Washington Research Council

Economic Profile

November, 2011

Trends in Washington's Life Sciences Industry 2007–2011

Although Washington and the nation are still in the midst of a deep recession, a relatively bright spot has been the life sciences. Indeed, the life sciences have been a rapidly growing part of the world economy as major scientific advances in the past few decades have opened the promise of substantial improvements in health, agriculture, energy and the overall quality of life. These advances have provided cures for diseases and mitigations of a wide range of disabilities common in the industrialized world. They also hold the promise of alleviating widespread suffering and death in developing countries where infectious diseases and poor health infrastructure are common. Agricultural advances have improved crop yields and created promising new sources of renewable energy.

A 2010 report from Battelle notes that nationally "the bioscience industry, while impacted by the recession, was not as negatively affected as many other industry sectors and appears to be rebounding more quickly." A 2011 report from Ernst & Young confirms this generally for biotechnology: "Despite the global economy being mired in a historic recession, the industry's revenue growth held up well" in 2009. Then, in 2010, "the industry … turned the corner" with research and development expenditures growing by 2 percent across the established biotech centers, compared with the 29 percent drop in 2009.

In Washington, the number of life science jobs has grown significantly since 2008, while employment for the overall state economy remains well below pre-recession levels. Important scientific discoveries are being made here by both start-up and established companies that are turning their innovations into useful products and services. The state's research universities and not-for-profit institutions contribute immensely to the scientific exploration and innovation taking place in the field. And in a short period of time, the state has become a major center for global health, leading efforts to eradicate disease and improve the lives of billions of people.

All of this activity, which has been growing quietly for decades, adds up to an important part of the state's economy. But because it involves a diffuse group of organizations without clearly demarcated markets, it is difficult to distinguish. Although the life sciences may not meet the exact definition of a "cluster," this group of enterprises and institutions certainly contains many of the characteristics of a self-sustaining activity around which economic development strategies can be built.

This industry is important not only because of its size, but also because of its potential for growth. As societies become wealthier they consume healthcare services at higher rates, and science and technology keep providing new products and services that have value to consumers. The new emphasis on global health increases the need for products and services aimed at developing countries.

Measuring the life sciences industry is a challenge. Activities in the life sciences cut across various industry and employment classifications, making it difficult to quantify the industry. Therefore, this update to our 2009 study will use a combination of quantitative methods to indicate the economic impact of the life sciences, and qualitative descriptions to show the ways in which these industries

shape the economy now and how they will grow in the future.

The Life Sciences Industry and Washington's Economy

The life sciences industry forms an important and growing segment of Washington's economic base—that is, enterprises that bring in money from out of state and export value to the rest of the nation and the world. The earnings of the economic base are what allow Washingtonians to import consumer products, such as cars or clothing, that are made elsewhere. Dollars earned by those working in industries that make up the economic base circulate within the state to create jobs in retail, construction and other local services.

The analysis in this report estimates that the various segments of the life sciences industry directly employ over 33,500 people in the state, about two-thirds as many people as are employed in the software industry. Those life science jobs support 57,000 additional jobs throughout the state's economy, so that the total employment impact is nearly 91,000.

But unlike software, or other familiar industries such as food products or tourism, life sciences is not an easy industry to grasp in the mind's eye.

When we think of a sector of the economic base, we typically think of indus-

Life Sciences Profile: Seattle Genetics, Inc.

Location:	Bothell
Year Founded:	1998
Structure:	Public corporation
Employees:	~500
Annual Volume:	2009: $52 million; 2010: $107 million

Business: Seattle Genetics is a biotechnology company focused on the development and commercialization of monoclonal antibody-based therapies for cancer.

In August 2011, Seattle Genetics' first commercial product, ADCETRIS™ (brentuximab vedotin) (formerly called SGN-35), was approved by the Food and Drug Administration for the treatment of relapsed Hodgkin lymphoma and systemic anaplastic large cell lymphoma. ADCETRIS is an antibody-drug conjugate (ADC) targeting the CD30 antigen, which is expressed on multiple types of lymphoma as well as other hematologic malignancies and solid tumors.

The company is jointly developing ADCETRIS with Millennium: The Takeda Oncology Company under an agreement where Seattle Genetics has full commercialization rights in the United States and Canada, while Millennium has commercialization rights in all other countries.

In addition to ADCETRIS, Seattle Genetics is advancing three other clinical-stage ADC programs for the treatment of cancer. The firm also has collaborations with a number of biotechnology and pharmaceutical companies under which it licenses its proprietary ADC technology.

Seattle Genetics has a long-term strategy of leveraging its ADC technology through both internal product development and collaborations to continue to build its pipeline. This is a capital intensive business: In 2010, the firm spent $146 million on research and development and another $29 million on operations.

Growth Potential: Key to the firm's strategy is to execute on a successful launch of ADCETRIS and to conduct additional clinical trials with ADCETRIS in other CD30-positive malignancies in order to expand the potential of the drug. Seattle Genetics looks to maintain an active clinical and preclinical pipeline, and invests in research to continually look for new products and technologies that can feed into the pipeline for future clinical trials.

tries that are dominated by the private sector, such as aerospace or software, or those completely public sector, such as the military. Life sciences comprises private sector companies, not-for-profit research organizations, and public universities and laboratories. The work of the life sciences can move fluidly among these organizations. For example, a federally-funded discovery in a university laboratory may move to a not-for-profit laboratory for further refinement and then on to a private firm for commercialization.

Making things even more complicated is that key personnel also move fluidly among the institutions. Researchers may be on the faculty at a university, hold a fellowship at a research institute, and also have a stake in a for-profit firm. Individuals can shift among these sectors as new opportunities arise.

Perhaps the best way to view the life sciences is to think of it mostly as the creation of knowledge and intellectual property. While the state does have employment in the production of products and services provided directly to the healthcare, agriculture or energy industries, the bulk of the output of the life science industry in the state is scientific discovery and the translation of discovery into the design and engineering of useful products. This means that the most important policy direction for enhancing the industry in the state is one

Life Sciences Profile: Novo Nordisk

Name:	Novo Nordisk
Location:	Research Center in Seattle
Year Founded:	Novo in 1924, Nordisk in 1923, the two merged in 1989
Structure:	Public corporation
Employees:	71 in Washington; 31,400 worldwide
Annual Sales:	2009: $9.8 billion; 2010: $10.8 billion

Business: Novo Nordisk is a health care company with market leadership in diabetes, hemophilia, growth disorders, and hormone therapy. The company created innovative insulin delivery systems and disposable needles, and developed novel insulin and insulin analog formulations.

In 2009, Novo Nordisk opened its Inflammation Research Center in Seattle, with the goal of adding to the company's clinical pipeline of products for the treatment of chronic inflammatory diseases.

Novo Nordisk is working, in Seattle, to develop novel immunotherapies that will significantly improve the lives of people with autoimmune and chronic inflammatory diseases such as rheumatoid arthritis, lupus, inflammatory bowel disease, and psoriatic arthritis.

Growth potential: Novo Nordisk currently has a number of innovative monoclonal antibody projects in clinical development within autoimmune and inflammatory diseases. The Anti-NKG2D (a monoclonal antibody for treatment of Crohn's Disease), Anti-NKG2D (a monoclonal antibody for treatment of rheumatoid arthritis), and Anti-IL2O (a monoclonal antibody that neutralizes the interleukin 20 protein) are in Phase 2 of the pipeline. Anti-C5aR, Anti-IL21, and Anti-NKG2A (monoclonal antibodies for treatment of rheumatoid arthritis) are in Phase 1.

In just three years, the Inflammation Research Center has grown from zero to over 70 world class research experts and established collaboration with several life sciences institutions in the region. The Research Center is expected to grow 20-25 percent annually to support inflammation research projects.

that promotes innovation, protects intellectual property, and enhances the ability of the industry to attract and retain its most important "capital" assets, its people and the tools they need to do their work.

