

The Dimensions and Contributions of the Bioscience Industry in Oregon in 2009

Prepared for the Oregon Bioscience Association

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Association

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Executive Summary

Assignment

ECONorthwest¹ was asked by the Oregon Bioscience Association (“OBA”) to measure the economic contributions of the bioscience industry to the Oregon economy in 2009. This effort represents an update to our 2008 study where we measured the economic contributions of the bioscience industry in 2002 and 2007.

Unlike most industry sectors, the bioscience industry consists of various sectors and activities that do not fit neatly into a single, government-defined industry code. Moreover, the bioscience industry also includes research activities at hospitals and universities that would not be captured by official government industry codes. This diversity required ECONorthwest to classify bioscience activities into two general categories: 1) bioscience-related activities carried out by private industry and identified by North American Industry Classification System codes as defined by Battelle (“private bioscience”);² and 2) bioscience-related research at universities and hospitals (“life science research”). Using this classification scheme, ECONorthwest then obtained payroll and employment data from the Oregon Employment Department and funding/expenditure, payroll, and employment data from research universities and hospitals in Oregon.

Data was gathered for 2009.³ This data was used to measure or define the dimensions of the bioscience industry in Oregon and evaluate changes over the seven- year time period. With the country entering into a recession in December 2007, we focus much of our efforts in evaluating how the bioscience industry has fared over the last two years. In addition to defining and measuring the bioscience industry, ECONorthwest used the 2009 employment and payroll data as inputs into an economic impact model of the Oregon economy to measure the economic linkages of the bioscience industry to other industry sectors in this state. Because the two major industry components were measured using different data sources, the results of our analysis are, first, reported separately and then combined to show the total dimensions and impacts of the industry.

Key Findings

The following are the key findings of this study.

¹ This report was prepared by staff at ECONorthwest’s Portland office. Alec Josephson, senior economist, was the primary researcher and author of this report. He received valuable research assistance from Carsten Jensen, economist. Mr. Josephson can be contacted by phone at 503-222-6060 or by email at josephson@portland.econw.com.

² The private bioscience industry is defined using North American Industry Classification System codes (“NAICS”) identified in Battelle’s 2006 and 2007 studies, and their most recent 2010 study. Battelle, *Growing the Nation’s Bioscience Sector: State Bioscience Initiatives*, April 2006, and *Growing the Nation’s Bioscience Sector: A Regional Perspective*, January 2007. Battelle, *State Bioscience Initiatives*, prepared for the Biotechnology Industry Organization, May 2010.

³ Due to the way the data is collected, the private bioscience industry is based on calendar years and life science research is based on fiscal years.

1. **As defined in this study and reported in Table ES1, Oregon’s bioscience industry directly generated almost \$4.1 billion in output or economic activity (an 18.3 percent increase from 2007), including \$882.3 million in personal income (+10.4 percent) and 14,221 jobs (+4.3 percent) in Oregon in 2009.** The economic dimensions for the two major components of the bioscience industry in 2009 are as follows:

- a) Oregon’s private bioscience industry in 2009 consisted of 664 establishments (+8 percent from 2007) that generated \$3.7 billion in output (+20.4 percent), and employed 10,814 workers (+5.8 percent) who received \$608.3 million in income (+8.3 percent). With many production processes requiring high-skilled workers and/or advanced university degrees, the average annual wage in the private bioscience industry was approximately \$56,300 or almost 41 percent greater than the statewide average for private sector covered employment (\$39,980) in 2009.
- b) According to data provided by universities and hospitals, in 2009, spending on life science research in Oregon totaled \$479.1 million (+4.4 percent from 2007). Most of this spending was financed by federal funds, thus life science research brings “new” money into the state. Spending on life science research directly generated 3,407 jobs (FTEs) and \$273.9 million in personal income.

Table ES1: Economic Dimensions of Oregon’s Bioscience Industry, 2002, 2007, and 2009 (Millions of Current Dollars)

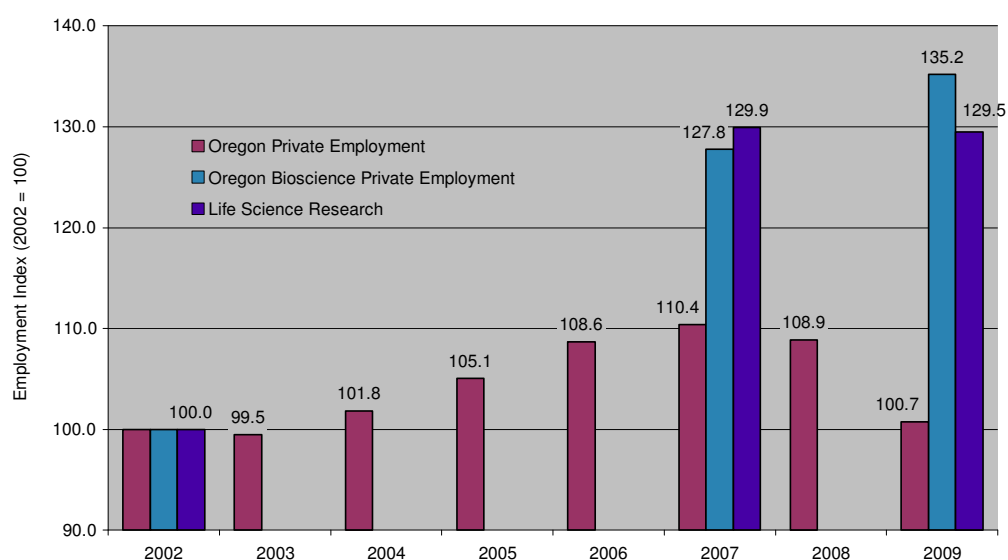
Major Industry Component / Economic Measure	2002	2007	2009	Change 2002 to 2009	% Change 2002 to 2009	Change 2007 to 2009	% Change 2007 to 2009
Private Industry							
Output	\$1,414.1	\$3,035.6	\$3,653.5	\$2,239.4	158.4%	\$617.9	20.4%
Personal Income	\$340.0	\$561.7	\$608.3	\$268.3	78.9%	\$46.7	8.3%
Employment	7,997	10,218	10,814	2,817	35.2%	596	5.8%
Life Science Research							
Expenditure	\$340.4	\$458.9	\$479.1	\$138.7	40.8%	\$20.2	4.4%
Personal Income	\$145.5	\$237.8	\$273.9	\$128.4	88.2%	\$36.1	15.2%
Employment	2,631	3,418	3,407	776	29.5%	-11	-0.3%
Combined							
Output / Expenditure	\$1,754.4	\$3,494.5	\$4,132.5	\$2,378.1	135.6%	\$638.0	18.3%
Personal Income	\$485.6	\$799.5	\$882.3	\$396.7	81.7%	\$82.8	10.4%
Employment	10,627	13,636	14,221	3,594	33.8%	585	4.3%

Source: ECONorthwest calculations using Oregon Employment Department ES202 data, the IMPLAN modeling system, and information supplied by life science research institutions.

2. **Between 2002 and 2009, employment and personal income growth in the bioscience industry was significant and far exceeded the growth rate for the Oregon economy as a whole.** In total, bioscience employment increased by almost 3,600 jobs, or by 33.8 percent between 2002 and 2009. Nominal (not inflation adjusted) personal income in the bioscience industry increased by 81.7 percent between 2002 and 2009. This is about 3.7 times the increase in nominal payrolls (+21.8 percent) for private covered employment in Oregon over the same time period.

