total sales tax revenues, and $15.1 million in corporate income tax revenues. The majority of economic activity generated by the biopharmaceutical industry in West Virginia stems from manufacturing (71.4 percent), while professional & scientific services is a distant second at 6.4 percent. The state and local tax liability were estimated at $19.5 million.

The Milken Institute study includes an index that evaluates states' abilities to capitalize on opportunities in the biopharmaceutical industry. The index is based upon the presence of a suitable workforce, access to funding resources, and incentives for research activity. It also encompasses a state and/or region's research, financial, and human capital infrastructure. In order to construct the index, four key requirements are judged: biopharmaceutical research funding, biopharmaceutical risk capital funding, biopharmaceutical human capital and workforce, and biopharmaceutical innovation output. Rather than comparing absolute measures of the four requirement areas, the data is scaled in order to evaluate the relative strengths of a state.

Research funding is a vital component in the development and potential commercialization prospects of promising biopharmaceutical initiatives. Moreover, according to the Milken Institute study, the level of research funding can be used as an indicator of a region's future innovative capacity, as it aids in attracting companies, the appropriate workforce, and necessary capital. Major national funding sources include the National Institutes of Health (NIH), National Science Foundation (NSF), and Small Business Administration (SBA), among others. As a component of the larger, overall biopharmaceutical index, the research funding index considers the following: biopharmaceutical investment in R&D, total NIH funding; NIH funding to biopharmaceutical industry; academic funding of biopharmaceutical R&D; NSF funding to the industry; Small Business Innovation Research funding; and Small Business Technology Transfer funding. In the Milken study, Massachusetts was ranked as the top state in the biopharmaceutical research funding index, with Connecticut and Maryland completing the top three positions. West Virginia was ranked 48th, above only South Dakota and Alaska, which occupied the 49th and 50th positions, respectively.

In order to enhance the commercialization potential of research discoveries, companies need access to financial capital that will support these ventures. Risk capital, or venture capital, funding is an important aspect of the biopharmaceutical industry and its small businesses and entrepreneurs. In order to evaluate this component of a state's overall biopharmaceutical development prospects, the Milken Institute study looks at three important aspects of risk capital funding: biotech venture capital growth between 2001 and 2003, growth of biotech companies receiving venture capital, and biotech venture capital dollars per $100,000 of gross state product.

Massachusetts was again the top ranked state, while West Virginia was tied for last with seventeen other states which showed little or no biotech venture capital activity.

As with many industries, an educated workforce is vital for any development prospects. The biopharmaceutical industry, in particular, requires an accessible supply of labor well-versed in technology and science. The Milken Institute study measured states' relative human capital by focusing on biopharmaceutical-related bachelor degree attainment levels as a share of total bachelor degree attainment, the percentage of people with advanced degrees, the percentage of graduate students enrolled in biological and medical sciences, and biological technician employment as a share of a state's overall employment, among other measures. West Virginia ranked 22nd in this index component, with Delaware ranked first and South Dakota last.

The final component of the Milken Institute's biopharmaceutical innovation pipeline index relates to a state's capacity for biopharmaceutical innovation, encompassing many different indicators. The number of clinical (early, mid, and late-stage) trials measures commercialization potential, while the number of new drug applications, count of biotechnology and pharmaceutical patents and patent citations, patent technology cycle time, and the share of biopharmaceutical patents as a percentage of total number of state patents, all evaluate the level and success of research discoveries. Also included in this component is the number of biotechnology companies on the 'Technology Fast 500' list, composed by Deloitte, which are located in the state. Massachusetts took the first spot in this index component, with Alaska ranked 50th. West Virginia was ranked 31st.

Using these four components (research funding, financial capital, educated workforce and innovation pipeline), the Milken Institute study reports an overall state biopharmaceutical index. Not surprisingly, Massachusetts comes in as the top-ranked state, with Maryland and Connecticut next in line. West Virginia is ranked 41st, one spot lower than Louisiana, but just above Arkansas. Bottom-ranked states include Alaska, South Dakota, and Wyoming. The Milken Institute study notes that for states such as West Virginia, greater efforts at attracting research-intensive business, specially trained workers, and financial capital support are needed.

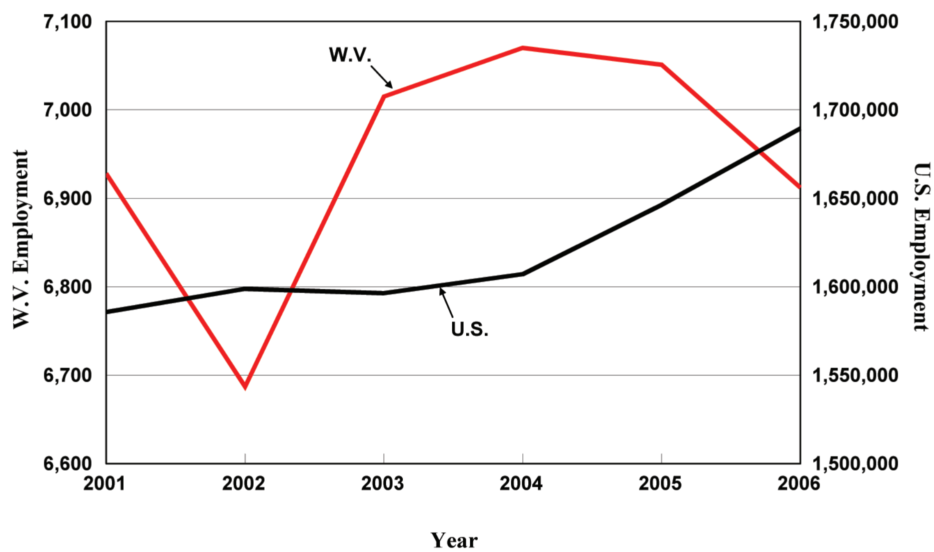
The Milken Institute study also provides projections from 2004-2014 for the industry at the national and state levels. Direct biopharmaceutical employment in the United States is projected to grow from 413,800 in 2004 to 536,300 in 2014, while the total employment impact (sum of direct, indirect and induced) of the industry will generate over 3.6 million jobs by 2014. Real output contribution of the industry (1996 dollars) is expected to rise from $69.2 billion in 2004 to $128.3 billion in 2014, while total (direct and indirect) real output is projected to increase to $350.1 billion. Finally, direct biopharmaceutical earnings are forecast to increase from $31.4 billion in 2004 to $56.6 billion in 2014, with the total earnings contribution rising to $218 billion.

Industry employment according to the Milken Institute study is expected to grow in West Virginia by 51.5 percent, as jobs increase from 1,960 in 2004 to 2,970 in 2014. Moreover, 6,250 additional, indirect jobs are expected to be generated by the industry over the same time period. Biopharmaceutical real output (1996 dollars) is projected to increase to $1.1 billion by 2014, then accounting for 2.1 percent of West Virginia's total non-farm real output. This is an increase of 216.8 percent over 2004 levels, and is two-and-a-half times faster than the U.S. average.

A Profile of the West Virginia Bioscience Industry[10]

Figure 1 illustrates employment in the bioscience sector for both West Virginia and the U.S. between 2001 and 2006. In West Virginia, employment peaked at 7,070 in 2004, but has since declined somewhat to 6,912 in 2006, little changed from 2001. This decline is largely the result of significant employment declines in the All Other Basic Organic Chemical Manufacturing Sector (NAICS 325198) which had employment of 1,892 in 2001 and 741 in 2006 (Table A-4). The U.S. has seen a steady increase in bioscience employment, from 1.59 million in 2001 to 1.69 million in 2006.

Figure 1 Total Bioscience Employment
U.S. & W.V. 2001-2006



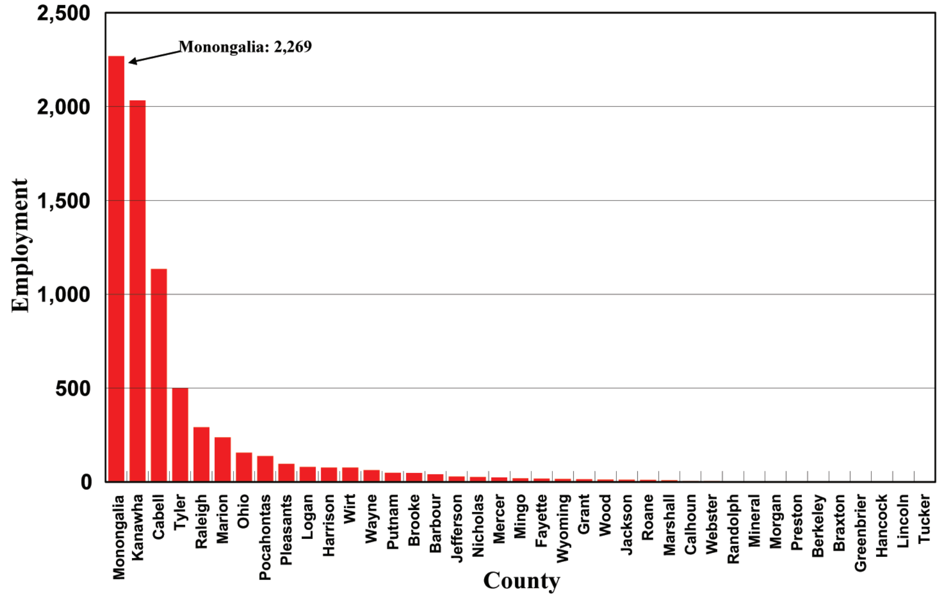
Source: IMPLAN (2007)

As shown in Figure 2 (next page), bioscience employment in West Virginia in 2006 appears to be concentrated in four counties, each with at least 500 employees. Monongalia County leads the state with 2,269 workers, just above Kanawha County's 2,033 workers. Cabell County showed 1,135 employees, while Tyler County registered 501. Sixteen counties witnessed no bioscience-related employment. West Virginia maps by county documenting the employment, earnings, and establishment data are presented in Appendix B.

In 2006, West Virginia saw activity in 15 of the 27 bioscience sub-sectors, with employment in those sub-sectors shown in Figure 3 (next page). Pharmaceutical preparation manufacturing employed the most workers, with 2,369. Physical, engineering, and biological research registered 1,142 employees, while testing laboratories showed 1,019 jobs during 2006.

[10] This section is based upon data provided by IMPLAN. Detailed data tables are available in Appendix A.