On this last point, one thing is critical: size. Agglomeration economics suggests that the larger the pool of people doing similar work, the more productive those people will be. Concentrations of people lead to the sharing of ideas and perspectives, and maximize the likelihood that individuals will find the best place to use their talents. Furthermore, a large industry presence decreases risk for individuals by increasing the possibilities for employment should they need to leave their current job. For this reason, areas with larger industry concentrations tend to be more attractive places to pursue careers. We can think of the life sciences industry as increasing in quality and vitality exponentially with size. Thus, the discussion below about Washington's success along various metrics with respect to other states is not about bragging rights but about the viability of the industry.

Describing the Life Sciences Industry

Components of the life sciences industry can be categorized in many ways. The industry is described here in four categories, based roughly on the output or end use of the technologies being developed and sold. While there is some overlap among them, these groupings tend to be the ones within which organi-

Life Sciences Profile: CMC Biologics

Location:	Manufacturing facilities in Bothell and Copenhagen, Denmark
Year Founded:	2001
Structure:	Private Corporation
Employees:	180 Washington; 360 Worldwide
Annual Volume:	N/A

Business: CMC Biologics is a global biopharmaceutical contract manufacturing and development organization (CMO). The company provides full-service manufacturing—from DNA to active pharmaceutical ingredient (API)—and has extensive expertise in process, analytical, and formulation development. It tailors its team and approach to each of its client's needs, whether complete, turnkey manufacturing or specific, stand-alone services.

CMC Biologics is leading the CMO industry by utilizing single use technologies and offering large scale single use bioreactors for manufacturing. It offers multiple cGMP manufacturing lines for mammalian cells (up to 3,000L) and microbial fermentation (up to 1,500L). Processes can be developed for batch, fed-batch, and continuous operation for clinical or market supply.

CMC Biologics team is highly experienced in working with global regulatory agencies, including the U.S. Food and Drug Administration and the European Medicines Agency.

Growth potential: In September 2011, CMC Biologics unveiled a $10 million expansion of its Bothell cGMP manufacturing facility—doubling capacity and extending its capabilities to commercial scale quantities. The company also recently completed installation of a 2,000 liter single-use bioreactor, the largest of its kind in Europe, at its facility in Copenhagen.

The company plans to grow its employee base by up to 35 people in 2012, and targets further manufacturing facility expansion to meet the demands of a growing commercial biologics market.

zations collaborate and within which individuals move throughout their careers.

Biopharmaceuticals. This category of organization works to develop and sell drugs aimed at curing or mitigating a wide range of disorders, particularly those of concern in industrialized societies. Much of the research that forms the basis for these products begins in privately funded research facilities owned and operated by the biopharmaceutical industry, in university laboratories, or in organizations such as the Fred Hutchinson Cancer Research Center in Seattle. Individual for-profit firms, often labeled "biotechnology" companies, can begin with discoveries from universities or laboratories, or with their own proprietary discoveries. But whatever the origins and path of the technology, the final

Life Sciences Profile: Philips Healthcare

Location:	Bothell, WA
Year Founded:	Philips Healthcare acquired ATL Ultrasound in 1998 ATL Ultrasound was incorporated in 1973
Structure:	Philips Healthcare is a subsidiary of Royal Philips Electronics
Employees:	Royal Philips Electronics: 120,000 employees worldwide Philips Healthcare: 35,000 employees worldwide Philips Ultrasound: 1,755 employees in six locations (Headquarters Bothell) • Bothell, WA – 748 employees • Andover, MA – 362 employees • Bangalore, India – 80 employees • Reedsville, PA – 300 employees • Shanghai, China – 220 employees • Toronto, Canada – 45 employees
Annual Volume:	Philips Healthcare: EUR 8.6 billion in sales in 2010 Philips businesses in Washington State (includes: Ultrasound, Oral Healthcare, HeartStart, Philips Healthcare Shared Services, Sales and Service) generate $175 million in payroll.

Business: Philips Healthcare, based in Andover, Mass, acquired ATL Ultrasound in 1998. Philips Healthcare combines its unique clinical expertise with human insights to develop solutions that deliver value throughout the care cycle: from disease prevention to screening and diagnosis, through to treatment, monitoring and health management—wherever care is given: in the hospital or at home.

Philips Healthcare is divided into four key business areas: Imaging Systems, Home Healthcare Solutions, Patient Care and Clinical Informatics and Customer Service. The Ultrasound Business Unit is a division of Imaging Systems and is headquartered in Bothell. Ultrasound products are manufactured in Andover, Mass.; Bothell, Wash.; Reedsville, Penn.; and Shanghai, China. Six systems are produced in the Bothell facility including the iU22, iE33, HD11, HD15, HD9, and CX50 ultrasound systems. In addition to manufacturing and production, research and development, marketing and many administrative functions are based in Bothell. .

Growth Potential: Healthcare continues to be a growth industry globally. Ultrasound is a versatile and cost effective modality that is being adopted for increasingly diverse diagnostic and treatment applications.

goal is a biopharmaceutical product that gains Food and Drug Administration (FDA) approval and has a promising market share.

The challenge in the biopharmaceutical business is that capital requirements are extremely high, along with the risk of failure. Investors must put up huge amounts of cash to fund research and clinical trials, always aware that the promised breakthrough may never arrive or that the product may be rejected by regulators. When a firm does achieve success, the outcome is frequently sale of the successful product, or the entire firm, to a large pharmaceutical manufacturer that undertakes production, marketing and distribution.

Thus, although the state has seen its share of breakthroughs in biopharmaceuticals, it has not seen many large firms grow out of those. A pattern has emerged 30 years after the first biotech companies formed: the state's formidable talents and resources for research and development of biopharmaceuticals support a robust and valuable research industry, but the state's lack of competitiveness as a manufacturing location inhibits the growth of large production and distribution facilities. From an economic development perspective this is a

Life Sciences Profile: Cadwell Laboratories

Location:	Kennewick
Year Founded:	1979
Structure:	Private corporation
Employees:	125
Annual Volume:	N/A

Business: Cadwell is a leading developer, manufacturer and global marketer of neurodiagnostic and neuromonitoring instrumentation used by neurologists, physical medicine and rehabilitation physicians, pulmonologists and other physicians in the diagnosis of neurological, musculoskeletal and sleep disorders.

Patients who suffer from diseases such as epilepsy, carpal tunnel syndrome, sleep apnea and other related neurological, neuromuscular and sleep related disorders can be diagnosed using Cadwell devices. Cadwell's neuromonitoring instruments are used by skilled technologists in the operating room along with surgeons to closely monitor nerve and muscle function during spine and neurological surgeries.

The company is credited with the development of the first microprocessor controlled electromyography device in the industry in 1980. The company also developed the first commercially available high speed cortical magnetic stimulator and the first digital portable EEG device. The tradition of innovation continues today. The company holds numerous patients for magnetic stimulators, cable shielding designs, neural network analysis of EEG, QuickConnect Electrical Locking Systems, Pulse Oximetry, Digital Video Compression, Video Quantitative Measurement of Movement and database designs..

Growth Potential: As the patient population becomes more aware of and affected by neurological, neuromuscular and sleep disorders, the demand for sophisticated and innovative instrumentation and data acquisition and reading software is rapidly growing worldwide. Skilled and motivated designers and engineers are an integral part of seeing this growth potential through to help physicians achieve a higher level of patient care. Cadwell's product line currently includes 10 distinct models and configurations and is growing.

In October 2011, Cadwell Laboratories began an expansion of its facility—22,000 square feet will be added to the current 28,000 square feet. The company expects to add 20-30 new employees, most of which are involved in R&D to be housed in the new facility.

good-news, bad-news story. The good news is that the state continues to attract highly skilled researchers who are paid well and boost the state's average wages. The bad news is that manufacturing jobs do not follow.

