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The Dimensions and Contributions of the Bioscience Industry in Oregon

Prepared for the Oregon Bioscience 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. Unlike most industry sectors, the bioscience industry consists of various activities that do not fit neatly into a single, official 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 official industrial codes; and 2) bioscience-related research at universities and hospitals. 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 acquired for both 2002 and 2007. This data was used to measure or define the dimensions of the bioscience industry in Oregon and evaluate changes during that time period. For 2007, this data was then fed 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. As defined in this study, Oregon’s bioscience industry directly generated almost \$3.5 billion in output or economic activity, including \$800 million in personal income and over 13,630 jobs in Oregon in 2007.** The economic dimensions for the two major components of the bioscience industry in 2007 are as follows:

¹ This report was prepared by staff at ECONorthwest’s Portland office. Alec Josephson, economist, was the primary researcher and author of this report. He received valuable contributions from Bob Whelan, senior economist, and John Tapogna, senior policy analyst. Questions regarding this report should be directed to Mr. Josephson at 503-222-6060.

- a) The private bioscience industry, defined using Battelle’s industry definition, consisted of 615 establishments that generated \$3.0 billion in output, and employed 10,218 workers who received \$561.7 million in income. With many production processes requiring high-skilled workers and/or advanced university degrees, the average annual wage in the private bioscience industry was approximately \$55,000 or almost 40 percent greater than the statewide average in 2007.
 - b) Bioscience of “life science” research activities at universities and hospitals will not show up in government statistics for private industry. According to data provided by universities and hospitals, in 2007, spending on life science research totaled \$458.9 million. 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 an estimated 3,420 jobs (FTEs) and \$237.8 million in personal income.
2. **Between 2002 and 2007, 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 just over 3,000 jobs, or by approximately 28.3 percent between 2002 and 2007. Employment growth in Oregon over that same time period was 9.9 percent. Thus, employment growth in the Oregon’s bioscience industry was almost three times greater than for the Oregon economy. Personal income for workers in the bioscience industry increased by almost 65 percent between 2002 and 2007. This was more than twice the growth rate in income for the state as a whole. Statistics for both major components of the bioscience industry are shown in Table 1 below.

Table 1: The Economic Dimensions of Oregon’s Bioscience Industry in 2002 and 2007 (in millions of current dollars)

Major Industry Component / Economic Measure	2002	2007	Change	Percent Change
Private Industry				
Personal Income	\$340.02	\$561.65	\$221.63	65.2%
Employment	7,997	10,218	2,221	27.8%
Life Science Research				
Personal Income	\$145.55	\$237.80	\$92.26	63.4%
Employment	2,631	3,418	788	29.9%
Total Bioscience Industry				
Personal Income	\$485.57	\$799.46	\$313.89	64.6%
Employment	10,627	13,636	3,009	28.3%

Source: ECONorthwest calculations using Oregon Employment Department ES202 data and information supplied by life science research institutions.

- a) Between 2002 and 2007, the private bioscience industry experienced a 27.8 percent increase in employment (Oregon +9.9 percent) and a 65.2 percent increase in personal income (Oregon payroll +29.0 percent). In addition, with the growth in personal income exceeding employment growth, average annual incomes for workers in this industry increased by 29.3 percent between 2002 and 2007. This exceeds the growth in average annual income in Oregon (+17.5 percent) by 67 percent, and was almost double the increase in the average price level in the nation (+15.2 percent change in US CPI) over this time period.

- b) As discussed previously, growth patterns for both major components of the bioscience industry were comparable over the 2002 to 2007 time period. Employment and income for workers conducting life science research at universities and hospitals increased 29.2 percent and 63.4 percent, respectively, between 2002 and 2007.
3. **The economic contributions of the bioscience industry in 2007 were considerable.** Using an economic impact model of the Oregon economy, ECONorthwest estimates that spending by the bioscience industry and its employees is associated with approximately \$6.2 billion in output, \$1.8 billion in personal income, and 37,050 jobs in Oregon in 2007. These larger multiplier effects occur as economic activity directly attributed to the bioscience industry “ripples” throughout the Oregon economy. These total contributions are summarized for each major component and for the bioscience industry as a whole in Table 2.

Table 2: Total Economic Contributions of the Bioscience Industry in 2007 (in millions of current dollars)

Type of Impact	Private Bioscience	Life Science Research	Total Bioscience
Output	\$5,427.44	\$816.46	\$6,243.90
Total Value Added	\$2,077.03	\$436.36	\$2,513.39
¥ Personal Income	\$1,409.28	\$377.06	\$1,786.33
¥ Other Income	\$550.69	\$44.33	\$595.02
¥ Indirect Business Taxes	\$117.07	\$14.98	\$132.04
Total State and Local Taxes	\$202.44	\$48.06	\$250.50
Jobs	30,002	7,049	37,051

Source: ECONorthwest using IMPLAN

4. **From an economic impact perspective, the bioscience industry has a relatively large multiplier effect and benefits many other sectors of the state economy.** The multiplier effect measures the degree to which economic activity in one sector affects or generates economic activity in others. For example,
- a) According to our economic impact model of Oregon, the bioscience industry has an employment multiplier of 2.70. This employment multiplier suggests that every 10 jobs in the bioscience industry support an additional 17 jobs in other sectors of the economy.
5. **The relatively large multiplier effect is attributed to purchases by the bioscience industry of goods and services necessary for production and research activities, 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 \$1.6 billion in economic activity, including \$529 million in personal income and 11,270 jobs. These economic impacts benefit a wide variety of supporting business sectors, including: wholesale trade, business support and employment services, legal services, and real estate.
- b) The direct and indirect increase in household incomes associated with the bioscience industry facilitated consumption spending and induced an additional \$1.1 billion in economic activity, including \$457.8 million in personal income and 12,140 jobs for workers and businesses in Oregon. This spending helps to spread the economic impacts to additional business sectors, including: health care and social assistance; retail trade; and accommodations and food services (4,610 jobs).

