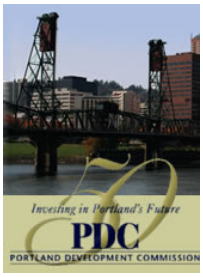
OREGON BIOSCIENCE INDUSTRY
SEGMENTATION AND CLUSTER ANALYSIS
FINAL REPORT
JULY 3, 2008

OREGON
ECONOMIC & COMMUNITY
DEVELOPMENT DEPARTMENT

OREGON HEALTH & SCIENCE UNIVERSITY
OHSU



Oregon Bioscience
ASSOCIATION

Creating Opportunity through
Community, Collaboration and Commercialization

www.oregonbio.org

Sponsored by:
Oregon Economic & Community Development Department
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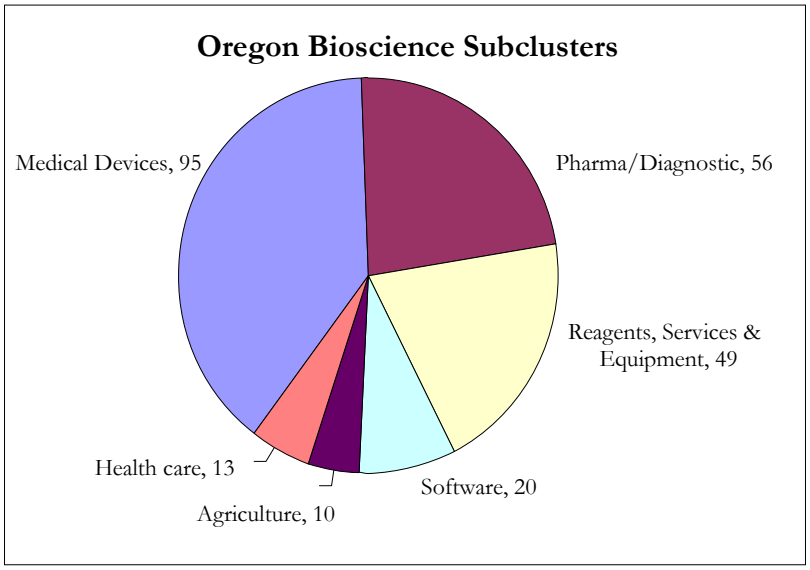
1. Executive Summary

The purpose of this study was to conduct a cluster-specific analysis of the Oregon bioscience industry to identify key industry subclusters and their linkages; provide a better understanding of the drivers and needs of the subclusters; and identify economic development strategies to promote bioscience industry growth in Oregon.

The Oregon bioscience industry includes companies that use science and technology related to living organisms to provide products and services directed to agriculture, pharmaceuticals, diagnostics, medical devices and research.

Alta Biomedical examined a variety of data sources and major groupings to identify 243 companies that fall within the definition of Oregon bioscience companies. These companies fall into six major subclusters. More than 80% of the companies identified fell into one of three subclusters: Medical Devices, Pharma/Diagnostic, and Reagents/Services/Equipment.

Key Findings



Bioscience manufacturing. Oregon has a key strength in bioscience manufacturing. This manufacturing requires superior technical skills as well as a highly educated work force and is regulated by the U.S. Food and Drug Administration (FDA) under current Good Manufacturing Practices (cGMP). The technical and educated work force is consistent with the overall strength of Oregon across industries as a manufacturing state. Recent company expansions in Oregon demonstrate that the state has competitive advantages for high skill-level manufacturing. Companies that moved here were attracted by cost of doing business, qualified work force, high quality of life, recruitment packages and tax policy. Oregon can leverage these advantages further to recruit companies and encourage growth of existing companies thus building critical mass.

The Oregon Work Force. Companies report satisfaction with the quality of the work force, but find that the talent pool is not deep. The industry needs a pipeline of leadership that builds on academic programs, mentoring, and attracting and retaining employees. Fifty percent of the companies interviewed indicated that they need work force training, with an emphasis on manufacturing and regulatory skills. In addition, attracting senior level talent in management, operations, validation, regulatory, QA/QC and marketing/sales presents challenges, with current recruitment primarily occurring out of state.

Capital. Companies have been successful in gaining significant equity investments from outside of Oregon. In spite of the state's efforts to develop capital through the Oregon Growth Account and other mechanisms, there remains a lack of early stage capital in Oregon. The recent passage of the Oregon Venture Development Fund for Oregon Universities will create a small amount of capital (up to $14 million), and will hopefully kick-start early stage investments. However, an increased access to capital (early as well as later stages) from within Oregon is needed to help promote industry growth.

Specialized infrastructure. Companies need facilities such as wet lab space and clean room manufacturing across the top three subclusters. Existing bioscience companies require an expansion of the networking infrastructure within the industry and other industry clusters. Currently, there is a perceived lack of such infrastructure around Portland, Eugene, Corvallis and Salem. Development of incubators with critical wet lab and clean room facilities can support these facilities.

Innovation. Companies generally view universities as sources of innovation. Most companies have some linkages (through research, licensing and use of core facilities) with local universities, but seek more "user friendly" mechanisms to access research capabilities and establish long-term relationships based on specific technological expertise. Two of Oregon's Signature Research Centers – the Oregon Nanoscience and Microtechnologies Institute (ONAMI) and the Oregon Translational Research and Drug Development Institute (OTRADI) - currently have or are in the process of creating linkages with industry. Supporting targeted recruitment of key researchers into the Signature Research Centers, funding specific projects and leveraging the successful federal grant process can enhance university technology commercialization.

Linkages. There are no significant linkages (i.e. sourcing from common suppliers, etc.) among Oregon bioscience companies based on customers or suppliers. Companies rarely target the same industry sub sectors or specific customers, nor do they use the same suppliers. Furthermore, companies reported few connections with large company partners. Most of the companies have international sales using direct sales or distributors, but see challenges to expanding internationally and therefore seek state help.

The emerging Oregon bioscience cluster – through growth and investment by the state, local and academic partnerships – demonstrates positive advancement in the foundational elements, but more needs to be done. Oregon needs a coordinated strategic plan, additional long-term support and a vision to enhance the growth of the bioscience cluster.

Recommendations from the Study

Conclusions drawn from this study indicate that the bioscience cluster in Oregon is larger than was initially perceived. However, due to the diversity of the cluster and the lack of actual or perceived linkages within the subclusters, there are opportunities for industry-led statewide strategic planning to develop the cluster. Such strategic planning should be facilitated by experts and include participation from industry, state and academic institution sectors. We highly recommend that such a process for strategic planning be put into place in the short term to utilize the findings of this study and capitalize on the local and regional resources in the state. Based on best practices in support of the industry in other states, the following five observations should be considered during the strategic planning process to create a more competitive environment across all subclusters:

1. Target recruitment of high value-added manufacturing companies and expansion of current initiatives for developing in-state companies
2. Grow capital for all stages of company development
3. Develop programs to recruit and expand access to senior managerial and scientific talent
4. Expand bioscience-specialized infrastructure, including wet laboratory space and clean room manufacturing space
5. Strengthen company linkages with universities and Signature Research Centers and through other networking activities.

The Oregon Economic & Community Development Department, with support from the Portland Development Commission, Oregon Health & Science University and the Oregon Bioscience Association retained Alta Biomedical Group to conduct this study.

2. Introduction

Becoming a cluster is a "state of maturity" within an ecosystem of related firms and occurs in three stages.[3]

1. Pre-cluster - Few firms with limited links. Little economic impact. Anchor firms emerging.
2. Emerging cluster - Firms creating links and organizing to form industry associations and alliances.
3. Expanding cluster - Growing linkages and critical mass. Economic impact expanding. Networking is spontaneous.

The State of Oregon has embarked on an industry cluster approach to economic development based on the premise that key industry groupings exist due to particular circumstances in the region and that innovation and competitive advantage are likely to be greater for such clusters. Industry clusters are groups of similar and related firms in a defined geographic area that share common markets, technologies, worker skill needs, and among other things are linked by buyer-seller relationships. Firms and workers within an industry cluster draw competitive advantage from their proximity, skilled work force, specialized suppliers and service providers, universities, colleges and professional associations. The cluster framework involves mobilizing stakeholders by fostering collaboration within the cluster in the region and implementing the actions identified as a result of the collaborative process. This is a valuable tool for improving economic conditions because it is market-driven, inclusive, collaborative, strategic, and value-creating. A concentration of companies is not a cluster.

This study characterizes the bioscience cluster by analyzing its dimensions, locations, linkages within the cluster and to external groups, and understanding the current environment through in-depth interviews with companies, investors, university commercialization officers, and government stakeholders.

This study has the following objectives:

- Identify key industry subclusters within the bioscience cluster and their linkages
- Provide a better understanding of the drivers and needs of Oregon's bioscience industry
- Identify opportunities best pursued to help the bioscience industry grow in Oregon.

3. Methodology

An important component of clusters is the linkages between companies or with external organizations based on technology, markets, suppliers and/or work force. Linkages between companies are based on a number of factors, including:

- Use or development of complementary or competing technology
- Availability of work force (key scientists, skilled labor or senior management)
- Reliance on specialized infrastructure or services
- Competition for angel and venture capital, or a common venture funding source
- Interaction with research institutions
- Reliance on common suppliers
- Competition for customers, or service of the same customers in different ways
- Collaboration between companies or with other regional industry subclusters.

Analysis of the Oregon bioscience industry and its linkages was both qualitative and quantitative, and was conducted as follows:

a. Secondary Source Analysis

Identification of Companies

An initial set of companies was identified by using a broad definition based on industry classification of bioscience by the Bioscience Industry Organization (BIO) and data derived from the *infoUSA* Employer database provided by OECDD.

Analysis of Company Websites

A review of company websites identified initial linkages based on technologies and markets. These contributed to the selection of the final list of companies for this study and the initial industry cluster groupings.

b. Analysis and Assessment of Successful Practices in Oregon and Other States

A 2006 publication from BIO, "State Legislative Best Practices to Support Bioscience Industry Development,"[1] documents the key needs for growth of a bioscience industry cluster and describes some key examples of state efforts to do this. The key needs identified in this report are consistent with the issues found in the interviews conducted with Oregon bioscience companies. The BIO report points out that beginning in 2005, many states passed initiatives supporting the growth of the bioscience industry in their state. Examples of some such initiatives are provided on the BIO website.[2]

The analysis of best practices from other states focused on the comparison of Oregon with two comparable states, Arizona and Colorado. These two states are comparable to Oregon in terms of size and maturity of the bioscience industry. Both have relatively small bioscience industries and have developed strategic plans, or roadmaps, for developing their industries by focusing and building on their strengths. In addition, they have regularly posted reports of progress against goals. Oregon has adapted many of "Successful Practices" drawn from more established bioscience clusters as well as from technology-based economic development in general, and has initiated some of its own.

c. Development of a "Bioscience" Definition for Oregon

To derive a more useful list of bioscience companies in Oregon for the purpose of this study, the definition of bioscience was refined based on information gathered from the broad list of companies, reviews of databases and interviews with stakeholders.

d. Collection of Primary Data Through Interviews

Interviews with Government, University and Financial Stakeholders

Interviews were conducted with regional economic development personnel, venture capital firms that invest in biosciences in Oregon (Northwest Technology Ventures and Oregon Life Sciences), and technology transfer personnel at Portland State University, University of Oregon, Oregon State University, Providence Medical Group and Oregon Health and Science University. The questions used for these interviews are shown in Appendix C: *"Technology Transfer and VC Questions."*

Identification of Additional Companies for the Defined Oregon List

Stakeholder interviews included the identification of new spinout companies from universities and other companies not identified through secondary sources.