3. **Bioscience growth continued between 2007 and 2009, as the nation and the state entered into a recession and subsequent slow-growth recovery period.** As a whole, the bioscience industry added 585 jobs (a 4.3 percent increase) between 2007 and 2009. In contrast, private covered employment in Oregon declined by 127,300 jobs (an 8.7 percent decrease). Bioscience job growth is attributed to the private bioscience industry as employment in life science research experienced a slight decrease between 2007 and 2009. In addition, total nominal payrolls in the bioscience industry increased by 10.4 percent between 2007 and 2009 while nominal private covered payroll declined by \$3.9 billion or by 6.9 percent over the same time period. Figure ES1 compares bioscience employment growth with total private covered employment growth over the 2002-2009 time period.

Figure ES1: Private Bioscience, Life Science Research, and Private Covered Employment, 2002-2009 (Employment Indexed to 2002 Levels)



Source: ECONorthwest calculations using Oregon Employment Department ES202 data, information supplied by life science research institutions, and covered employment data from the Oregon Employment Department's Oregon Labor Market Information System ("OLMIS").

4. **Using an economic impact model of the Oregon economy, ECONorthwest estimates that spending by the bioscience industry and its employees is associated with \$7.2 billion in economic activity, including \$1.9 billion in personal income, and 36,793 jobs in Oregon in 2009.** These larger multiplier effects occur as the spending directly attributed to the bioscience industry "ripples" throughout the Oregon economy. The total economic contributions are summarized for each major component and for the bioscience industry as a whole in Table ES2.

**Table ES2: Total Economic Contributions of the Bioscience Industry in 2009
(Millions of Current Dollars)**

Type of Impact	Private Bioscience	Life Science Research	Total Bioscience
Output	\$6,358.6	\$834.9	\$7,193.5
Total Value Added	\$2,466.2	\$472.4	\$2,938.6
¥ Personal Income	\$1,507.7	\$413.0	\$1,920.7
¥ Other Income	\$811.7	\$44.3	\$855.9
¥ Indirect Business Taxes	\$146.8	\$15.1	\$162.0
Total State and Local Taxes	\$221.1	\$47.0	\$268.0
Jobs	29,739	7,054	36,793

Source: ECONorthwest using IMPLAN

5. From an economic impact perspective, the bioscience industry has multiplier effects that benefit workers and business owners in other sectors of the Oregon economy.

The multiplier effect measures the degree to which economic activity in one industry affects or generates economic activity in other industries. All else considered, the larger the multiplier, the greater the interdependence between an industry and the rest of the economy. According to our economic impact model of Oregon, the bioscience industry, in aggregate, has the following Type SAM multipliers:

- a) **An employment multiplier of 2.6**, which suggests that every 10 jobs in the bioscience industry, on average, supports an additional 16 jobs in other sectors of the economy. (For comparison, the weighted average employment multiplier in Oregon is 1.85.)⁴
 - b) **A personal income multiplier of 2.2**, which shows that every \$1 million in personal income directly generated in the bioscience industry is linked to another \$1.2 million in income for workers and business owner in other industries in Oregon. (For comparison, the weighted average personal income multiplier in Oregon is 1.79.)
- 6. The bioscience industry above-average economic multipliers are attributed to the purchases of intermediate goods and services provided by Oregon businesses, and the above average wage of bioscience employees.** For example,
- a) Purchases of goods and services by the bioscience industry and its providers indirectly generated almost \$1.7 billion in economic activity, including \$583.0 million in personal income and 10,557 jobs. These supply-chain impacts accrue to a wide variety of supporting business sectors, including: wholesale trade, business support and employment services, legal services, and real estate.

⁴ The weights are based on the relative magnitude of the economic measure for each industry. For example, suppose Oregon's economy consisted of the following two industries: industry A (with \$1.0 million in output and a Type SAM multiplier of 2.0) and industry B (with \$5.0 million in output and a Type SAM multiplier of 1.1). The weighted average Type SAM output multiplier would be 1.42 and is calculated as $((\$1.0 \times 2.0) + (\$5.0 \times 1.1)) / (\$1.0 + \$5.0)$.

b) The average annual wage in the aggregate bioscience industry in 2009 was just over \$62,000. This is approximately 55 percent greater than the average annual pay for private covered employment in Oregon in 2009. Spending by bioscience employees and other employees who are indirectly affected by bioscience spending induced approximately \$1.3 billion in economic activity, including \$796.4 million in personal income and 12,015 jobs. These consumption-driven impacts benefit a wide variety of industries, including: retailers, health and social services, and food services and drinking establishments.

7. **In 2009, the economic activity associated with Oregon’s bioscience industry directly or indirectly generated approximately \$268.0 million in state and local tax revenues.** According to the economic impact model, the largest sources of tax revenues are property taxes (29.7 percent) paid primarily by businesses, personal income taxes (27.8 percent), and taxes on profits and dividends (16.4 percent). These fiscal impacts are reported in Table ES3.

Table ES3: Fiscal Impacts of the Bioscience Industry in 2009 (Millions of Current Dollars)

Type of Tax	Private Bioscience	Life Science Research	Total Bioscience	Percent of Total
Profits and dividends	\$39.4	\$4.5	\$43.9	16.4%
Business and personal property	\$66.6	\$13.0	\$79.6	29.7%
Personal income	\$52.7	\$22.0	\$74.6	27.8%
Social insurance	\$0.4	\$0.1	\$0.5	0.2%
Other taxes	\$34.8	\$3.3	\$38.1	14.2%
Fines, fees, and non-taxes	\$27.1	\$4.1	\$31.3	11.7%
Total state and local taxes	\$221.1	\$47.0	\$268.0	100.0%

Source: ECONorthwest using IMPLAN

The following sections of the report provide greater details regarding the dimensions and economic contributions of the bioscience industry in Oregon. The next section provides background information on how the bioscience industry is defined. It also provides detailed information on the economic dimensions of the bioscience industry in 2009, and how it changed between 2002 and 2009, and between 2007 and 2009 when the recession and slow-growth recovery period were the dominant macroeconomic themes. The last section provides an overview of economic impact methodology and the results of the impact analysis. This section provides detailed information about the contributions of the bioscience industry on the Oregon economy.

1. The Bioscience Industry in Oregon

In the United States, most industries are classified using the North American Industry Classification System (“NAICS”) coding framework. Industries have an official NAICS code, and government-provided data on the number of employees, payroll, and industry sales. Unfortunately, the bioscience industry does not conform neatly to the NAICS-based industry classification system. Indeed, the bioscience industry performs a variety of activities across a variety of industry sectors, each with their own NAICS code. In addition, a large component of the bioscience industry consists of research and development activities at universities and hospitals that are not captured in the NAICS-based coding system.

This section begins with a discussion of how the Oregon bioscience industry was defined for this analysis. For consistency with the 2007 report, the definition of the bioscience industry will remain the same. An industry overview includes an analysis of the sectors that make up the private bioscience industry, as well as the research and development activities at universities and hospitals. The economic dimensions of the bioscience industry are then evaluated for 2009.

1.1. Defining the Bioscience Industry

In general, the bioscience industry consists of two main components. The first component consists of private sector companies (“private bioscience”). As the name suggests—bio is a prefix meaning “life”—these companies apply science and technology to provide products and services related to human, plant, and animal life. The second component encompasses the bioscience or life science research activities at universities and hospitals (“life science research”).

To measure the private bioscience industry, ECONorthwest used Battelle’s definition as developed in their 2006 and 2007 studies,⁵ and their most recent 2010 study.⁶ Battelle is an international leader in science and technology. Their industry definition was first used to evaluate the bioscience industry on national basis. It has since been adopted in numerous state and regional studies. By using this definition, OBA and others will be able to compare Oregon’s bioscience industry to other states and regions that rely on the same industry definition. Battelle’s bioscience industry definition includes the following industry sectors (identified by NAICS codes) and is shown in Table 1.

⁵ Battelle, *Growing the Nation’s Bioscience Sector: State Bioscience Initiatives*, April 2006, and *Growing the Nation’s Bioscience Sector: A Regional Perspective*, January 2007.