6. In 2007, the bioscience industry in Oregon directly or indirectly generated approximately \$250.5 million in revenues for state and local governments. According to the economic impact model, the largest source of tax revenues is personal income taxes (31.4 percent) and property taxes (33.7 percent) paid primarily by businesses. These fiscal impacts are reported in Table 3 below.

Table 3: Fiscal Impacts of the Bioscience Industry on State and Local Government in 2007 (in millions of current dollars)

Type of Tax	Total Bioscience Industry	Percent of Total
Profits and dividends taxes	\$36.30	14.5%
Property taxes	\$84.30	33.7%
Personal income taxes	\$78.61	31.4%
Social insurance taxes	\$0.68	0.3%
Other taxes	\$21.83	8.7%
Fines, fees and other non-taxes	\$28.78	11.5%
Total state and local taxes	\$250.50	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 2002 and 2007, and how it changed over that time period.

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 for Oregon’s economy.

The Bioscience Industry in Oregon

In the US, most industries are classified using the North American Industrial Classification System (NAICS) coding framework. Industries have an official NAICS code, and government-provided data on the number of employees, payroll, and industry sales. Using this information, it is a rather straightforward process to measure the economic contributions of an industry.

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 structure of the Oregon bioscience industry and how it was defined for this analysis. The 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 2002 and 2007.

Defining the Bioscience Industry

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

To measure the private sector bioscience industry, ECONorthwest was asked to use Battelle’s definition as developed in their national 2006 study.² 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.

Battelle’s bioscience industry definition includes the following industry sectors (identified by NAICS codes) and is shown in Table 4.

² Battelle, *Growing the Nation’s Bioscience Sector: State Bioscience Initiatives*, April 2006, and *Growing the Nation’s Bioscience Sector: A Regional Perspective*, January 2007.

Table 4: 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. They are:

- **Agricultural feedstocks and chemicals.** This sector uses biotechnology and other life science technologies to process agricultural goods and feedstocks, and produce chemicals.³ 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.

³ 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.

It's important to note that ECONorthwest accepted the Battelle definition of the private sector bioscience industry and did not make any alterations to that definition. However, we did have to use economic judgment to evaluate/include companies that provide testing and research laboratories. That is, only a portion of the activities carried out by companies in these NAICS categories is bioscience-related.⁴ Thus, ECONorthwest evaluated each record in the Oregon Employment Department ES202 data to identify firms that conducted bioscience-related activities. OBA survey data augmented this record-by-record evaluation. (ES202 data is discussed in detail in the next section of this report.)

In addition to the private sector industries identified by NAICS codes in Table 4, 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.”⁵

In this report, we refer to these entities collectively as “life science research” institutions. Employment and wage data for life science research institutions is not available by NAICS codes. As such, OBA worked closely with Oregon Health Sciences 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 life science research institutions provided the following data:

1. The Oregon University System (OUS) Chancellors Office provided detailed expenditure data (for almost 31,000 expenditure items), including payroll and employment in full-time equivalents (FTEs) for Oregon’s eight public universities in FY2002 and FY2008.
2. Oregon Health & Science University (OHSU) provided research spending by major activity code and funding by major source for FY2002 and FY2007.
3. The Center for Health Research at Kaiser Permanente provided funding for FY2002 and FY2008.

⁴ 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).

⁵ 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.”

4. Providence Health & Services Research Centers provided funding data for FY2002 and FY2008, and projected payroll and employment (FTE) data for FY2009. Providence did note that the FTEs for FY2009 are “the same for 2008.”
5. Legacy Health Systems (LHS) Research provided funding and employment data for 2002 and 2007.

To fully describe the economic dimensions of life science research in Oregon, ECONorthwest substituted data supplied by some institutions for missing data at others. To do this, we made three important assumptions.⁶ First, OHSU and Kaiser did not provide employment estimates. However, for institutions that did, the ratio of employment to funding was remarkably close, and yielded 7.5 FTE per million dollars in funding. This ratio was applied to the funding totals at OHSU and Kaiser to estimate their direct hires.

Second, only OUS and Providence provided payroll data. Providence payroll data was for 2009, so ECONorthwest backed out Providence’s assumed inflation rate to convert their payroll dollars to FY2007 dollars. The average annual wage was calculated for OUS and Providence FTEs, and this was then used to determine the payroll at OHSU, Kaiser, and Legacy based on the number of FTEs at each.

Third, OUS was also able to provide detailed revenue and expenditure data for life science research activities taking place at all eight Oregon public universities. This data was used to develop a production function⁷ for university research activities, and was then applied to life science research taking place at hospitals.

The Economic Dimensions of the Bioscience Industry

As discussed previously, ECONorthwest relied on the Battelle definition of the bioscience industry, utilized Oregon Employment Department ES202 data to measure the industry, and accepted ES202 industry code classifications as correct. In addition, ECONorthwest relied on funding/expenditure, payroll and employment 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, ECONorthwest will report their dimensions and impacts separately.

The Private Bioscience Industry

ECONorthwest obtained employment and wage data (called ES202 data) from the Oregon Employment Department. 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.

⁶ In order to provide the most realistic assessment of this component of the bioscience industry, ECONorthwest adopted the most conservative assumptions.

