Biotechnology in Minnesota
Enhancing the Life Science Ecosystem
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Executive summary
It is no secret that Minnesota is a medical device state. The strength of this cluster is undeniable, but that strength has not yet been leveraged to strengthen related life-science clusters such as biotech and pharmaceuticals, which remain quite small in comparison. There is great potential for biotech in the region with its talented local workforce, strong research presence from the University of Minnesota and Mayo Clinic, and transferrable knowledge and skills from the medical device value chain. However, medical device has seemingly carved out a cultural niche in Minnesota which actually hinders the creation of an environment in which biotech can thrive. Our analysis suggests that Minnesota simply does not have the entrepreneurial, risk-taking culture which is essential part of the biotechnology eco-system. This eco-system also requires access to start-up and venture capital, scientific entrepreneurs that take on high-risk high-reward products, and the increased commercialization of local discoveries. Minnesota may never be the next biotech capital, nor should it try to be, but it is a smart strategy for the region to leverage the strength of the medical device infrastructure while implementing strategies to diversify employment growth in related life science industries—after all, if med device begins to falter, so will the region. Cultivating this eco-system will not only set the conditions for growth in biotech but is also a sound strategy to encourage overall growth in the Minneapolis region.

Greater MSP must:

1. **Prioritize partnerships and policies to improve the biotech “eco-system.”** A risk-taking, start-up culture must be developed for biotech to take hold. Partnerships must also be developed with medical device leaders to get them on board toward a shared vision and to find out what is necessary to take advantage combination drug-device products. There is visionary interest from the device industry in the potential of combination device-drug products, but a new crop of managers must be developed to take on the regulatory and managerial challenges of this market. This in turn will encourage venture capital, since we have found that venture capitalists invest in people as much as they invest in products. If this can be accomplished, Minnesota might find itself in a position of national leadership in the combination device market.

2. **Improve commercialization of discovery.** There needs to be a better connection between industry and the University. This will be a difficult issue to solve, but robust partnerships need to
be developed to bridge the gap between the discovery that is happening locally and commercialization. It will also be important to get behind the new research park that is scheduled to be completed in 2015 at the University. This research park will include the needed “wet lab” space that is currently lacking in the region, potentially improve the relationship with industry and encourage knowledge sharing.

3. **Create a diabetes and cardiovascular regional “brand.”** The diabetes brand emphasizes a major partnership between the University and Mayo Clinic, two internationally known research institutions, called “the decade to end diabetes.” This strategy is also aligned with the Biobusines Alliance of MN and Department of Employment and Economic Development. Cardiovascular research has also been a traditional strength for the region.
**Introduction**

Throughout history, humanity has looked to develop and improve its everyday quality of life. In creating new inventions and a better environment, the goal has been to improve upon this concept. Usually this term is used in a wide range of contexts, including the fields of international development, healthcare and politics. We seek to present a context where the healthcare and life science industries, focused on quality of care and innovation, could make economic progress in the quality of life for the greater Minneapolis and St. Paul region.

Minnesota’s history is full of health and life science researchers and experiments working to improve people’s lives. The field is full of new issues and challenges that demands constant innovation. Notably, in 1958 the first pacemaker was implanted: a medical device used to maintain adequate heart rate for people who struggle with their heart rhythm. As a medical equipment service company, Medtronic was one of the first companies to improve this kind of medical device. Located in Minneapolis, the co-founder of Medtronic, Earl Bakken had become acquainted with pioneer open-heart surgeon Dr. C. Walton Lillehei of the University of Minnesota. By developing a viable, implantable pacemaker using primary cells as a power source, the linkage between health care and the life sciences in Minnesota has impacted heart patients worldwide.

A health cluster could be represented by organizations composed of hospitals and clinics, research organizations, financial services, medical professionals, and product manufacturers. One of the main uses in defining a cluster is to promote interaction among members around medical issues to develop new technologies and procedures building a reputation for extremely high quality healthcare¹.

Infrastructure and development of medical technologies represent a major part enabling medical professionals to give efficient treatment to patients. For instance, widespread use of Magnetic Resonance Imaging (MRI) and scanners represent a kind of medical service evolution able to detect and diagnose medical conditions like tumors or cancers. Innovation comes from many years of research and trials to detect conditions in need of improved treatment practices. This example represents one industry, medical device manufacturing, playing an important role in Health cluster growth. In order to

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create the means to develop said infrastructures and medical practices, it is important to develop a cluster relationship with university researchers, product engineers in medical device and pharmaceutical companies, and many other health and life science practitioners who play a role in making improved health delivery.

In addition, there is also the role of local government to take up the challenge by developing an attractive economic and health cluster location. Houston is one example with a high specialization in the biomedical area. The City of Seattle has also become one of these leading health care clusters, with considerable concentration in health care delivery, biomedical research and applications, and training for doctors and other medical staff. This healthcare industry cluster has propelled the Seattle economy forward by attracting substantial human and financial resources to the City, from which patients, research and development, the educational system, and the community all derive significant benefits.

One of the main challenges of Minneapolis-St Paul in a globally competitive environment will be to further develop its healthcare and life science cluster. There are many ways where this region can continue to grow. For the purpose of our research regarding this topic, we are going to focus on uncovering the linkages between its strong and proven medical devices industry and the relatively new biotechnology industry with room to grow. We believe this focus will uncover whether this sector holds potential to position the Minneapolis and St. Paul health and life science cluster for prolonged growth.

The United Nations Convention on Biological Diversity defines biotechnology as "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use." Biotechnology in a health setting uses the most modern techniques related to biochemistry and genetics to improve medical interventions and therapies. An example of one of the major fields where biotechnology has varied applications is drug production and pharmacogenomics, where drugs are designed and adapted to an individual's genetic makeup. As scientific discoveries advance, the many potential roles biotechnology can play in everyone's lives increases exponentially. Not only has biotechnology become extremely significant to life-altering discoveries, but recent trends in the medical field appear to favor addressing disease interventions from a biological perspective rather than a therapeutic perspective. This can be perceived as both a threat to

2 http://www.cbd.int/gbo1/chap-02.shtml
Minnesota’s traditionally strong medical device industry and an opportunity to leverage its strengths for future growth. Assessing the biotechnology industry’s potential to enrich human life and to use the existing medical device infrastructure to its advantage by examining the linkages between the two sectors can illuminate ways the Minneapolis-St. Paul region can position itself for growth in the future.
Minnesota Overview

Minnesota is located in the upper Midwest and is the 24th most populous state in the U.S. Known as “the land of 10,000 lakes,” Minnesota has significant natural resources which include the boundary waters to the north, Lake Superior to the east and is the source of the Mississippi river. Together with historical investment in major interstate highways and aviation infrastructure provides strong transportation groundwork for the economy. Recruiters have a saying that encapsulates a major weakness and strength of the State: because of the cold winters yet high overall quality of life, Minnesota is one the most challenging places to get people to move to, but is also one of the most challenging places to get people to move from.

The Minnesota economy is the 17th largest in the nation, with current-dollar GDP of $270 billion in 2010. Minnesota has been finding its way out of the current recession faster than the nation, seeing real GDP growth of 3.2% from 2009-2010 compared to 2.6%, though growth overall has been slightly slower than the nation during the last decade. A per capital personal income of $42,847 is 107% of the national average. Minnesota is home to the highest number of Fortune 500 companies per capita than any other state.

Minnesota has a high quality workforce, lauded for its intelligence, skill, loyalty, and work ethic. Known for a high labor force participation rate for men, women, African Americans, and Latino sub-groups; the working population is projected to increase by 6 percent to 3.2 million workers by 2020. Minnesota also boasts large concentrations of talent in engineering, design, high tech, sciences, business, and manufacturing relative to national averages. The workforce is also highly educated: among the top 30 largest U.S. Metropolitan Statistical Areas (MSA), Minneapolis-St. Paul ranks fifth with 37.9 percent of

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4 Principal Scientist & PK/PD Analysis Manager, Medtronic, interview by Team, December 2011.
6 Ibid.
7 Ibid.
10 Ibid.
the population with a Bachelor’s Degree or higher.\textsuperscript{11} The University of Minnesota ranks #7 as the institution graduating the most life science doctorates. This puts the University ahead of major institutions such as UC Berkeley (#11), UNC Chapel Hill (#10) and UC Los Angeles (#8).\textsuperscript{12} This indicates that there is significant talent being developed locally, if it can only be harnessed.

Of note to the study of the emerging biotechnology industry, the region is weaker in capturing venture capital investment and nurturing an overall entrepreneurial culture. Minneapolis ranks 11th in overall venture capital investment, taking in $256.2 million in 2009.\textsuperscript{13} However, funding for the third quarter of 2011 went primarily for medical device, with little if any venture investment going to biotechnology.\textsuperscript{14} This suggests that the funding environment specific to biotechnology is weaker than overall venture capital rankings would suggest. According to a 2011 report from the University of Nebraska, Minnesota ranks 25\textsuperscript{th} in the nation for entrepreneurship.\textsuperscript{15} New York, Washington, Massachusetts and New Jersey, all top biotech states, take the top 4 spots. However, the Minneapolis-St. Paul region consistently ranks high in areas such as technology indicators like patenting and R&D expenditures, and is rated sixth most inventive city by Bloomberg Businessweek magazine.\textsuperscript{16}


\textsuperscript{12} The University of Wisconsin Madison graduated the highest number of life science doctorates in 2009. "Compare Minnesota." \textit{Minnesota Department of Employment and Economic Development (DEED)}.