⁶ Battelle, *State Bioscience Initiatives*, prepared for the Biotechnology Industry Organization, May 2010.

Table 1: Battelle Definition of the Bioscience Industry

Major Subsector / NAICS Code	Industry Description
Agricultural Feedstocks and 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 organic fiber manufacturing
325312	Phosphatic fertilizer manufacturing
325314	Fertilizer (mixing only) manufacturing
325320	Pesticide and other agricultural chemical manufacturing
Drugs and Pharmaceuticals	
325411	Medicinal and botanical manufacturing
325412	Pharmaceutical preparation manufacturing
325413	In-vitro diagnostic substance manufacturing
325414	Other biological manufacturing
Medical Devices and 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 and Medical Laboratories	
541380*	Testing laboratories
541710*	Physical, engineering, and biological research
621511	Medical laboratories
621512	Diagnostic imaging centers

*Includes only the segments of these industries that are actually engaged in bioscience or life science research.
Source: Battelle, *Growing the Nation's Bioscience Sector: A Regional Perspective*, January 2007.

Battelle identifies four major sectors of the private bioscience industry.⁷ They are:

- **Agricultural feedstocks and chemicals.** This sector uses biotechnology and other life science technologies to process agricultural goods and feedstocks, and produce chemicals.⁸ Outputs include fibers and filaments; ethanol, natural oils and lubricants; natural and organic fertilizers; ammonium and phosphatic fertilizers; and insecticides, herbicides, and fungicides.
- **Drugs and pharmaceuticals.** Falling entirely within NAICS code #3254, this bioscience sector manufactures medicinal and pharmaceutical products. Products range from anesthetics and antibiotics, to botanical extracts and cough medicine.
- **Medical devices and equipment manufacturing.** This bioscience sector includes nine separate NAICS codes, with major groupings in electro-medical and control instruments manufacturing (NAICS 33451), and medical equipment/supplies manufacturing and dental labs (NAICS 3391). The bioscience sector produces a wide range of equipment and supplies, such as laboratory equipment, surgical supplies and equipment, and dental supplies and equipment.

⁷ It's important to note that ECONorthwest accepted the Battelle definition of the private bioscience industry and did not make any alterations to that definition. However, we did conduct additional secondary research to evaluate testing and research laboratories. That is, only a portion of the activities carried out by companies in these NAICS categories is bioscience-related. Thus, ECONorthwest evaluated each record in the Oregon Employment Department employment and wage data to identify firms that conducted bioscience-related activities.

⁸ Oregon does not have processors of agricultural commodities, NAICS 311221-311223.

- **Research, testing, and medical laboratories.** This sector encompasses bioscience activities where human capital is a major input. Activities include biotechnology research and medical/health testing. Research includes DNA technologies, nucleic acid chemistry, and protein engineering. This sector includes professional, scientific, and technical services (NAICS 514) and health care services (NAICS 621).⁹

In addition to the private sector industries identified by NAICS codes in Table 1, ECONorthwest also included bioscience or life science research activities at universities and hospitals. Indeed, according to Battelle,

“A *fifth* subsector of the biosciences might include research hospitals, academic health centers, and other research-driven medical institutions. Many U.S. hospitals partner with universities and other research centers to further advances in the biosciences with a particular focus on healthcare applications.”¹⁰

Employment and wage data for life science research institutions is not available by NAICS codes. As such, OBA worked closely with Oregon Health & Science University (OHSU), the Chancellor’s Office at the Oregon University System (OUS), Providence Research, Legacy Research, and the Kaiser Center for Health Research to obtain employment and payroll data for life science research. These are the same life science research institutions that provided data for the 2008 study.¹¹ These life science research institutions provided the following data:

1. The Oregon University System (OUS) Chancellors Office provided detailed expenditure data, including payroll and employment in full-time equivalents (FTEs) for Oregon’s eight public universities.
2. Oregon Health & Science University (OHSU) provided research spending by major activity code and funding by major source.
3. The Center for Health Research at Kaiser Permanente provided funding and employment levels.
4. Providence Health & Services Research Centers provided funding data and projected payroll and employment (FTE) data.
5. Legacy Health System (LHS) Research provided funding and employment data.

To fully describe the economic dimensions of life science research in Oregon, ECONorthwest made two important assumptions.¹² First, OHSU did not provide employment estimates. However, for institutions that did, the ratio of employment to funding was remarkably close, and yielded 7.43 FTE per million dollars in funding. This ratio was applied to the life science funding estimate provided by OHSU to estimate the number of direct hires. Second, OUS was also able to provide detailed revenue and expenditure data for life science research activities taking place at all eight

⁹ In 2002, the 541710 NAICS code included physical, engineering, and biological research. In 2007, this NAICS code was redefined to 541711: Research and development in biotechnology and 541712: Research and development in the physical, engineering, and life sciences (not including biotechnology).

¹⁰ Battelle, *Growing the Nation’s Bioscience Sector: A Regional Perspective*, January 2007, p. 3. Battelle also describes the inherent difficulty of measuring this segment of the bioscience industry—“From a data perspective, however, under the current NAICS system it is not possible to isolate the relevant bioscience research-oriented establishments within the larger hospitals sector. Thus, while Battelle acknowledges the critical role these research institutions play in advancing life sciences research and the bioscience industry, we are unable to accurately isolate this activity in the current federal data framework.”

¹¹ The data provided by life science research institutions is gathered and organized by fiscal year. The data acquired from the Oregon Employment Department for the private bioscience industry is for a calendar year.

¹² In order to provide the most realistic assessment of this component of the bioscience industry, ECONorthwest adopted the most conservative assumptions.

Oregon public universities. This data was used to develop a production function¹³ for university research activities, and was then applied to life science research taking place at hospitals.

1.2. Economic Dimensions of the Bioscience Industry

As discussed previously, ECONorthwest relied on the Battelle definition of the bioscience industry, utilized Oregon Employment Department employment and wage data to measure the industry, and accepted the industry code classifications as correct. In addition, ECONorthwest relied on funding/expenditure, payroll and employment data provided by institutions conducting life science research in Oregon. Because each of these two main components of the bioscience industry rely on different data sources, their dimensions and impacts will be reported separately.

1.2.1. The Private Bioscience Industry

ECONorthwest obtained employment and wage data (called ES202 data) for 2009 from the Oregon Employment Department.¹⁴ ES202 data is collected through a cooperative program—called the Covered Employment and Wages Program—involving the Bureau of Labor Statistics (BLS) of the U.S. Department of Labor and state employment security agencies.

ES202 employment data represents the number of covered workers who worked during, or received pay, for the pay period. ES202 data excludes members of the armed forces, the self-employed, proprietors, domestic workers, unpaid family workers, and railroad workers covered by the railroad unemployment insurance system.

ES202 wage data is reported on a quarterly basis and represents the total compensation paid during the calendar quarter, regardless of when the services were performed. Wages include vacation and other paid leave, bonuses, stock options, tips, the cash value of meals and lodging. In some states, ES202 data also includes contributions to deferred compensation plans, such as 401(k) plans.

ES202 data is the most comprehensive data series of monthly employment and quarterly wages. As such, ES202 data is used in wide range of economic analyses, and is a particularly valuable data source for evaluating labor trends, by major industry sector and geographic units, over time.¹⁵ The ES202 data that ECONorthwest received was not summarized or aggregated by industry sector. It was an electronic record of the raw data files that the Oregon Employment Department sends to BLS. As such, it is highly confidential information and can only be reported if it meets the following two conditions (and this report does):

1. If there are three (3) or more reporting units at the summary level desired, and
2. If no one unit represents 80 percent or more of the summary level employment.

¹³ A production function shows the expenditures associated with producing a good or service. Life science research, for example, requires the purchase of a variety of goods and services—from X-ray films and laboratory equipment, to legal and accounting services.