⁷ 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.

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 state, 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.⁸ 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:

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.

Table 5 shows the economic dimensions of the private bioscience industry in Oregon in 2002. According to Oregon Employment Department ES202 data, in 2002, there were 496 establishments with just under 8,000 employees earning approximately \$340.0 million in wages and benefits.

In 2002, the average annual wage for employees in the bioscience industry was \$42,520. According to the Oregon Employment Department, the average annual wage for all covered employees in Oregon in 2002 was \$33,685. Thus, the average wage in the bioscience industry exceeded the statewide average wage by approximately 26 percent in 2002.

⁸ 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 5: The Private Bioscience Industry in 2002 (in current dollars)

Sector	Number of Establishments	Employment	Payroll
Agriculture Feedstock and Chemical	20	329	\$13,154,306
Drugs and Pharmaceuticals			
Medicinal and botanical manufacturing	8	64	\$2,146,120
Pharmaceutical preparation manufacturing	12	337	\$11,272,828
In-vitro diagnostic substance manufacturing	7	242	\$10,297,124
Other biological manufacturing	7	109	\$3,054,042
Sector Total	34	752	\$26,770,114
Medical Devices and Equipment			
Electromedical & laboratory equipment manufacturing	37	1,216	\$57,476,051
Surgical, dental, and ophthalmic goods manufacturing	75	2,135	\$86,898,013
Dental labs	163	836	\$25,063,588
Sector Total	275	4,188	\$169,437,652
Research, Testing and Medical Laboratories			
Testing laboratories	26	253	\$8,147,160
Physical, engineering, and biological research	40	642	\$36,701,740
Medical laboratories	59	1,347	\$59,831,735
Diagnostic imaging centers	42	486	\$25,979,039
Sector Total	167	2,728	\$130,659,674
Total Private Bioscience	496	7,997	\$340,021,746

Source: ECONorthwest calculations using Oregon Employment Department ES202 data.

Table 6 provides establishment and employment counts, and payroll for the private bioscience industry in 2007. In 2007, ES202 data shows that there were 615 establishments with 10,218 employees earning over \$561.6 million in wages and benefits. The average annual bioscience wage was just under \$55,000 in 2007. The Oregon Employment Department reports that the average wage for all covered employees in Oregon in 2007 was \$39,564. Thus, the average wage in the bioscience industry exceeded the statewide average wage by approximately 39 percent in 2007.

Table 6: The Private Bioscience Industry in 2007 (in current dollars)

Sector	Number of Establishments	Employment	Payroll
Agriculture Feedstock and Chemical	32	507	\$27,698,448
Drugs and Pharmaceuticals			
Medicinal and botanical manufacturing	6	50	\$2,058,801
Pharmaceutical preparation manufacturing	18	418	\$19,499,485
In-vitro diagnostic substance manufacturing	7	161	\$10,515,377
Other biological manufacturing	7	170	\$6,973,847
Sector Total	38	799	\$39,047,510
Medical Devices and Equipment			
Electromedical & laboratory equipment manufacturing	31	1,671	\$135,391,590
Surgical, dental, and ophthalmic goods manufacturing	91	2,779	\$129,230,323
Dental labs	164	921	\$31,252,479
Sector Total	286	5,371	\$295,874,392
Research, Testing and Medical Laboratories			
Testing laboratories	34	435	\$16,640,467
Physical, engineering, and biological research	101	920	\$62,234,339
Medical laboratories	70	1,514	\$81,462,149
Diagnostic imaging centers	54	672	\$38,694,921
Sector Total	259	3,541	\$199,031,876
Total Private Bioscience	615	10,218	\$561,652,226

Source: ECONorthwest calculations using Oregon Employment Department ES202 data.

By all economic measures, the private bioscience industry in Oregon grew between 2002 and 2007. Table 7 provides establishment, employment and payroll information for the four main components of Oregon's private bioscience industry in 2002 and 2007.

Table 7: Oregon's Bioscience Industry in 2002 and 2007 (in current dollars)

Year / Subsector	Number of Establishments	Number of Jobs	Total Payroll	Average Annual Income
2002				
Agricultural Feedstocks and Chemicals	20	329	\$13,154,306	\$39,952
Drugs and Pharmaceuticals	34	752	\$26,770,114	\$35,610
Medical Devices and Equipment	275	4,188	\$169,437,652	\$40,461
Research, Testing and Medical Laboratories	167	2,728	\$130,659,674	\$47,896
Total All	496	7,997	\$340,021,746	\$42,520
2007				
Agricultural Feedstocks and Chemicals	32	507	\$27,698,448	\$54,659
Drugs and Pharmaceuticals	38	799	\$39,047,510	\$48,870
Medical Devices and Equipment	286	5,371	\$295,874,392	\$55,091
Research, Testing and Medical Laboratories	259	3,541	\$199,031,876	\$56,206
Total All	615	10,218	\$561,652,226	\$54,970
Change				
Agricultural Feedstocks and Chemicals	12	178	\$14,544,142	\$14,707
Drugs and Pharmaceuticals	4	47	\$12,277,396	\$13,260
Medical Devices and Equipment	11	1,183	\$126,436,740	\$14,630
Research, Testing and Medical Laboratories	92	813	\$68,372,202	\$8,311
Total All	119	2,221	\$221,630,480	\$12,449
Percent Change				
Agricultural Feedstocks and Chemicals	60%	54%	111%	37%
Drugs and Pharmaceuticals	12%	6%	46%	37%
Medical Devices and Equipment	4%	28%	75%	36%
Research, Testing and Medical Laboratories	55%	30%	52%	17%
Total All	24%	28%	65%	29%

Source: ECONorthwest calculations using Oregon Employment Department ES202 data.