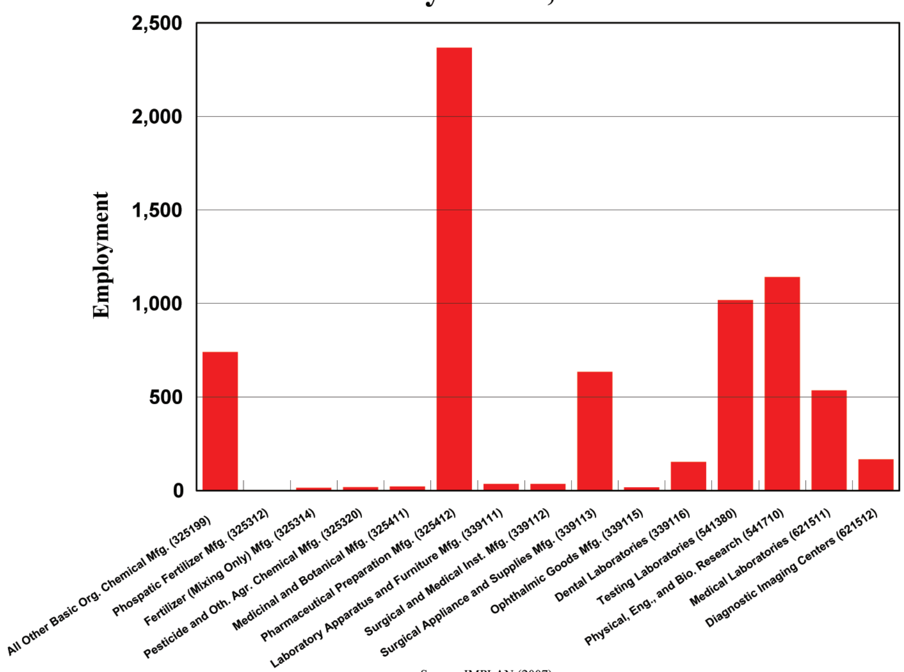
Figure 2 West Virginia Bioscience Employment by County, 2006



The following counties registered zero bioscience employment during 2006: Boone, Clay, Doddridge, Gilmer, Hampshire, Hardy, Lewis, McDowell, Mason, Monroe, Pendleton, Ritchie, Summers, Taylor, Upshur, Wetzel

Source: IMPLAN (2007)

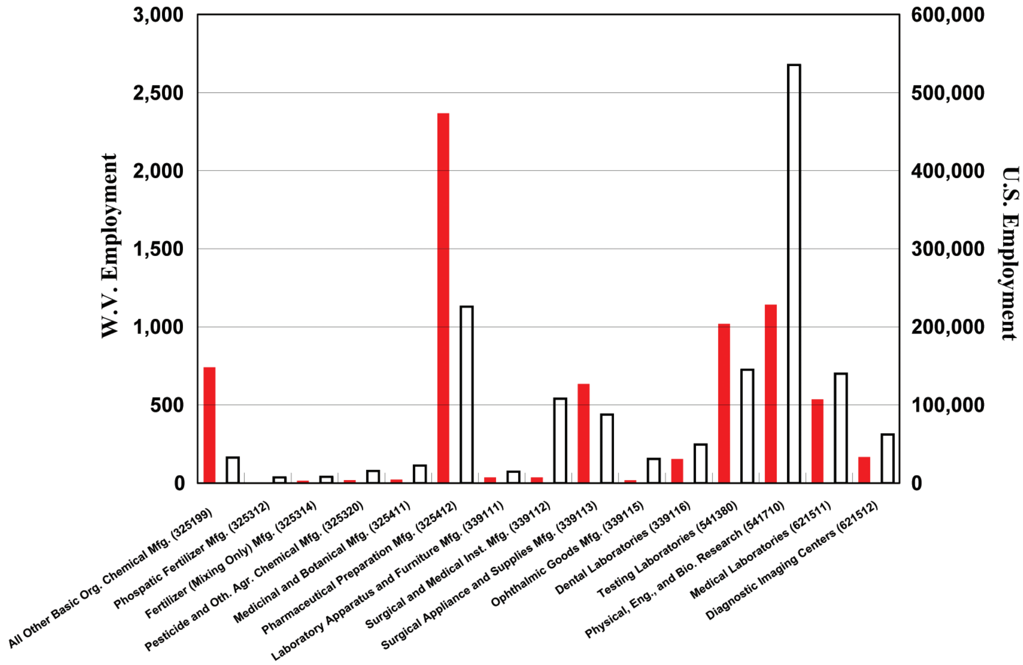
Figure 3 West Virginia Bioscience Employment by Sector, 2006



Source: IMPLAN (2007)

In Figure 4 below, employment levels are shown for both the U.S. and West Virginia in bioscience sub-sectors that were present in the state during 2006. The nation's three largest sub sectors – physical, engineering, and biological research, pharmaceutical preparation manufacturing, and testing laboratories – were also the state's largest sub-sectors, in terms of employment.

Figure 4 U.S. & W.V. Bioscience Employment by Sector, 2006

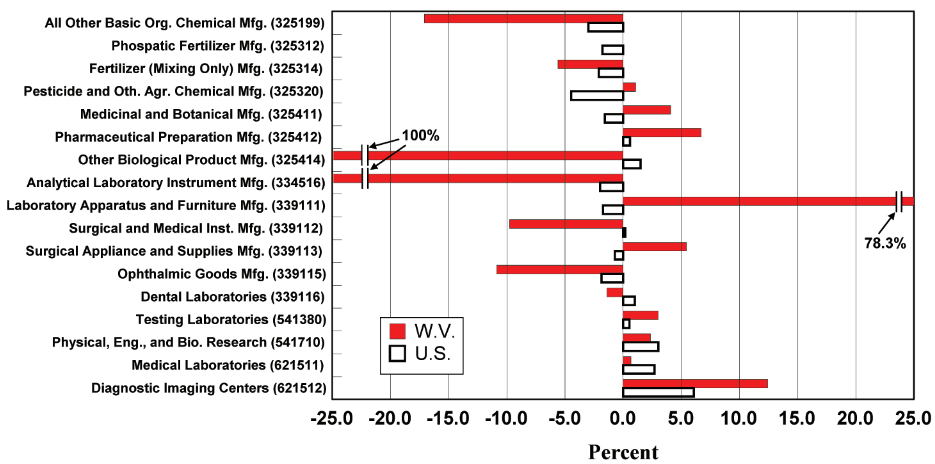


Source: IMPLAN (2007)

Average annual growth rates of selected bioscience sub-sector employment between 2001 and 2006 are illustrated in Figure 5 (next page) for both the U.S. and West Virginia. Laboratory apparatus and furniture manufacturing had the highest average annual growth rate in West Virginia, at 78.3 percent. On the other hand, the diagnostic imaging centers sub-sector witnessed the largest average annual growth rate in the U.S., at 6.1 percent. Two sub-sectors in West Virginia (Other Biological Product Manufacturing and Analytical Laboratory Instrument Manufacturing) saw their employment levels fall to zero during the period.

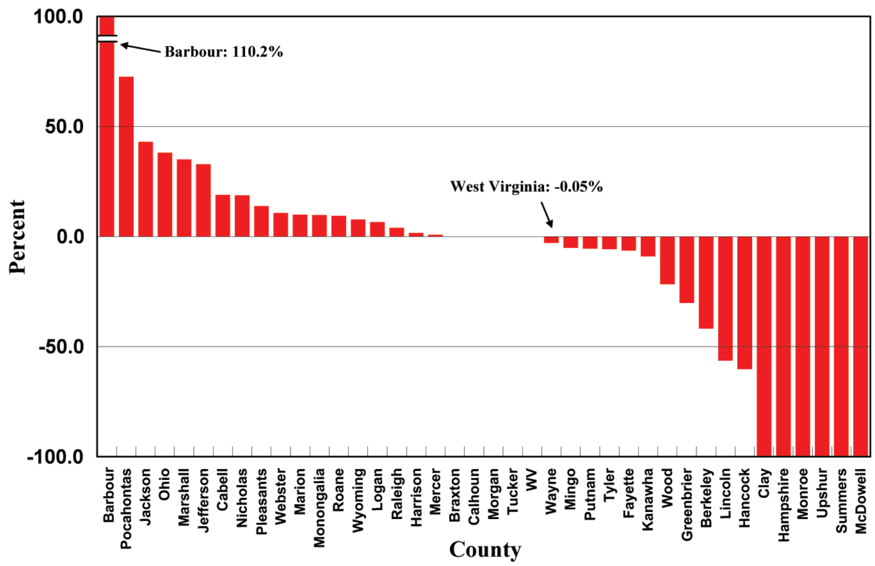
Figure 6 (next page) shows average annual growth rates of bioscience employment in West Virginia Counties between 2001 and 2006. Barbour County had the highest average annual growth rate at 110.2 percent, as employment increased from 1 to 41. The state's average annual growth rate was very close to zero, while several counties saw employment levels fall to zero, represented by a growth rate of -100 percent. Counties not included did not have sufficient bioscience employment over the period to calculate an average annual growth rate.

Figure 5 Average Annual Growth Rate of U.S. and W.V. Bioscience Employment by Sector, 2001 to 2006



Source: IMPLAN (2007)

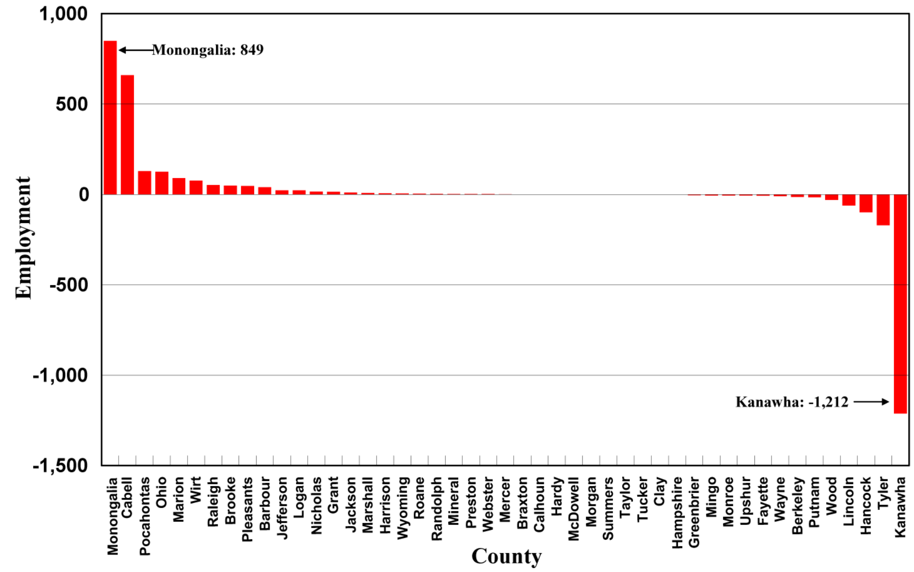
Figure 6 Average Annual Growth Rate of Bioscience Employment by County, 2001 to 2006



Counties not listed had insufficient bioscience employment data during period to calculate average annual growth rates

Source: IMPLAN (2007)