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1 www.bio.org/local/industryDev/IndustryDevelopmentSupport_BIO.pdf

2 bio.org/local/industryDev/i04.asp

Interviews with Key Companies

Companies were selected from three subclusters: Medical Devices (MD), Pharmaceuticals & Diagnostics (PD) and Reagents, Services & Equipment for Bioscience (RSE). These three subclusters comprise more than 80% of the companies in the Oregon bioscience cluster.

Consideration was given on the desirability to have representation from each of the major subclusters and subgroups, from small and large firms, and from companies that have made significant innovations.

Detailed interviews with senior management were conducted with 31 companies to determine linkages among companies. Two companies chose to submit written responses. The individual companies are listed in Appendix D: "*Key Companies Interviewed."* The complete list of questions can be found in Appendix E : "*Bioscience Interview Questions*."

4. Profile of Bioscience in Oregon

The study began with a broad definition of bioscience, thereby casting a broad net and resulting in a detailed list of life-science related companies. This list was then filtered using criteria that best represent bioscience companies in Oregon.

a. Battelle Bioscience Industry Definition

The bioscience sector of the U.S. economy is defined by several North American Industry Classification System (NAICS) codes. BIO describes the bioscience sector as "…*a diverse group of industries and activities with a common link - they apply knowledge of the way in which plants, animals, and humans function. The sector spans different markets and includes manufacturing, services, and research activities. By definition, the biosciences are a unique industry cluster and are constantly changing to incorporate the latest research.*"[3]

Taking the above definition into account, Battelle initially developed a definition using the NAICS codes in a 2004 study[4] and later modified in 2006.[5] The NAICS classifications included in the Battelle definition are shown in Table 1, on the following page. Many economic development groups use this definition to define the bioscience cluster within their state.

[3] www.bio.org/local/industryDev/i01.asp

[4] Laboratories of Innovation: State Bioscience Initiatives 2004. Battelle Technology Partnership Practice and STTI, June 2004.

[5] Growing The Nation's Biotech Sector: A Regional Perspective 2006 Battelle Technology Partnership Practice

Table 1: NAICS Codes included in the Battelle Definition, 2006

NAICS Code	NAICS Category
Agricultural Feedstock & Chemical	
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 & Pharmaceuticals	
325411	Medicinal & 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 & furniture manufacturing
339112	Surgical & medical instrument manufacturing
339113	Surgical appliance & supplies manufacturing
339114	Dental equipment & supplies manufacturing
339115	Opthalmic goods manufacturing
339116	Dental laboratories
Research, Testing and Medical Laboratories	
541380*	Testing laboratories
541710*	Physical, engineering, & biological research
621511	Medical laboratories
621512	Diagnostic imaging centers

* Includes only the portion of these industries engaged in relevant biological or other life sciences activities
Source: Growing The Nation's Biotech Sector: A Regional Perspective 2006 Battelle Technology Partnership Practice

Using the Battelle definition, 1083 Oregon companies in seven general groups were identified, as shown in Table 2, on the following page. The individual companies are listed in Appendix B: "*Oregon Bioscience Companies by Battelle 2006 Definition*." The company set largely was derived from the *infoUSA* Employer database provided by OECDD, and for the purposes of this initial data gathering, the NAICS codes (presumably provided by the companies) were accepted without modification.

Table 2: Oregon Bioscience Companies Using the Battelle Definition

NAICS Codes	NAICS Category	Oregon Companies*
3112, 3251, 3252, 3253	Agriculture	32
3254	Pharmaceutical and Medicine Manufacturing	54
334510, 339112-339115	Medical Equipment and Supplies Manufacturing	196
334516, 334517, 339111	Laboratory Equipment	19
339116	Dental Laboratories	248
54171	Research, Testing Labs	416
62151	Medical and Diagnostic Imaging Laboratories	118
	Total	**1083**

*Individual companies listed in Appendix B, Source: InfoUSA database provided by OECDD

Data from the Bureau of Labor Standards (BLS) for 2006 was obtained using the same NAICS codes. Company and employee numbers are shown in Table 3.

Table 3: Oregon Bioscience Companies using the Battelle Definition with Employee Data

NAICS Code	NAICS Category	Companies 2006 BLS	Employees 2006 BLS	Avg. Wage 2006 BLS
3112, 3251, 3252, 3253	Agriculture	36	389	$50,644
3254	Pharmaceuticals and Medicine Manufacturing	35	743	$47,990
334510, 339112-339115	Medical Equipment and Supplies Manufacturing	100	3305	$46,041
334516, 334517, 339111	Laboratory Equipment	18	564	$43,432
339116	Dental Laboratories	169	897	$33,059
54171	Research, Testing Labs	137	1343	$41,335
62151	Medical and Diagnostic Imaging Laboratories	121	2181	$54,215
	Total	**616**	**9422**	

* Employee data unavailable for some NAICS classifications due to low numbers of firms
Source: Data derived from Bureau of Labor Statistics, Quarterly Census of Employment and Wages (2006 annual averages)

Regarding differences between these two sources, note that not all of the companies obtained from the *InfoUSA* database were included in the BLS data, which includes only those companies that report payroll to Oregon Department of Revenue. In addition, it should be noted that employee data for some classifications is not included due to low numbers of firms in those classifications.

b. *Oregon Bioscience Industry Definition*

To derive a more useful list of bioscience companies in Oregon for the purpose of the cluster analysis, the definition of bioscience was refined. Overall, selection of companies was based on the following definition.[6]

> ***Companies that apply science and technology related to living organisms in order to provide products and services. These products and services are generally directed to agriculture, pharmaceuticals, diagnostics, medical devices and research.***

Use of this definition led to shifts in the companies included in the analysis (see further explanation of changes in section "c. Oregon Bioscience Subclusters" below). The listing of Bioscience companies in Oregon was developed using a number of sources, including the listing of companies using NAICS codes as described above, OBA membership lists, feedback from stakeholders in the bioscience industry and the contractors' knowledge of individual companies.

The goal was to identify the companies that best represent the bioscience cluster and subclusters that are current and emerging drivers of Oregon's bioscience economy. In this more detailed analysis, a small number of companies were assigned a different NAICS code to describe their business. This new definition and further analysis resulted in a final list of 243 companies as shown in Table 4, on the following page and as listed in Appendix A: "*Oregon Bioscience Companies.*"

[6] Alta Biomedical Group 2007

Table 4: Oregon Bioscience Companies Using Refined Definition

NAICS Code	NAICS Category	Companies 2006 BLS	Targeted Bioscience Companies	Expanded Company List	Notes
3112, 3251, 3252, 3253	Agriculture	36	4	10	Only included bioscience related products. Did not include fertilizer and pesticide manufacturing for agricultural use.
3254	Pharmaceuticals and Medicine Manufacturing	35	50	56	Some companies were reclassified on final list.
334510, 339112-339115	Medical Equipment and Supplies Manufacturing	100	98	95	Only included those that manufacturer medical-related products. Some companies reclassified.
334516, 334517, 339111	Laboratory Equipment	18	19	19	Some companies reclassified.
339116	Dental Laboratories	169	0	0	Not included for further study.
54171	Research, Testing Labs	137	28	28	Excluded environmental and ecological consulting labs.
62151	Medical and Diagnostic Imaging Laboratories	121	0	0	Not included. Consists primarily of clinical testing labs for patients and employers.
	Other			35	Final company list included firms with other NAICS cods (e.g., software).
	Total	**616**	**199**	**243**	

Source: Data derived from BLS, *InfoUSA* databases provided by OECDD, review of company websites, and primary interviews with technology transfer personnel and investors.

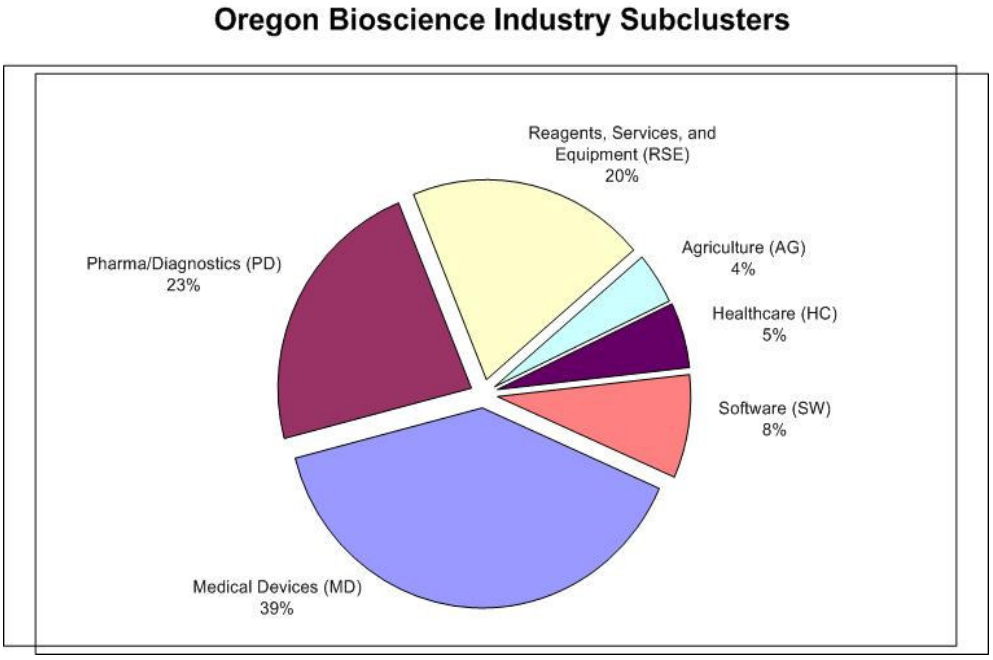
c. *Oregon Bioscience Subclusters*

The 243 companies were classified into the following six subclusters based on similar products and/or technologies.

1. Medical Devices (MD) – consistent with the Battelle definition and NAICS codes; includes Medical Equipment & Supplies Manufacturing
2. Pharmaceuticals and Diagnostics (PD) – consistent with the Battelle definition and NAICS codes; includes Pharmaceuticals & Medicine Manufacturing
3. Reagents, Services and Equipment for Bioscience Research (RSE) – derived mainly from three classifications used in the Battelle definition: Research and Testing Laboratories, Medical and Diagnostic Imaging Laboratories, and Laboratory Equipment
4. Agriculture (AG) – refined by excluding the fertilizer and pesticide classifications included in the Battelle definition

5. Health care (HC) - captures the major research hospitals and institutions in Oregon, which are considered by the advisory committee an important component of this industry, but were not included in the Battelle definition
6. Medical Software (SW) – included as an important component of many medical devices produced in Oregon

Figure 1: Oregon Bioscience Industry Subclusters



For the purposes of this study, we excluded medical diagnostic laboratories because in general they do not develop products or services, but perform tests provided by other companies. Dental laboratories were excluded for similar reasons. Environmental testing services also were excluded; while most of these firms are small and do not have websites, the websites examined indicate that the primary business of these laboratories is to conduct analytical evaluation of soil, water and air, to identify hazardous contamination, generally chemical in nature, and to provide remediation services.

The three largest subclusters in Oregon are Medical Devices (MD) with 95 companies, Pharmaceutical and Diagnostics (PD) with 56 companies and Reagents, Services and Equipment for Bioscience Research (RSE) with 49 companies. These three subclusters comprise more than 80% of the industry and are described in more detail below.