The number of private bioscience establishments increased by 24 percent between 2002 and 2007. Employment increased by 2,221 jobs or by 28 percent, and wages increased by 65 percent over the 2002–2007 time period. With wages increasing faster than employment, the average annual wage in the private bioscience industry also increased. Between 2002 and 2007, average annual wages in the private bioscience industry increased 29 percent.

As shown in Table 7, all four sectors of the private bioscience industry experienced growth between 2002 and 2007.

- **Agricultural feedstocks and chemicals.** The smallest sector of Oregon's bioscience industry added 178 jobs between 2002 and 2007. Much of this growth is attributed to the growth in Oregon's ethanol producing sector. Given its relatively small size, these additional jobs represented the largest percent change of all four bioscience sectors.
- **Drugs and pharmaceuticals.** Growth in employment and payroll was positive but also the smallest, in both absolute and percentage terms, of all four bioscience sectors.
- **Medical devices and equipment.** This is the largest of the four bioscience sectors. Between 2002 and 2007, it added almost 1,200 jobs (+28 percent) and over \$126.4 million in income (+75 percent). Average annual incomes in this sector increased by 36 percent between 2002 and 2007.

- **Research, testing, and medical laboratories.** The number of establishments in this sector increased by 55 percent (a net gain of 92 establishments) between 2002 and 2007. Employment and payrolls also increased by 30 percent and 53 percent, respectively, during this time period.

As the preceding discussion indicates, all four sectors of Oregon’s bioscience industry exhibited positive growth over the five-year analysis time period.⁹ Table 8 provides additional sectoral details for changes in employment between 2002 and 2007. (Some sectors have been aggregated to comply with Oregon Employment Department reporting requirements for ES202 data.)

Table 8: Employment Levels and Changes, 2002 to 2007

Sector	2002	2007	Change	Percent Change
Agriculture Feedstock and Chemical	329	507	178	54.0%
Drugs and Pharmaceuticals				
Medicinal and botanical manufacturing	64	50	-14	-21.9%
Pharmaceutical preparation manufacturing	337	418	81	24.1%
In-vitro diagnostic substance manufacturing	242	161	-81	-33.4%
Other biological manufacturing	109	170	61	56.0%
Sector Total	752	799	47	6.3%
Medical Devices and Equipment				
Electromedical & laboratory equipment manufacturing	1,216	1,671	455	37.4%
Surgical, dental, and ophthalmic goods manufacturing	2,135	2,779	643	30.1%
Dental labs	836	921	84	10.1%
Sector Total	4,188	5,371	1,183	28.2%
Research, Testing and Medical Laboratories				
Testing laboratories	253	435	182	71.8%
Physical, engineering, and biological research	642	920	277	43.2%
Medical laboratories	1,347	1,514	167	12.4%
Diagnostic imaging centers	486	672	186	38.2%
Sector Total	2,728	3,541	813	29.8%
Total Private Bioscience	7,997	10,218	2,221	27.8%

Source: ECONorthwest calculations using Oregon Employment Department ES202 data.

Table 9 compares changes in employment and payroll in the private bioscience industry to total covered employment in Oregon between 2002 and 2007. Between 2002 and 2007, ES202 data shows that employment in the private bioscience industry increased by almost 28 percent. Oregon covered employment increased by 9.9 percent over that same time period. Thus, over the five year time period covered in this analysis, employment growth in the bioscience industry was nearly three times greater than for the state as a whole.

⁹ In addition to the employment growth shown in the ES202 data, empirical evidence suggests that the healthcare industry—including firms engaged in bioscience related activities—are relatively more immune to economic fluctuations than other industry sectors such as the high-tech sector. Indeed, the Dallas Federal Reserve Bank found that Houston’s large healthcare presence helped the city avoid the economic downturn that hit other Texas cities in 2001 and 2002. See *Southwest Economy*, Issue 3, May/June 2005, <http://www.dallasfed.org/research/swe/2005/swe0503a.html>

Table 9: Economic Growth in the Bioscience Industry and the State, 2002 and 2007 (millions of current dollars)

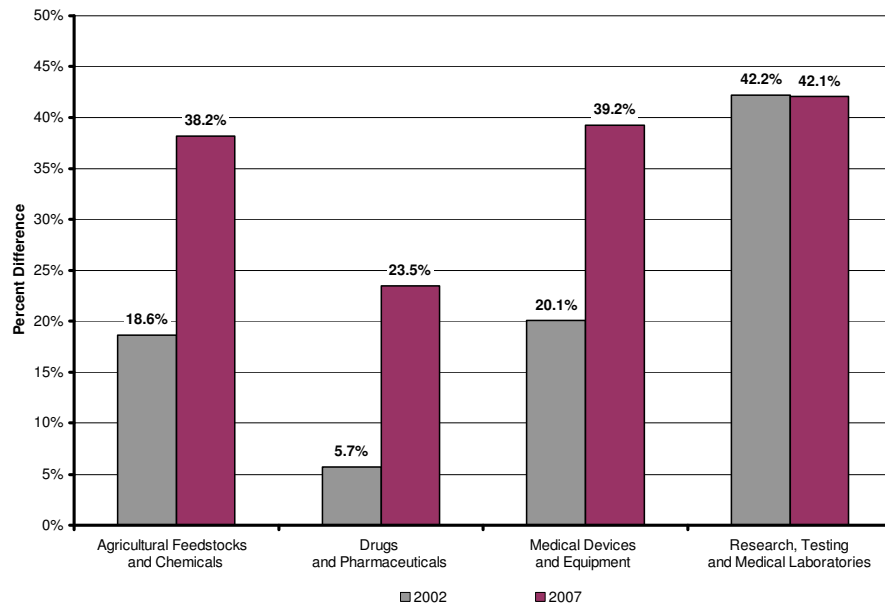
Statistic	2002	2007	Percent Change
Employment			
Bioscience industry	7,997	10,218	27.8%
Oregon covered employment	1,573,083	1,728,358	9.9%
Payroll (\$ millions)			
Bioscience industry	\$340.02	\$561.65	65.2%
Oregon covered employment	\$52,988.71	\$68,380.40	29.0%
Average Annual Incomes and Prices			
Bioscience industry	\$42,520	\$54,970	29.3%
Oregon covered employment	\$33,685	\$39,564	17.5%
US Consumer Price Index	179.9	207.3	15.2%