¹⁴ Preliminary ES202 data.

¹⁵ ES202 data is subject to a BLS audit process that includes the quarterly review and edits by the BLS, coordination among BLS and state agencies to review and resolve questionable entries, and a exportable macro-editing system that BLS provides state agencies to enhance their ability to process, review, and correct the data.

Table 2 shows the economic dimensions of the private bioscience industry in Oregon in 2009. According to Oregon Employment Department ES202 data, in 2009, there were 664 establishments with 10,814 employees earning approximately \$608.3 million in wages and benefits.

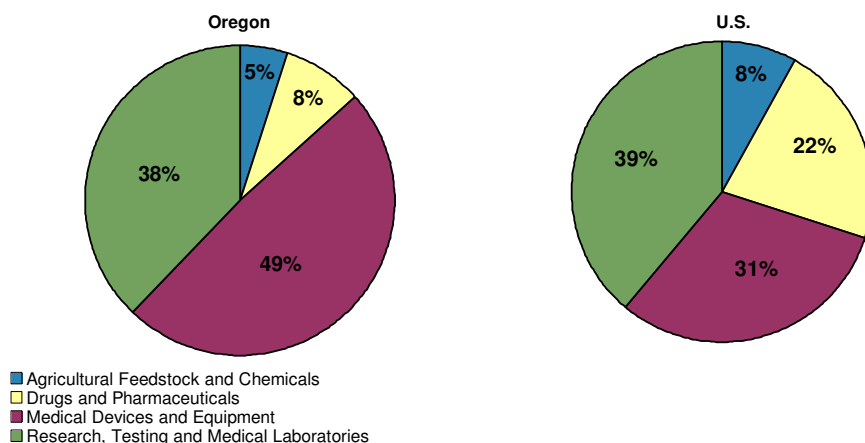
Table 2: The Private Bioscience Industry in 2009 (Current Dollars)

Sector / Subsector	Number of Establishments	Employment	Payroll
Agricultural Feedstock and Chemicals	38	546	\$34,693,320
Drugs and Pharmaceuticals			
Medicinal and botanical manufacturing	6	51	\$1,536,744
Pharmaceutical preparation manufacturing	18	464	\$17,655,134
In-vitro diagnostic substance manufacturing	7	157	\$7,306,732
Other biological manufacturing	6	239	\$11,595,995
Sector Totals	37	911	\$38,094,605
Medical Devices and Equipment			
Electromedical & laboratory equipment manufacturing	34	1,616	\$114,084,193
Surgical, dental, and ophthalmic goods manufacturing	95	2,754	\$134,679,883
Dental labs	157	887	\$30,015,948
Sector Totals	286	5,258	\$278,780,024
Research, Testing and Medical Laboratories			
Testing laboratories	41	346	\$14,322,989
Physical, engineering, and biological research	103	1,329	\$98,475,629
Medical laboratories	101	1,709	\$97,174,630
Diagnostic imaging centers	58	716	\$46,797,896
Sector Totals	303	4,099	\$256,771,144
Total Private Bioscience	664	10,814	\$608,339,093

Source: ECONorthwest calculations using Oregon Employment Department ES202 data.

Figure 1 compares employment in Oregon’s private bioscience industry with that of the nation. On a percentage basis, employment in Oregon’s private bioscience industry is more concentrated in medical devices and equipment manufacturing and less concentrated in drugs and pharmaceutical manufacturing. The other two sectors have employment concentrations that are similar to the U.S.

Figure 1: Employment Composition of the Private Bioscience Industry in Oregon and the U.S., 2009



Source: ECONorthwest calculations using Oregon Employment Department ES202 data and data from Battelle’s 2010 report.

The data shown in Table 2 defines the private bioscience industry in Oregon in 2009. Of particular importance in this study, however, is to evaluate how the bioscience industry in Oregon has changed over the 2002 to 2009 time period, and how the industry has fared over the last two years when the nation entered into the most severe economic downturn since the Great Recession.¹⁶ To do this, the data collected over the last two study periods will be used to evaluate the private bioscience industry in isolation and relative to changes elsewhere in Oregon's economy.

Table 3 provides employment data for the four main sectors of Oregon's private bioscience industry in 2002, 2007, and 2009.

Table 3: Private Bioscience Industry Employment, 2002, 2007, and 2009

Sector / Subsector	2002	2007	2009	Change 2002 to 2009	% Change 2002 to 2009	Change 2007 to 2009	% Change 2007 to 2009
Agricultural Feedstock & Chemical Manufacturing	329	507	546	216	65.7%	39	7.6%
Drugs and Pharmaceutical Manufacturing							
Medicinal and botanical	64	50	51	-13	-19.8%	1	2.7%
Pharmaceutical preparation	337	418	464	127	37.8%	46	11.0%
In-vitro diagnostic substance	242	161	157	-85	-35.1%	-4	-2.5%
Other biological	109	170	239	130	118.9%	69	40.3%
Sector Totals	752	799	911	159	21.2%	112	14.0%
Medical Devices and Equipment Manufacturing							
Electromedical & laboratory equipment	1,216	1,671	1,616	400	32.9%	-55	-3.3%
Surgical, dental, and ophthalmic goods	2,135	2,779	2,754	619	29.0%	-25	-0.9%
Dental labs	836	921	887	51	6.1%	-34	-3.7%
Sector Totals	4,188	5,371	5,258	1,070	25.6%	-113	-2.1%
Research, Testing and Medical Laboratories							
Testing laboratories	253	435	346	93	36.6%	-89	-20.6%
Physical, engineering, and biological research	642	920	1,329	687	107.0%	409	44.4%
Medical laboratories	1,347	1,514	1,709	363	26.9%	195	12.9%
Diagnostic imaging centers	486	672	716	229	47.1%	44	6.5%
Sector Totals	2,728	3,541	4,099	1,371	50.3%	558	15.8%
Total Private Bioscience	7,997	10,218	10,814	2,817	35.2%	596	5.8%

Source: ECONorthwest calculations using Oregon Employment Department ES202 data.

Between 2002 and 2009, the private bioscience industry added 2,817 jobs (a 35.2 percent increase) and all four sectors experienced overall employment growth. Employment increased the most in research, testing, and medical laboratories (+1,371 jobs), and medical devices and equipment manufacturing (+1,070 jobs). Given its relatively small size in 2002, agricultural feedstock and chemical manufacturing experienced the largest percent increase (+65.7 percent), followed by research, testing, and medical laboratories (+50.3 percent).

Between 2007 and 2009, as the nation entered into the most severe economic downturn since the Great Depression, three of the four sectors in the private bioscience industry showed employment increases. Research, medical, and testing laboratories added 558 jobs (a 15.8 percent increase), and drugs and pharmaceutical manufacturing added 112 jobs (a 14.0 percent increase). Only medical devices and equipment manufacturing lost jobs during the two-year period (-113 jobs, -2.1 percent). Overall, the private bioscience industry added 596 jobs between 2007 and 2009.

Table 4 reports private bioscience industry payrolls in 2002, 2007, and 2009.

¹⁶ According to the National Bureau of Economic Research, the recession (dubbed the "Great Recession" because of the scale of economic decline) officially began in December 2007. Oregon was particularly hard hit by the recession and, at one point, had the highest unemployment rate in the nation. Oregon currently has the seventh highest unemployment rate in the nation. See United States Department of Labor, Bureau of Labor Statistics, "Unemployment Rates for States," August 2010 (preliminary) at <http://www.bls.gov/web/laus/laumstrk.htm>.