The smaller three subclusters are Software (SW) with 20 companies connected through products and customers, Health Care (HC) with 13 major hospitals and research institutions and Agriculture (AG) with 10 companies based on plant-derived research.

In addition to identifying the subclusters, three subgroups within these subclusters that have closer linkages due to similarity of products, customers or technology were identified. Two subclusters are within the Pharmaceutical and Diagnostic (PD) subcluster and one within the Medical Devices (MD) subcluster. Table 5 lists the six industry subclusters and the three potential subgroups.

Table 5: Oregon Bioscience Industry Subclusters and Subgroups

Industry Subclusters Subgroups	Oregon Companies
Medical Devices (MD)	**95**
Mobility, Balance and Rehabilitation	24
Pharma/Diagnostics (PD)	**56**
Infectious Disease	10
Nutriceuticals and Supplements	12
Reagents, Services, and Equipment (RSE)	**49**
Agriculture (AG)	**10**
Health care (HC)	**13**
Software (SW)	**20**
Total	**243**

Source: Alta Biomedical Group 2007

Medical Devices (MD) - 95 companies

Medical device companies in Oregon manufacture a diverse range of products including prosthetics, wound dressings, drug delivery devices, devices for measurement and analysis of brain and cardiac electrical signals (EEG and EKG), pacemakers and component supplies. Two of the largest companies in this subcluster are Biotronik and Welch Allyn, both of which are subsidiaries of large global and national firms.

Within the Medical Devices subcluster, there were 24 companies (one quarter of the total) that offered products related to the diagnosis or treatment of mobility or balance disorders, or related to rehabilitation.

Pharmaceutical and Diagnostic (PD) - 56 companies

Pharmaceutical and drug discovery companies form more than 90% of this subcluster, with the other 10% represented by diagnostics companies. A recent addition to this group is Genentech, which is constructing a fill and finish facility in Hillsboro.

Within the Pharmaceutical and Diagnostics (PD) subcluster, two subgroups were identified:

a. Companies that focused on diagnosis, prevention or treatment of infectious diseases
b. Companies focused on nutriceuticals and supplements.

Reagents, Services and Equipment for Bioscience Research (RSE) – 49 companies

Companies within this subcluster are split evenly among reagents, services and equipment, with several companies offering a combination of products and services. There did not appear to be any specialty subgroups within this subcluster. The largest company in this subcluster is Invitrogen, which has acquired three Oregon companies during the last few years, and has its major Oregon facility in Eugene.

d. Selection of 3 Primary Subclusters

The three subclusters (MD, PD and RSE) comprise 200 of 243, or 82% of the Oregon bioscience companies. The companies interviewed were selected using the criteria below:

- Industry representation - representation from each of the major subclusters and subgroups
- Size – Representation of small and large firms
- Rate of growth – companies that have achieved growth through increased revenues or recent investment
- Research activity – companies that are making significant advances in research and technology

The number of interviews conducted is shown in Table 6. The individual companies interviewed are listed in Appendix D: "*Key Companies Interviewed.*"

Table 6: Key Company Interviews by Subcluster

Industry Subclusters and Subgroups	Oregon Companies	Companies Interviewed
Medical Devices (MD)	**95**	**12**
Mobility, Balance and Rehabilitation	24	3
Pharma/Diagnostics (PD)	**56**	**13**
Infectious Disease	10	4
Nutriceuticals and Supplements	12	2
Reagents, Services, and Equipment (RSE)	**49**	**6**
Agriculture (AG)	**10**	
Health care (HC)	**13**	
Software (SW)	**20**	
Total	**243**	**31**

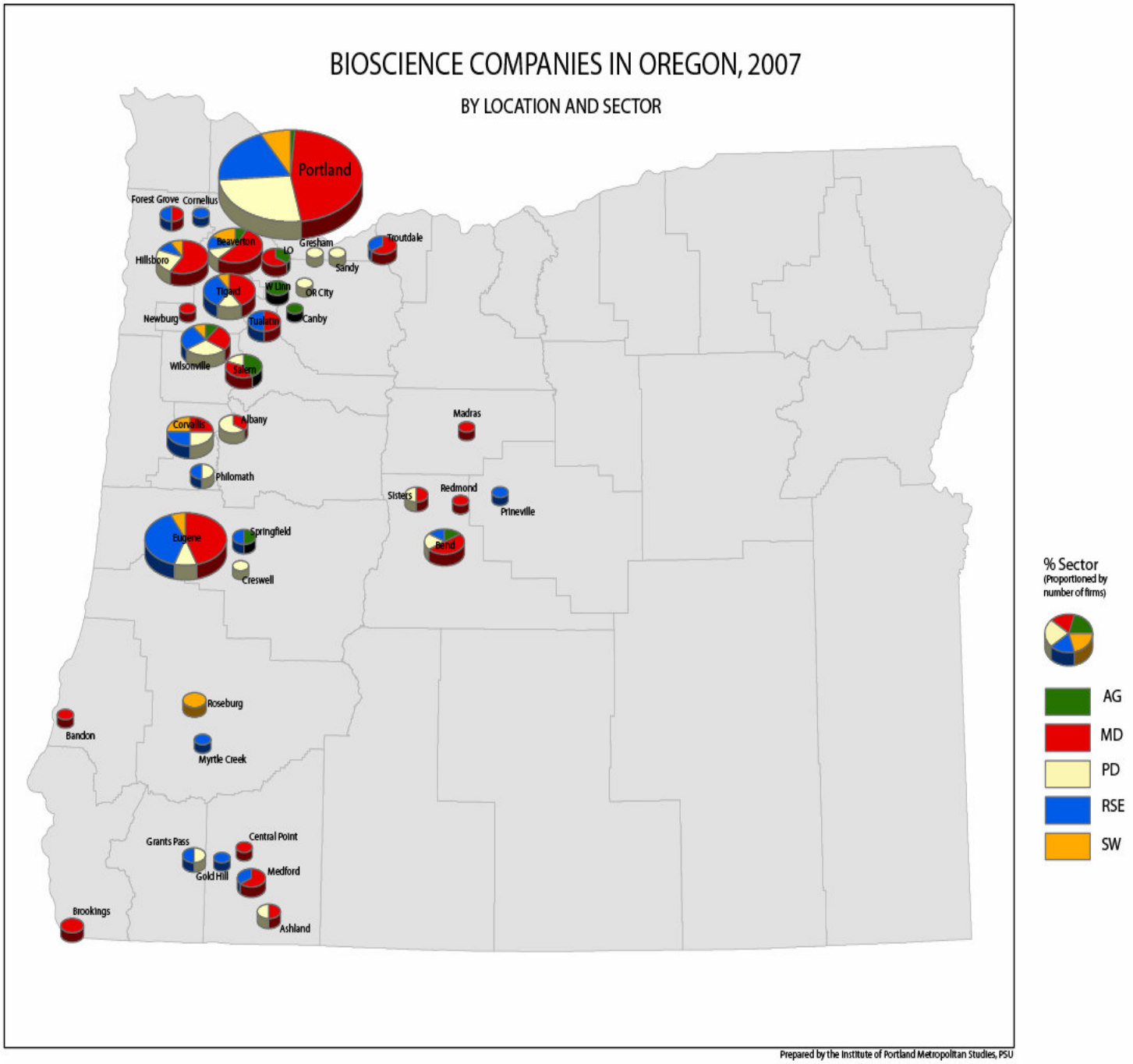
Source: Alta Biomedical Group, 2007

Each of the subclusters has sufficient members to gain a representative sample. Overall, the sample of 31 companies interviewed represented about 13% of the companies in the three major subclusters. Members of the subgroups of each subcluster were included to determine if there were significant characteristics common to these companies to warrant specific strategies to assist these subgroups to grow.

e. Geographical Distribution of the Industry

Figure 2 depicts the locations of the 243 bioscience companies in Oregon. The companies are concentrated around the major metropolitan areas, with a large number of companies in Portland, Hillsboro and Beaverton. Other company concentrations are primarily along the I-5 corridor, particularly near the major research universities in Eugene and Corvallis. There are additional concentrations in Southern Oregon and Bend.

Figure 2: Location of Bioscience Companies in Oregon



5. Results and Analysis

a. Input Conditions

Oregon's lack of a critical mass of bioscience companies is seen as a competitive disadvantage because of the impacts on work force, availability of capital and facilities, supplies and services. These issues were viewed as among the most critical and foundational needs for the industry.

Labor/Work Force

Oregon bioscience companies employ scientific and engineering personnel in both R&D and manufacturing as a high proportion of their total employees. At least half of the employees are scientific or engineering in all six RSE companies interviewed. Two-thirds of 13 PD companies and one-quarter of 12 MD companies reported that more than half of their work force consisted of employees with specialties in biology, chemistry, engineering, manufacturing, clinical applications and regulatory guidance. The larger share of scientists in the RSE subcluster may reflect the ongoing nature of product development requiring continuous research and development in that subcluster.

Companies reported significant recruiting challenges for top positions in both technical and non-technical positions. Currently, the majority of these positions need to be recruited from outside the state. The quality of the work force is considered good, but the pool of talent is not deep, especially for senior positions. Fifty percent of the companies indicated that work force training with an emphasis on manufacturing and regulatory skills is needed. These labor-related issues will continue to be important as company growth continues – 19% of companies interviewed project a doubling of their work force in the next year, with another 61% projecting growth ranging from 10% to 99%.

A major strength in the industry is high-level bioscience manufacturing, particularly in medical devices. Many of the companies interviewed are engaged in bioscience manufacturing that requires a highly skilled work force. Two of the subclusters (MD and PD) are regulated by the FDA and perform their manufacturing under current Good Manufacturing Practices (cGMP). This evidence of highly skilled manufacturing is consistent with the overall strength of Oregon as a manufacturing state.

Oregon is the most manufacturing-dependent state in the western United States, with 12.4% of all Oregon jobs in manufacturing and 211,000 individuals employed.[7] According to a fact sheet issued by Oregon InC, about 20% of all jobs paying more than $44,000 are in manufacturing.[8] In addition, value-added manufacturing in Oregon grew by more than 50% during the recession years 2001 through 2004.

Capital

Many companies received initial investment as a result of capital, grants and equity investment by angels. Most reported difficulties in raising subsequent rounds of capital from within Oregon. Companies that have been successful in gaining significant subsequent rounds of equity investments have done so from outside of Oregon. References were made to the perceived lack of actual investments in Oregon-based companies from a portion of the Oregon Investment Fund by Credit Suisse to encourage investment in Oregon.

Federal grants from the Small Business Association (SBA) are an important funding vehicle for Oregon bioscience companies in each of the three subclusters. About 40% of companies have received either Small Business Innovation Research (SBIR) grants, or Small Business Technology Transfer Research (STTR) grants that require collaboration with a research institution. Several

[7] governor.oregon.gov/Gov/P2007/press_072607.shtml

[8] www.oregoninc.org/events/inno/MFGfacts.pdf

companies attribute their survival as a company to receiving these grants. Several Oregon companies have leveraged these grants to receive larger federal grants and build relationships with corporate partners, leading to significant sales. Newer companies, however, are learning the rules, regulations and requirements for these grants and are actively seeking assistance.

Infrastructure/Facilities

Essentially all companies in the PD and RSE groups require wet laboratory space, while for the MD companies the emphasis is on current Good Manufacturing Practices (cGMP) manufacturing facilities and clean rooms. Most companies have the space they need right now but indicated that growth of their company would require new space in the future. Wet lab space currently is not readily available for new companies and/or expansion. Almost every company mentioned space as a major issue facing their growth, with many indicating that the type of facility they needed was not available locally, meaning that in most cases the companies would be responsible for the capital investment into construction of new facilities.