\textsuperscript{13} PricewaterhouseCoopers, LLC 2011

\textsuperscript{14}<http://newsroom.unl.edu/releases/2011/08/02/UNL+report%3A+Nebraska+moves+up+in+national+entrepreneurship+rankings>. This measure takes into account five components, “a state’s percentage growth and per capita growth in business establishments, its business formation rate, the number of patents per thousand residents and gross receipts of sole proprietorships and partnerships per capita.”

Biotechnology and the Life Sciences – An Overview

The chart below from the BioBusiness Alliance of MN is a great introduction to the industries which comprise the life sciences as a whole (of which biotechnology is a part) and what each industry requires to thrive. The industries of focus in this paper are pharma/biologics and the connection with medical devices. These two industries together comprise the majority of the U.S. human life sciences sector. Animal health is the same color as pharma/biologics and medical devices because some discoveries in animals are translatable to humans, but there is reason to treat the animal health industry separately since a similar regulatory environment is what binds the medical science in humans cluster together.17

Biotechnology broadly speaking occurs in each of the six industries. A more specific term for biotechnology applied to the creation of treatments and medicines for humans would be “biologics,” but for the purposes of this paper the term “biotechnology” will refer to the specific applications to humans, since that is the common meaning of the term.

17 Vice President, Medical Technology Cluster, Biobusiness Alliance, interview by Team, November 2011.
The chart clearly describes the foundational capabilities and the enabling knowledge clusters that form the base of support for all the life science industries, but this paper will focus on several of the commercialization catalysts that were identified as issues during interviews. Leadership talent, funding and technology transfer are uniquely important to the biologics industry and appear to be specifically lacking for this industry in the region.

The graph below gives snapshot of the global size of the biologics, medical device and pharmaceutical industries. Biologics is roughly comparable in size to medical devices, $93 billion compared to $113 billion in 2006, whereas the pharmaceutical industry took in an enormous $653 billion in 2007. (Wahlstrom, et al. 2010) Although biologics is the smallest of the three industries, the annual growth of roughly 15% per year is the largest, nearly double that of pharmaceuticals.
Research Methodology
Precisely defining the biotechnology industry cluster using NIACS codes can be tricky. Some researchers use a broad definition to include pharmaceuticals and part of what others define as medical devices, while others take a narrower view. Whatever definition is selected, the NAICS codes on which they are based still do not neatly represent the industry. As one source says, “[t]he best that can be done is to select a group of industry categories to act as a proxy.” (Willoughby 2011) This paper follows the example of Willoughby and treats NAICS 54171 R&D in the life sciences as a rough proxy for R&D in biotechnology, excluding manufacturing activity.\(^{18}\)

According to Porter’s national cluster data, R&D in the life sciences (which includes NAICS codes 541711 and 541712) can be found in the “research organizations” subcluster. Unfortunately, public policy research and public opinion polling industry codes are also included in this definition. This fact complicates interpretation, but the definition is good enough to give a rough idea of comparative regional strengths.\(^{19}\) As pharmaceutical activity is often included in definitions of biotech, special attention will be paid to the biopharmaceuticals cluster along with the biotechnology proxy in order to develop a more complete picture of the Minneapolis-St. Paul regional position. A comparison of several different definitions of the biotechnology cluster is included in the appendix for reference. (Appendix 2)

Further research by Michael Porter helps to expand the definition of the various life science-related clusters to other related and supporting industries. Clusters are, by his definition, “geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions...in particular fields that compete but also cooperate.” (M. Porter 2008) There is significant overlap between medical devices, pharmaceuticals, education and knowledge creation, information technology and the analytical instruments clusters. (Appendix 1) Special attention will be paid to these clusters to illustrate other potential areas which could benefit from their connection to the strong medical devices cluster in Minnesota. The connection between these clusters and medical devices could be a fruitful area for future research.

\(^{18}\) Even this definition has its problems, as noted in (Willoughby 2011), since the NAICS code 541712 R&D in the physical, engineering, and life sciences (except biotechnology) includes approximately half biotechnology activity—and part of that activity can be better classified as “agri-bio and bio-industrial technology.”

\(^{19}\) R&D in the life sciences might be better allocated to the biopharmaceuticals cluster, helping it earn its “bio” prefix in the process, since there appears to be little reason to treat R&D in the life sciences alongside social science research and opinion polling.
Literature Review

Before moving on to a more detailed look at biotechnology in the Twin Cities metro area, it will be helpful to understand what the literature says about the biotechnology industry and its cluster formation. Many economic development and industry analysis studies attempt to discover the factors and dynamics of regional economies that promote growth in biotechnology and related industries. Combining studies, the key factors shaping a regional biotech cluster fall into many categories: regional inputs, market competition, human capital networks, and so on. In order to help uncover the key factors that shape the Twin Cities regional biotech cluster, this section highlights a literature review of applicable studies that will be used to enhance our final analysis:

- Goetz and Morgan (1995) find that venture capital and favorable fiscal policies, R&D spending, and raising the number of doctoral degrees awarded were important factors in establishing biotech firms.
- Gray and Parker (1998) examined the location and organization of biotech firms based on product life-cycle theory: manufacturing capabilities and marketing channels of more established companies in mature regions are major sources of competitive advantage.
- Zucker, Darby, and Brewer (1998) added that intellectual human capital (e.g., star scientists) is the main determinant of where and when the biotech industry is developed and localized. Similarly, Hall and Bagchi-Sen (2001) examined the relationship between R&D intensity, innovation, and performance in the US biotech industry uncovering collaboration, specifically with university scientists, was important for successful biotech firms.
- Munroe, Craft, and Hutton (2002) using a survey of biotech companies in California showed that proximity to leading research centers and venture capital is the main reason for the firm’s location.
- Sambidi and Harrison (2006) tested the hypothesis of spatial agglomeration economies in the biotech industry and confirmed it using spatial econometrics.
- Vusovic (2006) included the demand factors of location, such as regional income, family composition, and population growth and showed that these factors were also important for the locational choice of biotech firms. Kim, Harris, and Visovic (2009) examine the effect of clustering on performance and conclude that the clustering of the biotech industry leads to increased productivity. Their analysis notes the direct causes in forming a locational biotech cluster are high-tech infrastructure and regional income. Indirect factors stemming from regional income are firm size, biotech-oriented universities, and the general education of the population.

Combining studies, it is apparent that collaboration among public and private sector actors is necessary to successful biotech cluster formation. Successful clusters rely on the flow of human and traditional capital to new businesses and entrepreneurialism to generate growth. However, these factors must be tailored to specific challenges that face most biotech firms: long periods of product development and testing, specialized human capital needs, and regulatory uncertainty. Initial returns to biotech investors are also small as years of development are required to bring a successful product to market. Biotech firms depend on venture capital, research contracts, and capacity investments from large pharmaceutical companies to produce, market, and distribute their product. They also depend on high levels of education and regional investment in research institutions and facilities. Additionally, the presence of collaboration between research organizations and firms is important to drive the transfer of discovery into commercial product. The literature suggests patient investment by both the public and private sector are required harvest biotechnology’s potentially unlimited growth.

Perhaps scathingly, Cortright and Mayer’s 2002 study, Signs of Life, finds no room for Biotech cluster formation within the Minneapolis-St. Paul region. They foresee cluster growth only in established regions, as other regions will not have the organic capacity (i.e. research, investment, and industry) necessary to keep up. This report tells a cautionary tale about the Minneapolis-St. Paul region’s potential to develop a significant biotech presence.
Biotechnology in Greater MSP
The research organizations subcluster (proxy for biotechnology) has experienced significant growth since 1998. While the subcluster does not show remarkable specialization in the region it is growing faster regionally than the cluster is nationally. The same can be said for the biopharmaceuticals cluster, which is slightly more specialized than research organizations, but has experienced more growth regionally since 1998 than the national cluster. These numbers taken together with medical devices suggest strength in these three related clusters is present to build from.

The challenge emerges when comparing the Minneapolis region to benchmark regions. The Minneapolis MSA ranks 15th in biotech employment and 9th in pharmaceuticals. While regional growth in biotech has been promising, specialization and wages are quite low compared to top regions. While comparatively low wages could be attractive to certain companies when considering the region, it may make the attraction of top talent difficult.

Regional Employment, Location Quotient and Shift-Share Analysis
Business services, education and knowledge creation, financial services, distribution services, and transportation and logistics make up the largest traded clusters in the region. (Table 1) Medical device is the 6th largest traded cluster, employing 21,414. To get an idea of just how dominant medical device is in the Minneapolis region, nearly 60% of overall life science employment comes from the medical device cluster, far surpassing LA which has the second highest share of 33%. (Appendix 4). The region has yet to grow the clusters related to medical devices, such as biotech and pharmaceuticals, as other regions have.