Sources: Oregon covered employment and payrolls from Oregon Employment Department, Oregon Labor Market Information Systems (OLMIS). US Consumer Price Index from US Department of Labor, Bureau of Labor Statistics, US City Average, All Urban Consumers, All Items, 1982-1984 indexed to 100.

Perhaps even more significantly, wages in the bioscience industry increased dramatically between 2002 and 2007. According to ES202 data, total payroll in the private bioscience industry increased by 65.2 percent between 2002 and 2007. With payroll increasing faster than employment, average annual wages in the private bioscience industry grew between 2002 and 2007. Indeed, over that time period, average annual wages increased by over 29 percent. This growth in average annual wages is 70 percent greater than the growth in average annual wages in Oregon and almost twice as much as the increase in the average price level of goods and services (inflation) during that time period.

Figure 1 compares average annual wages in each of the four major private bioscience sectors to the state as a whole in both 2002 and 2007. Across all sectors, average annual wages are greater than the state average. In 2002, the difference in average wages ranged from 5.7 percent greater in drugs and pharmaceuticals to 42.2 percent greater in research, testing and medical laboratories.

Figure 1: A Comparison of Average Annual Wages in the Private Bioscience Industry and the State of Oregon, 2002 and 2007



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

Between 2002 and 2007, wages in research, testing, and medical laboratories still showed the greatest discrepancy, but the smallest overall change. Average annual wages in the other three bioscience sectors increased considerably more than the state average annual wage over that time period. Importantly, as shown in Figure 1, the average annual wage in the medical devices and equipment sector was 20.1 percent greater than the state average in 2002 and 39.2 percent greater in 2007. With 5,400 jobs, this sector is the largest employer in the bioscience industry.

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 years 2002 and 2007. These results are shown in Table 10.

Table 10: Life Science Research in Oregon, 2002 and 2007 (millions of current dollars)

Item	FY2002	FY2007	Change	Percent Change
Spending	\$340.35	\$458.91	\$118.56	34.8%
Personal Income	\$145.55	\$237.80	\$92.26	63.4%
Jobs (FTE)	2,631	3,418	788	29.9%

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

In FY2002, life science research activity in Oregon directly generated approximately \$340.4 million in spending, including an estimated \$145.6 million in personal income and 2,631 jobs (FTEs). In FY2007, life science research activity in Oregon directly generated approximately \$458.9 million in spending. Just over one-half of this spending went towards payroll. In FY2007, life science research directly generated over \$237.8 million in personal income and 3,418 FTEs.

Recent growth in the life science research sector strongly mirrored growth in private bioscience industries, and both significantly outpaced the Oregon economy as a whole. Between 2002 and 2007, the employment and income in the life science industry increased by 29.9 percent and 63.4 percent, respectively. (This compares to the 27.8 percent increase in employment and 65.2 percent increase in personal income in private bioscience industries as a whole.)

Table 11 provides summary information for both major components of the bioscience industry in 2002 and 2007. In 2002, employment in Oregon's bioscience industry was approximately 10,630 jobs. By 2007, this had increased to over 13,630 jobs, or by 3,000 jobs. To put this into context, in 2002, the bioscience industry accounted for 0.676 percent of total statewide covered employment. In 2007, the relative direct employment in the bioscience industry increased by 17 percent and accounted for approximately 0.789 percent of total statewide covered employment.

Table 11: Major Components of Oregon's Bioscience Industry, 2002 and 2007 (millions of current dollars)

Major Industry Component / Economic Measure	2002	2007	Change	Percent Change
Private Industry				
Output	\$1,414.05	\$3,035.57	\$1,621.52	114.7%
Personal Income	\$340.02	\$561.65	\$221.63	65.2%
Employment	7,997	10,218	2,221	27.8%
Life Science Research				
Expenditure	\$340.35	\$458.91	\$118.56	34.8%
Personal Income	\$145.55	\$237.80	\$92.26	63.4%
Employment	2,631	3,418	788	29.9%
Combined				
Output / Expenditure	\$1,754.40	\$3,494.48	\$1,740.07	99.2%
Personal Income	\$485.57	\$799.46	\$313.89	64.6%
Employment	10,627	13,636	3,009	28.3%

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.

There are bioscience companies that may not be captured by ES202 data or be included in the information provided by life science research institutions. These include, for example, the self-employed and proprietors. In addition, there may be companies whose primary NAICS code doesn't fall within the Battelle definition of the industry, but who conduct bioscience-related activities as a secondary business pursuit.