Medical devices and technology. This sector produces hardware and accompanying software, as well as implanted devices, for use in medical diagnostics and treatment. This industry pre-dates the emergence of biopharmaceuticals in the state, with several firms growing out of technologies developed at the University of Washington in the 1970s. In particular, medical ultrasound was developed at the UW, and several firms have spun that technology out into large imaging companies.

The medical device and technology companies face many of the same capital and regulatory hurdles that the biopharmaceutical firms do, but approval times can be shorter, especially for diagnostic equipment. FDA approval for therapeutic and implanted devices, however, can be quite complicated and expensive. Manufacturing of medical devices is complex and costly, as these devices must meet exacting FDA standards.

There is continuing national and global consolidation in the medical device field, and medical device firms are frequently acquired once they become successful. If the acquiring firm's objective is simply intellectual property, an acquired firm may lose its presence in the state. But many firms have been acquired by large multi-nationals and kept their state presence. Manufacturing operations, however, can be vulnerable to outsourcing or inter-firm consolidation.

Global health. This collection of organizations cuts across both the biopharmaceutical and medical device categories, but also includes groups that address the management and delivery of health services. Global health efforts operate at several levels. First are efforts to develop new products to prevent and treat diseases that are common in developing countries but that have been given little attention by Western pharmaceutical companies. Second is to promote the distribution of existing medications and vaccines in areas that need them, with the goal that no one should die of a disease that we already know how to cure. Third concerns the development of healthcare infrastructure in developing countries.

As one might imagine, much of the activity in global health is carried out by universities and not-for-profit research institutions. Washington has seen a significant expansion in such organizations, and is thought by many to be second only to Geneva in its concentration of global health assets. But with the need to produce large quantities of healthcare products destined for developing countries, there are also private firms now targeting those markets. The scale of global health efforts, however, tends to favor large, established firms rather than small startups. With the leadership of the Gates Foundation, the World Health Organization and other agencies, the perception that there is no money to be made in global health is changing rapidly.

In a 2007 study, "Economic Impact Assessment of Global Health on Washington State's Economy," an interdisciplinary team at the University of Washington found that global health activities aimed at developing countries produced over $700 million in direct economic activity in the state in 2005. In 2010, Paul Allen gave WSU $26 million to support WSU's School for Global Animal Health. In 2011, the Washington Global Health Alliance and Seattle's Office of Economic Development released a "Global Health Strategic Mapping Portfolio." The portfolio documents Washington's expertise in infectious and chronic disease, as well as technology and device development. The 59 organizations responding to the global mapping survey reported 2,979 fulltime equivalent employees working in global health in the state.

Agriculture, energy and environment. The life sciences do not stop with medicine. The state has active research and industries in plant and animal sciences to improve agriculture, and, increasingly to develop sustainable biofuels. The

state's two research universities are heavily involved in these areas, as is the Pacific Northwest National Laboratory in Richland. In 2011, UW and WSU each received federal grants of $40 million to work on making cellulosic biomass (wood) into fuel.

The nation's first attempts to radically increase the use of biofuels—ethanol and bio-diesel—did not turn out well, due to the unsustainability of the stream of feedstocks. Researchers and entrepreneurs are in a race to find ways to create feedstocks that do not compete with food sources, do not use excessive resources, and do not, themselves, result in high output of carbon during production.

This is an intensely competitive business, with scientists and engineers around the world looking for ways to extract fuel from various plants and algae, and it is likely that only a few technologies will emerge as winners. So, unlike biomedical industries, where there are thousands of disorders in need of attention, there are just a handful of fuels that need renewable substitutes. The risks facing these businesses are high, but given the amount of fuel that needs to be created, the potential

Life Sciences Profile: PATH

Location:	Seattle
Year Founded:	1977
Structure:	501(c)(3) nonprofit organization
Employees:	430 in Washington; ~1,100 worldwide
Annual Volume:	2009: $257 million; 2010: $283 million

Services. PATH (Program for Appropriate Technology in Health) works with public- and private-sector partners to provide appropriate health technologies to developing countries. PATH describes its mission as being "to improve the health of people around the world by advancing technologies, strengthening systems, and encouraging healthy behaviors." Their work encompasses five areas: vaccines and immunization, emerging and epidemic diseases (e.g., AIDS, tuberculosis, and malaria), health technologies (for low-resource areas), reproductive health, and maternal and child health.

PATH's approach "moves solutions from innovation to impact: supporting new ideas through inception, development, and testing; paving the way for introduction in low-resource countries; and working with governments and communities to integrate and expand the most successful ideas."

Current projects include running the Meningitis Vaccine Project, along with the World Health Organization (WHO); developing infectious disease diagnostics (new test platforms that can be used in low-resource settings); and working to develop a malaria vaccine through the PATH Malaria Vaccine Initiative.

Growth Potential: Revenues have grown significantly, from $87.8 million in 2004 to $283.3 million in 2010. PATH is funded by foundations, governments, and individual donors. Additionally, according to PATH, "Partnerships with businesses are a critical and unique element of our approach," resulting in "private-sector resources applied for public good—and solutions that stand on their own, for the long haul."

One example is through the PATH Malaria Vaccine Initiative. A vaccine candidate being developed with GlaxoSmithKline Biologicals has shown some success: In October 2011, the first results from a large-scale Phase III trial of a malaria vaccine candidate showed that it reduced the risk of malaria in children aged 5 to 17 months by 56 percent for clinical malaria and 47 percent for severe malaria.

rewards are correspondingly high.

What about healthcare? The delivery of healthcare services—hospitals, clinics, doctors, laboratories—is not included in the definition of life sciences for purposes of this report (we do count research performed at some medical institutions in the state, as specifically delineated by those institutions). The reason for omitting healthcare itself is that the vast majority of healthcare services performed in the state are consumed by residents of the state, and therefore do not constitute part of the state's economic base. It is true that patients do come to Washington from other states and nations to receive specialized care, but those exported services are not measured in any systematic way.

Life Sciences Profile: Inland Northwest Health Systems

Location:	Spokane
Year Founded:	1994
Structure:	501(c)(3) non-profit corporation
Employees:	1,082
Annual Volume:	2009: $157 million; 2010: $168 million

Services: Formed when Spokane's hospitals decided to merge competing business lines, Inland Northwest Health Systems (INHS) oversees a variety of health care divisions and services that work together to improve outcomes, lead the way in health care innovation and create healthier communities. The idea is to reduce health care costs while increasing quality of care, through collaboration.

Divisions and services of INHS include: St. Luke's Rehabilitation Institute (inpatient and outpatient physical medicine and rehabilitation), Northwest MedStar (critical care air and ground transport), Community Health Education and Resources (consumer screenings, assessments, involvement and education improving health), Northwest TeleHealth (telemedicine, video-conferencing network), health@work (a health, wellness and productivity program for businesses), Health Training Network (professional education and certifications), Northwest MedVan (patient transport at no cost to the patient), Center of Occupational Health and Education (improving care for injured workers), the Center of Philanthropy (generating support for Children's Miracle Network Hospitals and the INHS Foundation) and Information Resource Management (a nationally recognized model of integrated health information technology increasing efficiencies and improving care).

Hospitals on the INHS health information network are consistently ranked as the "100 Most Wired" in the nation by Hospitals and Health Networks magazine, with 19 hospitals recognized in 2011.

INHS was selected by the Office of the National Coordinator for Health Information Technology as one of 17 Beacon Communities in the nation to lead a collaborative regional effort to address reducing costs and improving health outcomes for Type 2 diabetes. In collaboration with the Department of Veterans Affairs and Department of Defense, INHS was selected as the fourth pilot community in the nation to help develop the Virtual Lifetime Electronic Record for veterans and servicemembers. INHS is also a partner in working with the Centers for Disease Control and the Social Security Administration for data integration and analysis.

Growth potential: The health care industry is evolving, and with that change comes opportunity. Opportunities include building on the region's health information exchange and expanding the connectivity ensuring critical patient information is available to those providing care. INHS' collaborative, community model helps minimize further increases of the cost of health care, reduces redundancies and ultimately puts patients in the middle of their care.