Wages in life-science related clusters are also higher than the average regional wage. (Appendix 5) Research organizations falls between biopharmaceuticals and medical devices with an average wage of $74,586 in 2009, but this is much higher than the average regional wage of $47,126. One source

<table>
<thead>
<tr>
<th>Rank</th>
<th>Cluster</th>
<th>Employment</th>
<th>%*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Business Services</td>
<td>69,195</td>
<td>16%</td>
</tr>
<tr>
<td>2</td>
<td>Education and Knowledge Creation</td>
<td>40,982</td>
<td>9%</td>
</tr>
<tr>
<td>3</td>
<td>Financial Services</td>
<td>40,318</td>
<td>9%</td>
</tr>
<tr>
<td>4</td>
<td>Distribution Services</td>
<td>31,535</td>
<td>7%</td>
</tr>
<tr>
<td>5</td>
<td>Transportation and Logistics</td>
<td>28,165</td>
<td>6%</td>
</tr>
<tr>
<td>6</td>
<td>Medical Devices</td>
<td>21,414</td>
<td>5%</td>
</tr>
<tr>
<td>12</td>
<td>Information Technology</td>
<td>15,205</td>
<td>3%</td>
</tr>
<tr>
<td>13</td>
<td>Analytical Instruments</td>
<td>13,232</td>
<td>3%</td>
</tr>
<tr>
<td>15</td>
<td>Research Organizations (subcluster)</td>
<td>10,754</td>
<td>2%</td>
</tr>
<tr>
<td>23</td>
<td>Biopharmaceuticals</td>
<td>4,263</td>
<td>1%</td>
</tr>
</tbody>
</table>

*Percentage of regional traded cluster employment
estimates an employment multiplier of 5.14 in Minnesota for biotech jobs; meaning that for every one direct job in biotech, 5.14 jobs are created indirectly from extra wages rolling around the economy and supporting additional employment.\(^\text{20}\) (Battelle/BIO 2010)

A more complete picture of the importance of these clusters emerges when the location quotient (or “LQ”) is calculated.\(^\text{21}\) The Minneapolis regional economy is more heavily oriented towards employment in the life sciences than the economy of the nation, due in part to the dominance of medical devices.

**Table 2: Specialization by Industry Cluster 2009 - Minneapolis-St. Paul-Bloomington, MN-WI Metropolitan Area**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Cluster Name</th>
<th>Employment</th>
<th>LQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Medical Devices</td>
<td>21,414</td>
<td>3.71</td>
</tr>
<tr>
<td>3</td>
<td>Analytical Instruments</td>
<td>13,232</td>
<td>1.85</td>
</tr>
<tr>
<td>12</td>
<td>Information Technology</td>
<td>15,205</td>
<td>1.16</td>
</tr>
<tr>
<td>13</td>
<td>Biopharmaceuticals</td>
<td>4,263</td>
<td>1.13</td>
</tr>
<tr>
<td>20</td>
<td>Research Organizations (subcluster)</td>
<td>10,754</td>
<td>1.00</td>
</tr>
<tr>
<td>21</td>
<td>Education and Knowledge Creation</td>
<td>40,982</td>
<td>0.96</td>
</tr>
</tbody>
</table>


Not only is the medical device cluster the most specialized cluster in the region but it has gained in specialization since 1998 as measured by percentage of national cluster employment. (Appendix 3) The biopharmaceutical and analytical instrument clusters have gained the most specialization by this measure. Information technology remains specialized but has lost ground by .24 percentage points. Research organizations (not shown in Appendix 3,) remains specialized and has gained .59 percentage points. Education and knowledge creation has gained specialization, but remains the only cluster related to medical devices which remains less specialized than the nation as whole.

\(^{20}\) This figure is taken from the drug and pharmaceuticals segment.

\(^{21}\) Location quotient compares the ratio of employment in a regional industry to total employment in the same region to the ratio of the national industry to total national employment. By this measure, an LQ greater than 1 indicates that a region is specialized, or employs comparatively more people in a particular cluster than the national average.
Shift-share analysis also yields useful information about the regional clusters. The Minneapolis region proves to have a competitive advantage in each of the clusters related to medical devices (with the exception of information technology,) but the standout clusters are research organizations and biopharmaceuticals. (Table 3) Employment in the research organizations subcluster nearly tripled from 1998-2009. What is even more remarkable is the 126% competitive shift in the cluster, indicating that 126 percentage points of the growth in this regional cluster has come over and above national trends. The biopharmaceuticals cluster saw growth of 57% over the same time period, which was 57 percentage points above national trends. There is clearly something happening with these two clusters as growth has occurred while the regional economy declined by over 14%.

<table>
<thead>
<tr>
<th>Cluster Name</th>
<th>Local Emp.</th>
<th>Change in local cluster</th>
<th>Change in nat’l cluster</th>
<th>Change in nat’l emp.</th>
<th>Competitive shift</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Orgs. (subcluster)</td>
<td>3,596</td>
<td>10,754</td>
<td>199%</td>
<td>76%</td>
<td>-3%</td>
</tr>
<tr>
<td>Biopharmaceuticals</td>
<td>2,723</td>
<td>4,263</td>
<td>57%</td>
<td>3%</td>
<td>-3%</td>
</tr>
<tr>
<td>Education and Knowledge</td>
<td>23,019</td>
<td>40,982</td>
<td>78%</td>
<td>46%</td>
<td>-3%</td>
</tr>
<tr>
<td>Creation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analytical Instruments</td>
<td>17,513</td>
<td>13,232</td>
<td>-24%</td>
<td>-32%</td>
<td>-3%</td>
</tr>
<tr>
<td>Medical Devices</td>
<td>18,371</td>
<td>21,414</td>
<td>17%</td>
<td>12%</td>
<td>-3%</td>
</tr>
<tr>
<td>Information Technology</td>
<td>1,7642</td>
<td>15,205</td>
<td>-14%</td>
<td>-1%</td>
<td>-3%</td>
</tr>
<tr>
<td>Total local traded clusters</td>
<td>513,551</td>
<td>438,430</td>
<td>-14%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>U.S. Total</td>
<td>31,889,815</td>
<td>30,851,249</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


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22 This technique tells us how much regional cluster growth comes from local conditions by subtracting out national trends, such as overall national employment and the growth of the national cluster. The number that is left over after subtracting out national trends, called the competitive shift, is an indicator of competitive advantage for a region.
**National Competitive Position**
The Minneapolis-St. Paul region is not among the top 10 biotech regions in terms of employment, coming in at 15\textsuperscript{th} in the nation. (Appendix 6) Specialization is also disappointing. The Minneapolis-St. Paul is the least specialized of its peers (LQ of 1.) Wages are comparatively low as well, again the lowest when compared to the top 10 regions. The only bright spot to speak of is in the growth of biotech employment from 1998-2009. The Minneapolis region saw the third highest compound annual growth in employment over this time period with 10.47% annual growth.

The Minneapolis region is in a stronger competitive position in biopharmaceuticals. (Appendix 7) The region comes in at 9\textsuperscript{th} with respect to employment and ranks 4\textsuperscript{th} in the compound annual growth of employment. This is significant as the growth in major pharmaceutical regions has slowed or even declined over the last decade. The Minneapolis region also has the 3\textsuperscript{rd} highest wages of peer metropolitan areas, and the 2\textsuperscript{nd} highest growth in average wages. This indicates that the region has significant talent and takes part in high value activities. The region is slightly specialized with an LQ of 1.13, and ranks 7\textsuperscript{th} in overall specialization.
Value Chain

Michael Porter’s value chain is a framework to describe the core activities in the development of a product or service. It is used to show the way a firm differentiates itself by creating and executing core competencies to create value which are distinguishable from those more common to general product development. A firm’s activities are broken down into primary and support activities. Primary activities express the point-in-time processes involved in production, while support activities generally occur across the organization and are designed to sustain primary activities. By investing capital in those activities that add value while streamlining or reducing those that do not, a firm can become more efficient and by extension, profitable.23

Companies within different industries or clusters may find different parts of their businesses more important than others in creating this value. Similar to most life science product development, the biotechnology value chain differs slightly from Porter’s generic model because its primary activities are successive due to lengthy testing and regulation requirements. Development and testing can last upwards of 16 years for most.24 Each activity, then, heavily influences value creation because of intensive knowledge and specialization requirements for each development milestone.

Typically, the biotechnology value chain involves a series of transformations that take place from scientific discovery and clinical testing all the way through final distribution to healthcare patients. Interviews with sector leaders confirm that the chain is very specialized in labor as well as knowledge intensive.25 Analysis of the biotechnology value chain produces the following primary activities:

- Research and Development: highly specialized and controlled knowledge means the majority of companies retain R&D as their core competency. R&D occurs throughout production focusing on each stage of the value chain.
- Inbound Logistics: highly specialized products such as bacterial cultures and stem cells must be preserved in sterile and controlled environments.
- Product Development: the most robust portion of the value chain is broken up into three categories

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25 Director, Member Services, Lifescience Alley, interview by Team, November 2011.
○ Discovery: the invention of the biologic drug or technology is very research and capital intensive.