OBA conducted a survey of their industry in the fall of 2008.¹⁰ Although a comprehensive review of the OBA survey methodology and findings is beyond the scope of this study, ECONorthwest did evaluate the survey results for a non-random sample of NAICS codes. This review showed that OBA survey data did include some bioscience firms that were not included in the ES202 data. However, in order to provide the most consistent (and conservative) measure of the bioscience industry across the two time periods, ECONorthwest did not include OBA survey data.¹¹

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 at 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;
- 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 2007. 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.

¹⁰ ECONorthwest did not participate in this survey, but reviewed OBA survey results. According to OBA, they combined their membership data and publicly available data from the Oregon Labor Market Information System (OLMIS) website to develop a list of companies in 2008. OBA then reviewed the OLMIS data for consistency with their own, with particular attention paid to the NAICS code attached to each company. In some cases, where OBA and OLMIS NAICS codes did not match, OBA followed up by researching and/or contacting individual companies.

¹¹ It's important to emphasize that ECONorthwest did not independently review the OBA survey methodology or conduct a comprehensive review of their findings. Moreover, the OBA survey was conducted in the fall of 2008 and is, therefore, not directly comparable to the ES202 data provided for the 2007 calendar year.

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 model, modified specially for this application.¹² 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.)
- **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.

¹² 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.

- **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.
- **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.
- **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.

Analysis Results

Private Bioscience Industry

In the previous section, ECONorthwest used ES202 data and data provided by life science research institutions to describe the economic dimensions of the bioscience industry. These measures of output or expenditures, and employment and personal income are called direct impacts. The direct impacts of the private bioscience industry are shown in Table 12, below.

Table 12: Private Bioscience Industry Direct Contributions to the Oregon Economy, 2007 (current dollars)

Sector	Number of Establishments	Employment	Payroll
Agriculture Feedstock and Chemical Drugs and Pharmaceuticals	32	507	\$27,698,448
Medicinal and botanical manufacturing	6	50	\$2,058,801
Pharmaceutical preparation manufacturing	18	418	\$19,499,485
In-vitro diagnostic substance manufacturing	7	161	\$10,515,377
Other biological manufacturing	7	170	\$6,973,847
Sector Total	38	799	\$39,047,510
Medical Devices and Equipment			
Electromedical & laboratory equipment manufacturing	31	1,671	\$135,391,590
Surgical, dental, and ophthalmic goods manufacturing	91	2,779	\$129,230,323
Dental labs	164	921	\$31,252,479
Sector Total	286	5,371	\$295,874,392
Research, Testing and Medical Laboratories			
Testing laboratories	34	435	\$16,640,467
Physical, engineering, and biological research	101	920	\$62,234,339
Medical laboratories	70	1,514	\$81,462,149
Diagnostic imaging centers	54	672	\$38,694,921
Sector Total	259	3,541	\$199,031,876
Total Private Bioscience	615	10,218	\$561,652,226

Sources: ECONorthwest using Oregon Employment Department ES202 data

ES202 data shows that the private bioscience industry, in aggregate, directly generated almost 10,218 jobs and \$561.7 million in wages in 2007. ECONorthwest used the detailed employment and payroll data, as shown in Table 12, as the inputs into an input-output model of the Oregon economy. This model will allow us to estimate the ripple effects or impacts associated with the bioscience industry.

Table 13 reports the economic contributions of the private bioscience industry in 2007. 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 2007, the private bioscience industry directly contributed \$3.0 billion in output, including \$561.7 million in personal income, \$240.1 million in other income, and \$13.9 million in indirect business taxes for federal, state, and local taxing jurisdictions.

Table 13: Private Bioscience Industry Economic Contributions to the Oregon Economy in 2007 (millions of current dollars)

Type of Impact	Direct	Indirect	Induced	Total
Output	\$3,035.57	\$1,452.48	\$939.39	\$5,427.44
Total Value Added	\$815.64	\$710.17	\$551.23	\$2,077.03
¥ Personal Income	\$561.65	\$462.89	\$384.74	\$1,409.28
¥ Other Income	\$240.10	\$189.46	\$121.13	\$550.69
¥ Indirect Business Taxes	\$13.88	\$57.82	\$45.36	\$117.07
Total State and Local Taxes				\$202.44
Jobs	10,218	9,663	10,121	30,002

Source: ECONorthwest

The third column of Table 13 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 economic sectors.¹³ In total, the indirect impacts of the bioscience industry in 2007 are significant and are associated with \$1.5 billion in economic activity and over 9,660 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).

Table 14 provides additional context for the indirect job impacts associated with the private bioscience industry. Industry sectors are ranked by job impacts in descending order for the top twenty industry sectors. Non-payroll spending by the private bioscience industry on goods and services benefits a wide range of industry sectors, including wholesale trade (+1,074 jobs), business support services, (+753 jobs), and employment services (+698 jobs).

¹³ Spending on out-of-state suppliers is not counted and has no impact on Oregon.

Table 14: Indirect Job Impacts, Ranked in Descending Order, 2007

Rank	IMPLAN Sector Description	Jobs
1.	Wholesale trade	1,074
2.	Business support services	753
3.	Employment services	698
4.	Management of companies and enterprises	596
5.	Real estate	416
6.	Legal services	356
7.	Architectural and engineering services	284
8.	Food services and drinking places	263
9.	Accounting and bookkeeping services	243
10.	Truck transportation	232
11.	Services to buildings and dwellings	230
12.	Warehousing and storage	228
13.	Scientific research and development services	227
14.	Financial institutions	221
15.	Hotels and motels	216
16.	Oil and natural gas	170
17.	Advertising and related services	168
18.	Maintenance and repair of nonresidential buildings	117
19.	Couriers and messengers	115
20.	Plastics manufacturing	114

Source: ECONorthwest using IMPLAN

The induced impacts of the bioscience industry are reported in the fourth column of Table 13. 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 2007 were approximately \$55,000 (or 39 percent above the statewide average).