The ideal arrangement for start-up companies is either to rent laboratory space at universities or in facilities such as incubators that allow some flexibility regarding the expansion (or contraction) of space. An example of an excellent resource is in Eugene at the Riverfront Research Park which has several different classes and sizes of space at different costs, and the Marquam II facility at OHSU, which offers flexible and shared laboratory space for a number of small companies.

Facilities requirements for current Good Manufacturing Practices are regulated. Most of these regulations are designed to prevent infection or cross-contamination with other products. The net result is an increase in cost compared with non-regulated products. By the time companies have FDA-approved products ready for manufacturing they generally have more financial stability, However, the build-out costs are substantial and two companies stated that they will compare costs in southern Washington with those in Oregon before making their next location decision.

Typically, the cost of setting up laboratories is more than double the cost for office space. Due to the requirements of specialized systems, most property owners are unwilling to bear the additional costs of establishing wet lab space with the risk that it will be difficult to re-lease if vacated.

Given adequate funding, of course, companies can and do establish their own laboratories. However, for companies that are still early-investment stage, investors prefer not to invest in "bricks and mortar" and do not like the delays associated with building out space. If laboratory space were to be available, companies would be able to move forward quickly with productive R&D, leading to additional equity invesment as milestones are reached.

Infrastructure/Networking

Networking among bioscience companies in Oregon is still relatively weak, but was viewed as an important factor in building the industry. It is important that industry leaders drive networking. A need for more networking with clear business agendas is understood, but most companies do not give it a high priority due to time and budget constraints. In fact, most companies tend to work through challenges alone, sometimes taking valuable resources that could be leveraged elsewhere. OBA is viewed as the major facilitator of networking activities and there was praise for the OBA-sponsored CEO networking group.

Services

General business services such as legal (intellectual property and general counsel), accounting, human resources and marketing can be and generally were obtained locally. Specialized services such as technical or engineering consulting, biological research services, and sterilization, clinical and pre-clinical services were generally obtained from outside Oregon. The two companies using pre-clinical

services and one company using regulatory-compliant analytical laboratory services indicated that a regional service provider would be very much preferred, and one would like to see a manufacturing resource for clinical trial cGMP-quality materials (but commented that technology needs may vary with different products and between companies.) Two medical device companies would like to have local sterilization and packaging services to enable faster turnaround. However, there are many types of sterilization used, so further information would be needed to determine if multiple companies could use the same service if it became available.

Cost of Doing Business

The three companies interviewed that moved to Oregon from outside the state included cost of doing business as one of the reasons for their move, along with factors such as qualified work force, quality of life, recruitment packages put together by economic development officials, and tax policy. A couple of companies interviewed specifically mentioned the single sales factor (i.e., corporate income tax apportionment based on sales in Oregon) as a positive factor.

Suppliers

A majority of the companies require specialized goods for their products. Few of these requirements overlap, and seem to be specific to each company. Medical device companies have a requirement for printed circuit boards, specialty plastic molding and sensors. A minority of companies developed their major reagents and products in-house (in some cases these are proprietary) or from readily available supplies. Regarding regional access to goods, few companies had concerns. In general, companies can access what they need locally or do not see a pressing need for a local source. The issue of access to source of goods was not expected to change with growth.

b. Demand Conditions

Customers

There are no significant linkages among the Oregon companies based on their customers, even when they reported similarities in the types of customers. MD companies sell into hospitals while PD and RSE sell to pharmaceutical companies and researchers. Customers are located across the world. While the similar types of customers are mentioned, the particulars differ. For example, many medical device companies sell to hospitals, but target different medical specialties (e.g. cardiology, emergency care etc.) Similarly, large pharmaceutical companies are a broad class of customers that use a range of different products and services. The Federal Government (Department of Defense and Department of Homeland Security) is a significant customer for several companies, but they do not cooperate in applying for grants from those agencies. We found no examples of a local customer, with the ability to drive R&D, being served by more than one Oregon bioscience company.

Companies expect to grow initially from expanding into existing markets with increases in sales penetration and later from targeting new market applications. The customers would remain the same, but the mix might change. Companies expect to use distributors largely in the future and to develop more corporate partnerships.

Most of the companies have or expect to have international sales using direct sales and/or distributors. Companies see an opportunity for their products in Asia/China, but also see significant challenges to expanding internationally. Challenges include finding the right distribution partner; regulatory requirements in other countries; and cultural, education and communications issues. International business has been achieved with little or no state or federal assistance, although five companies mentioned support relating to the Medica conference. Specific forms of assistance identified include:

- Screening, identifying and checking potential distributors
- State sponsored trade missions, offices, training and education opportunities
- Training in import/export mechanisms and documentation
- Travel subsidies.

Some or all of these services are available in Oregon, but companies are not aware of the level of assistance they can receive.

Related and Supporting Industries

The inter-industry interactions that were expected did not surface. The electronics, software, metals and materials industries are currently viewed as suppliers of goods, rather than potential partners. However, ten of the companies interviewed expressed a dependence on the pharmaceutical industry (outside the state), for example, as potential corporate partners to assist companies in the pharmaceutical/diagnostics subcluster with product development. They would serve these large corporate partners by developing new technology and products that help to fill their product development pipelines.

Oregon bioscience companies reported few connections with larger company partners, whether inside or out of the state. There are several large companies in Oregon that have the potential to impact the bioscience cluster, including two bioscience companies that are new to the state – Genentech and Invitrogen. Both are beginning to establish outreach activities. Non-bioscience companies with local operations that could have an impact include:

- Intel has a research collaboration[9] with OHSU and the Oregon Center for Aging and Technology (ORCATECH[10]) to develop technologies for independent living for the aging population. These technologies include ways to monitor activity, detect neurological decline, and detect and prevent decline in mobility.
- Precision Castparts, which provides components for hip, shoulder and knee prosthetics.
- HP, which has inkjet technology that has been partly developed for various life science applications before a change in company strategy put these projects on hold.

c. Trade Shows and Trade Associations

Oregon bioscience companies attend many trade shows and conferences. The trade shows are extremely specific to each company and few of them overlap among companies (except Medica). Among medical device companies, Medica and MDM (Medical Device Manufacturers) seem to attract the most comapnies. Specialty shows include Emergency Medicine, Orthopedic Surgeons, American Academy of Neurology and American Acute Care. More than 40 possible shows were mentioned in interviews. Only five companies interviewed believe that a state presence at trade shows is helpful because the shows are very specialized and should relate to recruiting. Trade shows

[9] www.intel.com/health care/research/index.htm?iid=health+lhn_hri

[10] www.orcatech.org/

such as BIO, Medica and MDM are examples that would be appropriate for the purpose of lead identification for recruitment.

Fourteen companies indicated that they are active in trade associations and 11 are active in OBA, which they see as useful for information sharing and networking. The main issue limiting participation is time. Other industry groups mentioned include Advamed, American Society of Mechanical Engineers, Printed Circuits APEX, NW Food Processors, NW Defense Coalition and Oregon Entrepreneurs Network. Seven companies indicated that they attended 25 or more trade shows. Most others indicated that they attended three or four major trade shows.

The industry is beginning to show signs of self-organizing through the OBA. Fifty-three of the 243 companies in the Oregon bioscience cluster are OBA members, including most of the larger companies. Issues of shared interest include work force training, lobbying for general state support of the industry and the provision of services, SBIR training, facilitation of space, business training and facilitating interaction among companies, industries and universities.

d. Context for Firm Strategy and Rivalry (Industry support)

At the current time, the bioscience industry has little rivalry and little competitive advantage. The bioscience cluster has not upgraded its own level of business sophistication. This is partly because the foundations of a bioscience cluster are weak and require the full attention of the business executives involved and because of the lack of readily accessible resources in the region.

The development of a more sophisticated and productive environment is essential for the growth of the cluster, and this is beginning to be recognized. Both Genentech and Invitrogen bring a high degree of sophistication to their operations, and are taking an active role in industry-wide efforts. The Oregon Bioscience Association is beginning to act as a catalyst to drive industry initiatives that are seen to benefit all companies. Most of these current initiatives fall under the input conditions such as work force training, capital and infrastructure.

The local regulatory environment was not viewed as an important issue. However, the FDA regulates all companies in the medical device and pharmaceutical subclusters. Common needs for advice and training act as a linkage among companies, which share consultants, work force training, etc.

Strategic Plans for the Industry

OBA intends to develop a strategic plan and currently has established committees to address work force, capital, regulatory, government affairs, and increased networking. Bioscience also forms one section of the overall Oregon Business Plan.

The Oregon Business Plan is also conducting a series of focus groups to look at opportunities and challenges. Each industry's needs and cluster-specific initiative ideas will be shared with the relevant organizations statewide and used to guide future agendas.

e. Stage of development of bioscience cluster

A 2002 report of Oregon Clusters by the New Economy Coalition (NEC)[11] noted criteria for defining a cluster. An overview of these criteria is shown in Table 7.

Table 7: Characteristics of Clusters at Different Stages of Development

Stages of Cluster Development	
Pre-cluster	Few firms with limited links. Anchor firms emerging.
Emerging cluster	Firms creating links and organizing to form industry associations and alliances.
Expanding cluster	Growing linkages and critical mass. Economic impact expanding. Networking is spontaneous.

Source: New Economy Coalition Report, 2002

Within these criteria, the Oregon bioscience industry could be described as an **emerging cluster**. It lacks many of the competitive advantage characteristics of a cluster, but has some of the properties of horizontally integrated clusters (e.g. sharing markets and work force) and technology-integrated clusters (sharing technology sources). Essentially all products and services are provided to out-of-state or international customers. There is a well-educated work force available, although the pool is not as large as companies would prefer. There has been acquisition of Oregon companies (without relocation) by Welch Allyn, Biotronik and Invitrogen, leading to significant manufacturing and R&D subsidiaries, as well as active re-location into Oregon, including a Genentech manufacturing facility. Over the last few years, and particularly during 2006 and 2007, increased industry support has revitalized the Oregon Bioscience Association, which has an active role in networking and work force training.

The status of Oregon's bioscience cluster is shown in Table 8: Criteria for Stage of Development of Cluster**.**

Table 8: Criteria for Stage of Development of Cluster

Criteria for Cluster	Oregon Bioscience
Net Exporter	Yes
Ample specialized labor	Present but not ample
Senior Management	Few
Specialized supplier present	No
Specialized capital present	No
Specialized infrastructure	No
Active relocation or investment	Modest
Self-organizing	Recent
New companies formed	Yes
Innovation source	Yes-moderate
Rapid diffusion of innovation	Yes-moderate
Use technology as a competitive advantage	Yes
Higher than average growth rate	Need accurate metrics

Source: New Economy Coalition Report, 2002 and Alta Biomedical Group, 2007

[11] www.oregoneconomy.org/NEC%20POV.clusters%20-%2011-11-02%20final%20v2.ppt

6. Assessment of Gaps in Oregon

This section describes some of the key bioscience-related efforts and provides an overview of the gaps found between Oregon practices, the practices of other states, and outlines the particular needs and concerns expressed by the companies interviewed for this study. Oregon has made considerable progress in TBED in the past five years, largely as a result of a Government-University- Industry (GUI) partnership initiated and piloted with the Oregon Council for Knowledge and Economic Development (OCKED), and formalized in 2005 by Governor Kulongoski in Oregon InC. (Oregon Innovation Council).