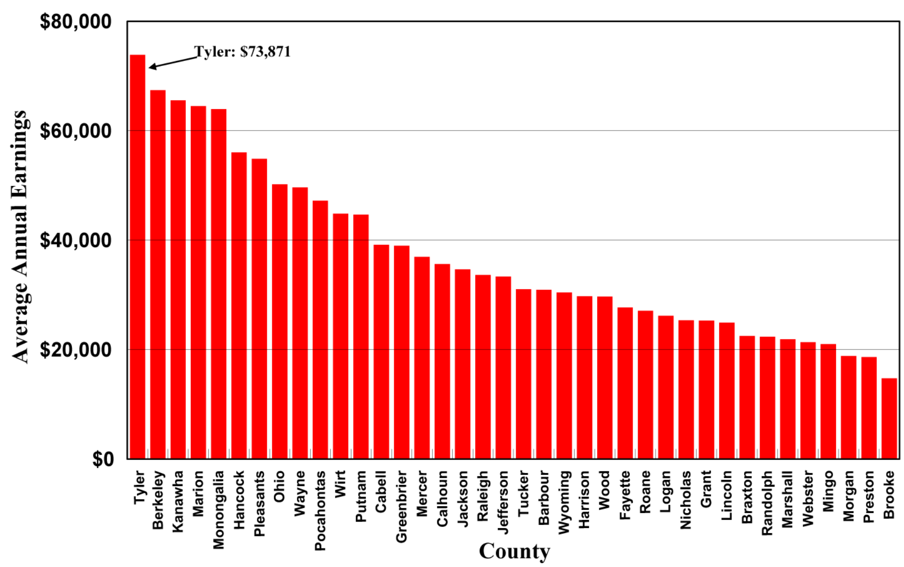
Figure 7 Change in Bioscience Employment by County, 2001 to 2006



The following counties registered zero bioscience employment between 2001 and 2006: Boone, Doddridge, Gilmer, Lewis, Mason, Pendleton, Ritchie, Wetzel

Source: IMPLAN (2007)

Figure 8 Average Annual Bioscience Earnings by County, 2006



The following counties registered zero Bioscience employment during 2006: Boone, Clay, Doddridge, Gilmer, Hampshire, Hardy, Lewis, McDowell, Mason, Mineral, Monroe, Pendleton, Ritchie, Summers, Taylor, Upshure, Wetzel

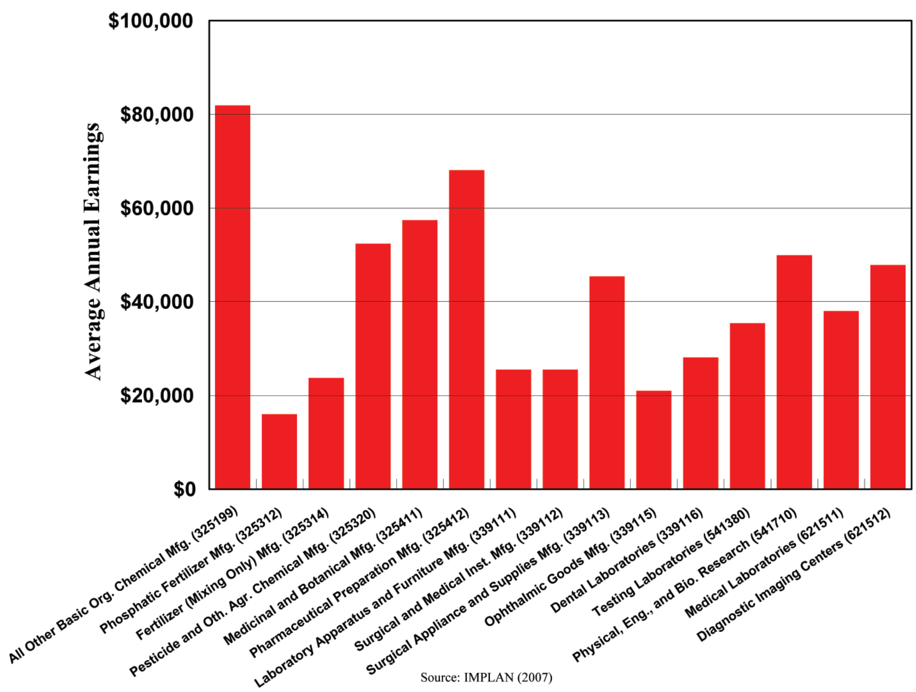
Source: IMPLAN (2007)

The absolute change in bioscience employment by county, from 2001 to 2006, is shown in Figure 7 (previous page). Monongalia County gained 849 jobs during the period, the largest of any county in the state. In contrast, bioscience employment fell by 1,212 jobs in Kanawha County, the largest decline among counties. The latter was largely due to the job losses at Dow Chemicals when it downsized its South Charleston Division.

Average annual earnings in the bioscience sector are shown in Figure 8 (previous page) for West Virginia counties in 2006. Bioscience positions in Tyler County averaged $73,871 per year, nearly double the state average of $37,894.[11] Five other counties – Berkeley, Kanawha, Marion, Monongalia, and Hancock – joined Tyler County in having average annual bioscience earnings above the state average.

In Figure 9 below, average annual earnings for each bioscience sector is shown for West Virginia during 2006. The highest average annual earnings were seen in the All Other Basic Organic Chemical Manufacturing sector, at $81,913, while Pharmaceutical Preparation Manufacturing was the next highest at $68,136. Phosphatic Fertilizer Manufacturing had the lowest average annual earnings, at just below $16,000.

Figure 9 Average Annual Bioscience Earnings by Sector (2006)

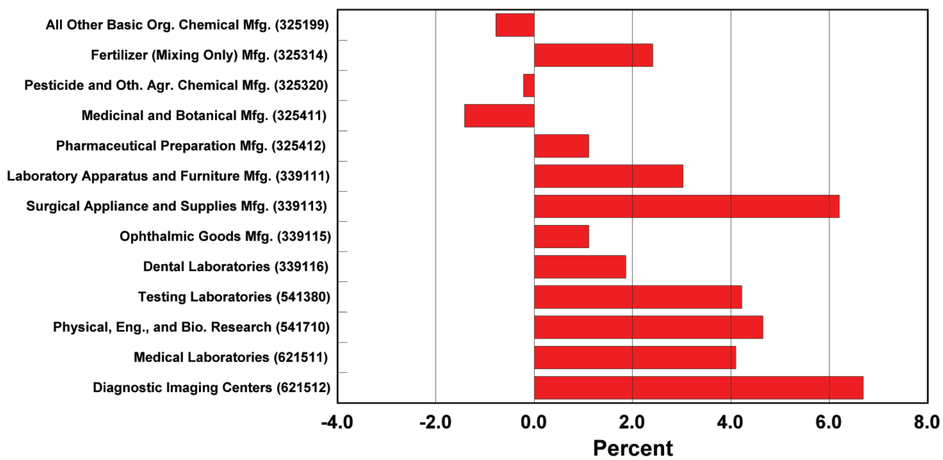


The average annual growth rate of earnings in the West Virginia bioscience sector between 2001 and 2006 is shown in Figure 10 (next page). Earnings in the diagnostic imaging centers

[11] Bureau of Economic Analysis, U.S. Department of Commerce, State Economic Profiles-West Virginia, Table SA30.

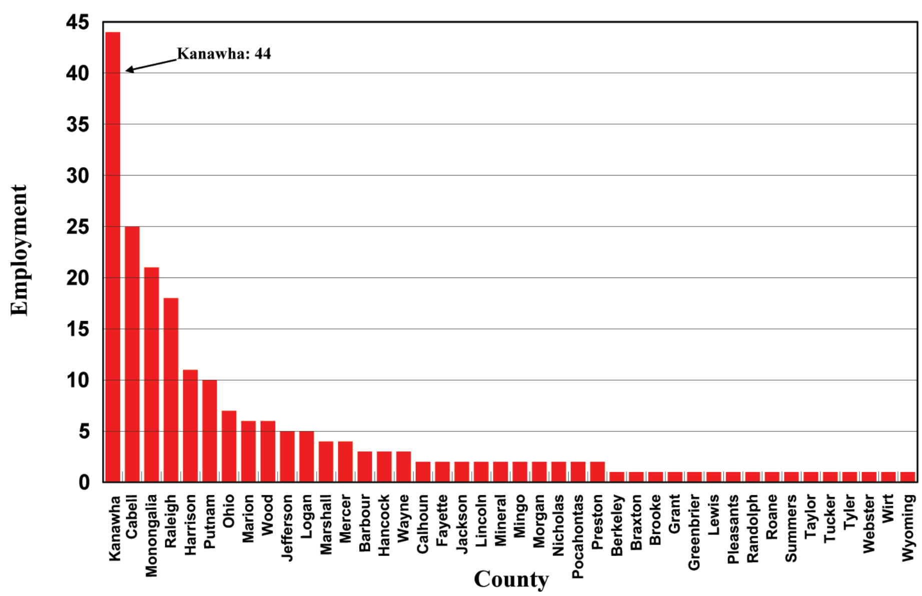
sub-sector experienced an average annual growth rate of 6.7 percent, the highest of any sub-sector. Surgical appliance and supplies manufacturing saw the second-fastest average annual growth rate in earnings, at 6.2 percent. Sub-sectors not shown in the figure did not have sufficient available earnings data in order to calculate an average annual growth rate.

Figure 10 Average Annual Growth Rate of Bioscience Earnings by Sector, 2001 to 2006



Source: IMPLAN (2007)

Figure 11 West Virginia Bioscience Establishments by County, 2006



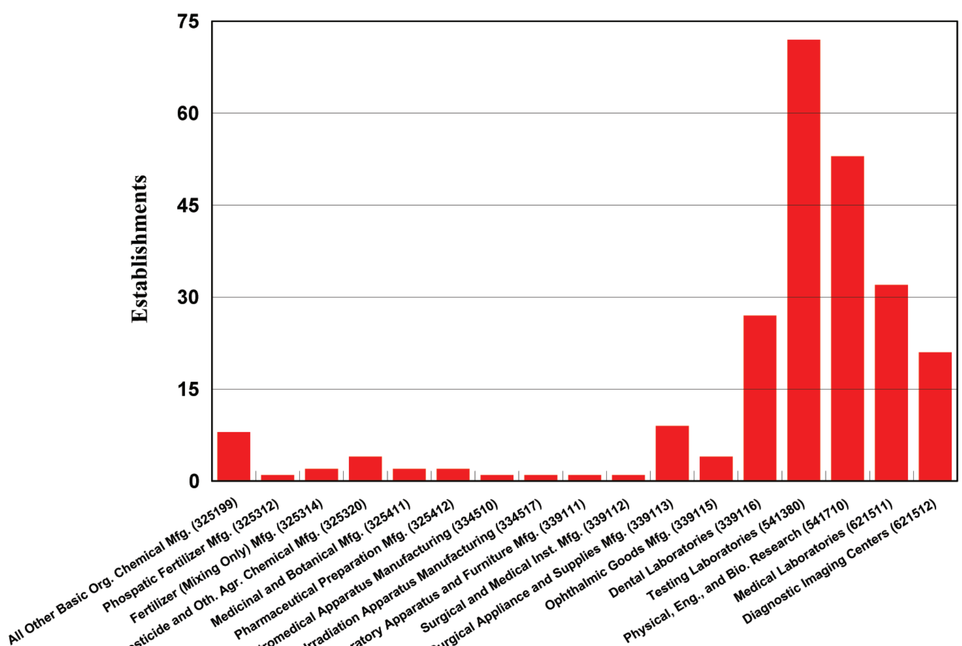
The following counties registered zero bioscience employment during 2006: Boone, Clay, Doddridge, Gilmer, Hampshire, Hardy, McDowell, Mason, Monroe, Pendleton, Ritchie, Upshur, Wetzel

Source: IMPLAN (2007)

According to Figure 11 (previous page), Kanawha County has the highest number of bioscience establishments in 2006, with 44. Cabell County and Monongalia County contained 25 and 21 establishments, respectively. Thirteen counties did not have any bioscience establishments during 2006. The total number of bioscience establishments in West Virginia was 241.