In 2007, the induced impacts attributed to the bioscience industry totaled approximately \$939.4 million in economic activity, including \$384.7 million in personal income, \$121.1 million in profits, rents, and other income, and 10,120 jobs.

The indirect and induced impacts associated with the private bioscience industry in 2007 were considerable, providing strong evidence that the bioscience industry has extensive linkages to other sectors of the Oregon economy. (This will be discussed in greater detail elsewhere in this report.) In total, the economic contributions of the bioscience industry to Oregon's economy consisted of \$5.5 billion in output, including \$1.4 billion in personal income, \$550.7 million in other income, \$202.4 million in state and local tax revenues, and just over 30,000 jobs. These employment impacts represent approximately 1.74 percent of total covered employment in the state in 2007.

Activity directly attributed to the private bioscience industry will generate additional economic activity in other sectors of the Oregon economy. Table 15 shows the total economic impacts by, major industry sector, in Oregon.

Table 15: Private Bioscience Industry's Economic Contributions in Oregon, by Industry Sector, 2007

Aggregate Industry Sector	Output	Personal Income	Other Income	Total Value Added	Jobs
Agriculture, forestry, fishing and hunting	\$13.19	\$3.96	\$1.47	\$5.62	215
Mining	69.54	5.68	6.97	13.98	197
Utilities	38.51	7.34	12.39	23.88	54
Construction	22.49	9.21	0.39	9.77	186
Manufacturing	2,880.46	423.89	217.15	653.36	7,769
Wholesale trade	261.07	98.88	38.61	176.06	1,399
Retail trade	100.95	45.79	11.01	58.48	958
Transportation and warehousing	132.42	53.54	15.63	87.42	1,937
Information services	94.53	21.87	13.39	38.31	425
Finance and insurance	143.78	45.11	30.61	79.27	791
Real estate and rental and leasing	154.65	23.18	57.44	95.58	881
Professional and technical services	405.24	180.93	14.58	198.31	3,392
Management of companies and enterprises	127.47	57.09	15.33	73.57	654
Administrative and waste services	119.47	59.47	11.33	72.79	2,299
Educational services	19.01	9.06	0.60	9.78	418
Health care and social assistance	554.86	208.45	68.73	281.49	4,092
Arts, entertainment, and recreation	19.03	7.40	1.79	10.26	482
Accommodation and food services	84.11	28.76	9.85	43.77	1,497
Other services, except public administration	55.98	22.56	4.76	29.48	947
Government and unclassified sectors	130.68	88.52	18.67	107.22	1,409
Total All Industry Sectors	\$5,427.44	\$1,400.67	\$550.69	\$2,068.42	30,002

Note: Total value added equals the sum of personal income, other income, and indirect business taxes (not shown in this table)

Source: ECONorthwest using IMPLAN

Economists often calculate “multipliers” to measure the overall impact with which activity in one sector influences or affects jobs and incomes in other sectors. Larger multipliers suggest greater linkages to the rest of the economy.

Table 16 shows Type SAM multipliers for output, personal income, and employment for private bioscience’s four major sectors and for the industry as a whole.¹⁴ The multipliers provide a mathematical shortcut for understanding the full contribution of the bioscience industry. For instance, the bioscience industry employed approximately 10,200 workers in 2007. Economic activity attributed to the industry generated a total employment impact of slightly over 30,000 jobs. Thus, the bioscience industry job multiplier is 2.94 (*30,000 divided by 10,200*). In other words, every 10 jobs in the private bioscience industry are linked to another 19.4 jobs in other sectors of the economy.

¹⁴ Multipliers can be measured across all impact categories. 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.

Table 16: Impact Multipliers for the Private Bioscience Industry, 2007

Type of Impact / Multiplier	Agricultural Feedstocks and Chemicals	Drugs and Pharm.	Medical Devices and Equipment	Research, Testing and Medical Laboratories	All Bioscience
Direct Output	\$489.3	\$624.3	\$1,391.0	\$530.9	\$3,035.6
Total Output	\$783.6	\$1,075.5	\$2,600.0	\$968.4	\$5,427.4
Multiplier	1.60	1.72	1.87	1.82	1.79
Direct Personal Income	\$27.7	\$39.0	\$295.9	\$199.0	\$561.7
Total Personal Income	\$100.9	\$176.0	\$686.5	\$344.4	\$1,307.9
Multiplier	3.64	4.51	2.32	1.73	2.33
Direct Jobs	507	799	5,371	3,541	10,218
Total Jobs	2,458	4,167	15,488	7,889	30,002
Multiplier	4.85	5.22	2.88	2.23	2.94

Source: ECONorthwest using Oregon Employment Department ES202 data and IMPLAN.

The economic activity linked to the bioscience industry generated substantial tax revenues for Oregon and its local governments in 2007. Table 17 shows the bioscience industry's fiscal impacts for state and local taxing jurisdiction. In 2007, economic activity associated with the private bioscience industry generated approximately \$202.4 million in revenues for state and local taxing jurisdictions. The largest revenue sources are property taxes (\$70.7 million or 34.9 percent of total tax revenues) and personal income taxes (\$57.1 million or 28.2 percent of total tax revenues).