Diverse Sources of Funding

Describing the life sciences industry is further complicated by the unusual ways in which money flows into the state to the industry: it is often quite different from other parts of the economic base. We can easily understand money flowing into Washington to purchase aircraft or geoducks, or to pay fees for architectural services or for a hotel stay. We can also understand money flowing in for payroll at military bases. Large parts of the life sciences industry, however, do not bring dollars into the state in traditional ways—but the dollars are just as green. Sources of revenue for the life sciences industry include:

Internal company funds. Many life sciences firms in Washington are branches of national or global firms, either under their own name or their parent company name. The research and development operations of these firms in Washington are funded by internal operating funds of the parent firm. For example, Amgen's R&D facility in Seattle is one of just five in the nation, with its payroll and operating costs paid for by revenues generated through Amgen's global sales of pharmaceutical products. Amgen reports that in 2010 it spent $2.9 billion companywide on R&D, or about 20 percent of its product sales.

Venture Capital. Research and development activities that take place within private firms with an eye toward commercial products are funded mostly with venture capital. While the state does have a robust venture capital community that attracts investors from within the state, most venture funding still comes from out of state, and most of the investors in those funds are not from Washington. In many respects, the investors in these venture funds are paying firms in the life sciences industry of the state to produce intellectual property that will eventually be sold at a large profit.

Figure 1 shows venture capital investment in Washington since 1995. The bars show funds going to life science firms in both biotechnology and medical equipment. The line shows the trend in total venture capital investments in the state, reflecting the very high rate of investment during the dot-com boom of 2000. Investments in the life sciences have been more steady, if not as spectac-

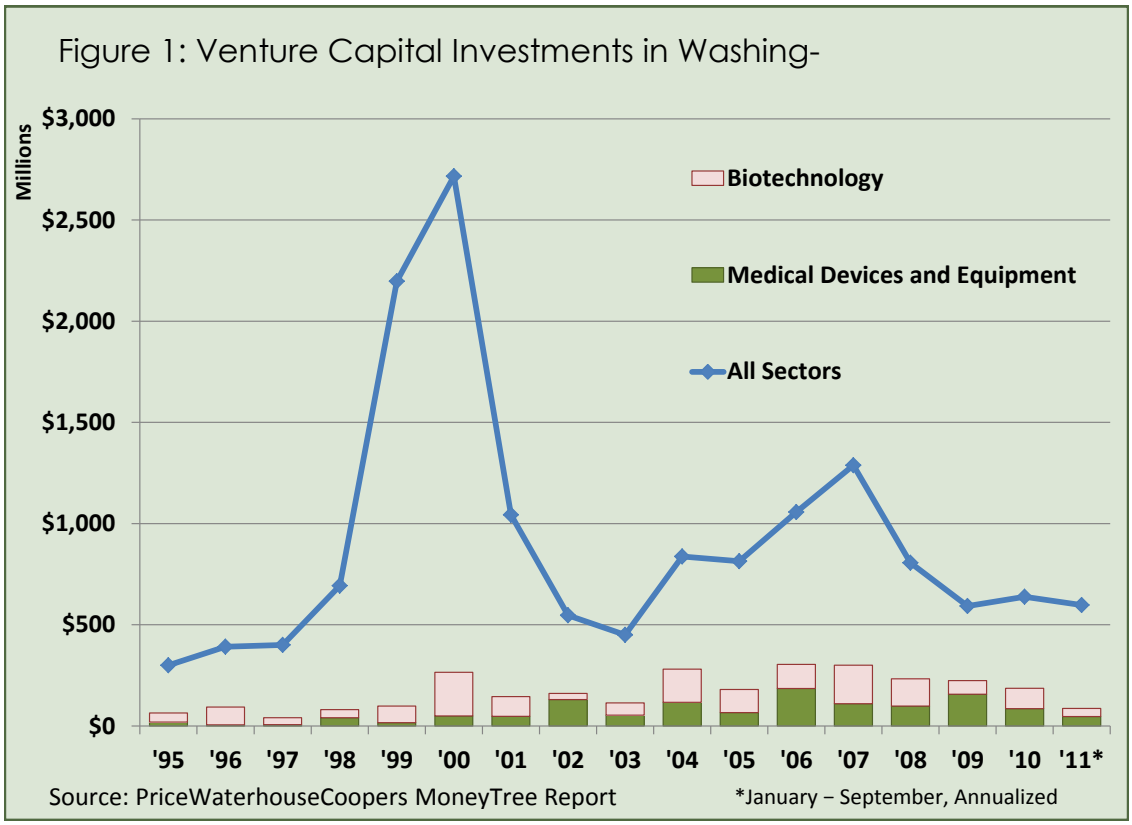


Figure 2: 2nd Quarter 2011 VC Deals in Washington

Biotechnology	Location	Product	Stage	Amount
Immune Design Corporation	Seattle	Therapeutic Vaccines	Early stage	$10.6 million
Theraclone Sciences, Inc.	Seattle	Native Human Antibodies	Early stage	$10.6 million
Medical Devices				
Cardiac Dimensions, Inc.	Kirkland	Heart Failure Treatment	Later Stage	$6.4 million.
RF Surgical Systems, Inc.	Bellevue	Surgical Disposables Tracking	Expansion	$12.0 million

Source: PriceWaterhouseCoopers MoneyTree Report

ular. Over the last two and three-quarters years, life sciences accounted for about 28 percent of venture capital invested in the state. Figure 2 shows the four venture capital deals in the life sciences in Washington that were placed in the third quarter of 2011, which totaled just short of $40 million. In that quarter, more funding was reported for biotechnology firms than for medical devices.

Federal research grants. The state's two research universities, the Pacific Northwest National Laboratory, the Fred Hutchinson Cancer Research Center and other non-profit and public research centers attract billions of dollars in research funding for the life sciences. Most of these grants are competitive, so in many respects, these institutions compete for customers like any service business.

The federal government has long made a commitment to basic research that is not directed at solving any particular problem. Thus, much of what is discovered is not tied to any product or immediately usable outcome, but simply advances knowledge in certain areas. We can think of the state's life sciences research capacity as an industry in itself, rather than as simply a stop on the path toward commercialization.

The vast majority of federal research funding for the life sciences comes through the National Institutes of Health (NIH). In 2010, NIH awarded 1,453 separate grants in Washington, totaling $813 million, for an average grant of $560,000. Figure 3 shows the recipients of NIH funding in Washington that received at least $2 million during 2009 and 2010. Figure 4 provides brief descriptions of the ten largest grants awarded in 2010.

Foundation grants. The research organizations that receive federal grants also receive grants from private foundations. The largest of these, the Gates Foundation, is located in the state. Although the Foundation makes grants on a global basis, local organizations have benefited greatly from its funding. For example, the *2011 Washington Global Health Strategic Mapping Portfolio* noted the "unique collaborative nature" of the global health sector in Washington. The Gates Foundation has partnerships with nine other members of the WGHA. In 2010, the Foundation awarded 16 global health grants totaling nearly $100 million to six of these partners.