West Virginia bioscience establishments were concentrated in the testing laboratories sub-sector, with 72 throughout the state. Figure 12 below shows that physical, engineering, and biological research and medical laboratories are the next two largest sub-sectors, in terms of number of establishments, with 53 and 32, respectively.

Figure 12 West Virginia Bioscience Establishments by Sector (2006)

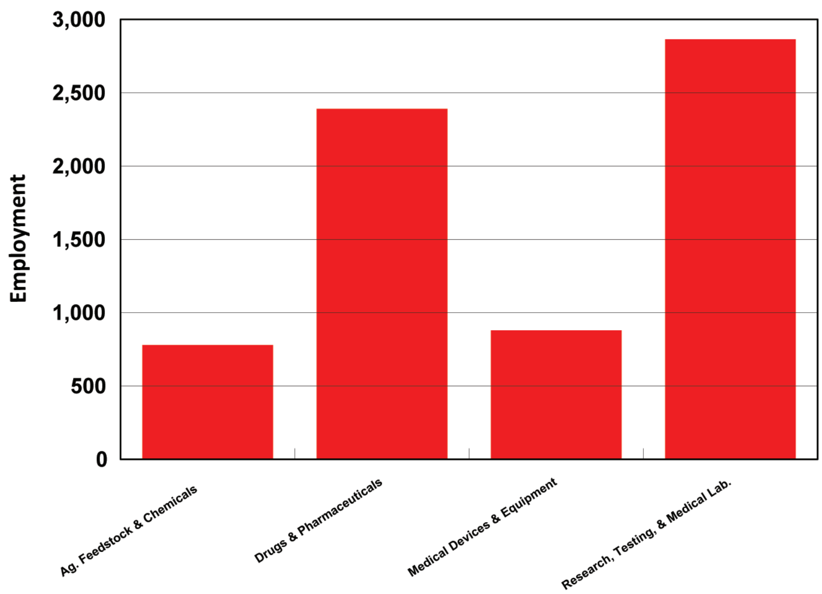


Source; IMPLAN (2007)

Figure 13 (next page) illustrates bioscience employment in West Virginia in 2006 by the four supersectors, as defined by the Battelle Memorial Institute study. West Virginia registered the largest bioscience employment in the research, testing, and medical laboratories supersector, with drugs and pharmaceuticals the second largest. Medical devices and equipment and agricultural feedstock and chemicals witnessed substantially fewer employees than the two largest.

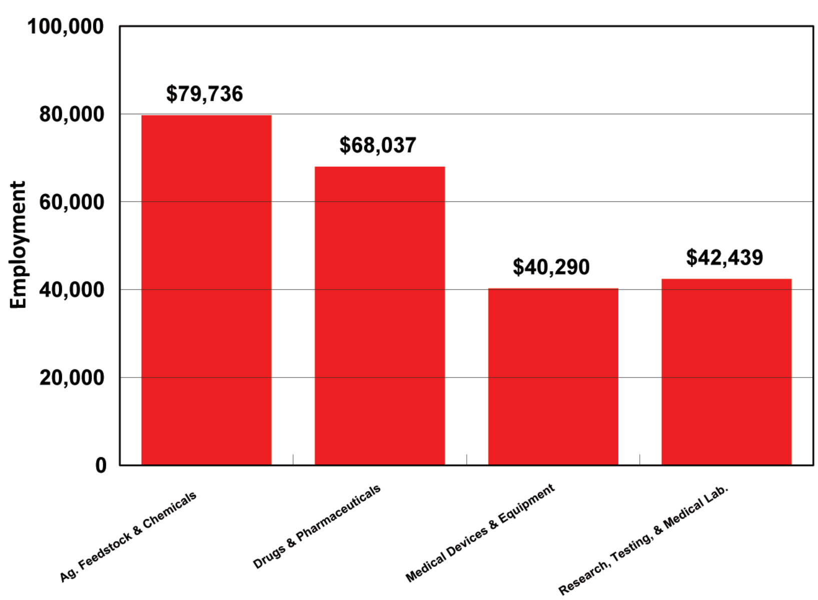
In Figure 14 (next page), earnings by supersector are shown for bioscience employment in West Virginia during 2006. Employees in the agricultural feedstock and chemicals supersector had the highest average annual earnings at $79,736, with drugs and pharmaceuticals next at $68,037. Research, testing, and medical laboratories had the third highest average annual earnings, at $42,439, while medical devices and equipment averaged $40,290.

Figure 13 West Virginia Bioscience Employment by Supersector, 2006



Source: IMPLAN (2007)

Figure 14 West Virginia Bioscience Earnings by Supersector, 2006



Source: IMPLAN (2007)

State Initiatives to Promote the Bioscience Industry

States are implementing various initiatives aimed at promoting the development of the bioscience industry. For the most part, these initiatives fall into one of the following categories: building R&D capacity, encouraging academic/industrial interaction, providing commercialization assistance, enhancing access to capital, creating office space for emerging companies, and supporting relevant workforce development and education programs. Not every state has a program in each category, nor are the initiatives being implemented within each category the same. A short overview of programs in each category is described below. Table 2 also provides a short summary of many of these programs.[12]

In their attempts to build R&D capacity, states are implementing faculty development and bioscience research programs, along with investing in bioscience R&D infrastructure. In order to encourage greater collaboration between academic institutions and industry, matching grant programs for universities and industry have been developed, along with facilities that serve both academic researchers and industry participants. Commercialization assistance is being accomplished through technology transfer funding and entrepreneur support. Access to capital has been enhanced by states through seed capital programs, tax credits, and grants, as well as creation of public and private venture capital funds. Companies' need for space is being met by the development of bioscience incubators and research parks. Finally, states are supporting the bioscience industry's requirement of a well-educated workforce by implementing talent recruitment programs, and by encouraging a greater K-12 focus on math and science and post-secondary education programs.

Creating an attractive overall environment for the bioscience industry is vital to state competitiveness in the sector and is the motivation for building R&D capacity. Infrastructure improvements are being accomplished through state grants, loans, and bond funding that supports construction. Support for research programs is achieved by states primarily through funding assistance. Competitive R&D awards, direct grant and matching funds programs, seed funding for start-up companies, and support of research centers directly are initiatives currently being used by states to encourage research. Finally, faculty development programs are being pursued by several states, primarily through the creation of endowments that will provide funding in order to attract prominent researchers and scholars. Along with bond funding, several other creative funding programs exist, such as Georgia's 'tax check-off' donation program on personal income tax returns that directs funding to the Georgia Cancer Research Fund, Louisiana's use of a portion of its cigarette tax, and several states' use of tobacco settlement funds for bioscience funding.

The Battelle Memorial Institute study notes that as the number of corporate research laboratories has declined in recent years, academic institutions offer the bioscience industry important access to advanced R&D capabilities. States are employing matching grant programs for research partnerships. By supplementing the funds gained from federal, private,

[12] This section is largely based upon the results provided by the Battelle Memorial Institute study.

or industry aid, state matching programs are helping to stimulate interaction between industry and education institutions. Furthermore, greater collaboration between industry and universities can be accomplished through shared facilities. Several states have contributed funding resources to construction of these facilities.

The benefits of research and innovation are realized through widespread adaptation of a new ideas or processes. Therefore, the entrepreneurs in the research-intensive bioscience industry are likely to be attracted to states which assist in the commercialization of research discoveries. Some states have directed funding to assist with university-based technology transfer centers, while others are supporting free-standing centers to provide assistance to new companies. Also, states are developing commercialization funds to provide early-stage financing for companies; these funds range in size from $200,000 to $20 million. Finally, programs to assist entrepreneurs with business development are being put into place by many states. These programs offer support services that include business mentoring, planning support, advisory forums, and financial assistance, among others.

Financing is a very important component of state assistance to bioscience start-ups, as well as other entrepreneurs. Battelle notes that while private financing firms have grown in size, this has reduced, somewhat, their contributions to start-ups very early in their lives. Therefore, states have stepped in to provide and/or encourage seed capital funding. Numerous states offer tax credits targeting investors in technology and bioscience firms. Two states have bioscience-specific tax credits, while seven others have bioscience seed funds. Also, several states are also providing smaller grants that aid firms in obtaining SBIR (Small Business Innovation Research) and STTR (Small Business Technology Transfer) awards. Finally, states are encouraging greater funding through the use and support of venture capital, accomplished in three ways: creating a fund that makes direct investments, investing in private funds which then invest in state companies, or creating a fund that invests in private venture capital funds. The Battelle Memorial Institute study notes that the most popular option is investing in private venture funds that agree to attempt to invest in state-based companies.

The creation of business incubators and technology research parks allows states to provide bioscience companies with the necessary lab and office space. Wet-lab-equipped space, particularly, is demanded in the bioscience sector. Forty-three states have wet-lab-equipped incubators, while the Battelle Memorial Institute study identified a total of 114 bioscience incubators, some with their own investment funds. Three states have dedicated bioscience facilities funds. Along with incubators, research parks provide support to bioscience ventures and can also help to encourage academic/industrial partnerships. Twenty-eight bioscience research parks currently exist and, at the time of Battelle’s study, twenty bioscience parks were under development. Finally, states are designating multi-use zones around universities and medical complexes to encourage development.

A skilled workforce is vital to states’ attractiveness to bioscience firms. First, in order to address existing talent needs, states have implemented programs that bring entrepreneurs and successful business practitioners together for advice, insights, and guidance. Moreover, bioscience internship and entrepreneurial education programs have been created to assist in attracting individuals. Education is an important component for states’ future levels of competitiveness among bioscience companies. Bioscience-based degree programs and curriculum additions at the college level have been a recent trend, while middle and high school outreach programs can give students information about bioscience career opportunities.