Oregon InC is a cross-sector leadership team created by the Governor and State Legislature to drive the state's innovation strategy. Oregon InC's mission is "to identify Oregon's top innovation-driven growth opportunities, maximize the state's competitive advantages and establish Oregon's niche in the global economy."[12] Oregon Inc. is addressing issues such as building research capacity in the state university system, providing the research and applications infrastructure, and expanding the seed and venture capital available to promote local technology transfer and commercialization. The initiatives are applicable statewide and important to the Oregon bioscience industry.

Initiatives include:

- Signature Research Centers: Investment into opportunities committed to accelerating the commercialization of cutting-edge research and facilitating public-private partnerships that anchor next-generation industries in Oregon. These include ONAMI, OTRADI and BEST (see above).
- Capital formation: Three specific proposals intended to bridge the gap in pre-seed and early-stage capital:
    - Expand the Oregon Growth Account Board's scope and authority to include investing in funds that provide early stage financing for Oregon's newest growth businesses and seed financing for new innovations launched by existing Oregon firms.
    - Modify the statutory language governing the University Venture Development Fund, effecting modest changes in the statutory language to clarify the law's intent and better support its implementation.
    - Endorse the effort to develop a statewide angel and entrepreneur network to better connect entrepreneurs with financing opportunities.
- Improvement of higher education resources
- Improvement of technology commercialization support from the state.
- Supporting funding for an Innovation Accelerator ($5 million) in partnership with OECDD, to provide on-going support for the cultivation and nurturing of these and other great ideas. (Not funded to date).

A detailed description of the 2007 Innovation Plan containing these initiatives can be found at the Oregon InC website.[13]

[12] www.oregoninc.org/index.htm

[13] www.oregoninc.org/07plan/sum4.htm

a. Oregon's gaps as identified through primary and secondary sources
Recruitment and Industry Promotion

The Oregon bioscience cluster is relatively small and does not have the critical mass to have a competitive advantage as a whole or in any of the subclusters. Feedback from the companies indicates that this is a major challenge. Until recently, it has not seemed feasible to recruit additional companies to Oregon. However, now there is an emerging opportunity for Oregon to recruit companies that wish to manufacture medical/bioscience products in the U.S based on the manufacturing strength of the region.

Oregon's history as a manufacturing state and the leading manufacturing state on the West Coast should be leveraged for these opportunities.[14] The opportunity for bio-based manufacturing has arisen due to changes in the industry over the last few years. First, the bioscience industry as whole is maturing. Earlier, companies were created in every state using local resources, grew largely in place and built their manufacturing plants close to the source of technical expertise. There wasinsufficient incentive to relocate during the early stages of a company's growth or even during early stage manufacturing. Now, as a number of companies have matured, they approach the location of manufacturing sites in a highly structured way, more similar to the approach used in other industries. There is still reluctance for many companies to move highly technical manufacturing offshore due to the potentially life-threatening nature of manufacturing errors for patients. This presents a growing opportunity for states with lower costs, educated work force and other favorable business conditions to compete on locating new manufacturing facilities. Oregon has demonstrated this potential with the recruitment of Genentech, as well as the successful retention of Welch Allyn, Biotronik and Invitrogen.

Another contributing factor is that the cost of living and doing business has continued to increase more rapidly in other areas, particularly in some of the bioscience centers, such as the San Francisco Bay Area, San Diego and Boston. Currently, it is difficult to attract personnel to these areas because of the cost of housing, making Oregon a more attractive location.

Capital Availability Gap

A critical need is a continuous pipeline of financing sources, including university and Signature Research Center funding, followed by angel, seed and Round A funding. Round A funding may be followed or replaced by venture capital investments for A and B rounds, leading to higher valuation and further equity investment rounds. Only a few of these sources are in place in Oregon for bioscience companies. Oregon and other states have used various techniques to address this gap. Within Oregon, initiatives have been designed to provide early stage funding from OGA and later stage VC funding from the funds managed by Credit Suisse. While Northwest Technology Ventures has made an impact investing in bioscience, there has been little other venture investing in the industry from within the state of Oregon. The level of angel funding in Oregon has been increasing over the last few years, partly due to OEN-sponsored programs. As a result of these programs, the Oregon Angel Fund has made two bioscience investments to date.

[14] Portland Business Journal

Oregon InC has an active committee that addresses the capital needs of emerging companies and has made a number of recommendations that would assist bioscience companies:[15]

- Support Oregon's Angel Network Initiative.
- Increase pre-seed capital by expanding the scope of the Oregon Growth Account to leverage smaller investments.
- Increase seed and early-stage capital by implementing University Venture Fund program changes.

Angel Organizations and Pre-Seed Investments

The earliest stages of investment funding for companies come from private investors known as angels, and from organizations that do what is called "pre-seed" investing – earlier investments than major investors such as venture capital firms will make. The state through the Oregon Growth Account (OGS) is considering the possibility of an initiative in the area of angel investing and representatives of the OGA management group have attended meetings of the Oregon Angel Fund (a private fund comprising angel investors). There are a number of angel groups that are active and which consider bioscience deals for investment. These include:

Oregon Entrepreneurs Network (OEN)
OEN sponsors two angel networks, one angel fund and one angel event as well as entrepreneurial training:

Portland Angel Network (PAN)
Women's Investment Network (WIN)
Oregon Angel Fund
Angel Oregon

Portland Venture Group – long established angel network

Keiretsu Forum – an angel forum with offices in many cities, Keiretsu has recently established a Portland group.

Tech Coast Angels – a national angel umbrella organization with funding committed by OGA pending first close.

FluffCo – the investment vehicle of Irving Levin, a prominent Portland financier and prolific angel investor.

Angel networks in Eugene and Bend, including Bend Resources (Bend Venture Conference) and Bend Capital Group

Broadly available to Oregon research universities is the new university-driven **University Venture Development Fund,** based on Oregon legislation providing tax credit for donors, which will be important to help commercialize technologies from the universities. In addition, one of the Signature Research Centers, ONAMI, has established the **ONAMI Gap Fund** that has invested in one local biomedical company. In addition, OHSU has the Innovation & Seed Fund (OHSU's implementation of the University Venture Development Fund) used to advance technologies in the development pipeline, and provide small seed capital as part of additional angel, venture capital or other equity investments in start-up companies based on OHSU research.

[15] www.oregoninc.org/07plan/capacity.htm

Seed stage venture funds

The following seed stage funds are an important piece of the "pipeline" of continuous funding in Oregon and are only able to make modest investments at this time. Specific bioscience investments by each of these funds are shown in Table 9.

Northwest Technology Ventures (NWTV) – a $14 million fund from the Oregon Growth Account in 2002. NWTV is the lead firm making bioscience investments in Oregon with more than half its portfolio in life science-based companies. Unfortunately, it is almost fully subscribed.

Capybara Ventures – a $2 million fund from private investors. Capybara does not have a specific focus on bioscience but has made one bioscience technology investment.

Oregon Life Sciences – a hybrid angel/venture fund which does not have committed capital but syndicates investors and invests on a deal-by-deal basis. OLS has made several investments in the past but has not been active recently.

Table 9: Seed Stage Venture Investments in Bioscience

NWTV	Oregon Life Sciences	Capybara Ventures
Acrymed	Artielle Immunotherapeutics	Lumencor
Artielle Immunotherapeutics	ID Biopharma	
Virogenomics	Neuroprotect	
Anti-Gene	Virogenomics	
AlphaDry Corporation		
NuMedics		
Receptor Biologix		
Neuroprotect		
Clinicient		
Vigilan		

Source: Alta Biomedical Group interviews, 2007

Early stage venture funds

Oregon Investment Fund, a fund of funds managed by Credit Suisse with funding from the Oregon Investment Council, has made investments in Burrill & Co. (San Francisco) and DJF Frontier (Sacramento). Both of these early stage venture funds make investments in life science companies. Burrill has invested in Proteogenix, an OHSU spinout, and is reviewing several others. Frontier is in discussions with companies but has not yet made any bioscience investments in Oregon.

Later stage investment and Oregon State Funds

Later stage investments tend to be larger ($5 million and up) and made in more fully developed companies. Later stage investments in Oregon bioscience companies have come largely from out of state funds, or from groups funded through state initiatives.[16]

[16] Information in this section has been obtained from a number of sources, including web sites, press releases and personal communication from William Newman, Northwest Technology Ventures.

Private venture firms
Out-of-state firms currently fill the need for later stage capital. Private venture firms from outside of Oregon that have invested in Oregon bioscience companies include:

- Sanderling
- UVen
- Tenex
- Domain
- Takeda Pharmaceutical Ventures
- Essex Woodlands
- New Science Ventures
- Voyager
- Village Ventures
- Highway 12

Alloy Ventures has received funding from the OHSU Foundation, but has not invested in Oregon companies and has not been a presence locally.

Oregon Growth Account
The Oregon Growth Account (OGA) receives 10% of the funds from the Oregon Stability Fund (formerly known as the Education Endowment Fund) which receives 18% of lottery proceeds. Returns are generated by investing in funds whose charter is to invest in emerging companies in key industries. Funds are placed with fund managers for investment. However, this charter has evolved over time and the OGA invests in a broad range of funds, from mezzanine debt to venture to buyout.

Oregon Investment Fund
The Oregon Investment Council, which manages all state investment, hired Credit Suisse in 2004 for managing a $100 million Oregon Investment Fund that "targets venture capital firms in the Northwest, geared toward investing in Oregon-based companies."[17]

As of September 2007, the Oregon Investment Fund had committed $86 million to nine venture funds. According to a recent press release, these funds have invested in eight Pacific Northwest companies, which received $41 million from these funds and leveraged $29 million from other venture firms. (The number of Oregon companies receiving funding was not disclosed.)

Other

SBIR/STTR grant funding
Federal grants from the Small Business Association are an important funding vehicle for Oregon bioscience companies in each of the three subclusters. Several have leveraged this R&D funding to obtain larger federal grants, build relationships with corporate partners, and acquire equity investment and sales. Companies also see this as an area where the State should provide more assistance in the form of both grant application assistance, training and education regarding rules and regulations, and matching or gap funding. The US National Institutes of Health exclusively funds health-related projects and its grants are one indicator of bioscience SBIR/STTR funding. This funding has been growing. As of October 2007, the number of NIH grants was 86, up from 50 in 2004 (see Table 10, page 27).

In the past, the Oregon Economic and Community Development Department (OECDD) has sponsored programs to help companies obtain SBIR grants, including SBIR training, train-the-trainer

[17] http://www.ost.state.or.us/divisions/investment/OIC/InvestOregon.htm

programs, and assistance with grant applications. In addition, an online toolbox for grant applicants was developed and is available on the web.[18] In 2006 and 2007, OECDD had a modest budget of $60,000 to fund grant writing assistance or participation in regional or national SBIR/STTR training conferences. Given the importance of SBIR/STTR grant funding, this is an area where enhanced funding could allow effective initiatives such as those seen in other states. A well-publicized and increased investment in this area could have a significant impact on the ability of Oregon firms to attract federal funding under these programs.

Table 10: SBIR/STTR NIH Grants for Oregon Bioscience

Year	Number Grants: SBIR/STTR
2004	50
2005	46
2006	71
2007	86

Source: Summarized from data at http://grants2.nih.gov/grants/funding/award_data.htm

Industry Initiatives

OBA has established a Capital Formation committee to address the needs of companies. The intent is to develop a set of "briefings" for companies that are seeking funding and to develop a database of potential investors.