Licensing and partnership revenue. Most life sciences start-up firms are built around proprietary technology that is used to produce innovative biopharmaceutical or agricultural products. These new technologies are often of great interest to larger firms elsewhere in the country that see the applicability to their own products. Some of the state's life sciences firms engage in licensing agreements or develop partnerships with out-of-state firms through which they collect

Figure 3: Largest Washington Funding Recipients from the National Institutes of Health, 2009–2010

	FY 2009	FY 2010	Total 2009–10
University of Washington	$376,797,762	$444,493,906	$821,291,668
Fred Hutchinson Cancer Research Center	$223,976,009	$209,174,195	$433,150,204
Seattle Children's Research Institute	$22,989,173	$25,933,340	$48,922,513
Group Health Cooperative	$18,624,801	$20,141,540	$38,766,341
Battelle Pacific Northwest Laboratories	$15,858,161	$15,657,490	$31,515,651
Washington State University	$15,553,135	$15,358,175	$30,911,310
Seattle BioMed	$11,632,849	$13,283,086	$24,915,935
Institute for Systems Biology	$8,822,038	$9,306,226	$18,128,264
Benaroya Research Inst. at Virginia Mason	$6,893,621	$10,288,440	$17,182,061
Seattle Inst. for Biomedical/Clinical Res	$4,785,647	$6,307,336	$11,092,983
Axio Research, LLC	$376,892	$5,078,168	$5,455,060
Geneva Foundation	$2,481,273	$2,468,154	$4,949,427
Etubics Corporation	$2,682,560	$2,131,695	$4,814,255
PATH	$2,296,183	$2,177,084	$4,473,267
Behavioral Tech Research, Inc.	$2,742,209	$1,491,842	$4,234,051
Infectious Disease Research Institute	$1,975,057	$2,017,824	$3,992,881
Talaria, Inc.	$2,550,422	$1,393,046	$3,943,468
Emerald Biostructures	$3,865,333	-	$3,865,333
Syntrix Biosystems, Inc.	$2,067,819	$1,715,241	$3,783,060
Puget Sound Blood Center	$2,977,430	$721,675	$3,699,105
Swedish Medical Center, First Hill	$1,425,122	$1,694,873	$3,119,995
Pacific Northwest Diabetes Research Institute	$1,562,969	$1,516,623	$3,079,592
Pharmain Corporation	$1,772,442	$1,264,233	$3,036,675
Bastyr University	$330,951	$1,984,809	$2,315,760
Allen Institute for Brain Science	$1,173,609	$1,117,191	$2,290,800
Total All Washington Recipients	$753,288,021	$813,262,820	$1,566,550,841

Source: National Institutes of Health

Figure 4: Largest NIH Grants in Washington in 2010

Organization	Project Title	Amount
University of Washington	Resuscitation Outcomes Consortium (ROC) Data Coordinating Center	$36,866,000
Fred Hutchinson Cancer Research Center	Leadership Group for a Global HIV Vaccine Clinical Trials Network	$21,443,783
Fred Hutchinson Cancer Research Center	HVTN Laboratory Program	$13,724,431
University of Washington	National Primate Research Center	$13,493,592
Fred Hutchinson Cancer Research Center	Leadership for HIV/AIDS Clinical Trials Networks; HIV Vaccine Trials Network	$12,347,128
Fred Hutchinson Cancer Research Center	Cancer Center Support Grant (Comprehensive)	$11,342,319
University of Washington	Institute for Translational Health Science (UL1)	$9,926,823
University of Washington	NW Research Center for Excellence in Biodefense and Emerging Infectious Diseases	$7,965,311
Axio Research, LLC	AIM-HIGH	$5,078,168
Fred Hutchinson Cancer Research Center	Leadership for HIV/AIDS Clinical Trials Networks; HIV Prevention Trials Network	$4,752,947

Source: National Institutes of Health

fees for the use of their proprietary technology.

Product and service sales. The most basic form of revenue generation in the economy is often the least available source for life sciences companies in Washington. The state has never had a significant presence of biopharmaceutical manufacturing firms, so the production, marketing and sales operations that generate direct revenue for these products and services do not occur very much in the state. The state does have a significant number of manufacturers of medical devices, so revenue from sales of those products will flow into the state.

Life Sciences Employment in Washington

An economic impact analysis of an industry generally begins with the direct jobs in that industry, and uses an economic model to determine how many additional jobs are generated elsewhere in the state by the activity of the industry. The additional employment generated by the industry comes from two sources. "Indirect" employment is generated through purchases made by the industry in the local economy, such as supplies, utilities, financial and legal services. "Induced" employment is generated by the spending of households who are employed either directly or indirectly in the industry. The combination of the three employment sources—direct, indirect, induced—yields a "multiplier" which, when applied to the direct employment, yields the total employment created by the industry.

Our definition of the Life Sciences industry expands on that used by Battelle in its studies for the Biotechnology Industry Association (BIO). Battelle's definition of the bioscience sector comprises all or part of 27 6-digit NAICS (North American Industrial Classification System) industries, which Battelle

groups into four subsectors; agricultural feedstocks and chemicals; drugs and pharmaceuticals; medical devices and equipment; and research, testing and medical laboratories, as delineated in Appendix 1. We include two additional subsectors: university faculty and staff engaged in life sciences research; and hospital staff in research activities. (Note: the industry definition we use here is a bit broader than the definition we used in our 2009 study, which included neither the agricultural feedstocks and chemicals subsector nor testing, medical or diagnostic laboratories.)

There are two basic ways to collect employment data. The first is to use administrative records that capture data as part of compliance with employment law. The most commonly used employment data is collected through unemployment insurance programs, and measures all individuals who are covered under the program. Covered employment statistics are quite accurate in terms of the count of individuals, but are only as useful as the categories into which the employees are placed. This report uses covered employment data, supplemented by other sources. Covered employment data was also used in recent national studies of the life sciences conducted by Archstone Consulting (2009) and Battelle (2008, 2010).

The second way to obtain employment data is to survey the universe of employers. This method was used in a 2002 study of Washington's biotechnology and medical device industry (Chase 2002), which used employment numbers from a survey by Lifesciences.com. Similarly, the Community Attributes study of biomedical devices (2008) and the UW study of global health (2007) used survey data. This method is more transparent than using administrative records, but is accurate only to the extent that the surveyor correctly identifies the universe of employers and that these employers respond to the (voluntary) survey.

For purposes of this report, the covered employment data from the Bureau of Labor Statistics (BLS) has some problems, stemming from the categorizations available in NAICS. First, since

Figure 5: 2009 R&D in the Life Sciences at Universities and Colleges
(Dollars in thousands)

	All Life Sciences	Agricultural Sciences	Biological Sciences	Medical Sciences	Other Life Sciences
University of Washington	$517,978	$17,233	$89,848	$396,872	$14,025
Washington State University	$157,517	$82,822	$43,352	$27,621	$3,722
Western Washington University	$2,744	-	$2,744	-	-
Eastern Washington University	$590	-	$590	-	-
Gonzaga University	$385	-	$385	-	-
Seattle University	$285	-	$285	-	-
University of Puget Sound	$234	-	$231	-	$3
The Evergreen State College	$225	-	$225	-	-
Central Washington University	$169	-	$169	-	-
Whitman College	$138	-	$130	-	$8
Pacific Lutheran University	$74	-	$74	-	-
Seattle Pacific University	$57	-	$57	-	-

Source: National Science Foundation

2007, BLS has provided employment numbers for the NAICS industry called "research and development in biotechnology" (NAICS 541711). But most of private sector life sciences research employment, including most of the employees of the state's non-profit research institutions, fall under another NAICS category called "research and development in the physical, engineering, and life sciences (except biotechnology)" (NAICS 541712). To address this shortcoming, we adapt the methodology used by Battelle to impute the share of those working in NAICS 541712 who are in life sciences.

Second, BLS data do not break out two important life sciences employers. Life science researchers who are on the faculty or staff of an academic institution are lumped under "education," with no attempt made to break them out by research focus. Similarly, researchers who work in a hospital are categorized under healthcare. We impute the number of academic life sciences workers based on research expenditures of the institutions, as reported by the National Science Foundation. Our figures on the number's employed in research at hospitals come largely from a survey by the WBBA.

Employment impacts of the life sciences are determined as follows:

Agricultural Feedstocks and Chemicals. In 2010, average employment in this subsector was 901 at an average wage of $55,651.

Figure 6: 2010 Research Funding at Medical Institutions

Benaroya Research Institute	$30,741,000
Group Health Research Institute	$44,080,188
Puget Sound Blood Center	$7,017,000
Seattle Children's Research Institute	$67,082,430
Swedish Research Center	$14,485,288
Tacoma General Hospital	$748,855

Drugs and Biopharmaceuticals. Average employment in this sub sector was 2,085 in 2010, with an average wage of $52,495. Within this subsector, in-vitro diagnostic substance manufacturing (NAICS 325413) employed 429 at $63,286 average pay, while biological product (except diagnostic) manufacturing employed 634 at $59,652 average pay.