States are competing on a wide range of fronts to attract bioscience companies. From R&D facilities to funding programs, financing options to educational enhancements, states are implementing initiatives that they hope will position them to be an attractive environment for bioscience companies. With such varied initiatives, it is imperative that states remain aware of the most successful ventures implemented by other states and then adapt or improve their approach to position themselves for bioscience investment.

Table 2 State Initiatives in Bioscience Sector

Category	Programs	State Initiatives
Building R&D Capacity	R&D Infrastructure	Funding for facility construction and enhancements
	Research Funding	Competitive R&D Awards
		Direct grant & matching funds programs
		Early-stage/seed funding
		Direct funding of research centers
	Faculty Development	Endowments to attract academic scholars
Academic/Industry Interaction	Research Funding	Matching funds programs
	Shared Facilities	Funding for facility construction
Commercialization Assistance	Technology Transfer Funding	Funding for university-based and freestanding technology transfer centers
		Commercialization funds for early-stage financing
	Entrepreneur Support	Business mentoring, planning support, advisory forums, and financial assistance programs
Access to Capital	Seed Capital	Tax credits
		Grants for pursuit of SBIR & STTR awards
	Venture Capital Funds	State-owned venture capital funds or direct investments in private venture capital funds
		Creation of funds that invest in private venture capital funds
Space for Emerging Companies	Business Incubators	Wet-lab-equipped incubator space
		Incubator-run investment funds
	Research Parks	Bioscience-specific research parks
		Multi-use zoning around universities and medical complexes to encourage development
Workforce Development and Education	Talent Recruitment	State-funded internship programs
		Entrepreneurial education programs
	Postsecondary Programs	Bioscience-based degree programs and curriculum additions
	K-12 Education	Outreach programs focusing on bioscience career opportunities

Reference: Growing the Nation's Bioscience Sector: State Bioscience Initiatives 2006, Battelle Institute

West Virginia State Initiatives Promoting the Bioscience Industry

In West Virginia, bioscience research facility investments are located primarily at West Virginia University (WVU) and Marshall University, with much more limited research at the West Virginia School for Osteopathic Medicine (WVSOM). In addition, supporting and collaborative programs are also located elsewhere in the state. The following section describes some of these programs but is not inclusive of all initiatives.[13]

At WVU, the Blanchette Rockefeller Neuroscience Institute is projected to open in 2008 as will the Biomedical Science Research Laboratory Facility. An expansion is under construction at the Mary Babb Randolph Cancer Center, and new research space is located in the Health Sciences Center Library. Funding for the Blanchette Rockefeller Neuroscience Institute was accomplished through bond issuance, while three state development agencies composed a funding package for the other WVU facility investments. The WVU Biomedical Science Research Laboratory Facility is also projected to open in 2008, providing facilities for the expanded research program within the Health Sciences Center.

The Chemical Alliance Zone Biotechnology and Allied Sciences Incubation Center, in South Charleston, provide laboratory and office space, and business services. West Virginia University is in the process of building a research park in Morgantown that will house a business incubator, supplementing a current incubator located in the WVU Research building. The latter incubator now houses 12 start-up firms, including three in the bioscience area.

The Velocity Center is a $7 million business incubator located at Kinetic Park in Huntington which will work with the Robert C. Byrd Biotechnology Center at Marshall University. Finally, the Institute for the Development of Entrepreneurial Advances, also at Marshall, will establish an $8.2 million, 22,000-square-foot incubator primarily geared towards commercializing research in molecular life sciences and medicine.

At Marshall University, the Robert C. Byrd Biotechnology Sciences Center opened in August of 2006 and aims to facilitate interdisciplinary research between the College of Science and School of Medicine. Also, the proposed MU Biotechnology Development Center will provide support for the commercialization of scientific concepts and for non-university affiliated biotech companies in need of R&D resources. A recent addition to the MU Forensic Science Center provided additional classrooms and DNA laboratories. Finally, the Edwards Comprehensive Cancer Center opened in January of 2006, offering advanced linear accelerator technology and other enhanced diagnostic and treatment options.

While appropriate R&D facilities are essential to encouraging bioscience sector growth, so are effective research programs. These can include direct grant programs specifically targeted to the biosciences, seed funding provided to researchers in search of federal funds, and support for educational institutions in their funding pursuits. Twenty-seven states have implemented

[13] The examples provided were largely based on web-based research.

some sort of bioscience research program, many with annual funding levels to support research efforts.

The West Virginia Experimental Program to Stimulate Competitive Research (EPSCoR) focuses on fostering research competitiveness and collaboration among institutions, individuals, and teams. It develops, administers, manages, and implements West Virginia's experimental research improvement program. Also, the grant-funded Biometrics Knowledge Center at WVU conducts interdisciplinary biometrics-focused research. Finally, the Marshall University Forensic Science Center, with assistance from both the U.S. and West Virginia departments of agriculture, is creating a bacterial source tracking database which will assist in identifying sources of contamination and lead to remediation efforts in five major West Virginia watersheds.

Promising research discoveries must have access to an efficient commercialization process. States are providing funding to universities in order to build technology transfer and commercialization capacity, as well as supporting free-standing commercialization centers. Moreover, commercialization funds have been created by twenty-three states for early-stage activities. More widespread are states' efforts geared towards assisting entrepreneurs and emerging companies; forty-six states reported having an entrepreneurial assistance program, but only eight had bioscience-specific programs.

The Institute for the Development of Entrepreneurial Advances at Marshall University focuses on commercializing technology findings, with an emphasis on biotechnology, and was funded with the sale of $1 million in state tax credits. The institute will establish a business incubator, collaborate with the Marshall Center for Business and Economic Research to increase research dollars, and connect entrepreneurs with faculty researchers. Focusing exclusively on West Virginia innovators, the INNOVA Commercialization Group is an initiative of the West Virginia High Technology Consortium Foundation whose mission is to create wealth for West Virginia by providing business development assistance and necessary capital.

Finally, the Mid-Atlantic Technology, Research, and Innovation Center (MATRIC), provides product incubation services, access to facilities, and technical talent primarily for the disciplines of chemistry, biotechnology and the biosciences, and software systems. MATRIC has developed partnerships with many West Virginia educational institutions and provides R&D services to numerous clients. MATRIC is currently in a growth period, capitalizing on the intellectual resources available in the Kanawha Valley. MATRIC currently occupies about 25 offices and 14 labs in Building 740 at the South Charleston Technology Park. Union Carbide Corporation, a subsidiary of Dow Chemical, donated the building to West Virginia University in August, 2007. The facility now serves as WVU's Charleston Research Campus, and MATRIC leases space to house its Kanawha Valley operations.

Access to capital is an essential piece of building a research-intensive industry, and states offer a wide-range of financing options. Many states, including West Virginia, have a seed-capital tax credit, while some also support pre-seed and seed funds. Other efforts include assistance in obtaining SBIR (Small Business Innovation Research) and STTR (Small Business Technology Transfer) awards, fund-matching programs, and bridge funding. States have also increased the availability of venture capital to bioscience companies by creating funds that invest directly in companies, investing in privately managed funds that will invest in state companies, and creating funds which invest in privately managed funds that will invest in state companies.

The West Virginia Jobs Investment Trust (JIT) is a public venture capital fund that invests in early-stage, later-stage, and mature small companies looking to expand. With the goal of developing, promoting, and expanding West Virginia's economy, JIT has invested $4 million in each of the following funds: Adena Ventures, Anthem Capital, Mountaineer Capital LP, PA Early Stage, Toucan Capital, and Walker Ventures. Also, the West Virginia Economic Development Authority provides direct and indirect financing for businesses, including an enhanced loan insurance program for technology-based products and processes.

A skilled workforce is vital to enhancing a region's growth prospects and states are implementing programs that encourage the development of strong local talent. These efforts include programs which link bioscience entrepreneurs and researchers with mentors, identify 'coaches' that can assist entrepreneurs in their early ventures, and encourage entrepreneurial education through internships and fellowships. Also, states are creating outreach programs in order to better understand bioscience companies' needs, and then transferring this knowledge to colleges and secondary schools to enhance curricula. Finally, K-12 students and teachers are being exposed to the bioscience sector and its potential careers through specialized bioscience high schools, academies, institutes, and seasonal camps.

In West Virginia, the Marshall/West Virginia Science Technology Engineering Math Academy, which supports and encourages participation in these fields, will be established by Marshall University. At WVU, the Forensic Identification and Biometrics Degree program incorporates academic and research activities in biometric and forensic investigative science.

The most recent development is Governor Joe Manchin's legislative proposal for a "Bucks For Jobs" initiative, part of which involves the creation of the West Virginia Research Trust Fund (SB287). This major initiative builds on the West Virginia Research Challenge Fund created in 2004, which provides around $4 million each year to support creation of research centers that foster economic development. In the FY2008 budget, $10 million was included to assist in building the WVU and Marshall research programs. The next step entails the WVRTF, which infuses $50 million that will support the recruitment of world-class scholars and scientists, along with associated research staff and infrastructure. The WVRTF will provide state funds to match private donations with 70 percent of the funds allocated to WVU and 30 percent to Marshall. The funds must be targeted to six research areas, one of which are biological, biotechnological and biomedical sciences.

West Virginia has numerous efforts underway as well as new initiatives that will create an environment that is more attractive and welcoming to the bioscience sector. However, it is important to evaluate the initiatives that have recently been completed, are ongoing, or are planned in other states, in order to gauge West Virginia's relative strengths and weaknesses. As mentioned above, state strategies can be categorized into building research and development capacity, encouraging academic-industry interaction, commercializing technology and discoveries, enhancing access to capital, providing space for bioscience companies, and addressing educational and skill needs. In order to remain competitive in the bioscience realm, West Virginia must continue to assess the sector's needs in order to make existing programs more effective and to assist in the creation and implementation of new programs that the sector, and its companies, will find attractive and beneficial.

The Economic Impact of West Virginia's Bioscience Industry 2006

While the bioscience industry appears to be a small but significant sector in West Virginia, a more comprehensive view is available through the estimation of the indirect and induced economic impacts associated with the industry. The indirect impacts result from the bioscience firms' purchases from their suppliers, and they, in turn, purchase from their suppliers. The induced effects occur from the purchases by households whose members are employed by the bioscience industry. These economic impacts are estimated through the use of the IMPLAN® economic impact modeling system (www.implan.com) and the definitions of the impacts are included in Table 7 in the Appendix.

The economic impacts estimated include business volume, employment, output, employee compensation, value added and assorted state taxes. Table 3 provides the estimates of the economic impact of biosciences in West Virginia in 2005. The total economic impact was $7.2 billion in business volume, 21,935 jobs (full- and part-time), $6.1 billion in output, $1.0 billion in employee compensation, $1.9 billion in value added and nearly $57 million in assorted state taxes.