Table 4: Private Bioscience Industry Payroll, 2002, 2007, and 2009 (Millions of Nominal Dollars)

Sector / Subsector	2002	2007	2009	Change 2002 to 2009	% Change 2002 to 2009	Change 2007 to 2009	% Change 2007 to 2009
Agricultural Feedstock & Chemical Manufacturing	\$13.2	\$27.7	\$34.7	\$21.5	163.7%	\$7.0	25.3%
Drugs and Pharmaceutical Manufacturing							
Medicinal and botanical	\$2.1	\$1.3	\$1.5	-\$0.6	-28.4%	\$0.2	16.1%
Pharmaceutical preparation	\$11.3	\$15.4	\$17.7	\$6.4	56.6%	\$2.2	14.4%
In-vitro diagnostic substance	\$10.3	\$7.0	\$7.3	-\$3.0	-29.0%	\$0.3	4.8%
Other biological	\$3.1	\$6.7	\$11.6	\$8.5	279.7%	\$4.9	72.9%
Sector Totals	\$26.8	\$30.4	\$38.1	\$11.3	42.3%	\$7.7	25.2%
Medical Devices and Equipment Manufacturing							
Electromedical & laboratory equipment	\$57.5	\$135.4	\$114.1	\$56.6	98.5%	-\$21.3	-15.7%
Surgical, dental, and ophthalmic goods	\$86.9	\$129.2	\$134.7	\$47.8	55.0%	\$5.4	4.2%
Dental labs	\$25.1	\$31.3	\$30.0	\$5.0	19.8%	-\$1.2	-4.0%
Sector Totals	\$169.4	\$295.9	\$278.8	\$109.3	64.5%	-\$17.1	-5.8%
Research, Testing and Medical Laboratories	\$0.0	\$0.0	\$0.0				
Testing laboratories	\$8.1	\$16.6	\$14.3	\$6.2	75.8%	-\$2.3	-13.9%
Physical, engineering, and biological research	\$36.7	\$62.2	\$98.5	\$61.8	168.3%	\$36.2	58.2%
Medical laboratories	\$59.8	\$81.5	\$97.2	\$37.3	62.4%	\$15.7	19.3%
Diagnostic imaging centers	\$26.0	\$38.7	\$46.8	\$20.8	80.1%	\$8.1	20.9%
Sector Totals	\$130.7	\$199.0	\$256.8	\$126.1	96.5%	\$57.7	29.0%
Total Private Bioscience	\$340.0	\$553.0	\$608.3	\$268.3	78.9%	\$55.3	10.0%

Source: ECONorthwest calculations using Oregon Employment Department ES202 data.

Between 2002 and 2009, total private bioscience payroll (in nominal or current dollars) increased by \$268.3 million, or by 78.9 percent. Indeed, all four sectors of the bioscience industry had increases in nominal, or not-inflation-adjusted payroll. With the exception of medical devices and equipment manufacturing, this payroll growth continued across the 2007 to 2009 time period. This growth in payroll should be expected in an industry that is adding jobs, however, it's important to point out that industry payroll has been growing much faster than industry employment and, as a result, the average annual nominal income in the private bioscience industry has increased. (The effects of inflation are discussed later in this report.) The average annual incomes for each private bioscience sector are reported in Table 5, below.

Table 5: Private Bioscience Industry Average Annual Incomes, 2002, 2007, and 2009 (Nominal Dollars)

Sector	2002	2007	2009	Change 2002 to 2009	% Change 2002 to 2009	Change 2007 to 2009	% Change 2007 to 2009
Agricultural Feedstock and Chemicals	\$39,952	\$54,632	\$63,589	\$14,680	36.7%	\$8,957	16.4%
Drugs and Pharmaceuticals	\$35,610	\$38,094	\$41,824	\$2,483	7.0%	\$3,730	9.8%
Medical Devices and Equipment	\$40,461	\$55,087	\$53,022	\$14,626	36.1%	-\$2,066	-3.7%
Research, Testing and Medical Laboratories	\$47,896	\$56,208	\$62,636	\$8,312	17.4%	\$6,428	11.4%
Total Private Bioscience	\$42,520	\$54,124	\$56,257	\$11,604	27.3%	\$2,132	3.9%

Source: ECONorthwest calculations using Oregon Employment Department ES202 data.

Table 6 summarizes the employment, payroll, and average annual income in the private bioscience industry in 2002, 2007, and 2009.

Table 6: Summary of the Private Bioscience Industry in Oregon, 2002, 2007, and 2009 (Nominal Dollars)

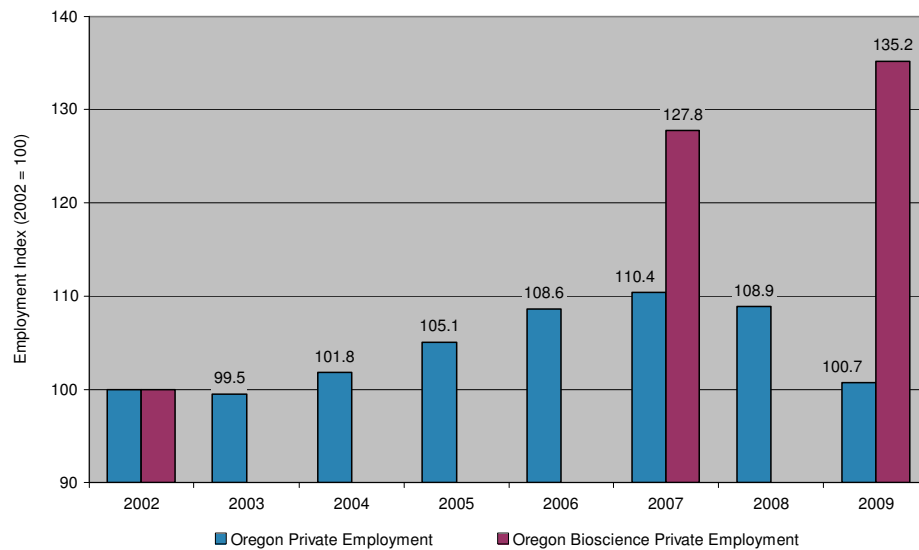
Metric	2002	2007	2009	Change 2002 to 2009	% Change 2002 to 2009	Change 2007 to 2009	% Change 2007 to 2009
Employment	7,997	10,218	10,814	2,817	35.2%	596	5.8%
Total Payroll (millions)	\$340.0	\$553.0	\$608.3	\$268.3	78.9%	\$55.3	10.0%
Average Annual Income	\$42,520	\$54,124	\$56,257	\$13,736	32.3%	\$2,132	3.9%

Source: ECONorthwest calculations using Oregon Employment Department ES202 data.

Across all economic metrics, the private bioscience industry in Oregon is much larger than it was in 2002, and was able to weather the economic recession and slow growth recovery period between 2007 and 2009. But, how does this growth compare to the rest of the Oregon economy? To provide additional economic context, ECONorthwest researched and acquired employment and wage data from the Oregon Labor Market Information System (OLMIS). To make this an apples-to-apples comparison, ECONorthwest used data for private covered employment in Oregon, i.e., total covered employment not including government covered employment.

Figure 2 compares private bioscience employment with private covered employment in Oregon (employment levels indexed to 2002). Between 2002 and 2009, private bioscience employment increased 35.2 percent, compared to 0.7 percent for all private covered employment in Oregon. In addition, over the recession and slow-growth period between 2007 and 2009, the private bioscience industry added 596 jobs (+5.8 percent) while private covered employment in Oregon fell by 127,300 jobs (-8.7 percent).

Figure 2: Private Bioscience Industry and Private Covered Employment in Oregon, 2002-2009 (Employment Indexed to 2002 Levels)



Source: ECONorthwest calculations using Oregon Employment Department ES202 and OLMIS covered employment data

Table 7 compares the average annual pay in the private bioscience industry with private covered employment in Oregon in 2002, 2007, and 2009. In general, the average annual wage in the private bioscience industry is greater than that for total private covered employment, and that difference has been increasing over time. In 2002, the average annual private bioscience industry wage was 28.6 percent higher than the average annual wage for all private covered employees in Oregon. By 2009, this difference increased to 40.7 percent. In addition, over the 2007–2009 time period, the average annual wage in the private bioscience industry increased by 10.0 percent, while the average annual wage for all private covered employees in Oregon increased by 2.0 percent.