Medical Devices and Equipment. This subsector employed 7,953 in 2010, with average pay of $66,903. The largest industry within this subsector was electromedical apparatus manufacturing, which employed 3,503 at an average wage of $92,090.

Research, Testing, and Medical Laboratories. 16,269 were employed in this subsector, with $77,490 annual average pay. The R&D in biotechnology industry (NAICS 54711) employed 3,730 with average pay of $121,716. We estimate that 6,850 worked in R&D in life sciences other than biotechnology, with $93,364 annual pay.

University Faculty and Staff. ESD reports none of the state's R&D employment within the public sector, so all university faculty and staff who are working in R&D in the life sciences will appear in the larger "education" category (we assume that faculty and staff at private universities do as well). To estimate the number of jobs attributable to life sciences R&D, we begin with the total value of R&D activity at the state's institutions of higher education. Figure 5 shows that in 2009 the state's higher education institutions performed $680.4 million of life sciences research. The recent economic impact report prepared for the University of Washington indicated that in the 2009 academic year $1.15 billion received for sponsored research and other sponsored programs supported 9,050 full-time equivalent jobs at the university (TrippUmbach 2010). Based on this, we estimate that every $1 million in research spending produces 7.8 jobs. Applying this ratio to life sciences R&D spending at the state's higher education institutions results in 5,355jobs.

Figure 7: 2010 Life Sciences Employment in Washington

	Jobs	Annual Pay
Agricultural Feedstock and Chemicals	901	$55,651
Drugs and Pharmaceuticals	2,085	$52,495
Medical Devices and Equipment	7,953	$66,903
Research, Testing and Medical Laboratories	16,269	$87,078
Subtotal	27,208	$77,490
University Faculty/Staff in Life Sciences	5,355	NA
Hospital Staff in Research Activities	955	NA
Total	33,519	NA

Source: WRC and BLSE

Hospitals and Institutions. Six medical institution affiliated research centers in the state received grants from the NIH in 2010. These centers had additional sources of research funding, with the total shown in Figure 6. The institutions report that their research centers employ 955.

Figure 7 summarizes employment in the life sciences in Washington, based on data from ESD and estimates from other sources. A base of over 33,500 jobs makes the life sciences industry an important part of the state's economy. Figure 8 shows 2010 employment for the life sciences in Washington along with employment in selected other major industries that contribute importantly to the economic base of the state. Life sciences has surpassed basic industries such as wood products manufacturing and paper manufacturing,

Figure 8: Major industries in Washington

	2010 Employment
Transportation Equipment Manufacturing	89,483
Agriculture	65,450
Software	50,900
Food and Beverage Manufacturing	37,773
Life Sciences	**33,519**
Computer and Electronic Product Manufacturing	18,981
Fabricated Metal Product Manufacturing	16,083
Mineral and Primary Metal Manufacturing	13,193
Wood Products Manufacturing	12,722
Paper Manufacturing	11,555

Source: WRC and Washington State ESD

Figure 9: 2010 Employment Impact of Life Sciences in Washington

	Direct Employment	Indirect & Induced Employment	Total Employment Impact	Jobs Multiplier
Agricultural Feedstock and Chemicals	901	4,614	5,515	6.12
Drugs and Pharmaceuticals	2,085	7,543	9,628	4.62
Medical Devices and Equipment	7,953	14,971	22,924	2.88
Research, Testing and Medical Laboratories	16,269	20,998	37,267	2.29
University Faculty and Staff Working in Life Sciences	5,355	7,715	13,070	2.44
Hospital Staff in Research Activities	955	1,377	2,332	2.44
Total	33,519	57,218	90,737	2.71

Figure 10: 2010 GDP and Personal Income Impact of Life Sciences in Washington

	Direct Employment	GDP (2011$, Millions)	Personal Income (2011$, Millions)
Agricultural Feedstock and Chemicals	901	$691	$433
Drugs and Pharmaceuticals	2,085	$1,328	$831
Medical Devices and Equipment	7,953	$3,173	$1,584
Research, Testing and Medical Laboratories	16,269	$3,634	$2,638
University Faculty and Staff Working in Life Sciences	5,355	$1,305	$960
Hospital Staff in Research Activities	955	$233	$171
Total	33,519	$10,364	$6,617

Estimating the Economic Impact of the Life Sciences in Washington

With reasonable estimates of life sciences employment in the state we can estimate the additional jobs that are produced in the economy as a result of spending by life sciences institutions and firms, and the spending of households. We use a model constructed for the Research Council by Regional Economic Models Inc. (the WRC-REMI model) to derive the multipliers for the various sectors. The REMI model provides multipliers for each of the NAICS codes except the new biotechnology code. We have only one multiplier to use for all R&D in the life sciences.

Figure 9 shows the results of applying the multipliers to the employment estimates. We can estimate that the 33,509 directly employed in the life sciences results in 55,718 additional jobs elsewhere in the state's economy, for a total economic impact of 90,737 jobs. The overall jobs multiplier (the ratio of direct employment to total employment) is 2.71.

Figure 10 shows the impact of these jobs on the state's gross domestic product (GDP) and personal income. Altogether, the life sciences industry generated $10.4 billion of GDP and $6.6 billion of personal income.

The Life Sciences Industry Around the State

The life sciences industry tends to respond to clustering effects, with the largest concentrations of firms and institutions near the University of Washington. Activity is, however, spread around

Figure 11: Selected Life Sciences Sectors

	Drugs & Biopharma + Biotech R&D	Medical Devices & Equipment	Physical, Engineering & Life Sciences (ex Biotech) R&D
Seattle	40.0%	4.5%	33.9%
I-90 /I-405 Corridors	22.0%	52.0%	7.7%
Balance of Puget Sound Region	10.8%	19.1%	7.9%
Balance of State	27.1%	24.4%	50.6%

Source: PSRC, ESD

many other areas of the state. Figure 11, based on employment data from the Puget Sound Regional Council and ESD, shows the distribution of employment in the readily identifiable segments of the life sciences industry in the Puget Sound region and elsewhere in the state. (Data suppression—not providing data that could lead to disclosure of proprietary information about firms—makes it difficult to calculate employment distribution at a finer grain than this.)

Figure 12 shows the distribution of life sciences businesses and institutions in cities around the state, as reflected in a database maintained by the Washington Biotechnology and Biomedical Association. Figure 13 shows the distribution of grants from the NIH around the state. Both figures indicate that, while most firms want to be near the major research institutions and laboratories, researchers can locate themselves well outside these centers.

The 2010 Battelle report ranks the Seattle-Tacoma-Bellevue metropolitan area as having the nation's 17th largest employment in medical devices and equipment and the 14th largest employment in research, testing, and medical laboratories. In research, testing, and medical laboratories, Kennewick-Richland-Pasco ranks second among medium-sized metropolitan areas and Spokane ranks 11th; Mount Vernon-Anacortes ranks fourth among small metropolitan areas.

Economic Drivers of the Life Sciences Industry

Relative to state size, Washington has one of the nation's strongest life sciences industries. According to a 2010 study by Battelle, on a per capita basis, Washington ranks sixth among the states in research funding from the NIH, 21st in the awarding of biosciences degrees and eighth in placement of biosciences venture capital. Washington ranks sixth in total bioscience venture capital. Further, Battelle reports that Washington "has seen each of its bioscience industry subsectors grow at a faster rate than the nation since 2001."

But how can we ensure that the state remains strong in the life sciences? A 2008 Battelle study listed a number of key "success factors of biosciences industry growth." Among them are:

Engaged research institutions with active leadership. The report states that "without major research stature, reputation and standing within given fields, no region can succeed with a biosciences-driven strategy for its economic growth." Washington certainly has excellent research institutions, with its two major research universities and nonprofit institutes.