○ Testing and Clinical Trials: the tools and testing required to ensure the product has a cost-effective significant and safe effect. Examples include toxicology studies; Absorption, Distribution, Metabolism, and Excretion (ADME) studies for optimal yields; and the animal and patient FDA-required Phase I to III clinical trials that must be carried out prior to FDA review.

○ Regulation and Reimbursement: portion under direct review of the FDA (also Phase IV trials) and proving value to CMS and private health insurance payers for future patient reimbursement.

• Manufacturing: Highly design intensive process for each product. Requires state-of-the-art facilities and stringent FDA inspection. Many small firms rely on large pharmaceutical companies or contract research manufacturers.

• Sales and Marketing: promotion of products through alliance organizations, trade shows, and global market promotion to expedite product uptake.

• Service: Customized biologics require patient genetic and vitals information. This creates necessity for high attention to patient services. Public awareness of product as well as its side effects and risks must be tracked and enacted upon for successful market penetration.

The following supporting activities describe specific organizational level activities that can enhance value in biotechnology firms:

• Intellectual Property, Regulatory Compliance and Procurement: there is a large need for biotechnology firms to obtain process and product patents in order to raise capital and protect product differentiation throughout the production cycle. Also, speed to market depends on regulators so there is need to form a clearinghouse to report product information and gather relevant policy information from applicable government agencies, offices, and laboratories.

• Human Resource Management: Highly specialized talent in the form of biotechnologists for research and clinical oversight places high value on retention.

• Technology and Information Systems: R&D and product analysis is highly technology-driven. Analyzing molecular structures and advanced data-mining techniques require supercomputing tools, access to large genomic databases, and state-of-the-art optics and visualization tools.
- Firm Infrastructure/Strategy: similar to Porter’s generic value chain, biotechnology firms rely on corporate and strategic planning teams to carry products forward. Particular to the health industry in general, demand for medicine in developed countries remains fairly constant and inelastic. This gives firms and investors wide discretion in pursuing lucrative pricing strategies.
- Financial and Investor Relations: Biotech firms are highly reliant on venture capital and angel investors because of the high risk and lengthy nature of its product development cycle.

**Value Chain Applied to Twin Cities Life Science Cluster**

Each stage of the Biotechnology Value Chain and its supporting activities require key success factors to enhance the profitability of a firm. In this setting, small start-up firms can specialize in or outsource certain stages of the value chain to diffuse cost or capacity issues. Additionally, a value chain can also be thought of as embedded in a larger value system within its suppliers, contract partners and local cluster.
participants. Minnesota’s existing biopharmaceutical industry, while relatively small, has a widespread base with participant firms spread along the entire value chain.\(^{26}\)

R&D activities are primarily completed in-house but require close ties with universities, technology transfer organizations and other life science cluster participants. The University of Minnesota and Mayo Clinic stand as strong R&D players recognized as world leaders in molecular and tissue engineering. The world’s first institute dedicated to stem cell research began at the University in 1999.\(^{27}\) Chemical engineering, the backbone of pharmaceuticals and biopharmaceuticals, is a traditional strength as well. For example, the chemical engineering program at the University is consistently ranked 1 or 2 in the nation.\(^{28}\) However, the University’s R&D capacity does not historically transfer well into commercialization and it is not well coordinated with local industry. Recent trends within the biotech industry note the increasing use of Mergers and Acquisitions or alliance strategies by large pharmaceutical firms for technology acquisition to keep R&D costs down.\(^{29}\) The region’s lagging pharmaceutical presence creates a challenge to both attract such investment, but with a caveat to keep acquired biotech start-ups local once acquired.

The regulatory and reimbursement environment requires early and active engagement with government and other agents to gauge feasibility and seek approval. Early phase clinical trials mostly occur in-house and within the U.S. Institutions like the University of Minnesota and Mayo Clinic have robust experience in developing trials, creating a strong network of expertise and consultants along the entire FDA trials process.\(^{30}\) The local medical device capability also has the infrastructure to enable designs for advanced delivery, monitoring, and control technologies for biologic agents.\(^{31}\) Also, a strong state regulatory environment and local culture make Minnesota a desirable location to design and conduct product

\(^{26}\) Wahlstrom, et al. 2010  
\(^{27}\) http://www.stemcell.umn.edu/about/facts/home.html  
\(^{28}\) Ibid.  
\(^{30}\) Bioscience/Medical Device Professional, MN State Department of Employment and Economic Development, Interview by Team, December 2011.  
\(^{31}\) Ibid.
However, recent trends place a higher proportion of clinical trials outside of the U.S. to reduce costs and tap into emerging markets abroad.33

The Greater MSP region has strengths in its marketing and sales, legal compliance, and technology and information systems presence. A high density of local Fortune 500 corporate headquarters creates deep marketing and sales talent pools. The presence of nationally recognized integrated health care networks provides access to quality health specialists for treatment and trial development, as well as targeted product placement. Minnesota has a known historical strength in supercomputing with the presence of pioneering firms such as Control Data Corp., Unisys, Honeywell and IBM.34 IBM Rochester has a long-standing partnership with the Mayo clinic which uses the Blue Gene supercomputer to help model and understand disease.35 This partnership has recently launched an open source consortium to further develop tools for searching medical records.36 Despite some promising resources in health IT, industry research suggests that the capacity for bioinformatics in Minnesota is not adequate to meet the growth potential in this area.37

Manufacturing, local firm infrastructure, and venture capital investment are weaknesses in the local value chain. A diminished pharmaceutical industry limits the availability of manufacturing resources. Limited private sector leadership within the local biotechnology industry exposes the region’s lack of experience and limits the availability of biotech gurus and consultant services. Lastly, local venture capital investors are well-acquainted with the medical device industry and have not shown a propensity to invest in the longer and riskier development timeline of biotech.38

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32 Director, Member Services, Lifescience Alley, interview by Team, November 2011.
33 Ernst & Young 2000
34 http://www.cbi.umn.edu/resources/MHHC/HiddenHistory_01.html
37 Wahlstrom, et al. 2010
38 Ibid.
Federal and State Policy

Food and Drug Administration (FDA)

FDA regulation has been consistently cited as a challenge to the biotech industry. To understand why this is, the two core responsibilities of the FDA must be understood. First, the FDA is responsible for assuring the safety of food, drugs, medical devices, biologics, cosmetics and many other consumer goods. The responsibility to protect consumers is accomplished by applying the best possible science to its regulatory activities—from pre-market review of efficacy and safety to post-market product surveillance to review of product quality. Secondly, the FDA seeks to advance regulatory science to speed innovation, improve regulatory decision-making, and get safe and effective products to people in need. These two roles are somewhat contradictory in nature. If more safety is desired then a certain amount of speed must be sacrificed, whereas if innovation is desired then increased safety measures can slow down the process to the point where innovation becomes difficult. The balancing of these two mandates is one of the central tensions of the FDA’s role in regulating the biotech industry.

The regulatory processes for medical devices and pharmaceuticals are fairly mature and already in place, but the processes for biologics are still evolving. Since it deals with live organisms the complexities are manifold and the perceived hazards make the regulations extremely cautious in approach while dealing with them. This lack of an understanding of how biologics should be regulated poses another challenge to the industry.

This regulatory process causes the development of products in the biologics industry to take a very long time—from 10-15 years compared to the much shorter time frame of 6-8 years for medical devices. The fate of regulatory approvals is known only at a very late stage which makes it difficult to attract venture capital and other investments into the sector. The barrier is both due to high technology and high cost (long gestation period) of developing products.

In Europe safety and performance are the criteria for regulatory approvals whereas safety and efficacy along with economic benefits are looked into by the FDA before an approval is granted. For therapies performance and efficacy becomes the same whereas for a tool like scalpel these are different. In Europe private bodies like British Standards Institute (BSI) does the pre-market review which is the basis for the government to grant regulatory approval. These private bodies operate on market forces and if they are not fast enough, people may move to some other agency (TUV, a German organization, for
example). This has the effect of speeding the approvals process in Europe by 2-4 years compared to the United States. Consequently there is a tendency among new ventures to move away from the U.S., virtually exporting the industry out of this region.

There is an opinion that speed makes compromises but the fact that dead bodies are not found in Europe over new therapies raises questions about FDA regulatory practices. There is growing concern that the regulatory atmosphere here is stifling innovation. Real value addition is in intellectual capital where money ought to be made, not on manufacturing. Result is that venture capitalists are shy of moving into the area. Enterprises are having non-US strategies. Companies introduce products first in Europe. Existing players in the MSP region are expanding their presence elsewhere and laying off locally.  

In the US, there are legal issues with involvement of private bodies for things like pre-market review as some of these functions can’t be delegated to private entities under the existing law. But mechanisms can be evolved whereby they can be advisory bodies to the Government, on whose recommendation FDA can take decisions. Statutory changes are possible here too. Then the FDA can have more time to concentrate on complex issues.