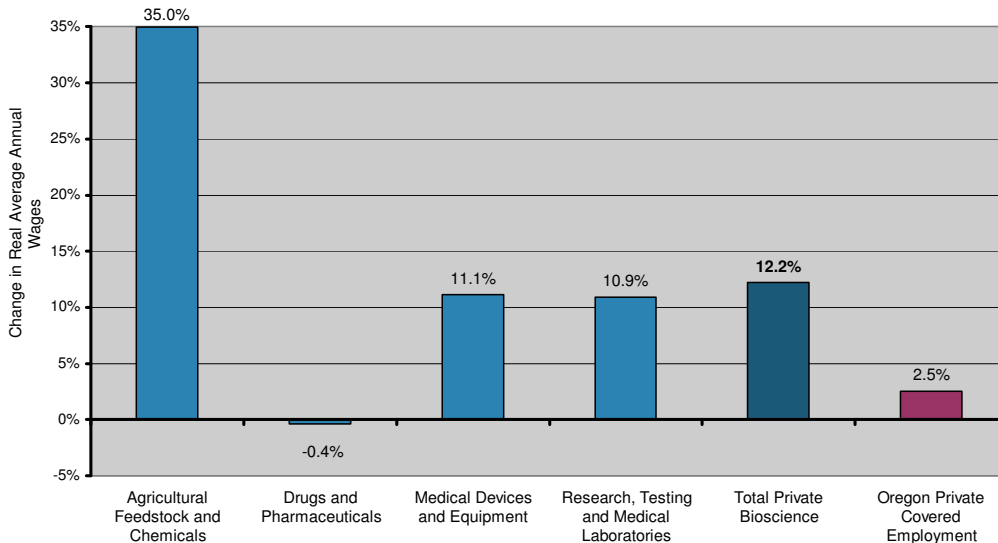
Table 7: Average Annual Pay for Private Bioscience Industry and Private Covered Employment, 2002, 2007, and 2009 (Nominal Dollars)

Year	Oregon Private Covered Employment	Private Bioscience	Percent Difference
2002	\$33,066	\$42,519	28.6%
2007	\$39,177	\$54,124	38.2%
2009	\$39,980	\$56,257	40.7%

Source: ECONorthwest calculations using Oregon Employment Department ES202 and OLMIS covered employment data

Nominal dollars do not account for inflation and the tendency for increases in the average price level to reduce purchasing power.¹⁷ To account for this, economists use a price index to convert (or deflate) nominal dollars into real dollars. Real dollars are inflation-adjusted dollars. Figure 3 shows how real average annual wages in private bioscience sectors, the private bioscience industry, and Oregon private covered employment have changed over the 2002 to 2009 time period.

Figure 3: Changes in Real Average Annual Wages from 2002 to 2009, Private Bioscience Industry and Private Covered Employment (2002 base year)



Source: ECONorthwest calculations using Oregon Employment Department ES202 and OLMIS covered employment data. Inflation data from BLS Consumer Price Index All Urban Consumers, West Region

1.2.3. Life Science Research at Universities and Hospitals

In addition to the private bioscience industry described in the previous section, a significant amount of life science research occurs at universities and hospitals in Oregon. Using data provided by individual life science research institutions, ECONorthwest measured the economic dimensions of the life science research sector in fiscal 2009. These results, and those from our previous study, are shown in Table 8.

¹⁷ Inflation also arbitrarily redistributes purchasing power.

Table 8: Life Science Research in Oregon, 2002, 2007, and 2009 (Millions of Current Dollars)

Item	FY2002	FY2007	FY2009	Change 2002 to 2009	% Change 2002 to 2009	Change 2007 to 2009	% Change 2007 to 2009
Spending	\$340.4	\$458.9	\$479.1	\$138.7	40.8%	\$20.2	4.4%
Personal Income	\$145.5	\$237.8	\$273.9	\$128.4	88.2%	\$36.1	15.2%
Jobs (FTE)	2,631	3,418	3,407	776	29.5%	-11	-0.3%

Source: ECONorthwest calculations using data provided by OUS, OHSU, Kaiser, Providence, and Legacy.

Across all economic metrics, life science research in Oregon has increased since 2002. Between 2002 and 2009, spending is up 40.8 percent, employment increased by 29.5 percent (+776 jobs), and total nominal personal income increased 88.2 percent (+\$128.4 million).

Over the 2007 to 2009 time period, economic growth in the life science research sector has been relatively modest. However, all economic metrics have generally outperformed the private sector in Oregon over that time period. Between 2007 and 2009, nominal life science research spending is up 4.4 percent, nominal personal income or payrolls increased 15.2 percent, and employment declined 0.3 percent. Based on these statistics, life science research in Oregon has, so far, weathered the economic recession and slow growth recovery period of the last two years.

Table 9 compares the average annual pay in life science research and private covered employment in Oregon in 2002, 2007, and 2009. On average, employees in life science research earn more than private covered employees in Oregon, and the difference has grown over the 2002–2009 time period.

Table 9: Average Annual Pay for Life Science Research and Private Covered Employment, 2002, 2007, and 2009 (Nominal Dollars)

Year	Oregon Private Covered Employment	Life Science Research	Percent Difference
2002	\$33,066	\$55,327	67.3%
2007	\$39,177	\$69,567	77.6%
2009	\$39,980	\$80,400	101.1%

Source: ECONorthwest calculations using data supplied by life science research institutions and OLMIS covered employment data.

1.2.4. The Combined Bioscience Industry in Oregon

Table 10 summarizes the economic dimensions of the private bioscience industry and life science research, and the bioscience industry as a whole in 2002, 2007, and 2009. In total, the bioscience industry in Oregon consisted of 14,221 jobs with combined earnings of \$882.3 million in 2009.

Table 10: Economic Dimensions of Oregon’s Bioscience Industry, 2002, 2007, and 2009 (Millions of Current Dollars)

Major Industry Component / Economic Measure	2002	2007	2009	Change 2002 to 2009	% Change 2002 to 2009	Change 2007 to 2009	% Change 2007 to 2009
Private Industry							
Output	\$1,414.1	\$3,035.6	\$3,653.5	\$2,239.4	158.4%	\$617.9	20.4%
Personal Income	\$340.0	\$561.7	\$608.3	\$268.3	78.9%	\$46.7	8.3%
Employment	7,997	10,218	10,814	2,817	35.2%	596	5.8%
Life Science Research							
Expenditure	\$340.4	\$458.9	\$479.1	\$138.7	40.8%	\$20.2	4.4%
Personal Income	\$145.5	\$237.8	\$273.9	\$128.4	88.2%	\$36.1	15.2%
Employment	2,631	3,418	3,407	776	29.5%	-11	-0.3%
Combined							
Output / Expenditure	\$1,754.4	\$3,494.5	\$4,132.5	\$2,378.1	135.6%	\$638.0	18.3%
Personal Income	\$485.6	\$799.5	\$882.3	\$396.7	81.7%	\$82.8	10.4%
Employment	10,627	13,636	14,221	3,594	33.8%	585	4.3%

Source: ECONorthwest calculations using ES202 data provided by Oregon Employment Department and life science research data provided by OUS, OHSU, Kaiser, Providence, and Legacy.

*Bioscience industry – Economic measures are for calendar years. Output is measured in IMPLAN and employment represents full- and part-time jobs.

*Life science research – Economic measures are for fiscal years. Employment is in FTEs.