Other government funding

In addition to funding via SBIR/STRR grant mechanisms, Oregon bioscience companies receive direct funding from several US government agencies. For example, Hemcon Medical Technologies has received $29 million in contract and grant funds from the US Department of Defense in support of product development and manufacturing and supply of its hemorrhage control bandages. Siga Technologies received a grant of $4 million from the U.S. Air Force to create systems for rational development of vaccines and therapeutics against potential agents of biological terrorism. AVI Biopharma received four contracts related to an $11 million allocation for defense-related development of therapeutic antisense drugs. Other companies such as Acute Technologies, NTI and Flash Sensor Tech also received federal dollars outside the traditional SBIR/STTR routes.

Gaps in Management and Work Force

Companies identified a need for experienced management and senior technical staff in addition to more trained work force. Oregon bioscience companies employ a high percentage of scientific and technical personnel ranging from 20% to 100% of total employees. Recruiting is more difficult for positions that require experienced technical and management personnel. More than 80% of the companies experienced challenges in finding employees with the right experience or skills in the local pool. These generally must be recruited from out of state, with associated recruiting and relocation costs.

Most companies indicated that it was possible to recruit entry- and mid- level technical people with undergraduate training from local and regional universities and companies in similar businesses although the pool of potential candidates is not large. Companies viewed OBA's initiatives in this area positively and now seek a wider set of training courses.

[18] http://www.bizcenter.org/Services/7530/6198/7548/

Work force training needs mentioned by companies included:

- Management, including medical, financial, organizational and Medicare/Medicaid reimbursement issues
- Manufacturing, including current Good Manufacturing Practices (cGMP) for devices and drugs, clean room, Lean Manufacturing, SixSigma
- FDA regulatory requirements, including Quality Assurance (QA), Quality Control (QC), development, scale-up, Standard Operating Procedures, design control, equipment validation, biologicals and software
- Marketing, including medical device, pharmaceutical and off label use of approved drugs
- General laboratory skills, with some noting colleges or universities as possible sources of courses.

OHSU, University of Oregon, Oregon State and Portland State all have MBA and other programs with some emphasis on entrepreneurship. OHSU and University of Portland are jointly developing a new certificate program in technology entrepreneurship for graduate students at both schools. Programs such as these do not fill the immediate need for experienced executives, but they do train future managers and entrepreneurs.

The Oregon bioscience cluster also lacks significant interaction with other Oregon industries that could contribute significantly to the supply of managerial talent. Interactions with these other sectors must be promoted. These other sectors bring a rigor and sophistication to their business operations that could be applicable across industries and could benefit Bioscience companies. In Washington, for example, new management in some bioscience companies comes from the software industry, and brings a new perspective to bioscience. In Oregon, few high technology managers have entered the bioscience area. OBA could encourage this crossover by promoting board participation in bioscience start-ups by high technology senior managers.

OBA is embarking on an expanded program of work force and executive training and has established a steering committee comprised of industry human resource and training personnel to select from among many possible course offerings. The direct costs of implementing the training will be covered by federal funding through WorkSystemsInc., a nonprofit organization that invests in employment and work force training programs. They have identified multiple sources of trainers in different areas. This year's effort builds upon a successful training program in 2006 directed towards training incumbent employees in regulatory affairs, which was almost fully subscribed and attended by 135 individuals from the industry. While the initial 2006 training was offered in the Portland metropolitan region, about two-thirds of the Bioscience cluster is headquartered in that region, and OBA is working to make appropriate training available on a broader geographic basis.

The OBA also supports a job fair to introduce Oregon university graduates to companies. The job fair was first held in 2007, and was a success by many standards – 193 attendees interacted with representatives of more than two dozen Oregon companies.

In addition, universities are aligning some of their programs with industry's needs, and are developing new curricula and intern programs that cut across biosciences, materials science, electronics and computing, as well as management.

Two Seattle based development and construction companies are currently researching their potential entry into the Portland market with attention to wet laboratory space. Key stakeholders in the Oregon bioscience industry can work to link them with potential anchor tenants such as the universities to encourage them to expand locally.

At present, there are several locations where a limited number of Bioscience companies have found space to lease that includes wet lab space.

- OHSU houses several OHSU-affiliated bioscience companies in its Marquam Hill facility and on its West campus. OHSU leases laboratory space to OHSU-affiliated startup companies.
- Portland State University operates a business incubator in Portland; the facility has no wet lab or clean room space, limiting its usefulness for bioscience companies. The university is temporarily renting laboratory space in university buildings to a few PSU-affiliated bioscience and chemistry companies.
- The University of Oregon is in a partnership to operate the Riverfront Research Park in Eugene. Several bioscience companies are located in facilities there which range from "starter" space with minimal facilities in the Innovation Center, to well-developed laboratories and tissue culture facilities. The university also provides access to certain specialized facilities by means of individual use agreements.
- The Open Technology Business Center in Beaverton leases space and provides entrepreneurial support services, but again has no wet laboratory space. One bioscience company from the RSE subcluster is housed in this Center.

Infrastructure/Networking

Networking is viewed as an important factor in building the industry in certain competitive regions such as San Diego. Networking events must focus on clear business needs and should be driven by industry leaders and OBA.

The OBA has expanded the number of networking events available to the industry and offers networking support through CEO-only sessions; topical information and networking to the community more broadly through the BioForum series; an industry-wide informational, trade show and networking event at its annual meeting; an annual job fair, and a social networking through Bio on the Vine.

University Linkages and Research Strength

Almost 90% of the companies interviewed reported linkages with Oregon research institutions. About one-third had licensed technologies and several had ongoing research collaborations. Several companies indicated that they would like to have a closer relationship with universities, but developing this relationship is percieved as challenging for companies.

The strength of university research was not studied specifically in this study, but was assumed as an underlying requirement for the success of the bioscience industry. This requirement is strongly supported by BIO and by studies of the bioscience industry in other states. Many initiatives, including several in Oregon, have been adopted to strengthen and focus university research strengths. Technology transfer, while viewed as essential, was also not specifically addressed in this study.

Oregon research institutions are the source of about 34 spin-out companies in the state, with additional research sponsors and facility users bringing the number of company linkages to about 40 (See Table 11, on page 31). Companies with links to the research institutions are found in most of the subclusters of the Bioscience industry. The research institutions also provide many resources to companies, including specialized research facilities, incubator space, gap funding, and business start-up support.

Oregon universities are collaborating in the area of innovation commercialization and have spurred the recent creation of a shared web portal providing linkages to inventions and research collaboration opportunities at the four major institutions – OHSU, OSU, PSU and UO.

In addition, there are at least two academic business programs that have included bioscience companies:

- PSU's "Lab2Market" mentoring program, a collaborative partnership across the state of Oregon to promote innovation. It is a three-year, $600,000 project, funded by the NSF's Partnerships for Innovation Program and managed by PSU. The goal is to deepen the commitment to commercializing novel technologies by forging networks between private-sector business expertise and world-class research at Oregon's primary research universities.[19]
- UO's Lundquist College of Business business plan competition, which reviews business plans by teams including UO students and entrepreneurs, and provides support for winning plans.

[19] http://www.lab2market.pdx.edu/

Table 11: Oregon Research Institution Linkages with Bioscience Companies (Spinout Companies)

OHSU	UO	OSU	PSU	Providence
Acute Innovations	Cerebral Data Systems	Home Dialysis Plus	DesignMedix	HemCon
Advanced PsychSysterms	Electrical Geodesics, Inc.	SIGA Technologies	QuZyme	
AMES Technologies	FloraGenex, Inc.			
Artielle ImmunoTherapeutics	Insignia Health			
BioSpeech	Mouldworks			
Cylerus	Mitosciences, Inc.			
Columbia Biotech	Oregon Research Institute			
Elepar	Oregon Social Learning Center			
ID Biopharma				
Molecular MD				
Najit Technologies				
Neuroprotect				
Oncosolutions				
Portland Bioscience				
ProteoGenix				
Restoration Genetics				
Sim Health				
Thetus				
VeinCo				
Virogenomics				
Yecuris				
Znomics, Inc.				
Licensees				
All of the above	Invitrogen/Molecular Probes	AVI Biopharma		
	Virogenomics, Inc.	Electro Scientific Industries		
		Invitrogen/Molecular Probes		
Research Sponsors				
Chemica Technologies AMES Technologies Neuroprotect Restoration Genetics	Mitosciences, Inc.	Chemica Technologies	DesignMedix	
		Coherent Group		

Source: Alta Biomedical Group interviews with technology transfer officers at listed institutions

Oregon research institutions are collaboratingto commercialize research and promote Signature Research Centers (SRC). The most mature example of an SRC is the Oregon Nanoscience and Microtechnologies Institute (ONAMI)[20], a network of nanoscience and microtechnology expertise that is moving nanoscience and microtechnology innovations from basic research through to commercialization. ONAMI has stakeholders from all the major Oregon research institutions and the

[20] http://www.onami.us/

Pacific Northwest National Lab. The recent agreement to add OHSU to ONAMI will enhance the bio applications of nano- and microtechnology, and contribute to the growth of the Medical Device subcluster. ONAMI collaborations have resulted in several joint grants and patent applications, including biomedical applications.

A new Signature Research Center, the Oregon Translational Research and Development Institute (OTRADI)[21], is now funded. Collaborations include scientists from PSU, OHSU, UO, and OSU cooperating to advance technologies for diagnostics and therapeutic applications in infectious diseases. OTRADI will provide services to evaluate new chemical compounds, beginning with the Oregon Collection, a set of compounds that has already been identified. Intellectual property agreements have been established with all four research institutions to cover the possibility of new inventions arising out of the service work. The Institute will offer its services to for-profit companies as well as to the universities. OTRADI will be physically located at PSU.

In 2007, the legislature approved an increased budget for higher education in the state, including $21 million for enrollment growth, $10 million to improve Oregon faculty salaries that are among the lowest in the nation, $233 million for capital construction and support for regional universities and community colleges. The investment is viewed as critical to supporting research and student capacity.

Goods and Services

A majority of the companies require specialized goods for their products. Few of these requirements overlap and are specific to each company, such as printed circuit boards, specialty plastic molding and sensors. A minority of companies developed their major reagents and products in-house (in some cases these are proprietary) or from readily available supplies. Regarding regional access to goods, few companies had concerns.

A 2006 publication from BIO, "State Legislative Best Practices to Support Bioscience Industry Development"[22] documents the key needs for growth of a bioscience industry cluster and describes some key examples of state efforts to do this. These key areas are consistent with the issues found in the interviews conducted with Oregon bioscience companies: Technology transfer and commercialization:

- Facilities for growth
- Venture capital and discovery funds
- Bioscience work force initiatives
- Supportive business climate incentives.

> "Despite the rapid advancement of technologies in the biosciences, and a heightened awareness by policy makers of the business and regulatory challenges confronting the bioscience industry, the fact of the matter is that most of the biosciences industry is populated by emerging companies that continue to need support mechanisms to sustain their research and development activities. While the industry has grown significantly in the past decade, it faces a long evolution before it becomes an economic engine in many states."
>
> ~ www.bio.org

The report points out that many states passed initiatives during the 2005-2006 legislative session in support of the bioscience industry in their state. The BIO document provides many examples of initiatives that support each of the key needs. However, the report stresses that the process is slow and takes patience.[23]

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21 http://www.oregoninc.org/events/inno/OTRADIfacts.pdf

22 www.bio.org/local/industryDev/IndustryDevelopmentSupport_BIO.pdf

23 bio.org/local/industryDev/i04.asp

The analysis of practices from other states focuses on initiatives from two comparable states, Arizona and Colorado. These two states were selected for detailed assessment because they share several attributes with Oregon. They have:

- Similar populations in the 4-6 million range
- Similar economies, with a mix of emerging high tech clusters in IT and traditional industries such as farming, mining and forestry
- A similar geographically dispersed system of state research universities, with total annual research volumes of ~$500 million
- Relatively small bioscience industries with no major Pharma or health care companies as anchors
- Developed strategic plans, or roadmaps, for the development of their industries by focusing and building on their strengths.