Table 17: Private Bioscience Industry's Fiscal Impact on State and Local Government Revenues in 2007 (millions of current dollars)

Type of Tax	Revenues	Percent of Total
Profits and dividends taxes	\$31.50	15.6%
Property taxes	\$70.68	34.9%
Personal income taxes	\$57.06	28.2%
Social insurance taxes	\$0.57	0.3%
Other taxes	\$18.33	9.1%
Fines, fees and other non-taxes	\$24.30	12.0%
Total state and local taxes	\$202.44	100.0%

Source: ECONorthwest using IMPLAN

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. In addition, it allows the analyst the flexibility to adjust each spending component for known relationships that exist in the immediate impact area, e.g., whether a particular purchase was made from a local or non-local provider. 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 2007 are shown in Table 18.

Table 18: Economic Contributions of Life Science Research in 2007 (millions of current dollars)

Type of Impact	Direct	Indirect	Induced	Total
Output	\$458.91	\$155.14	\$202.41	\$816.46
Total Value Added	\$237.80	\$89.98	\$108.58	\$484.42
¥ Personal Income	\$237.80	\$66.18	\$73.08	\$377.06
¥ Other Income	NA	\$18.37	\$25.96	\$44.33
¥ Indirect Business Taxes	NA	\$5.43	\$9.55	\$14.98
Total State and Local Taxes				\$48.06
Jobs	3,418	1,610	2,021	7,049

Source: ECONorthwest using IMPLAN

The direct output, personal income, and employment were provided by life cycle research institutions and are shown in the first column in Table 18. (Because of the way impacts were measured, it is not possible to estimate the direct impacts on other income and indirect business taxes.)

In total, in FY2007, life science research contributed approximately \$816.5 million in output, including \$377.1 million in personal income, \$44.3 million in other income, and approximately 7,050 jobs (FTEs). In addition, the economic activity associated with life science research generated approximately \$48.1 million in tax revenues for state and local taxing jurisdictions. More detail regarding these fiscal impacts are shown in Table 19, below.

Table 19: Fiscal Impacts of Life Science Research in 2007 (millions of current dollars)

Type of Tax	Revenues	Percent of Total
Profits and dividends taxes	\$4.80	10.0%
Property taxes	\$13.62	28.3%
Personal income taxes	\$21.56	44.8%
Social insurance taxes	\$0.11	0.2%
Other taxes	\$3.50	7.3%
Fines, fees and other non-taxes	\$4.48	9.3%
Total state and local taxes	\$48.06	100.0%

Source: ECONorthwest using IMPLAN

Combined Bioscience Industry Impacts

The direct, indirect, and induced economic impacts associated with the combined bioscience industry (private industry and life science research) are shown in Table 20.

Table 20: Economic Contributions of the Bioscience Industry (millions of current dollars)

Type of Impact	Direct	Indirect	Induced	Total
Output	\$3,494.48	\$1,607.62	\$1,141.80	\$6,243.90
Total Value Added	\$1,053.44	\$800.14	\$659.81	\$2,513.39
¥ Personal Income	\$799.46	\$529.06	\$457.81	\$1,786.33
¥ Other Income	\$240.10	\$207.83	\$147.09	\$595.02
¥ Indirect Business Taxes	\$13.88	\$63.24	\$54.91	\$132.04
Total State and Local Taxes				\$250.50
Jobs	13,636	11,273	12,142	37,051

Source: ECONorthwest using IMPLAN

The total economic contributions of the bioscience industry are shown for the private bioscience industry and life science research in Table 21. Using our economic impact model of Oregon, ECONorthwest estimates that spending by the bioscience industry and its employees is associated with approximately \$6.2 billion in output, almost \$1.8 billion in personal income, and 37,050 jobs in Oregon in 2007. These larger multiplier effects occur as economic activity directly attributed to the bioscience industry “ripples” throughout the Oregon economy.

Table 21: Economic Contributions of the Bioscience Industry in 2007, (millions of current dollars)

Type of Impact	Private Bioscience	Life Science Research	Total Bioscience
Output	\$5,427.44	\$816.46	\$6,243.90
Total Value Added	\$2,077.03	\$436.36	\$2,513.39
¥ Personal Income	\$1,409.28	\$377.06	\$1,786.33
¥ Other Income	\$550.69	\$44.33	\$595.02
¥ Indirect Business Taxes	\$117.07	\$14.98	\$132.04
Total State and Local Taxes	\$202.44	\$48.06	\$250.50
Jobs	30,002	7,049	37,051

Source: ECONorthwest using IMPLAN

In 2007, the bioscience industry in Oregon directly or indirectly generated approximately \$250.5 million in state and local tax revenues. According to the economic impact model, the largest sources of tax revenues are personal income taxes (31.4 percent) and property taxes (33.7 percent) paid primarily by businesses. These fiscal impacts are reported in Table 22 below.

Table 22: Fiscal Impacts of the Bioscience Industry in 2007, (millions of current dollars)

Type of Tax	Private Bioscience	Life Science Research	Total Bioscience Industry	Percent of Total
Profits and dividends taxes	\$31.50	\$4.80	\$36.30	14.5%
Property taxes	\$70.68	\$13.62	\$84.30	33.7%
Personal income taxes	\$57.06	\$21.56	\$78.61	31.4%
Social insurance taxes	\$0.57	\$0.11	\$0.68	0.3%
Other taxes	\$18.33	\$3.50	\$21.83	8.7%
Fines, fees and other non-taxes	\$24.30	\$4.48	\$28.78	11.5%
Total state and local taxes	\$202.44	\$48.06	\$250.50	100.0%

Source: ECONorthwest using IMPLAN