2. Measuring the Bioscience Industry’s Economic Contributions

This section of the report describes the contribution or relative importance of the bioscience industry to Oregon’s economy. To measure this, ECONorthwest:

- 1) Relied on the Battelle definition of the private bioscience industry and included life science research conducted by universities and hospitals;
- 2) Measured the direct economic activity (employment and personal income) associated with the industry using ES202 data provided by the Oregon Employment Department, and expenditure, funding, payroll, and employment data provided by research hospitals and universities; and
- 3) Fed these measures of direct economic activity into a specially constructed, input-output model of the Oregon economy.

The next sections report our modeling approach and economic impact results. The economic impact results are measured for 2009. To be consistent with the dimensions of the industry—measured and reported in the previous section—the economic impacts are reported separately for the private bioscience industry and for life science research conducted at universities and hospitals.

2.1. Modeling Approach

The bioscience industry *directly* contributes to the Oregon economy by producing goods and services, hiring workers, and paying wages. The bioscience industry also affects other sectors that are related through supply or sales chain links. These types of impacts are called *indirect* impacts. For example, in order to produce goods and services, the bioscience industry, itself, must purchase a variety of goods and services such as physical property or workspace, insurance, research supplies, legal services, transportation services, and utilities. Providers of goods and services to the bioscience industry will have to do the same.

This direct and indirect economic activity will generate income for workers and business owners. This income increases household purchasing power and will influence or affect the pattern of final consumption in Oregon. As incomes rise, so, too, does purchasing power. Households will use this income to pay their rent, purchase groceries, and take their children in for medical care. These types of impacts are called *induced* impacts.

The economic modeling framework that best captures these direct, indirect, and induced effects is called *input-output modeling*. Input-output models provide an empirical representation of the economy and its inter-sectoral relationships, enabling the user to trace the effects (economic impacts) of a change in the demand for commodities (goods and services). ECONorthwest used specially constructed, input-output model of the Oregon economy to trace the direct economic activity associated with the bioscience industry as it ripples through the Oregon economy. Specifically, ECONorthwest used the IMPLAN (for IMPact Analysis for PLANning) statistical bioscience, modified specially for this application.¹⁸ The following impacts are reported in this analysis:

- **Output** represents the total value of industry production. It is the broadest measure of economic activity, and includes purchases by businesses of intermediate goods and services, as well as the total value added during production. (Total value added is discussed below.)
- **Total value added**, is the sum of personal income (wages and business income), other income, and indirect business taxes. Total value added is a component of output, and the two should not be added together. In addition, total value added is a close approximation of gross state product.
 - **Personal income** consists of wages and small business income. Workers' wages include other benefits such as health and life insurance, and retirement payments, and business income (or proprietary income) received by small-business owners or self-employed workers. Business income would include, for example, income received by private business owners, doctors, accountants, attorneys, etc.
 - **Other income** includes payments to individuals in the form of rents received on properties, royalties from contracts, dividends paid by corporations, and profits earned by corporations.
 - **Indirect business taxes** are taxes paid by businesses to local, state, and federal taxing jurisdiction. In Oregon, indirect business taxes consist primarily of property taxes. Further, in Oregon, approximately 85 percent of the indirect business taxes paid accrue to state and local taxing jurisdictions; the remainder goes to the federal government.
- **Jobs** include both full- and part-time employment.
- **State and local taxes** include indirect business taxes (discussed above) as well as personal income taxes; social insurance (employer and employee contributions) taxes; and various other taxes, fines, and fees paid by businesses and households.

¹⁸ IMPLAN was developed by the Forest Service of the US Department of Agriculture in cooperation with the Federal Emergency Management Agency and the Bureau of Land Management of the US Department of the Interior to assist federal agencies in their land and resource management planning. ECONorthwest has applied the model to a variety of public and private sector projects including, most recently, an impact evaluation of Portland's Green Building Program, and the potential loss of federal matching funds for long-term care services for seniors and persons with disabilities in Oregon and Washington.

2.2. Analysis Results

2.2.1. Private Bioscience Industry

Table 11 reports the economic contributions of the private bioscience industry in 2009. The direct payroll and employment impacts are those gathered from ES202 data. The direct output, other income, and indirect business taxes are estimated in the economic impact model. In 2009, the private bioscience industry directly contributed \$3.7 billion in output, including \$608.3 million in personal income, \$335.8 million in other income, and \$17.2 million in indirect business taxes for federal, state, and local taxing jurisdictions.

Table 11: Private Bioscience Industry Economic Contributions to the Oregon Economy in 2009 (Millions of Current Dollars)

Type of Impact	Direct	Indirect	Induced	Total
Output	\$3,653.5	\$1,612.9	\$1,092.3	\$6,358.6
Total Value Added	\$961.3	\$834.9	\$670.0	\$2,466.2
¥ Personal Income	\$608.3	\$529.0	\$370.3	\$1,507.7
¥ Other Income	\$335.8	\$245.6	\$230.3	\$811.7
¥ Indirect Business Taxes	\$17.2	\$60.2	\$69.4	\$146.8
State and Local Taxes	\$60.9	\$81.8	\$78.3	\$221.1
Jobs	10,814	9,263	9,663	29,739

Source: ECONorthwest using IMPLAN.

The second data column of Table 11 shows the indirect impacts attributed to the private bioscience industry. Purchases of goods and services by the private bioscience industry will generate the first round of indirect impacts. Providers to the bioscience industry will have to purchase intermediate goods and services from other sectors, causing the indirect impacts to filter to additional industries.¹⁹ In total, the indirect impacts of the private bioscience industry in 2009 are significant and are associated with \$1.6 billion in economic activity and over 9,263 full- and part time jobs in other sectors. These large indirect effects contribute to the industry's relatively large multiplier effect on the Oregon economy (discussed later).

The induced impacts of the bioscience industry are reported in the third data column of Table 11. These, too, are significant given the size of the initial or direct impacts. Induced impacts are generated by the direct hires in the bioscience industry, and by employment and incomes generated indirectly in other industry sectors. These relatively large induced impacts are explained, in part, by the relatively high-paying jobs in the industry where average annual wages in 2009 were approximately \$56,257 (or 40.7 percent above the statewide average). In 2009, the induced impacts attributed to the private bioscience industry totaled approximately \$1.1 billion in economic activity, including \$370.3 million in personal income and 9,663 jobs.

The indirect and induced impacts associated with the private bioscience industry in 2009 were considerable, providing strong evidence that the bioscience industry has extensive linkages to other sectors of the Oregon economy. (These linkages and multiplier effect will be discussed in greater detail later in this report.) In total, the economic contributions of the private bioscience industry to Oregon's economy consisted of \$6.4 billion in output, including \$1.5 billion in personal income and just over 29,700 jobs.

¹⁹ Spending on out-of-state suppliers is not counted and has no impact on Oregon.

As shown in Table 12, the economic activity linked to the private bioscience industry generated substantial tax revenues for state and local governments in 2009. In 2009, economic activity associated with the private bioscience industry generated approximately \$221.1 million in revenues for state and local taxing jurisdictions. According to the economic impact model, approximately 27.6 percent (or \$60.9 million) of this total was paid directly by the private bioscience industry.

Table 12: Private Bioscience Industry Fiscal Impacts, 2009 (Millions of Current Dollars)

Type of Tax	Revenues	Percent of Total
Profits and dividends	\$39.4	17.8%
Business and personal property	\$66.6	30.1%
Personal income	\$52.7	23.8%
Social insurance	\$0.4	0.2%
Other taxes	\$34.8	15.7%
Fines, fees, and non-taxes	\$27.1	12.3%
Total state and local	\$221.1	100.0%

Source: ECONorthwest using IMPLAN

2.2.3. Life Science Research

Similar to the private bioscience industry, from an economic impact perspective, the main economic drivers associated with life science research are funding/expenditures, payroll and employment. For life science research, ECONorthwest used funding/expenditure, payroll, and employment data provided for the eight public universities in Oregon by the OUS Chancellors Office, and comparable data provided by OHSU, Providence, Legacy, and Kaiser.