A Public Private Partnership is going to be finalized soon among Life-science Alley, University of Minnesota and the Food and Drug Administration to work on regulatory sciences which involve policy, process and law, to explore how the time frame can be shortened. Computer modeling and simulation is one avenue by which testing can be done quicker without compromising on safety and efficacy. There are about 10 bills which are currently at different stages of consideration, but given the complex nature of influences that biologics can potentially have it may be a long time until these issues are resolved.

**Center for Medicare and Medicaid Service (CMS)**

Once a drug makes it through the FDA regulatory process a firm still has to figure out how the drug will be paid for. This is where the Center for Medicare and Medicaid Service (CMS) comes in with a whole other round of trials and processes. As the aging baby boomer population and the rising cost of medical care squeezes government budgets, the pressure to deliver treatments at an ever lower cost increases.

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39 Director, Medical Industry Leadership Institute, Carlson School of Management, Interview by Team, November 2011.

40 CEO, MR3 Medical, Interview by Team, November 2011.
The cost of development is high for biologics because one disease can have many variations. For example, breast cancer used to be tackled as one disease, but now the sub-population of BRCA hormone positive is treated with a different drug for it to be more efficacious. A treatment restricted to fewer people means they will have to pay more for the cost of the development of the drug.

New and often expensive biologics pose a problem for CMS. Medicare will probably move carefully with biologics because of the newness of such products and that they often target small patient populations. The traditional approach to coverage is to wait to see whether a new biologic treatment becomes an essential part of the community's standard of practice. Medicare may use the Coverage with Evidence Development (CED) process for these drugs, which conditions coverage and payment for a technology on the collection of additional clinical evidence, but it is unclear that coverage could be withdrawn if the drug proves to be only modestly efficacious. Given the high financial and political stakes, Medicare will be loath to rush into anything and will want the private insurers and the medical community at the local level to lead the way. In the meantime, Medicare will exert more pressure on manufacturers for supporting evidence, genetic testing or protein markers, or other ways of identifying the patient population who would most benefit from an expensive new biologics.\textsuperscript{41}

The safety/efficacy debate is one that is weighed by the FDA and CMS in every decision they make. Because resources are finite, society has to make hard decisions about how to divide those finite resources between health care and other forms of consumption. Reasonable people disagree about how well they maintain that balance in Medicare policy, but because of the uncertainties and expense associated with biologics, reimbursement is an issue and will likely become even more of an issue for the industry in the future.

**State Policy Environment**

Minnesota had the 12th highest state local tax burden in 2008 with a rate of 10.2 percent compared to the US average of 9.2 percent. Minnesota had the 20th highest total taxes among states in 2005 according to Minnesota House of Representatives Fiscal Analysis Department. The state ranked 7th in income tax, 10th in corporate tax, 30th in sales tax, and 35th in property tax.\textsuperscript{42}

\textsuperscript{41} \url{http://www.ahdbonline.com/feature/medicare-coverage-policies-biologics-broad-gray-line}
\textsuperscript{42} Wahlstrom et al. 2010
Despite the tax environment, a fairly conducive package of incentives is present that benefit the biotech industry, such as:

- **Small business development loan fund**: $1-$5 million loans are available for small businesses located in or intending to locate in the state.

- **Angel tax credit**: Started in 2010 and expanded in 2011, this tax credit encourages investment in early-stage Minnesota businesses and supports entrepreneurial companies, particularly those in the technology field. 47 jobs were estimated to be created by this program in the first year of operation.\(^{43}\) As of October 2011, MN businesses have received an estimated $53.2 million in investments since the creation of the program.\(^{44}\)

- **R&D tax credit**: A State tax credit offered to incentivize businesses to make capital investments, with any excess credit carried forward up to 15 years. This program supports technology in agriculture, tourism, manufacturing, and transportation.

- **Bioscience Zones**: These designated zones give existing and start-up bioscience companies greater access to educational institutions and provide tax incentives to facilitate their growth.

- **MN job skills partnership**: Training grants of up to $400,000 can be provided to educational institutions that partner with businesses to develop new job training or retraining for existing employees.

- **Tax incentives**: The Minnesota legislature has enacted an eight-year phase-in of single sales apportionment of corporate income tax to be completed in 2014. Minnesota’s sales tax law also exempts capital equipment used in the manufacturing process. Minnesota also does not have a personal property tax.

During the Minnesota Governor’s Job Summit 2011\(^{45}\), Governor Mark Dayton has announced his seven priorities for job creation:

- Increase access to capital for new businesses, small businesses and small business expansion.

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• Align our education system to prepare Minnesotans for the jobs in demand.
• Continue to streamline government regulations.
• Invest in state infrastructure, such as roads, bridges and border-to-border high-speed Internet.
• Continue reform efforts under Better Government for a Better Minnesota, improving services and reducing cost.
• Increase exports of state products, coupled with an effort to entice foreign investment in Minnesota.
• Close the educational achievement and employment gap by working to end disparities based on race, class and place in Minnesota.

Industry leaders should advocate for polices to increase capital to new businesses that are more flexible than traditional State programs. As the business model for biotech start-ups is to avoid capital expenditures as much as possible, traditional programs to make capital available for fixed-assets alone are often not sufficient to grow biotech.46

46 Bioscience/Medical Device Professional, MN State Department of Employment and Economic Development, Interview by Team, December 2011.
**Disconnect Between Discovery and Commercialization**

A recurring theme emerged from numerous interviews of leading academics, local Institutions For Collaboration (IFC’s), and industry professionals; the University of Minnesota is recognized as a great potential resource underpinning the biotechnology and medical device clusters, yet many expressed confusion about the role of the University in commercialization. While the University is widely regarded for its quality and quantity of graduates and research, those interviewed communicated a lack of both transparency and strategic collaboration between industry and the University of Minnesota. Many expressed an interest in developing a map of all of the R&D tracks and institutes to clarify and uncover possible linkages between these institutes and regional cluster counterparts. One representative from a local IFC commented that such a map also needed “a legend to know who is, or is not, willing to work with firms.”

As a necessary strategy to enhance the development of a local biotechnology cluster, this section evaluates the role of the University of Minnesota in connecting research, discovery and commercialization. First, the relative strengths and added value of the university will be discussed. Second, its Venture Center commercialization model will be analyzed to help guide understanding of how the University plans to link its discoveries and their implementation into commercialized products.

**Resources at the U of M**

The University of Minnesota (U of M), in partnership with the Mayo Clinic and with some help from the state of Minnesota, have made large investments in the development of pharmaceutical and biopharmaceutical treatments. Moreover, the University produces a strong, skilled workforce. Each year 210 graduate and undergraduate degrees are given in chemical engineering and 1,900 degrees in biological and biomedical sciences, including biomedical technologists, biotechnology laboratory technicians, and biomedical engineers. This is a large part of why the Minneapolis/St. Paul region is considered 3rd for having the most educated workforce and 15th in best education climate.

Beside these accolades, the U of M continues to develop new professional development and sector collaboration initiatives throughout the biosciences. One example is the inauguration of the BioBusiness Clearinghouse, a “one-stop-shop” of digital biobusiness-related resources such as education materials, conferences, and other professional development activities. Another is numerous professional

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47 Director, Member Services, Lifescience Alley, interview by Team, November 2011.
48 Wahlstrom, et al. 2010
development workshops devoted to bioscience topics each year. A new mobile science laboratory program emerged related to the actual need in this specific health care & life science area. Another positive resource is the Biomedical Discovery District research park project slated for completion in 2015. This 700,000 square foot research park will house specialists in neuroscience, the Stem Cell Institute, the Center for Infectious Disease and Microbiology, the Center for Magnetic Resonance Research housing the world’s largest imaging magnet, and heart and cancer care institutes within a flexible and collaborative research space. The district is touted as a place where discoveries happen as disciplines meet: combining scientific research with clinical counterparts to derive new cures and therapies.49

Yet another example is the University of Minnesota’s Office of Technology Commercialization (OTC), which established a University Innovation Grants program that will support translational research not supported by federal or industry funding. In 2005, the University of Minnesota opened the McGuire Translational Research facility whose mission is to expedite process of moving new discoveries from research laboratories to real-life clinical and commercial applications.

To conclude on the bulk of U of M resources, there are a lot of positive resources built up around the health and life science research. Many different programs and initiatives promote the interest of finding new discoveries. Furthermore, the University of Minnesota is well ranked nationally and has influence creating partnerships with extensive organizations. Despite this, the challenge remains to develop a strong collaboration between the University and regional commercial partners to foster economic growth and funding the development and commercialization of further life science technologies.

**U of M Commercialization Model**

In order to better understand the University’s perspective in its perceived role linking discovery and commercialization, explanations will be extracted from a guide created by The U of M and Venture Center to help faculty, staff, and entrepreneurs interested in starting a new business based on University of Minnesota research.

Venture Center is a business unit within the Office for Technology Commercialization (OTC). Working with researchers, entrepreneurs, and investors, the office strives to create new start-up companies

49 http://www.health.umn.edu/research/bdd/the-impact/index.htm
based on research conducted at the University of Minnesota. The purpose of the Venture Center is to create businesses that accelerate and maximize the impact of University innovations that save lives, create jobs, and enhance public welfare.