Table 3 Economic Impact of West Virginia's Bioscience Industry 2006 (millions of $)

	Direct	Indirect & Induced	Total
Business Volume	$3,374	$3,821	$7,195
Employment (Jobs)	6,912	15,023	21,935
Output	$3,374	$2,720	$6,094
Employee Compensation	$457	$499	$956
Value Added	$825	$1,053	$1,878
Assorted State Taxes	-	-	$63.7

Note: Totals may not sum due to rounding. Assorted state taxes include consumer sales, use, personal income, corporate net income and business franchise.

An additional economic impact of the bioscience industry relates to the research undertaken by West Virginia University, Marshall University and the West Virginia School of Osteopathic Medicine. While both WVU and Marshall have fairly extensive research enterprises spanning a wide variety of fields inclusive of biosciences, the focus of this section is on research expenditures in the life sciences as defined by the National Science Foundation's annual survey of research and development expenditures at universities and colleges.[14]

[14] The definition of life sciences is inclusive of agriculture, biological, medical and other related research areas. Institutions were requested to provide the data reported to the NSF so that comparable information would be available in the event this report was updated. West Virginia University and Marshall University provided data in the NSF report format. The WVSOM did not have an NSF report but provided data on research expenditures.

During FY2007, the total life sciences research and development expenditures at the three institutions were: WVU—$85,556,000; Marshall—$13,939,000; and WVSOM—$349,000. In all three institutions a portion of the expenditures were directed toward equipment procurement, most of which was probably supplied by firms outside of West Virginia. The latter represents a leakage from the West Virginia economy. The bulk of the expenses were for personal services, fringe benefits and current expenses.

The direct, indirect and induced, and total economic impacts associated with the research and development expenditures by the three institutions were estimated and are reported in Tables 4-6. An examination of these results indicates that the economic impacts associated with life sciences research are considerable.

Table 4 Economic Impact of West Virginia University Life Science Research Expenditures FY2007 (thousands of $)

	Direct	Indirect & Induced	Total
Business Volume	$85,556	$86,876	$172,432
Employment (Jobs)	760	620	1,380
Output	$85,556	$62,988	$148,544
Employee Compensation	$30,339	$16,515	$46,854
Value Added	$39,938	$34,230	$74,169
Assorted State Taxes	1,358	995	$2,353

Note: Totals may not sum due to rounding. Assorted state taxes include consumer sales, use, personal income, corporate net income and business franchise.

Table 5 Economic Impact of Marshall University Life Science Research Expenditures FY2006 (thousands of $)

	Direct	Indirect & Induced	Total
Business Volume	$10,845	$9,865	$20,710
Employment (Jobs)	90	70	160
Output	$10,845	$7,162	$18,007
Employee Compensation	$3,462	$1,869	$5,331
Value Added	$4,557	$3,900	$8,457
Assorted State Taxes	$155	$113	$268

Note: Totals may not sum due to rounding. Assorted state taxes include consumer sales, use, personal income, corporate net income and business franchise.

Table 6 Economic Impact of West Virginia School of Osteopathic Medicine Life Science Research Expenditures FY2007 (thousands of $)

	Direct	Indirect & Induced	Total
Business Volume	$265	$274	$539
Employment (Jobs)	2	2	4
Output	$265	$199	$464
Employee Compensation	$96	$52	$148
Value Added	$126	$108	$234
Assorted State Taxes	$4	$3	$7

Note: Totals may not sum due to rounding. Assorted state taxes include consumer sales, use, personal income, corporate net income and business franchise.

Appendix A

Table A-1
Bioscience Employment by County

	2001	2002	2003	2004	2005	2006	Avg. Ann. Growth
Barbour	1	-	1	34	39	41	110.2
Berkeley	15	15	-	3	3	1	-41.8
Boone	-	-	-	-	-	-	-
Braxton	1	1	1	1	1	1	0.0
Brooke	-	-	-	45	47	48	-
Cabell	476	544	609	965	1,010	1,135	19.0
Calhoun	5	7	21	15	15	5	0.0
Clay	1	1	-	-	-	-	-100.0
Doddridge	-	-	-	-	-	-	-
Fayette	25	24	21	14	23	18	-6.4
Gilmer	-	-	-	-	-	-	-
Grant	-	1	1	7	8	14	-
Greenbrier	6	6	3	-	-	1	-30.1
Hampshire	1	4	4	1	-	-	-100.0
Hancock	100	93	92	2	1	1	-60.2
Hardy	-	21	5	-	-	-	-
Harrison	71	292	303	73	73	77	1.6
Jackson	2	2	1	15	14	12	43.1
Jefferson	7	14	18	2	27	29	32.9
Kanawha	3,245	2,661	2,385	2,348	2,197	2,033	-8.9
Lewis	-	-	-	-	-	-	-
Lincoln	63	67	70	1	1	1	-56.3
Logan	58	61	58	58	66	80	6.6
McDowell	-	13	12	-	-	-	-100.0
Marion	148	170	175	363	354	238	10.0
Marshall	2	7	5	5	14	9	35.1
Mason	-	-	-	-	-	-	-
Mercer	23	22	17	11	12	24	0.9
Mineral	-	-	13	1	1	2	-
Mingo	26	11	2	15	19	20	-5.1
Monongalia	1,420	1,496	1,759	1,820	2,134	2,269	9.8
Monroe	6	5	4	2	1	-	-100.0
Morgan	2	2	2	2	2	2	0.0
Nicholas	11	11	10	17	23	26	18.8
Ohio	31	34	13	202	137	156	38.2
Pendleton	-	-	-	-	-	-	-
Pleasants	50	48	44	68	95	96	13.9
Pocahontas	9	7	6	150	135	138	72.6
Preston	-	-	6	3	3	2	-
Putnam	65	65	65	60	57	49	-5.5
Raleigh	239	243	241	232	284	291	4.0
Randolph	-	7	-	2	3	3	-
Ritchie	-	-	-	-	-	-	-
Roane	7	8	2	9	7	11	9.5
Summers	-	19	10	1	-	-	-100.0
Taylor	-	-	2	-	-	-	-100.0
Tucker	1	1	1	3	1	1	0.0
Tyler	672	661	612	541	546	501	-5.7
Upshur	6	-	-	-	-	-	-100.0
Wayne	73	80	78	125	83	63	-2.9
Webster	3	3	3	6	5	5	10.8
Wetzel	-	-	-	-	-	-	-
Wirt	-	-	110	83	85	76	-
Wood	44	34	34	12	18	13	-21.6
Wyoming	11	45	71	13	18	16	7.8
West Virginia	6,928	6,687	7,015	7,070	7,051	6,912	0.0
United States	1,585,650	1,598,752	1,596,335	1,607,083	1,646,262	1,689,455	1.3

Source: IMPLAN (2007)

Table A-2
Bioscience Earnings by County

	2001	2002	2003	2004	2005	2006
Barbour	19,238	-	18,513	18,776	20,872	30,939
Berkeley	33,438	37,134	-	31,556	35,219	67,420
Boone	-	-	-	-	-	-
Braxton	21,509	27,425	29,468	19,389	19,659	22,485
Brooke	-	-	-	12,399	13,124	14,753
Cabell	33,981	33,534	35,192	33,795	37,701	39,154
Calhoun	17,055	15,762	35,590	37,954	32,452	35,640
Clay	22,863	23,222	-	-	-	-
Doddridge	-	-	-	-	-	-
Fayette	23,621	26,649	26,603	26,245	29,545	27,709
Gilmer	-	-	-	-	-	-
Grant	-	11,100	11,732	23,521	24,309	25,288
Greenbrier	39,747	44,604	110,550	-	-	38,999
Hampshire	34,389	23,070	24,370	37,164	-	-
Hancock	16,495	17,359	19,175	35,347	53,813	56,051
Hardy	-	18,766	13,746	-	-	-
Harrison	22,669	22,751	26,209	37,547	32,428	29,740
Jackson	22,897	28,998	60,261	31,105	32,672	34,663
Jefferson	28,445	36,009	37,254	22,781	30,428	33,368
Kanawha	72,277	67,393	67,289	65,248	68,338	65,574
Lewis	-	-	-	-	-	-
Lincoln	18,617	21,164	18,138	25,525	28,415	24,932
Logan	19,229	23,049	26,881	28,604	28,408	26,178
McDowell	-	31,367	35,836	-	-	-
Marion	56,169	57,720	50,709	52,421	53,816	64,513
Marshall	15,261	31,640	52,798	41,731	28,549	21,919
Mason	-	-	-	-	-	-
Mercer	24,163	24,413	30,515	27,967	31,174	36,949
Mineral	-	-	-	-	-	-
Mingo	27,242	39,733	37,713	25,240	22,649	21,019
Monongalia	62,077	66,234	69,612	66,334	64,640	63,971
Monroe	22,755	23,663	24,857	21,191	43,005	-
Morgan	21,384	42,689	22,899	21,300	17,442	18,856
Nicholas	23,681	23,586	21,632	22,786	20,869	25,358
Ohio	34,553	32,669	29,001	40,255	53,177	50,210
Pendleton	-	-	-	-	-	-
Pleasants	56,339	61,041	67,941	63,938	52,772	54,879
Pocahontas	33,752	34,623	34,895	46,686	50,734	47,230
Preston	-	-	40,340	23,363	23,892	18,638
Putnam	30,082	35,956	37,207	38,876	38,824	44,685
Raleigh	31,449	32,520	30,897	32,725	31,778	33,658
Randolph	-	16,986	-	24,163	23,873	22,379
Ritchie	-	-	-	-	-	-
Roane	26,538	25,420	17,082	22,978	20,507	27,088
Summers	-	24,721	28,274	13,281	-	-
Taylor	-	-	53,002	-	-	-
Tucker	14,441	14,241	14,186	18,214	36,616	31,038
Tyler	58,823	62,431	60,792	70,165	71,275	73,871
Upshur	11,134	-	-	-	-	-
Wayne	44,087	44,782	47,493	50,593	49,921	49,666
Webster	17,234	22,764	22,305	24,139	26,971	21,370
Wetzel	-	-	-	-	-	-
Wirt	-	-	32,656	42,797	43,260	44,867
Wood	18,578	23,627	28,721	23,462	21,982	29,702
Wyoming	22,575	16,412	20,394	21,378	27,532	30,455
West Virginia	55,386	55,112	55,787	55,964	56,288	55,220
United States	60,278	61,602	64,838	68,462	71,458	74,111

Source: IMPLAN (2007)