Without a specific NAICS code (or codes) to attach to life science research, ECONorthwest employed an alternative impact methodology—called “analysis by parts”—to measure the economic contributions of life science research. This approach uses detailed spending data provided by life science research institutions (specifically OUS) to develop a spending pattern or production function of their research operations. This approach is more complicated and time consuming, however, client-provided data allows the analyst to over-ride national production relationships with information specific to the activity under consideration. As such, this approach generally yields more reliable impact estimates.

Under this type of analysis:

1. The **direct effects** are based on output (or expenditures), employment and personal income data supplied by life science research institutions.
2. The **indirect effects** are measured by identifying changes in output for each industry from which goods and services are purchased. In order to conduct research, institutions will purchase a variety of goods and services. This spending generates the first round of indirect impacts. Suppliers and vendors to life science research institutions will also have to purchase additional goods and services. In total, the indirect impacts of the life science research are what the IMPLAN model reports as direct and indirect impacts in this model.
3. The **induced impacts** are based, in part, on estimates of the direct personal income generated in production. This data is adjusted for taxes and savings, and then fed into a consumption function specific for that household income group and region. What is

specified as direct impacts in this model are actually the first round of induced impacts, so what is reported as induced impacts are the total impacts from this model plus the induced impacts from inter-industry expenditures noted in #2, above.

The economic contributions of life science research on the Oregon economy in 2009 are shown in Table 13.

Table 13: Economic Contributions of Life Science Research, 2009 (Millions of Current Dollars)

Type of Impact	Direct	Indirect	Induced	Total
Output	\$479.1	\$120.2	\$235.7	\$834.9
Total Value Added	\$273.9	\$72.0	\$126.4	\$472.4
¥ Personal Income	\$273.9	\$54.0	\$85.1	\$413.0
¥ Other Income	Ñ	\$14.0	\$30.2	\$44.3
¥ Indirect Business Taxes	Ñ	\$4.0	\$11.1	\$15.1
State and Local Taxes	Ñ	Ñ	Ñ	\$47.0
Jobs	3,407	1,294	2,353	7,054

Source: ECONorthwest using IMPLAN

Note: Because of limitations in the data and the way impacts were measured, it is not possible to estimate the direct impacts on other income and indirect business taxes, or to allocate total state and local tax impacts across direct, indirect, and induced dimensions.

The direct output (expenditures), personal income, and employment numbers were provided by life science research institutions and are shown in the first data column in Table 13. Life science research in Oregon involved \$479.1 million in spending (with the majority of funding coming from federal sources), \$273.9 million in personal income, and 3,407 jobs in FY2009.

In total, in FY2009, life science research contributed approximately \$834.9 million in output (expenditures), including \$413.0 million in personal income and approximately 7,050 jobs (FTEs). In addition, the economic activity associated with life science research generated approximately \$47.0 million in tax revenues for state and local taxing jurisdictions. These fiscal impacts are shown in Table 14.

Table 14: Life Science Research Fiscal Impacts, 2009 (Millions of Current Dollars)

Type of Tax	Revenues	Percent of Total
Profits and dividends	\$4.5	9.6%
Business and personal property	\$13.0	27.6%
Personal income	\$22.0	46.8%
Social insurance	\$0.1	0.2%
Other taxes	\$3.3	7.0%
Fines, fees, and non-taxes	\$4.1	8.8%
Total state and local	\$47.0	100.0%

Source: ECONorthwest using IMPLAN

2.2.4. Combined Bioscience Industry Impacts

The combined economic contributions of the bioscience industry are shown in Table 15. Using our economic impact model of Oregon, ECONorthwest estimates that spending by the bioscience industry and its employees is associated with approximately \$7.2 billion in output, including \$1.9 billion in personal income, and 36,793 jobs in Oregon in 2009. In general, the economic contributions are similar to those in 2007. All monetary impacts increased somewhat over the two-year 2007–2009 time period, with some of this increase due to inflation. Total job impacts fell slightly.

Table 15: Bioscience Industry Total Economic Contributions, 2009 (Millions of Current Dollars)

Type of Impact	Private Bioscience	Life Science Research	Total Bioscience	% Change from 2007
Output	\$6,358.6	\$834.9	\$7,193.5	15.2%
Total Value Added	\$2,466.2	\$472.4	\$2,938.6	16.9%
¥ Personal Income	\$1,507.7	\$413.0	\$1,920.7	7.5%
¥ Other Income	\$811.7	\$44.3	\$855.9	43.9%
¥ Indirect Business Taxes	\$146.8	\$15.1	\$162.0	22.7%
State and Local Taxes	\$221.1	\$47.0	\$268.0	7.0%
Jobs	29,739	7,054	36,793	-0.7%

Source: ECONorthwest using IMPLAN

All of the impact measures described previously can be summarized across direct, indirect, and/or induced impact categories using mathematical formulae to measure and explain what economists refer to as the “multiplier effect”. Economic multipliers succinctly quantify the linkages between an industry or activity and other sectors of the economy. All else considered, the larger the multiplier, the greater the interdependence between an industry or activity and the rest of the economy. Table 16 shows Type SAM multipliers for output, personal income, and employment for private bioscience’s four major sectors, for the private bioscience industry, for life science research, and for the bioscience industry as a whole.²⁰ The multipliers provide a mathematical shortcut for understanding the full contribution of the bioscience industry.

Table 16: Bioscience Economic Impact Multipliers, 2009

Sector	Output	Personal Income	Jobs
Private Bioscience	1.7	2.5	2.8
Agricultural Feedstock & Chemicals	1.6	4.2	4.9
Drugs and Pharmaceuticals	1.7	5.1	4.2
Medical Devices and Equipments	1.7	2.5	2.7
Research, Testing and Medical Laboratories	1.9	1.8	2.2
Life Science Research	1.7	1.5	2.1
Total Bioscience	1.7	2.2	2.6

Source: ECONorthwest using IMPLAN.

In 2009, the bioscience industry in Oregon directly or indirectly generated approximately \$268.0 million in state and local tax revenues. These fiscal impacts are reported in Table 17 below. According to the economic impact model, the largest sources of tax revenues are property taxes paid primarily by businesses (29.7 percent) and personal income taxes (27.8 percent). In addition, although the mix of tax payments changed with some types of taxes increasing and some decreasing, the combined fiscal contributions of the bioscience industry increased from \$250.5 million in 2007 to \$268.0 million in 2009, or by 7.0 percent.

Table 17: Bioscience Industry Fiscal Impacts, 2009 (Millions of Current Dollars)

Type of Tax	Private Bioscience	Life Science Research	Total Bioscience	Percent of Total	Percent Change from 2007
Profits and dividends	\$39.4	\$4.5	\$43.9	16.4%	21.0%
Business and personal property	\$66.6	\$13.0	\$79.6	29.7%	-5.6%
Personal income	\$52.7	\$22.0	\$74.6	27.8%	-5.0%
Social insurance	\$0.4	\$0.1	\$0.5	0.2%	-21.7%
Other taxes	\$34.8	\$3.3	\$38.1	14.2%	74.5%
Fines, fees, and non-taxes	\$27.1	\$4.1	\$31.3	11.7%	8.6%
Total state and local	\$221.1	\$47.0	\$268.0	100.0%	7.0%

Source: ECONorthwest using IMPLAN

²⁰ Generally, there are two types of multipliers. A Type I multiplier ($[\text{direct} + \text{indirect}]/\text{direct}$) measures the supply-chain relationship between the industry or activity and other business sectors. The Type II or Type SAM multiplier ($[\text{direct} + \text{indirect} + \text{induced}]/\text{direct}$) measures the total ripple effect of the industry or activity.