Available risk capital covering all stages of the business cycle. Washington consistently ranks among the top states in the placement of venture capital funding. In addition to the Battelle ranking of eighth in the placement of biosciences venture capital, the Milken Institute ranks Washington third in overall per capita venture capital placement. According to Battelle, Washington ranks among the top five states in bioscience venture capital investments in animal and equipment biotech and medical diagnostics. A persistent concern in the state, however, has been the reliance on venture funds from out of state. Another concern has been the challenge of finding "angel" capital for firms in their very early stages.

Workforce and talent pool. The pool of talent that feeds the life sciences industry requires specialized training that is not widely available. Washington's

Figure 12: Life Science Firms/Organizations by City

	Biotech/ Pharma	Medical Device/ Tech	Non-Profit Research/ Academic		Biotech/ Pharma	Medical Device/ Tech	Non-Profit Research/ Academic
Arlington	-	2	-	Maple Valley	-	1	-
Auburn	1	1	-	Marysville	-	1	-
Bainbridge Island	2	1	-	Mercer Island	2	2	-
Bellevue	8	13	2	Mill Creek	1	2	-
Bellingham	1	3	1	Monroe	-	1	-
Black Diamond	-	1	-	Mountlake Terrace	-	1	-
Blaine	-	1	-	Mukilteo	-	2	-
Bothell	15	21	1	Olympia	3	-	1
Camas	-	1	-	Port Townsend	-	1	-
Carlsborg	-	1	-	Poulsbo	-	2	-
Carnation	-	1	-	Pullman	1	3	1
Chehalis	1	-	-	Puyallup	-	1	-
Cheney			1	Redmond	10	23	-
Chimacum	-	1	-	Renton	-	1	-
Eastsound	-	1	-	Richland	1	7	2
Edmonds	-	1	-	Sammamish	1	3	-
Ellensburg			1	Seattle	82	69	21
Everett	2	7	-	Sequim	1	-	-
Federal Way	-	2	-	Silverdale	-	1	-
Ferndale	1	3	-	Snohomish	-	2	-
Freeland	-	1	-	Spokane	5	6	1
Friday Harbor	-	1	-	Spokane Valley	-	2	-
Gig Harbor	1	3	-	Stanwood	-	1	-
Glacier	-	2	-	Sumas	-	1	-
Issaquah	1	5	-	Tacoma	3	2	3
Kenmore	1	-	-	Tukwila	-	2	-
Kennewick	1	2	-	University Place	-	1	-
Kent	-	8		Valleyford	1	-	-
Kirkland	5	8	-	Vancouver	4	10	-
Lacey	3	-	-	Vashon	1	-	-
Lake Forest Park	-	1	-	Veradale	1	-	-
Lopez Island	-	1	-	Walla Walla		1	1
Lynden	1	1	-	Woodinville	1	3	-
Lynnwood	1	3	-				
				Total	163	249	36

Source: WBBA Database

Figure 13: NIH Grants by City

	2009	2010
Auburn	$2,067,819	$1,715,241
Bainbridge Island	$3,865,333	-
Bellevue	$973,673	$1,073,768
Bellingham	$507,506	$1,155,174
Bothell	$662,800	-
Ellensburg	-	$390,377
Friday Harbor	-	$93,752
Gig Harbor	-	$378,858
Granger	$32,400	-
Kenmore	$330,951	$1,984,809
Kirkland	$519,410	$390,262
Lakewood	$2,481,273	$2,468,154
Maple Valley	$100,036	-
Mercer Island	-	$254,737
Mountlake Terrace	$873,156	$183,233
Normandy Park	$249,356	$245,889
Olympia	$1,574,258	$382,912
Pullman	$15,553,135	$15,358,175
Redmond	$1,050,899	$382,286
Richland	$15,858,161	$15,657,490
Seattle	$704,496,429	$768,751,535
Sequim	$99,999	$100,000
Spokane	$441,383	$681,243
Tacoma	$1,137,341	$888,803
Vashon	$311,003	$108,381
Walla Walla	-	$202,400
Woodinville	$101,700	$415,341
Total	$753,288,021	$813,262,820

Source: National Institutes of Health

universities graduate individuals in these fields, but not nearly enough to meet the needs of the state's life sciences industry. A glance through the backgrounds of the leading scientists in the state's research institutions and biotech firms indicates that we import the majority of the talent working in the life sciences in the state. According to Battelle, although Washington's life sciences related employment ranks 12th in the country, Washington ranks 21st in degrees in life science.

There is perhaps no more important factor for the future of Washington's life sciences industry than our ability to attract and retain top scientific and technical talent from around the world. While Washington is an attractive place to live, we do need to be mindful that we are competing with states such as Massachusetts, California and New Jersey that offer outstanding career prospects for talented scientists and engineers. While impressive, Washington's life sciences industry does not yet offer as many career paths for scientists such that they will move to the state confident that if their current employment ends they will be able to find new employment easily.

Stable and supportive business, tax and regulatory policies. In the past decade Washington has become somewhat more friendly to technology businesses, but barriers do remain. The state's tax breaks for R&D equipment are favorable for startup businesses building or expanding laboratory space and a sales and use tax deferral for life sciences manufacturing is similarly a plus. The state also offers a Business and Occupation (B&O) tax credit for a portion of R&D expenses for firms that for the most part are still in the unprofitable start-up phase. However, employment taxes in the state are among the highest in the country, which can be a burden for labor-intensive research. Life sciences businesses may be concerned about the stability of the state's tax regime, given the regular calls to eliminate tax incentives such as the B&O tax credit.

According to Battelle, 37 other states offer R&D tax credits. Some of those states also use tax credits to encourage early-stage investment or to increase venture capital availability. Washington is one of 34 states that have a sales tax

exemption for equipment used in R&D and one of 33 states with a sales tax exemption for equipment purchased for biomanufacturing.

Patience and a long term perspective. Washington's life sciences industry has built slowly over decades. The University of Washington built its research and medical capacity over many years. The Fred Hutchinson Cancer Research Center has been steadily growing since the 1970s. Seattle BioMed began as a three-person laboratory in Issaquah in the 1970s and now employs hundreds of people in its Seattle and Tanzania laboratories.

While individual institutions have executed growth strategies, and county-level economic development organizations have promoted the life sciences, the industry has grown largely without any high profile, long term strategic actions on the part of government.