Table 12 scores Oregon against the BIO best practices relative to Arizona and Colorado.

Table 12: Oregon's Rating Against State Best Practices

Area	Oregon Rating	Particular Strength/Weakness
Company Recruiting	Low	- Few anchor companies - No big pharma
Research, Technology Transfer and Commercialization	Medium	+ ONAMI has national recognition + Venture Development Fund
Facilities for Growth	Low	- Limited bioscience incubators/accelerator space - Little wet lab space
Venture Capital and Discovery Funds	Medium	+ Gap and seed funds becoming available - Funds for later rounds hard to find in state
Bioscience Work Force Initiatives	Medium/High	+ Training programs for support workers + Professional certificates - Hard to find high level executives

Source: Alta Biomedical Group 2007

The table shows that Oregon has some form of activity in each area considered critical to the growth of the bioscience industry, and in a few cases has recognized "Successful Practices." Oregon Inc. has developed and maintains an Innovation Plan that outlines and coordinates objectives, strategies and activities. This allows the monitoring of progress, measurement of results and targeting future state investments.

Strategic Plans

The Oregon bioscience industry needs to develop a strategic plan and there are initiatives within the OBA to complete this task. Both Arizona and Colorado have developed plans and metrics for the growth of their bioscience industries.

Arizona

Since starting to implement their Bioscience industry roadmap[24], developed in 2003 under the sponsorship of the Flinn Foundation, Arizona has begun to measure outcomes.[25] Prior to the development of the roadmap, Arizona had multiple academic and medical programs that were quite good individually but had little coordination and cooperation with each other. In December 2006, they reported progress on most of their roadmap goals. They attribute their success to a systematic and strategic approach to investment that involves public, private and philanthropic resources and close interaction among the various government, university and industry stakeholders. Most of the initiatives are referenced in the Flinn Foundation website.[26]

According to the 2006 update from Battelle, Arizona has made substantial progress in its goal: "Initiate a statewide image, marketing and business development effort to market Arizona as a location for bioscience firms." A website[27] has been developed that provides a centralized portal for information about the biosciences in Arizona. In 2006, Arizona launched the Biozona brand to promote the state's bioscience industry.

Colorado

Colorado also developed a strategic plan in 2003.[28] They reported progress in 2004.[29, 33] The Colorado initiative is based on the view that bioscience has a good foundation in Colorado, is a high growth sector, is renewable and can contribute to the growth of other high technology sectors. The plan called for an alliance of business, universities and government. Colorado has a strong medical device industry, and in 2003 was 52% more concentrated in Colorado than nationally. Colorado also showed strong growth in the research and testing sector since 1998. The bioscience plan in Colorado does not appear to be as well coordinated as the effort in Arizona in terms of information available and regular updates on progress. However they have made significant progress. The Denver metro area has also developed an industry cluster report that reports 15,000 workers in 470 companies.[30] Denver Metro recognizes two subclusters, Pharmaceuticals and Medical Devices.

Recruiting companies to build critical mass within the industry

Arizona and Colorado have both developed strategic plans that include recruitment of bioscience companies. While Oregon has several advantages for recruiting as described above, it currently lacks a well-developed and publicized strategy for attracting bioscience companies. Colorado has made progress in promoting the bioscience industry using a number of strategies as reported by Colorado Bioscience Association (CBSA):

- Production of a new video, *Colorado Is Good for Bioscience; Bioscience Is Good for Colorado*, which will be used as an educational and advocacy tool for the industry.
- CBSA's quarterly newsletter has been expanded from six to eight pages in 2006, featuring companies and industry news.
- In 2006, CBSA's media coverage *ad value equivalency* doubled from $43,000 in 2005 to more than $86,000 in 2006. This coverage in 2006 reached a circulation audience of 5 million nationwide.
- BioScience Magazine, a leading edge publication by the Colorado BioScience Association, increased from 50 to 72 pages, with local, national and international distribution.

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24 www.flinn.org/bio/roadmap.cms
25 www.flinn.org/docs/Progress_Report_2006_989.pdf
26 www.flinn.org/bio/index.cms
27 www.arizonabiobasics.com/bioBasicsHome.cms
28 www.cobioscience.com/FINALCOBiosciencePlan.pdf
29 www.oed.state.co.us/oed/biosciences-emerging-industries/BioPlan2004.pdf
30 www.metrodenver.org/industries/docs/bioscience_100805.pdf

Capital Availability Gap

BIO suggests that successful practices for states include programs to address funding gaps, including commercialization, pre-seed and seed financing to help establish and build bioscience companies. Investors in this continuum include private, philanthropic and public entities. Active angel networks can also be important for investing in biosciences.

They list several state approaches to addressing risk capital:

- State pension fund investment in privately managed venture funds
- State assistance to leverage SBIR funds
- Technical assistance for companies to access financing sources
- Creation of capital access funds.

While the Arizona legislature has not invested directly in venture funding, with most of their funding going towards strengthening research programs (see above) and towards education, Arizona approved tax credits for angel investors in qualified bioscience companies. In addition, the state has seen an increase in venture funding and has attracted some new venture firms to the state. Over the 2003-06 period, Arizona exceeded its roadmap goal of $100 million with total venture capital bioscience investments in Arizona of $260 million (biopharmaceutical $81 million, health care services $76 million, medical devices $71 million and medical software $32 million). Funding slowed in 2006 and in the first quarter of 2007, Arizona companies received $37.7 million in venture funding.

In 2004, Colorado created the Colorado Venture Capital Authority, a state fund to invest in seed- and early-stage ventures. In 2005, Colorado life science companies received $164.7 million in venture funding.[31]

Gaps in Management and Work Force

BIO recognizes that the pool of talent is important for states to build competitive advantage. They recommend that educational institutions at all levels be responsive to the needs for bioscience workers.

Colorado provides companies a tax credit of $1000 to $3000 for each new job created. The state also provides up to $800 per employee (to a max of 60% of the cost) for job training.

Overall employment in the Biosciences increased 16% in Arizona during the 2001 – 2005 period. In 2003, Maricopa Community Colleges in Arizona co-sponsored a study to create a state work force development strategy in the biosciences. The study found a need for work force in the bioscience area and a mismatch in specific areas of demand and supply. In 2003 the colleges system passed a bond issue that included $100 million for bioscience and health care training. Overall employment in the Biosciences increased 16% in Arizona between 2001 – 2005.

Infrastructure/Facilities and Equipment

Provision of business incubation services is listed as one of the best practices for state governors to strengthen entrepreneurship and economic growth[32] and many states have developed incubator programs to support bioscience initiatives.

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31 www.cobioscience.com/resources-biosciencegrowsbestathighaltitude.pdf

33 www.nga.org/portal/site/hga/menuitem.9123e83alf6786440ddcbeeb501010a0/?vgnextoid=17e4303cb0b32010VgnVCM1000001a01010aRCRD

According to BIO, the states and regions that are most successful in bioscience have the following:

- Specialized bioscience incubators and research parks
- Access to specialized facilities in universities such as core labs and animal facilities is available
- Private markets with available space for bioscience companies

A study by the National Business Incubator Association (NBIA) published in 2002[33] focused on best practices and found that there was no direct correlation between business incubator practices and primary outcomes such as revenues and employment growth. The explanation provided by the study authors was that incubators can affect only the "precursors" to successful business outcomes, which are affected by many market factors beyond the impact of the incubator. However, there was a predictive effect of business assistance on secondary outcomes such as equity investment, patents, research grant support and licensed intellectual property. This was particularly true for bioscience companies, which had slower growth than electronics/IT focused incubators and their growth was dependent on equity investment. The study also found that the best in class incubators were located next to a research university and many had access to university infrastructure and resources. Overall the NBIA study supported the BIO recommendations above and suggested that measuring secondary outcomes is a valid way of evaluating performance.

The Arizona Center for Innovation, located in the University of Arizona Research Park, provides 12,500 square feet of office and laboratory space, including 4500 square feet of office space (10 company offices) and 8000 square feet of chemistry/wet lab and laser lab space. They provide business services, including business and investor development. There are additional incubators in Phoenix, Flagstaff and in other Arizona regions.

Colorado has several incubators within the Denver metro area, and at Fort Collins and Colorado Springs. One example is the Colorado Bioscience Park in Aurora. The 160-acre campus includes the University of Colorado Health Sciences Center and Hospital Complex, The Children's Hospital, and the Fitzsimons Commons town center. The bioscience park enables start-up and early-stage bioscience companies to use the university and hospital facilities as resources for the development of medical devices and biotech products. There are currently 18 bioscience companies in the park, and several university research programs and offices.

Infrastructure/Networking

Both Arizona and Colorado have active bioscience industry associations. Both states have also established high-level advisory groups such as Arizona Governor's advisory group on science and technology and Colorado's Governor's Office of Innovation and Technology. In Arizona, the Bioscience Roadmap Steering Committee, composed of leaders in science, business, economic development, and government is charged with overseeing the implementation of the Bioscience Roadmap's strategies and actions.

University Linkages and Research Strength

Best practices recommended by BIO include engaging universities with leadership that is actively committed to economic development. This includes having the infrastructure necessary to perform efficient technology transfer.

Arizona committed $35 million to establish the Arizona 21st Century Fund to make investments in new medical, scientific, and engineering research programs. The funds will flow through the new

[33] www.technology.gov/reports/TechPolicy/NBIA/2003Report.pdf

Science Foundation Arizona (SFAz) that committed to raise an additional $15 million. The fund has already drawn a $100 million matching commitment from the private Stardust Charitable Group. Arizona's 2002-2004 growth in academic R&D expenditures was 23.4%, and they reached $167 million total in annual NIH research grant funding in 2005.

A recent report from the Arizona Board of Regents[34] recommends that the state must support the medical and educational institutions ability to link together and synchronize their resources and priorities with local technology enterprises to enable them to become an economic driver in the bioscience industry.

The Colorado legislature passed a measure in 2006 providing $2 million for bioscience technology transfer to support research in bioscience by providing matching funds to technology development projects up to a cap of $150,000. During 2007, new legislative action provided $4.5 million in matching funds for proof-of-concept grants and SBIR matching grants for companies that have licensed bioscience technology from state universities and have received awards for Phase I SBIR or STTR grants. Derived from gaming revenue, the state funding would be about one-half of the grant funding (approximately $50,000 per Phase I grant) and would flow through the technology transfer offices.

Results
An Arizona progress report in December 2006 indicated the following:

- University bioscience R&D expenditures increased 23% from 2002 – 2004 (the top 10 states in the U.S. grew 20%)
- NIH grants grew 30% from 2002 – 2005 (compared with 21% for the top ten)
- Proposition passed to provide $1 billion over 20 years for university science and technology
- Institutional partnerships awarded competitive grants for clinical projects
- The Virginia Piper Foundation committed $50 million to recruit 10 world leaders in personalized medicine.

Colorado's report on progress in 2004 did not contain metrics on research funding. In that year, Colorado State University was ranked among the top five universities in annual growth of research grants.