The Office for Technology Commercialization (OTC) oversees all aspects of technology commercialization at the University of Minnesota. OTC has five business units: Agriculture and Horticulture, Life Sciences, Engineering & Physical Sciences, Software and Information Technologies, and the Venture Center. These business units work together to determine the best path of commercialization for each technology.

As a guideline, the University Regent’s Policy states that the University commercializes University-developed technology for two major reasons: first, to make these innovations available to the public; and second, to earn a return for the University. Separate pathways to licensure and venture start-ups
highlight this two-fold approach. While this model of commercialization is already in place at the U of M with the assistance of Venture Center, questions over its utilization and usefulness still remain.

**Solving the Disconnect**
While a visible connection between the U of M and life science professionals exists in its many professional organizations, there does not appear to be the same interaction between the University and local firms. This is exacerbated because of the sheer size and volume of research conducted, where it appears Minnesota’s university research and its medical technology industries are not well coordinated. Some rightly point out that academic research pursuits are not always aligned with commercial interests, however, there appears to be a lack of partnerships with local industry. This linkage is necessary to capitalize on the multitude of discoveries which occur at the university.

To improve this, the OTC has recently developed the Minnesota Innovation Partnerships (MN-IP) to improve industry sponsored research. This policy streamlines the negotiation of licensing rights to intellectual property developed during industry funded research. The proposal allows companies who sponsor U of M research to pay a small fee up front to retain exclusive worldwide rights where royalties only accrue in extreme commercial successes. affair. Aimed at generating more industry sponsored R&D partnerships at the U of M, this proposal is hoped to make the university more lucrative as an investment strategy while also increasing the incentive for industry to commercialize research through a pre-paid fee schedule.

However, the low density of biologic and biopharmaceutical companies in the state makes it difficult for the University to partner with that sector here. The OTC will have to actively work to attract industry sponsors in order to reap success from MN-IP. Additionally, the stock of capable entrepreneurs and risk capital available to support the conversion of research into commercially viable technology products and services does not appear to be available.

Some of the interviewed experts explained that this provides the actual context causing the lack of partnership and commercialization of new research mainly based in biologic and biopharmaceutical products. This lack of major regional investor explains why much of the data shows the University of Minnesota is good at making and developing innovative biologic and biopharmaceutical discoveries, but

relatively few are commercialized in state. For these reasons, it seems difficult for students and researchers to find local experience opportunities within the private sector, and also for the region to generate spin-off firms. Thus, a large portion of the licenses for commercialization of University biotechnology goes to companies located outside of Minnesota.

Indeed, a recent Finance & Commerce article features the Director of the Holmes Center for Entrepreneurship at the University of Minnesota’s Carlson School of Management, John Slavig. In it he explains that “economic uncertainty used to frighten investors away from new businesses”. However he also observes that this may be changing, as it appears that investors are now actively looking to invest in talented people who will be able to run new companies.\(^{51}\) This point of view is also shared by other interviews with experts working for the Life Science department and the managerial side of the Venture Center. They perceive that investors want to invest on people more than on technology. Thus, the challenge for the Office of Technology Commercialization within biotechnology has become not only finding out who and where the talent are, but also how to attract them. In one’s opinion, “We have the talent to create tools but don’t have the talent to run it.”\(^{52}\) Another added: “We need to find people who get [biotech] experience and know how to run a new company in order to succeed in developing this kind of cluster”.\(^{53}\)

Despite this, the University remains one of the region’s biggest strengths. Office of Technology Commercialization leaders are confident in the future partnership between the University and local firms thanks to recent investments in infrastructure and early stage businesses.\(^{54}\) The creation and utilization of Minnesota’s recent Angel Tax Credit represents a key factor in building these relationships. Other assets include the Center for Entrepreneurship which works with business students to develop their capabilities through events like the Minnesota Cup, an annual event put in place to help start-ups. This event creates a competition among local entrepreneurs that has gained in participatory and sponsorship popularity over its initial 6 years of existence. Another regional example is the creation of the Minnesota Angel Network that is slated to offer a way to give new companies access to the right


\(^{52}\) Associate Director, Venture Center, Interview by Team, December 2011.

\(^{53}\) Technology Strategy Manager, Life Science, Office for Technology Commercialization, Interview by Team, December 2011.

\(^{54}\) http://www.research.umn.edu/techcomm/documents/MNIP_factsheet.pdf
investors with instruction with how to go through the start-up process. Indeed signs are pointing up: according to the U of M Office of the Vice President for Research 2011 Annual Report, the OTC reports growth in most metrics for Technology Commercialization.55

2011 Research Report – Fiscal Year Technology Commercialization Data
(Source: University of Minnesota)

Enter University Enterprise Laboratories, Inc. (UEL)
Formed in 2004, the University Enterprise Laboratories, Inc. is a $24 million collaborative research center and nonprofit located in St. Paul, Minnesota. The 126,000 square foot facility seeks to incubate early stage bioscience ventures by providing premier facilities and services that enable innovation, growth, and commercial success.56 Designed to provide low cost wet lab and office facilities to start-up and University research spin-off tenants, the UEL struggled during its infancy to fill its capacity with bioscience clients. The UEL expanded its criteria and is now at capacity with roughly 30 tenants ranging

56 http://www.uelmn.org/
from established companies licensing university technologies to scientific equipment distributors and Child Development organizations. Expanding its client based allowed the facility to maintain a positive cash flow, but may not be fulfilling its original mission.

Of note, four start-ups have graduated from the UEL into their own facilities - Segetis, Twin Star Medical, Harland Medical Systems and OrthoCor Medical. However, a recent Medcity news article criticized UEL’s position as an economic development agent, noting that the organization does not track job creation through its program and is overly concerned with filling up its tenant list. The article goes on to explain that the cost of the facility is too high for start-ups and that only 2 of the 9 start-ups created from University research between July 2010 and June 2011 are based at the UEL. Despite this, the University has the ability to enforce a fine on the facility if it does not provide space to affiliated start-ups. However, it has waived this fine every year in an effort to alleviate additional financial burden to the nonprofit.

The UEL can provide a much needed link between the robust research capacity of the University of Minnesota, and the successful commercialization of its efforts. However, it seems that its reliance on public financial support has confounded its original mission to cultivate University bioscience start-ups. Despite this, the facility is currently seeking funding for a 40,800 square foot expansion of additional wet lab space to meet the needs of its waiting list.

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**Factor (Input) Conditions**

+/- Biotech expanding globally; but MSP region lacks rivals

+ Twin Cities high Fortune 500 density

+ New Angel and R&D tax credits

+ Life Science / Technology Talent

+/- Transportation Infrastructure / limited wet lab space

- Low productivity in R&D

- Poor Venture Capital Access

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**Context for Firm Strategy and Rivalry**

+ R&D Centers of Excellence

+ Well-integrated Health Systems and Clinical data

+ High Quality of Life

- Slow-moving Regulatory Environment

- Growing Achievement Gap

- Poor Entrepreneurial / Risk Culture

- Domineering medical device industry

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**Diamond of Advantage for Biotechnology in Minneapolis-St Paul**

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**Demand Conditions**

+ Expanding Global Healthcare Market

+ Individualized medicines and need for therapeutics

+ Growth potential for combination devices

+/- US consumers are diverse and wealthy, but rising healthcare costs are changing behaviors

- Lengthy regulation creates uncertainty and limits impact of consumer demand

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**Related and Supporting Industries**

+ Value Chain supplier, regulation, finance, and marketing expertise

+ Strong Healthcare Payer and growing bioinformatics presence

+ Institutions for Collaboration: Lifescience Alley/Biobusiness Alliance

- U of MN history of weak tech-transfer and commercialization

- Lack of "Big Pharma"
**Factor (Input) Conditions**

The region has centers of R&D excellence like the University of Minnesota and Mayo clinic which provide the area with an extraordinary base in education and R&D facilities. There is a large amount of discovery happening in the area. Further, a vast talent pool is present in the Greater MSP region. Being a global presence in medical device industry, world class engineering talent is available in the area. The region was the origin of supercomputers and remains strong in technology, making it a good base for future research.

Although the region has a very harsh climate, it has been rated as one of the top ten best places to live because of the high quality of life it provides. It has a good infrastructure in roadways, railways, waterways and air, which connects it smoothly to any part of the country and the world.

An overall lack of venture capital for biotech firms in the region is a major weakness. The comparatively lower risk medical device industry dominates venture funding in the region. Limited VC funds find their way to the more established and lesser risk medical device firms.

**Demand Conditions**

With rising income levels across the globe, particularly in the developing world, demand for healthcare is expected to expand. An aging population requiring more care is also a factor influencing demand. Further, there is an emerging trend of individualized medicines which are more effective where biologics hold the key. Applications of biologics and advanced pharmaceuticals also require precision instruments and the use of combination devices where medical device companies can play a role.