Table A-3
Bioscience Establishments by County

	2001	2002	2003	2004	2005	2006
Barbour	1	1	1	3	3	3
Berkeley	2	2	1	1	1	1
Boone	-	-	-	-	-	-
Braxton	1	1	1	1	1	1
Brooke	-	-	-	1	1	1
Cabell	37	30	34	27	28	25
Calhoun	1	1	3	2	2	2
Clay	1	1	-	-	-	-
Doddridge	-	-	-	-	-	-
Fayette	9	6	8	3	3	2
Gilmer	-	-	-	-	-	-
Grant	1	-	-	1	1	1
Greenbrier	3	1	3	3	2	1
Hampshire	1	2	1	1	1	-
Hancock	5	5	5	5	4	3
Hardy	-	1	1	-	-	-
Harrison	23	11	13	15	14	11
Jackson	1	3	3	2	2	2
Jefferson	2	3	5	2	4	5
Kanawha	41	41	41	47	47	44
Lewis	-	-	-	-	-	1
Lincoln	3	4	4	2	2	2
Logan	5	5	5	6	6	5
McDowell	0	9	9	-	-	-
Marion	5	5	4	7	8	6
Marshall	4	5	5	4	4	4
Mason	-	-	-	-	-	-
Mercer	7	7	6	4	4	4
Mineral	-	-	1	2	2	2
Mingo	4	3	1	2	2	2
Monongalia	19	15	17	21	22	21
Monroe	1	1	1	1	1	-
Morgan	1	1	1	2	2	2
Nicholas	2	2	2	2	2	2
Ohio	5	6	4	6	7	7
Pendleton	-	-	-	-	-	-
Pleasants	2	2	2	1	1	1
Pocahontas	1	3	2	2	2	2
Preston	1	-	5	3	3	2
Putnam	9	9	8	10	11	10
Raleigh	16	15	20	15	18	18
Randolph	-	3	1	1	1	1
Ritchie	-	-	-	-	-	-
Roane	3	3	2	3	3	1
Summers	-	2	2	1	1	1
Taylor	-	-	2	1	1	1
Tucker	1	-	1	2	1	1
Tyler	1	2	2	1	1	1
Upshur	1	-	-	-	-	-
Wayne	4	4	4	3	3	3
Webster	1	2	2	1	1	1
Wetzel	-	-	-	-	-	-
Wirt	-	-	2	1	1	1
Wood	7	7	8	6	6	6
Wyoming	2	3	5	2	2	1
West Virginia	234	240	245	253	254	241
United States	52,305	53,917	54,755	56,057	57,783	59,492

Source: IMPLAN (2007)

Table A-4
Bioscience Employment by Sector

NAICS	Description	2001	2002	2003	2004	2005	2006
311221	Wet Corn Milling	-	-	-	-	-	-
311222	Soybean Processing	-	-	-	-	-	-
311223	Other Oilseed Processing	-	-	-	-	-	-
325193	Ethyl Alcohol Manufacturing	-	-	-	-	-	-
325199	All Other Basic Organic Chemical Manufacturing	1,892	1,476	1,409	1,101	967	741
325221	Cellulosic Organic Fiber Manufacturing	-	-	-	-	-	-
325311	Nitrogenous Fertilizer Manufacturing	-	-	-	-	-	-
325312	Phosphatic Fertilizer Manfacturing	-	-	-	-	4	4
325314	Fertilizer (Mixing Only) Manufacturing	20	1	18	19	17	15
325320	Pesticide and Other Agricultural Chemical Manufacturing	18	18	20	20	20	19
325411	Medicinal and Botanical Manufacturing	18	19	20	23	24	22
325412	Pharmaceutical Preparation Manufacturing	1,711	1,821	1,938	2,294	2,346	2,368
325413	In-Vitro Diagnostic Substance Manufacturing	-	-	-	-	-	-
325414	Other Biological Product Manufacturing	41	-	-	-	-	-
334510	Electromedical Apparatus Manufacturing	-	1	1	-	-	-
334516	Analytical Laboratory Instrument Manufacturing	36	-	-	-	-	-
334517	Irradiation Apparatus Manufacturing	-	1	1	-	-	-
339111	Laboratory Apparatus and Furniture Manufacturing	2	-	49	43	34	36
339112	Surgical and Medical Instrument Manufacturing	-	-	49	43	34	36
339113	Surgical Appliance and Supplies Manufacturing	487	549	547	549	567	635
339114	Dental Equipment and Supplies Manufacturing	-	-	-	-	-	-
339115	Ophthalmic Goods Manufacturing	32	7	25	24	23	18
339116	Dental Laboratories	165	163	159	154	154	154
541380	Testing Laboratories	879	901	922	959	1,000	1,019
541710	Physical, Engineering, and Biological Research	1,016	1,084	1,153	1,147	1,160	1,142
621511	Medical Laboratories	518	527	531	526	535	536
621512	Diagnostic Imaging Centers	93	119	173	168	166	167

Source: IMPLAN (2007)

Table A-5
Bioscience Earnings by Sector

NAICS	Description	2001	2002	2003	2004	2005	2006
311221	Wet Corn Milling	-	-	-	-	-	-
311222	Soybean Processing	-	-	-	-	-	-
311223	Other Oilseed Processing	-	-	-	-	-	-
325193	Ethyl Alcohol Manufacturing	-	-	-	-	-	-
325199	All Other Basic Organic Chemical Manufacturing	85,183	82,675	84,207	87,448	89,743	81,913
325221	Cellulosic Organic Fiber Manufacturing	-	-	-	-	-	-
325311	Nitrogenous Fertilizer Manufacturing	-	-	-	-	-	-
325312	Phosphatic Fertilizer Manfacturing	-	-	-	-	17,661	15,999
325314	Fertilizer (Mixing Only) Manufacturing	21,069	21,264	20,624	22,948	21,335	23,731
325320	Pesticide and Other Agricultural Chemical Manufacturing	53,019	61,866	56,528	57,281	58,054	52,433
325411	Medicinal and Botanical Manufacturing	61,693	60,839	63,475	59,488	57,778	57,435
325412	Pharmaceutical Preparation Manufacturing	64,483	67,852	71,372	68,172	67,560	68,136
325413	In-Vitro Diagnostic Substance Manufacturing	-	-	-	-	-	-
325414	Other Biological Product Manufacturing	51,378	-	-	-	-	-
334510	Electromedical Apparatus Manufacturing	-	11,251	12,778	-	-	-
334516	Analytical Laboratory Instrument Manufacturing	33,509	-	-	-	-	-
334517	Irradiation Apparatus Manufacturing	-	11,251	12,778	-	-	-
339111	Laboratory Apparatus and Furniture Manufacturing	21,995	-	19,711	21,601	21,793	25,536
339112	Surgical and Medical Instrument Manufacturing	-	-	19,711	21,601	21,793	25,536
339113	Surgical Appliance and Supplies Manufacturing	33,635	32,849	34,705	37,554	43,976	45,441
339114	Dental Equipment and Supplies Manufacturing	-	-	-	-	-	-
339115	Ophthalmic Goods Manufacturing	19,894	26,286	20,293	21,253	22,714	21,020
339116	Dental Laboratories	25,645	26,334	26,017	27,274	27,492	28,123
541380	Testing Laboratories	28,832	30,984	31,976	33,270	33,754	35,443
541710	Physical, Engineering, and Biological Research	39,788	43,860	44,554	47,817	49,298	49,947
621511	Medical Laboratories	31,127	35,017	34,783	36,842	35,788	38,056
621512	Diagnostic Imaging Centers	34,609	35,258	38,730	40,031	44,309	47,852

Source: IMPLAN (2007)

Table A-6
Bioscience Establishments by Sector

NAICS	Description	2001	2002	2003	2004	2005	2006
311221	Wet Corn Milling	-	-	-	-	-	-
311222	Soybean Processing	-	-	-	-	-	-
311223	Other Oilseed Processing	-	-	-	-	-	-
325193	Ethyl Alcohol Manufacturing	-	-	-	-	-	-
325199	All Other Basic Organic Chemical Manufacturing	9	8	9	9	9	8
325221	Cellulosic Organic Fiber Manufacturing	-	-	-	-	-	-
325311	Nitrogenous Fertilizer Manufacturing	-	-	-	-	-	-
325312	Phosphatic Fertilizer Manfacturing	-	-	-	-	1	1
325314	Fertilizer (Mixing Only) Manufacturing	4	1	4	3	2	2
325320	Pesticide and Other Agricultural Chemical Manufacturing	1	1	1	4	4	4
325411	Medicinal and Botanical Manufacturing	1	1	2	2	2	2
325412	Pharmaceutical Preparation Manufacturing	6	5	6	3	3	2
325413	In-Vitro Diagnostic Substance Manufacturing	-	-	-	-	-	-
325414	Other Biological Product Manufacturing	1	-	-	-	-	-
334510	Electromedical Apparatus Manufacturing	-	-	1	-	1	1
334516	Analytical Laboratory Instrument Manufacturing	2	-	-	-	-	-
334517	Irradiation Apparatus Manufacturing	-	-	1	1	1	1
339111	Laboratory Apparatus and Furniture Manufacturing	2	1	1	1	1	1
339112	Surgical and Medical Instrument Manufacturing	-	-	1	1	1	1
339113	Surgical Appliance and Supplies Manufacturing	8	12	9	9	9	9
339114	Dental Equipment and Supplies Manufacturing	-	-	-	-	-	-
339115	Ophthalmic Goods Manufacturing	4	1	5	4	4	4
339116	Dental Laboratories	27	26	26	27	29	27
541380	Testing Laboratories	79	80	77	80	80	72
541710	Physical, Engineering, and Biological Research	38	39	40	47	49	53
621511	Medical Laboratories	30	29	32	35	34	32
621512	Diagnostic Imaging Centers	21	35	31	27	24	21

Source: IMPLAN (2007)

Table A- 7
Economic Impact Definitions

Assorted State Taxes:	West Virginia state revenues from consumer sales tax, personal income tax, corporate net income tax, and business franchise tax.
Business Volume:	Sales plus net increase in finished inventories and the value of intra-corporate shipments. Equals output (see below) plus the cost of goods sold in retail and wholesale trade.
Employment:	The number of jobs in a business, industry, or region. Also the number of jobs attributable to an impact (see below). This is a measure of the number of full-time and part-time positions, not necessarily the number of employed persons. Annual average by place of work unless otherwise stated.
Employee Compensation:	Wages and salaries plus employers' contribution for social insurance (social security, unemployment insurance, workers compensation, etc.) and other labor income (pension contributions, health benefits, etc.). By place of work unless otherwise stated.
Impacts:	The results of the recirculation of funds throughout a regional economy due to the activity of a business, industry, or institution. Estimated by tracing back the flow of money through the initial businesses' employees and suppliers, the businesses selling to the employees and suppliers, and so on. Thus, they are a way to examine the distribution of industries and resources covered in the costs of the initial activity.
Output:	For most sectors, measured as sales plus net inventories and the value of intra-corporate shipments. For retail and wholesale trade, measured as gross margins (i.e. mark-ups on goods sold).
Value Added:	A measure of the value created by a business or industry, or attributable to an impact (see above). Equal to value of production minus the cost of purchased goods and services. Also equal to employee compensation plus capital income (profits, interest paid, depreciation charges) and indirect business taxes (e.g. severance, excise). Corresponds to the aggregate concepts of gross domestic product (GDP) and gross state product (GSP).