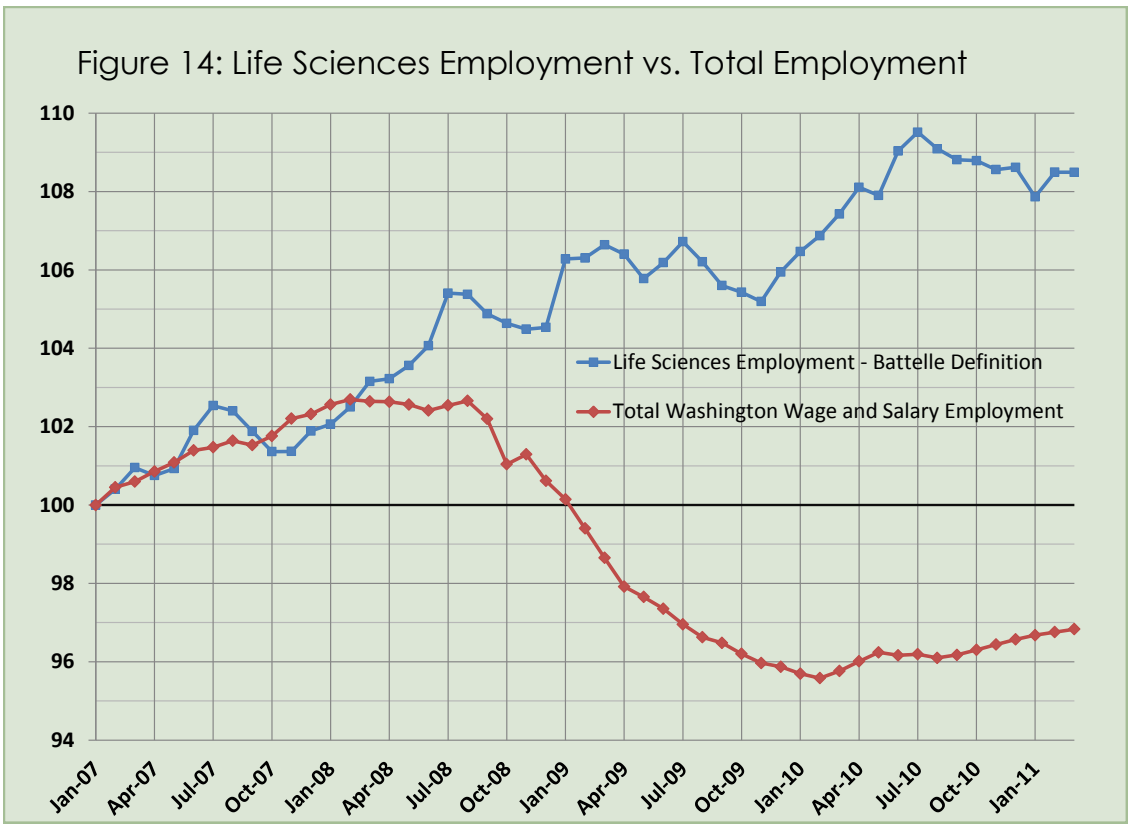
Although not mentioned specifically in the Battelle report, another critical factor in the growth of the life sciences industry is the presence of support services. Of particular interest are the legal and accounting services required for investors and for intellectual property protection. The steady growth of a range of technology-based businesses has been accompanied by strong growth in the state's related services sector.

The 2010 Battelle report lists some warning signs of threats to industry development, including capital availability, NIH funding given federal budget problems, and bioscience talent (particularly in K-12 math and science). Ernst & Young's Global Biotechnology Report 2011 warns that venture capital is increasingly meted out rather than given as an up-front payment and that companies "face an increasingly opaque regulatory environment."

Recent Performance

Figure 14 charts the employment trend of Washington's life sciences industry in comparison to overall employment in the state from January 2007 through March 2011. For the chart, we use the Battelle definition of the industry because we can get monthly employment numbers for these firms from the BLS's covered employment database. March 2011 is the latest month for which covered employment counts are available from BLS.

Figure 14: Life Sciences Employment vs. Total Employment



The contrast is striking. From August 2008 to February 2010, the state employment fell by 6.9 percent overall; life sciences grew by 1.4 percent. From that point to March 2011, life sciences employment grew by 1.5 percent; overall employment, by 1.3 percent.

In March 2011 the state had 91,800 fewer jobs overall than it had had in January 2007. Life Sciences added 2,100 jobs over that period.

Investing in life sciences requires commitment for the long haul. The sorts of fundamental breakthroughs that are sought by many of our life sciences companies do not come quickly or easily. As long as investors remain willing to make these commitments, the life sciences industry will remain somewhat detached from the business cycle.

Conclusion

The life sciences industry has grown to be an important part of Washington's economy. In employment it has passed many of the traditional resource based industries on which the state's economy was founded, and is in the same range of importance as some of the new, technology-based industries of the state. It is, however, difficult to recognize the importance of the life sciences industry because it is comprised of a diffuse array of organizations and firms, its "product" consists of everything from scientific papers to surgical instruments, and its "revenue" comes from all manner of public and private sources. Describing the life sciences industry is not as easy as describing the production and sale of lumber.

As Battelle notes, "the biosciences are positioned for continued growth." The growth of the life sciences industry is good news for the state. Demand for the products and services generated by the industry will continue to grow rapidly, in three principal areas: domestic healthcare, global health and sustainable biofuels. The state's life sciences industry has a good position in the first of these, is the national leader in the second, and has promise in the third.

On the other hand, as the recession has deepened, Ernst & Young's 2011 study reports that total venture capital funding decreased in 2010, and biotech "faces increasing competition from other sectors." "Biotech has long been 'the business of science'—an industry that has tried to build commercial undertakings based on a passionate belief in the science. Today, companies instead need to focus to a greater degree on the 'science of business'—bringing disciplined, market-aware, business-savvy approaches and processes to the unprecedented challenges they face."

The economic potential of the life sciences has, of course, not gone unnoticed in the rest of the country and the world. The competition for talent and investment capital is intense, and in spite of its excellent assets, Washington is still not among the top regions for the life sciences, but perhaps near the top of the second tier. Massachusetts, with its complex of leading universities, the San Francisco Bay area, with its universities and huge technology industry base, and New Jersey, with its large pharmaceutical industry, all have larger life sciences industries than Washington.

Washington has developed its niches in the areas of research and development and global health, and will not likely be a major area for manufacturing of biopharmaceutical products. These are, however, very valuable and lucrative niches which depend primarily on one input: talent. Washington may not have the largest life sciences industry in the nation, but it still competes at the highest level to attract and retain the best scientific and technical minds in the world. The future of Washington's life sciences industry will continue to be tied to the quality of talent in the state.

There are many complex factors that determine success in the life sciences industry, but none more important than ensuring that the state's universities, research institutions and businesses have the highly skilled people they need working in an environment that encourages innovation.

Appendix 1: Battelle Defined Bioscience Subsectors

NAICS Code	NAICS 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 fertilizer manufacturing
325312	Phosphatic fertilizer manufacturing
325314	Fertilizer (mixing only) manufacturing
325320	Pesticide and other agricultural chemical manufacturing
Drugs & Biopharmiceuticals	
325411	Medicinal and botanical manufacturing
325412	Pharmaceutical preparation manufacturing
325413	In-vitro diagnostic substance manufacturing
325414	Biological product (except diagnostic) manufacturing
Medical Devices & Equipment	
334510	Electromedical apparatus manufacturing
334516	Analytical laboratory instrument manufacturing
334517	Irradiation apparatus manufacturing
339112	Surgical and medical instrument manufacturing
339113	Surgical appliance and supplies manufacturing
339114	Dental equipment and supplies manufacturing
339115	Ophthalmic goods manufacturing
339116	Dental laboratories
Research, Testing, & Medical Laboratories	
541380*	Testing laboratories
541711	R&D in biotechnology
541712*	R&D in the physical , engineering, and l ife sciences (except biotech)
621511	Medical laboratories
621512	Diagnostic imaging centers

*Includes only a portion of these industries engaged in relevant life science

Appendix 2: About the WRC-REMI Model

The Washington Research Council uses a model of the Washington State economy constructed especially for WRC by Regional Economic Models, Inc. Because it allows supply and demand to respond to changes in prices and wages, and permits substitution among factors of production, the WRC-REMI model is more elaborate than the standard input-output models commonly employed to estimate regional economic impacts (Treyz 1993).

The standard input-output model fails to model the numerous capacity constraints within the economy, the processes that set prices for goods and services and the responses of consumers and producers to changes in these prices. In the input-output model, industry and labor supply are perfectly elastic—so prices and wage rates do not matter.

Prices and wages do matter in the WRC-REMI model. The model divides the state into two subregions: The Seattle Metropolitan Statistical Area (King, , Pierce and Snohomish Counties) and the balance of the state. There are 53 industrial sectors within each subregion. Within each subregion the model tracks inter-industry transactions, much as an input output model would.

Unlike an input-output model, however, the WRC-REMI model incorporates a number of significant behavioral responses to changes in prices and costs: The wage rate depends on the supply and demand for labor, migration and labor force participation rates respond to changes in wage rates, and consumer purchases of specific goods and services respond to changes in relative prices and personal income. In addition, producers substitute among production factors in response to changes in relative factor costs, market shares respond to changes in regional production costs, and investment rises in response to increases in output.

This report uses version PI + 1.2.6 of the WRC-REMI model.

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