The United States consumes the most healthcare as a percentage of GDP in the world. However, costs in healthcare are rising unchecked and are inducing changes to consumer behavior like the use of high deductible insurance, generic pharmaceuticals, and putting off routine medical care. The United States regulatory environment creates a phenomenon where everyday consumers (i.e. patients) do not drive the market. Agencies like the FDA and CMS create delays and uncertainty in bringing products to market and pricing them according to efficiency and utility.

**Related and Supporting Industries**

Expertise along entire value chain and strong supplier network is available in the region for biotechnology due to the presence of a mature medical device cluster. A significant number of tier one suppliers serve advanced manufacturing and medical device. The region has good presence in clinical trials, analytical instruments, financial institutions, regulatory and reimbursement consultants. This enables the presence of “virtual companies” which contract out the different phases of product development along supply chain.

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Engineering expertise of the medical device cluster is necessary to “scale up” or commercialize bioscience discoveries. Lack of presence of big pharmaceuticals in the region is a weakness. The region appears to lack necessary toxicology expertise, but overall the supply chain can be considered strong.

There is a strong presence of healthcare payer in the region by way of United Health which is a major strength. However for new biologics development, reimbursement remains an issue due to the complex nature of processes and technology involved. Alliances like the collaboration between Mayo clinic and IBM for health information within the University’s Biomedical Informatics and Computational Biology research center are positive, and institutions for collaboration (IFCs) like Biobusiness Alliance and Lifescience Alley are actively championing the cause of biologics industry in the region.

**Context for Firm Strategy and Rivalry**

There is a high concentration of fortune 500 companies with supporting infrastructure in the area which makes it attractive to business but a lack of an entrepreneurial culture in the region hampers growth of a high risk industry like biotech.

Taxation levels in the region are not the most competitive but there are incentives for business like angel tax and R & D credit have become increasingly competitive recently. Government support for start-ups is growing, but is still at an early stage. Dominance of medical device “culture” in the region, however, often overshadows smaller biotech start-ups in venture funding and talent. An unstable government budgetary environment may limit future R & D investment affecting the traditional strength of the region.

Biologics involves cutting edge technology dealing with large complex molecules and so the regulatory process for them is still evolving. There are many areas where there is no clarity. There is a feeling that the regulatory process is slow and stifles innovation. Tech transfer and commercialization from the University is weak too.

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60 http://www.r.umn.edu/research/bicb/
61 Greater MSP Regional Industry Overview for Microeconomics of Competitiveness: Firms, Clusters and Economic Development, University of Minnesota, Fall 2011
Minneapolis-St. Paul Biotechnology Cluster Map

Pharmaceuticals

Regulatory Consultants

Analytical Instruments

Clinical Trials

Reimbursement Consultants

Biotechnology

Medical Device Industry

Convergence of Drugs and Devices

Nano-biotechnology

Gene-based

Personalized Medicine

DNA-based

Regenerative Medicine

Data-based

Specialized Banking Services

Specialized Risk Capital

Specialized Research Service Providers

Research Organizations

Specialized Hospitals

Educational Institutions

Cluster Organizations
Biobusiness Alliance, Lifescience Alley
## Recommendations

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<td>A Advocate for reform</td>
<td>Underdeveloped and burdensome FDA regulation for biologics</td>
<td>Biobusiness Alliance, Lifescience Alley</td>
<td>National</td>
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<tr>
<td>B Advocate for long-term solutions to budget crises</td>
<td>Continuing State budget crises threaten historic investment in education</td>
<td>Greater MSP, Biobusiness Alliance, Lifescience Alley, U of M, Industry leaders</td>
<td>State</td>
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<tr>
<td>C Advocate for sustained investment in high-quality workforce</td>
<td></td>
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<td>State</td>
<td></td>
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<tr>
<td>D Develop biotech specific cluster organization</td>
<td>Poor Entrepreneurial Culture*</td>
<td>DEED, U of MN, Lifescience Alley, Biotech cluster IFC</td>
<td>State/Cluster</td>
<td></td>
</tr>
<tr>
<td>E Collaborate across IFC's to align strategies</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F Increase visibility of cluster</td>
<td></td>
<td></td>
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<tr>
<td>G Create industry-university collaboration, including private sector support of a &quot;concierge&quot; position</td>
<td>Weak commercialization of discoveries</td>
<td>Mayo Clinic, U of MN, Tech and Trade schools, Cluster IFC's</td>
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<tr>
<td>H Increase awareness of available resources</td>
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<tr>
<td>I Involve industry in creation of curriculum</td>
<td></td>
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<tr>
<td>J Cross-disciplinary educational programs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D Develop biotech specific cluster organization</td>
<td>Biotech cluster is still developing</td>
<td>DEED, U of MN, Lifescience Alley, Biotech cluster IFC</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>F Increase visibility of cluster</td>
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<tr>
<td>K Advocate for policy solutions</td>
<td>Growing achievement gap</td>
<td>Greater MSP, U of M</td>
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<td>L Develop industry specific internships, fellowships, grants and placement programs*</td>
<td>Disadvantage attracting talent*</td>
<td>U of M, IFC's, Greater MSP, biotech companies</td>
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<td>M Expand funded research positions*</td>
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<td>N Increase Angel funds available</td>
<td>Weak VC Climate</td>
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<td>O Extend R&amp;D credits</td>
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<td>State/Cluster</td>
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<tr>
<td>P Promote local healthcare collaborations</td>
<td>Increasing cost of healthcare*</td>
<td>U of M, Mayo Clinic, IFCs, healthcare industry</td>
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<td>Q Leverage strength of medical device value chain</td>
<td>Convergence of medical device and biotech</td>
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<td></td>
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<tr>
<td>R Focus on areas of convergence, such as diagnostics</td>
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<td></td>
<td>Cluster</td>
<td></td>
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<tr>
<td>S Persuade medical device and biotech clusters that their long-term interests are aligned</td>
<td>Trend away from devices and toward cures threatens stability of medical device industry</td>
<td>Greater MSP, IFC's, U of M</td>
<td>Cluster</td>
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</table>
Opportunities to Strengthen Related and Supporting Industries: Biotech has many significant strengths in the region, but it has yet to operate as an organized cluster with strategic goals. While several prominent IFC’s have been in existence in the region for some time, they have not been successful in leveraging the significant strengths of the region and coordinating a unified strategy for the cluster. The creation of an independent biotech cluster organization may be a good first step to raising the profile of biotech in the region. Collaboration with existing IFC’s will then be essential to create a unified strategy for the cluster.

Another significant challenges expressed by industry leaders is the apparent disconnect between the biotech industry and the University. To address this challenge, an industry-University collaboration should be created. Since the University has been unable to support the “concierge” position, the private sector can take on the creation of this role to act as the “front-door” to the University. This collaboration could work to build relationships and align interests, as well as make resources the University more visible. The collaboration should include the industry in the creation of curriculum to ensure graduates are prepared for future jobs, and consider cross-disciplinary degrees to take advantage of convergence opportunities.

Opportunities to Strengthen the Context for Firm Strategy and Rivalry: Federal regulatory policies affecting the biotech cluster must be addressed on a national level. Several bills related to streamlining FDA regulations will be heard in the upcoming legislative session and advocacy from the region must be strong during this process. The state political climate is also uncertain, with continual budget crises threatening historic investment in education. Continued investment in the state’s high-quality workforce is necessary, as is a permanent solution to continued budget deficits at the state level. Greater MSP, local IFC’s, the University and trade schools must all advocate for solutions.

Opportunities to Strengthen Factor Conditions: The growing achievement gap in Minnesota threatens the health and vibrancy of the state’s workforce. Greater MSP should advocate for varied policy solutions to this very real problem. The education of a diverse workforce is not only important social policy, lacking diverse talent in the state may make recruitment of talent from elsewhere more difficult.

Strategies to make a cold-weather state attractive to workers who may have options to work in competitor regions such as California and Massachusetts should also be expanded. Funded research
positions, industry specific internships for on the job experience, as well as fellowships, grants and placement programs should all be considered.

The weak climate for venture capital must also be addressed. Minnesota has done well by expanding the angel tax credit. It has proven so popular that the fund ran out of money for the year 2011 by October. The gap in the continuation of this credit may pose challenges to some, and solutions should be discussed. Expansion of R&D credits may also help improve the climate for venture capital in the region.

*Opportunities to Strengthen Demand Conditions:* Health care costs are increasing at an alarming rate. National health reform remains a priority because of this threat. As consumers and investors become more aware of these costs, resources will shift away from medical device technology and toward cures. This is both an opportunity for biotech growth in the region, but also a threat to the established medical device cluster.