7. Recommendations

As an "emerging cluster," the Bioscience cluster must continue to make progress concerning state incentives, a work force pipeline, technologies, facilities and equipment and capital. This will enable current companies already to grow and remain in Oregon, new companies to more easily form, and attract more out-of-state companies to locate in Oregon.

The focus of this section is to identify and develop strategies that will augment current efforts and address some critical gaps identified by our analysis.

34 http://www.abor.asu.edu/

a. Strategies

STRATEGY 1 – To address the critical gap of industry critical mass – identified as the top priority by the Medical Device subcluster

Grow the Bioscience cluster and its linkages through growth of existing companies, creation of new companies and recruitment of companies. Focus on the three major subclusters of medical devices, pharmaceutical and reagents and services for research, with additional focus on Oregon's benefits for high value-added manufacturing.

Actions:

- Leverage the state's **Manufacturing Initiative** and the **Manufacturing 21 Coalition** to recruit bioscience companies to set up manufacturing subsidiaries.
- Target west coast companies that are planning for growth but having problems with work force, facilities costs, taxes, etc.
- Develop a targeted marketing program for bioscience manufacturing.
- Develop an industry strategic plan to grow the Bioscience industry

STRATEGY 2 – to address the critical gap of seed-, early- and later-stage funding – identified as the top priority by the PD and RSE subclusters

Support a continuous pipeline of financing sources, including university and Signature Research Center funding, followed by angel, seed and venture funding

Actions:

- Create an easily usable "funding sources knowledge base" that could be used by bioscience companies as well as other types of technology companies in the state. A "wiki" oriented knowledge base would continually be expanded to reflect the experiences of Oregon's bioscience in seeking funding. Seek to expand the sources of input beyond Oregon to further enrichen this knowledge base. This would reduce the amount of effort, expense and time currently required to determine appropriate potential funding sources.
- Encourage Oregon's bioscience companies to use the services provided by the Oregon Entrepreneur's Network to help them with their business plans and presentations to investors.
- Enhance angel funding through a) Personal state income tax credits (i.e., similar to the situation for university spin-out companies through the University Venture Development Fund), and b) State matching of angel investments.[35]
- Fund an Oregon Bio/Seed Fund from the Oregon Growth Account, targeted at early stage companies.
- Re-examine and modify the Oregon Investment Fund investment strategy to encourage more venture funds specializing in the Biosciences to make investments in Oregon.
- Expand and stabilize support for SBIR/STTR grant applications, and provide matching and gap funds to leverage this significant funding source.

STRATEGY 3 – To address the critical gaps of managerial talent, and top scientific and bioengineering talent – identified as a priority by all three subclusters

Build a pipeline of "leadership" talent to manage existing companies, startup new companies, and assist in recruiting companies.

[35] Recently it was announced that the Oregon Growth Account will provide matching funding to the Oregon Angel Fund (OAF) for three years provided that OAF can raise at least $1 million in each of the years.

Actions:

- Increase the number of quality graduate students in biosciences and biomedical engineering through state/private fellowships
- Fund ("resource" isn't a verb) a Bioscience Management option in MBA programs at PSU, OSU and UO. Also expand the Health Science Professional Management certificates available from OHSU and PSU.
- Develop creative recruiting packages for senior level employees, tailored to the individuals' total needs.
- Create a "go-to" resource, perhaps within the Oregon Bioscience Association, for executives seeking to return to or move to Oregon.
- Create an executive level "Bioscience Mentoring Program" with retirees and volunteers from the private sector.
- Develop an "Oregon Roots" program and associated website, where Oregonians throughout the world can read about Oregon's advances and the opportunities for those who want to return home to a flourishing Bioscience industry. Build a "CEO/CTO/COO in waiting" list from responses to the website.

STRATEGY 4 – to address the gaps in the bioscience industry infrastructure – identified as a priority by all three subclusters

Provide the facility and networking infrastructure that supports the formation, growth, recruitment and retention of bioscience companies.

Actions

- Inventory existing wet lab and clean room space that is and will be available. In addition, inventory "core lab" functions available to industry at research institutions.
- Inventory wet lab, clean room and core lab functions needed by industry. Quantify the gaps between needs and availability of wet lab, clean room and document – for the basis of any realistic plan for meeting the immediate needs.
- Building on existing and new wet lab spaces and university research parks, create in all the major geographical locations of the bioscience cluster accelerators/incubators that have wet lab and clean room space as well as commercialization assistance.
- Continue and expand Oregon Bioscience Association initiatives to increase company to company networking, as well as company to university networking. Add networking opportunities with the mature industries in the state that can provide potential synergies
- Create incentives for private developers to build wet lab and clean room space by encouraging universities, state labs or larger companies to act as anchor tenants.
- Ensure that university research parks are "user friendly" to early stage bioscience companies, supplying ready access to university research and business support.

STRATEGY 5 – To address the need for universities to increase their impact on bioscience industry development – identified as a priority by the MD subcluster

Through the state Signature Research Centers, establish the Oregon university system as the primary "Research Engine" for current and future needs of the emerging Bioscience cluster.

Actions:

- Create a service that contacts industry executives about their R&D needs and links up those needs to R&D capabilities within the University system. First within Oregon, and if none found in Oregon, going to resources in our region – Washington state and British Columbia.

- Create a matching fund that supports industry paying for R&D services within Oregon's university system.
- Increase two-way linkages between universities and Bioscience companies (especially those that are not university spin-outs), including research collaborations and use of bioscience company products by university laboratories.
- Target recruitment of new research staff for the Signature Research Centers to fill key bioscience competence gaps in the university system.
- Expand ONAMI'sNanoNet into a Nano-Bio-Info Net that enables sharing of one-of-a-kind tools and software among universities and industry.

b. Discussion of recommendations

This report provides a broad range of recommendations necessary to grow the Bioscience industry in Oregon. Not all of these can be addressed by the economic development agencies of the state, certainly not alone. One major economic development recommendation is to develop a recruiting plan to attract additional manufacturing plants to the state. For the bioscience industry, this report recommends building on the existing strength by recruiting additional manufacturing companies or subsidiaries, training the work force in GMP-related skills and by increasing linkages with other manufacturing industries within the state.

Some recommendations, such as an industry-wide strategic plan, need significant input from industry leaders. Others, such as investment capital availability, are best addressed by independent advisory bodies such as Oregon InC. The universities, as major stakeholders in the development of new bioscience companies, must address those priorities that fall within their mission, including hiring of innovative faculty that increase the level of innovation in the state, and partnering with private and public groups to expand the infrastructure needed by early stage and growing companies. The major stakeholders, working together, can make significant progress growing the Oregon bioscience industry.

Medical Devices Subcluster
This subcluster faces three major challenges – *critical mass, facilities (specifically clean rooms) and local institutional interactions*. Eight of the 12 medical device companies interviewed reported the lack of critical mass as a major challenge. The Medical Devices subcluster in Oregon ranges across many markets and technologies. However, companies have some factors in common. They perform highly skilled, regulated manufacturing, often in a clean room environment and they require experienced managerial and engineering talent to design their products. Although their technologies differ, the work force skills for manufacturing can be transferred across companies, so it is of benefit to the subcluster as a whole to have more medical device manufacturing companies in the state. A recruiting program to increase the supply *of managerial experience (Strategy 2 above)* would also benefit this subcluster, as would infrastructure expansion focused on clean room facilities. More than any other subcluster, the Medical Devices subcluster expressed a desire for improved interactions with local research institutions and hospitals.

There are specific subclusters within Medical Devices subcluster that have sufficient critical mass to use as an attractant to recruit additional companies, e.g., orthopedic implants, electronic medical devices, and wound/tissue treatement/repair.

Pharmaceutical and Diagnostics Subcluster
Most of the companies in this subcluster are at an earlier stage of development and do not have manufacturing. (The exceptions are Genentech and some nutriceutical companies.) Their major priorities are *capital* and *facilities/infrastructure (including wet lab space)*. Half the companies interviewed report these as their major challenges. In many cases, the founding scientists are managing these companies. While this management approach may be adequate for the early stages of company formation, it is not commonly acceptable to the providers of venture capital. Thus, while this subcluster did not identify a need for managerial talent as a high priority, the authors believe it is important if these companies are to attract capital and reach their full potential. As the number of experienced managers in the state increases, this and all of the subclusters will benefit.

There are specific subclusters within Pharmaceutical and Diagnostics subcluster that have sufficient critical mass to use as an attractant to recruit additional companies, e.g., bioavailability of compounds, fill and finish of therapeutics, and (rapidly evolving) infectious disease.

Reagents, Services and Equipment Subcluster
The three main challenges reported by the companies in this subcluster were *access to facilities/infrastructure, access to capital* and *industry critical mass.* The need for experienced personnel (recommendation 2) was also seen as a challenge. Many of the companies in this subcluster are providing products for research – both in research institutions and in other companies. The companies interviewed are growing rapidly and have increasing needs for capital, facilities and people.

There are specific subclusters within Reagents, Services and Equipments that have sufficient critical mass to attract and recruit additional companies, e.g., cellular markers, skin cell lines, and electron microscopes.

Establishment of Priorities
The recommendations listed above are intended to stimulate discussion within the industry and broader group of stakeholders in Oregon. They are based on feedback from detailed interviews with 31 companies in three subclusters, the authors' knowledge of the industry locally and regionally, and research into best practices in several regions similar to Oregon. To refine and prioritize these

recommendations, and to get broad support for implementation, it will be important to gain input from additional members of the subclusters.

Development of Strategic Plan for the Bioscience Cluster

Implementation of the recommendations depends on the development of a strategic plan for the bioscience industry, which should be developed with leadership from the industry. The plan should also have input from universities, funding sources and economic development resources. Since not all recommendations will have the same priority, they should be implemented over a reasonable timetable.

8. Conclusion

This study analyzed the Oregon bioscience industry cluster by defining the industry cluster within the state, identifying the current drivers and key players in the cluster and looking at the linkages among companies and key stakeholders. Both primary and secondary analysis was carried out.

The industry consists of more than 240 companies that can be defined as working primarily in Bioscience. More than 80% of the companies fall into one of three subclusters – medical devices, pharmaceutical and diagnostics, and reagents, services and equipment for life science research. All of these subclusters have a majority of firms that manufacture their products, and trade out of state.

The company interviews found that the industry can be classified as an "emerging cluster,"," and that subcluster needs are more shared than subcluster-specific. The foundational requirements for bioscience are present in Oregon, but in some cases in short supply. These fundamental issues must be addressed before the industry can build strength and become a true cluster with significant competitive advantages. The major potential competitive advantage found in this study is strength in highly skilled, regulated manufacturing. This already has attracted a few companies to Oregon, and could be expanded with directed initiatives.

Overall, the Oregon bioscience industry shows much that is positive. There is growth in the number of bioscience companies, the industry trade association has become more visible and is making an impact that the industry values. University research institutions and Signature Research Centers show expanding interaction with companies. The state has begun to support venture capital funding that has made Oregon bioscience investments, and angel investing has grown. Gaps remain in capital availability, facilities infrastructure and management talent. There is a need for the industry to grow to critical mass.

The five sets of recommendations presented are designed to support the foundations of the industry and apply equally to the major subclusters. As the industry approaches critical mass, facilities and management will both become more available. As the university-based Signature Research Centers grow and innovate, they will spin off more companies. The availability of capital is likely to remain a significant challenge.

These recommendations deserve strong support from the multiple stakeholders for the industry in the state. These strategies can form the basis for a critical dialogue among industry, universities and government and lead to an expansion of partnerships in support of the industry as a whole.