Appendix B

Figure B-1: West Virginia Bioscience Employment by County – 2006

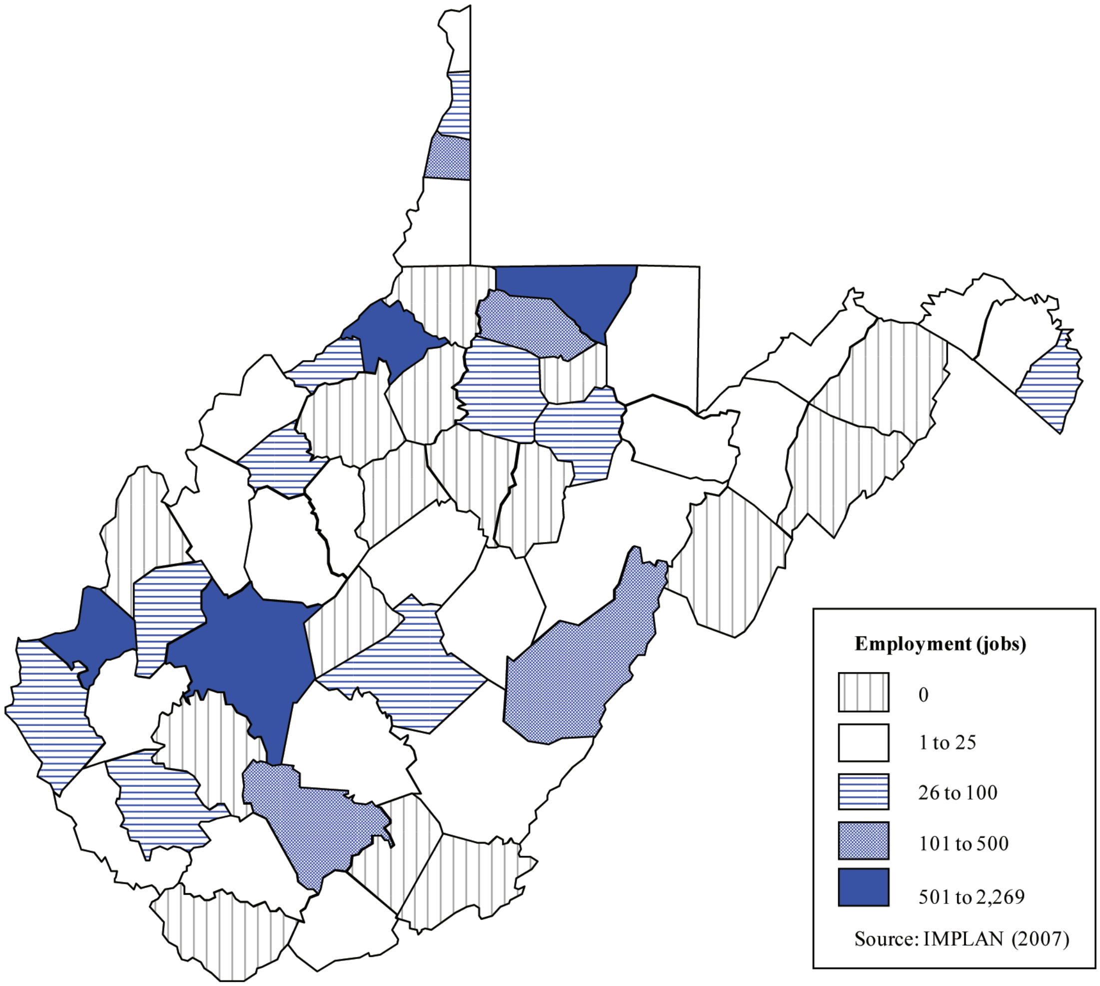


Figure B-2: Average Annual Growth Rate of Bioscience Employment by County – 2001 to 2006

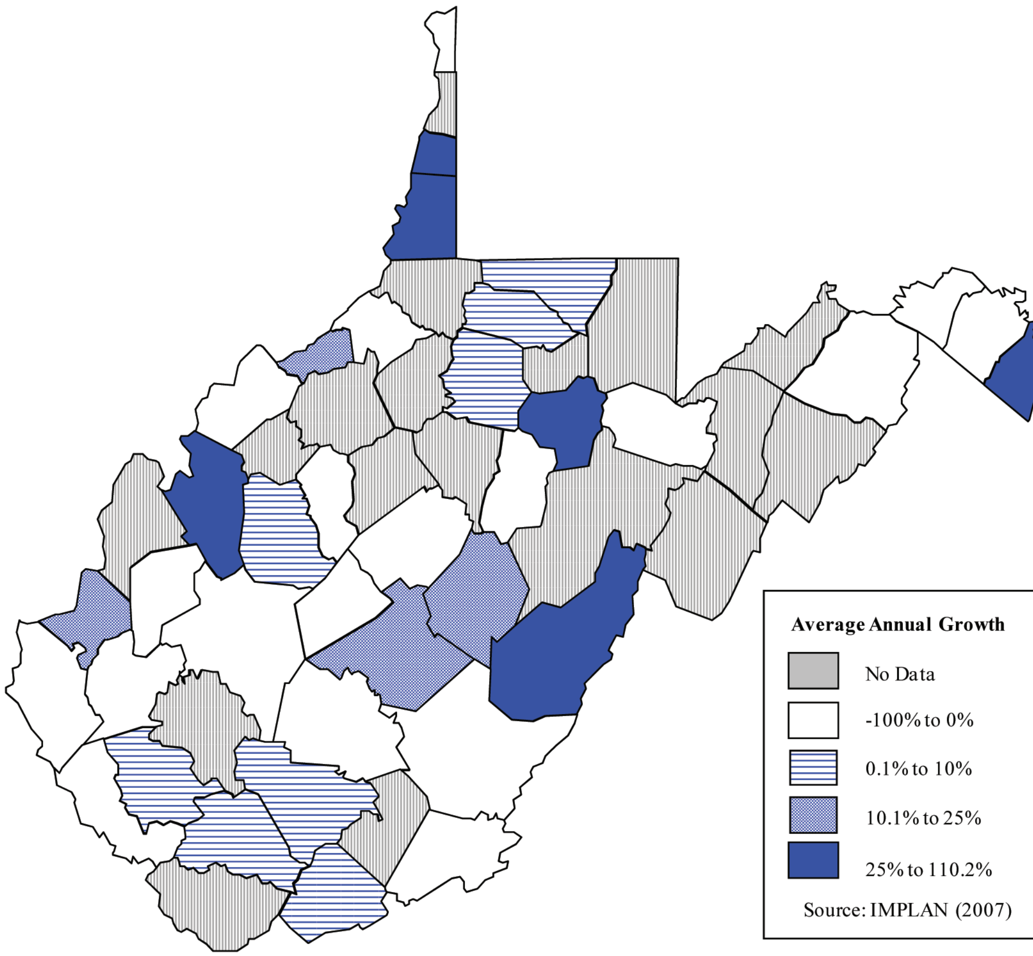


Figure B-3: West Virginia Bioscience Average Annual Earnings by County – 2006

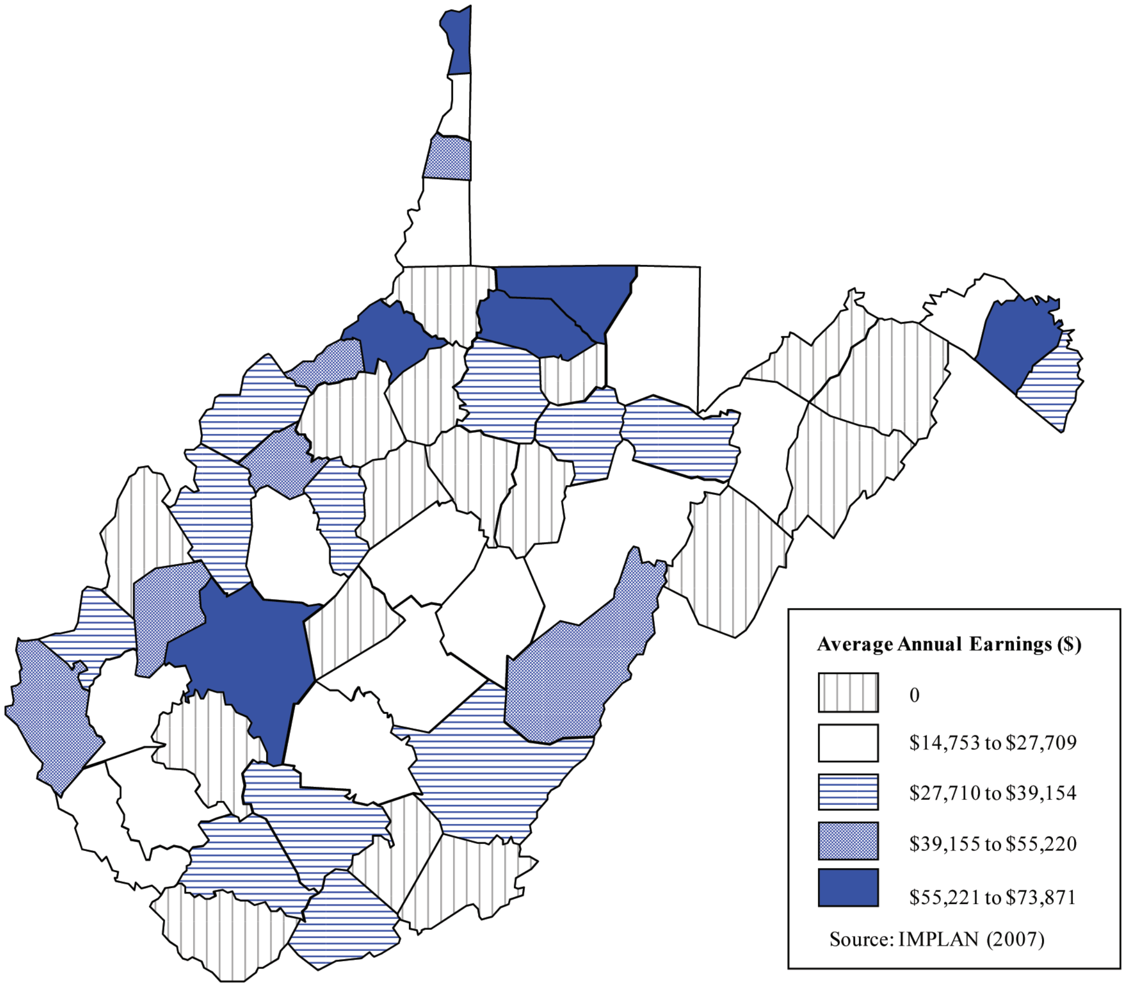


Figure B-4: West Virginia Bioscience Establishments by County – 2006