*Cluster Specific Strategies:* Industry leaders should be very focused in their attempts to build the biotech cluster in the region. The region may never be one of the main national players in the industry given the strength of competitor regions, but then this isn’t the goal. Strategic thinking could position the Minneapolis-St. Paul to develop niche in the international market for convergent devices. As the medical device industry converges with biologics, opportunities arise to leverage the historical strength of medical device in the region to expand into growing markets. This is a natural strategy given the presence of major medical device firms and the strength of medical device supply chain in the region. Not only does this build on existing strengths, but growth in convergent devices is also a good strategy to address the trend in medicine as shifting away from devices. Focusing on the convergence of medical devices and biologics addresses this threat while leveraging other strengths of the region. The medical device and biotech clusters must be convinced that their interests are aligned in the long-term.
Conclusion
Greater MSP region has a strong presence in Medical Device industry and is showing growing presence in biopharmaceuticals. There is a lot in the region particularly in terms of the medical device cluster that supports the growth of biotechnology in the area. The therapies in the future are going to have a more supplementary role between the two, where medical devices would be working in conjunction with biotechnology produced drugs. Personalized medicines are more effective and are made possible through innovations in biotechnology and ingenious use of medical device. It is this potential from an established medical device cluster that is required to be harnessed.

There are gaps too, that need to be addressed and can contribute to the overall growth of the region if nurtured well. Though the value chain for biotechnology has a lot in common with medical devices, there are many ‘cultural’ differences like the risk appetite and entrepreneurship that make a sector like biotechnology more challenging than the established medical devices cluster. Limited venture capital available in the region finds it more attractive to invest in medical devices than biotechnology. Long gestation periods for the new discoveries and complex regulatory environment make it even more challenging. Reimbursement for new biologics can be tedious because of lack of clarity.

There needs to be a concerted effort on the part of all the stakeholders to help provide an environment of enterprise for the start-ups. The gap between discovery at the University and commercialization can be bridged by enabling state support by way of incentives and tax credits, as well as nurturing human capital in entrepreneurship by backing emerging U of M commercialization initiatives and the formation of the Minnesota Angel Network. The biotechnology cluster can have more visibility through the work of IFCs working in the area. Finally the regulatory environment needs to be made more conducive to innovation and enterprise. FDA processes are required to strike out a balance between speed and safety so as not to let intellectual capital move out of the region. This will also help ease the reimbursement environment to an extent.

Recommendations for Greater MSP:

1. **Prioritize partnerships and policies to improve the biotech “eco-system.”** A risk-taking, start-up culture must be developed for biotech to take hold. Partnerships must also be developed with medical device leaders to get them on board toward a shared vision and to find out what is necessary to take advantage combination drug-device products. There is visionary interest from the device industry in the potential of combination device-drug products, but a new crop of
managers must be developed to take on the regulatory and managerial challenges of this market. This in turn will encourage venture capital, since we have found that venture capitalists invest in people as much as they invest in products. If this can be accomplished, Minnesota might find itself in a position of national leadership in the combination device market.

2. **Improve commercialization of discovery.** There needs to be a better connection between industry and the University. This will be a difficult issue to solve, but robust partnerships need to be developed to bridge the gap between the discovery that is happening locally and commercialization. It will also be important to get behind the new research park that is scheduled to be completed in 2015 at the University. This research park will include the needed “wet lab” space that is currently lacking in the region, potentially improve the relationship with industry and encourage knowledge sharing.

3. **Create a diabetes and cardiovascular regional “brand.”** The diabetes brand emphasizes a major partnership between the University and Mayo Clinic, two internationally known research institutions, called “the decade to end diabetes.” This strategy is also aligned with the Biobusines Alliance of MN and Department of Employment and Economic Development. Cardiovascular research has also been a traditional strength for the region.
Bibliography


**Team Interviews**

Principal Scientist & PK/PD Analysis Manager, Medtronic, Interview by Team, December 2011.

Bioscience/Medical Device Professional, MN State Department of Employment and Economic Development, Interview by Team, December 2011.

Pharmaceutical and Biological Products Consultant, BioBusiness Alliance, Interview by Team, October 2011.

Vice President, Medical Technology Cluster, BioBusiness Alliance, Interview by Team, October 2011.

Postdoctoral Researcher, Humphrey School of Public Affairs, Interview by Team, November 2011.
Director, Medical Industry Leadership Institute, Carlson School of Management, Interview by Team, November 2011.

Associate Director, Institute for Engineering in Medicine, Interview by Team, October 2011.

Senior Vice President, Chief Quality & Regulatory Officer, Medtronic, Interview by Team, November 2011.

CEO, MR3 Medical, Interview by Team, November 2011.

Associate Director, Venture Center, Interview by Team, December 2011.

Technology Strategy Manager, Life Science, Office for Technology Commercialization, Interview by Team, December 2011.

Director, BioTechnology Institute, Interview by Team, November 2011.

Director, Member Services, Lifescience Alley, interview by Team, November 2011.

 Constituent Services Representative, Office of U.S. Congressman Erik Paulsen (R), Interview by Team, November 2011.
Appendix

Appendix 1:

Creating Competitiveness
Linkages Across Clusters

Note: Clusters with overlapping borders or identical shading have at least 20% overlap (by number of industries) in both directions.
### Appendix 2: Biotech Cluster Definitions

#### Porter Cluster Definitions

<table>
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<th>Cluster</th>
<th>Subcluster</th>
<th>NAICS</th>
<th>NAICS Description</th>
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<td></td>
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<td>Research and Development in Biotechnology</td>
</tr>
<tr>
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<td></td>
<td>541712</td>
<td>Research and Development in the Physical, Engineering, and Life Sciences (except Biotechnology)</td>
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<td>541720</td>
<td>Research and Development in the Social Sciences and Humanities</td>
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<td>Marketing Research and Public Opinion Polling</td>
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<td>Educational Institutions</td>
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<td>Colleges, Universities, and Professional Schools</td>
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<td>611430</td>
<td>Professional and Management Development Training</td>
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<td>Zoos and Botanical Gardens</td>
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### Cortright and Mayer (2002) Biotech Cluster Definition

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### Kelton et al (2006) Biotech Cluster Definition

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Note: Each industry code is further weighted to the degree which biotech activity occurs.
Appendix 3: Specialization by Traded Cluster, 1998-2009

Minneapolis-St. Paul-Bloomington, MN-WI

Appendix 4:

Share of Life Science Clusters in Peer Regions (2009)

Appendix 5:

Appendix 6:

Research Organizations Subcluster Activity by Metropolitan Area

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<tr>
<td>7</td>
<td>Philadelphia-Camden-Wilmington, PA-NJ-DE-MD</td>
<td>28,905</td>
<td>7.11</td>
<td>$106,850</td>
<td>7.4</td>
<td>1.77</td>
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<td>8</td>
<td>Chicago-Naperville-Joliet, IL-IN-WI</td>
<td>27,674</td>
<td>2.66</td>
<td>$81,061</td>
<td>6.52</td>
<td>1.07</td>
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<tr>
<td>9</td>
<td>San Diego-Carlsbad-San Marcos, CA</td>
<td>25,947</td>
<td>3</td>
<td>$96,659</td>
<td>4.91</td>
<td>3.52</td>
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<tr>
<td>10</td>
<td>Durham, NC</td>
<td>20,008</td>
<td>13.93</td>
<td>$106,905</td>
<td>6.9</td>
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</tr>
<tr>
<td>15</td>
<td>Minneapolis-St. Paul-Bloomington, MN-WI</td>
<td>10,754</td>
<td>10.47</td>
<td>$74,586</td>
<td>6.15</td>
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</tbody>
</table>

## Appendix 7:

### Biopharmaceutical Activity by Metropolitan Area

<table>
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<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>New York-Northern New Jersey-Long Island, NY-NJ-PA</td>
<td>39,693</td>
<td>-3.76</td>
<td>$77,358</td>
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<td>Chicago-Naperville-Joliet, IL-IN-WI</td>
<td>23,710</td>
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<td>$64,660</td>
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<tr>
<td>3</td>
<td>San Francisco-Oakland-Fremont, CA</td>
<td>18,605</td>
<td>13.13</td>
<td>$40,044</td>
<td>-0.94</td>
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<td>4</td>
<td>Los Angeles-Long Beach-Santa Ana, CA</td>
<td>17,293</td>
<td>0.38</td>
<td>$50,896</td>
<td>2.83</td>
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<td>5</td>
<td>Philadelphia-Camden-Wilmington, PA-NJ-DE-MD</td>
<td>12,029</td>
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<td>$72,826</td>
<td>0.02</td>
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<tr>
<td>6</td>
<td>St. Louis, MO-IL</td>
<td>5,590</td>
<td>1.2</td>
<td>$60,525</td>
<td>4.33</td>
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<tr>
<td>7</td>
<td>Boston-Cambridge-Quincy, MA-NH</td>
<td>5,107</td>
<td>1.73</td>
<td>$89,150</td>
<td>3.87</td>
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<tr>
<td>8</td>
<td>Dallas-Fort Worth-Arlington, TX</td>
<td>4,557</td>
<td>-3.23</td>
<td>$45,795</td>
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</tr>
<tr>
<td>9</td>
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<td>4,263</td>
<td>4.16</td>
<td>$76,161</td>
<td>5.62</td>
<td>1.13</td>
</tr>
<tr>
<td>10</td>
<td>Miami-Fort Lauderdale-Pompano Beach, FL</td>
<td>4,051</td>
<td>19.63</td>
<td>$65,483</td>
<td>8.34</td>
<td>0.94</td>
</tr>
</tbody>
</table>