



CHICAGO BIOTECH

A cluster analysis

ABSTRACT

Chicago's biotechnology cluster is falling behind. In the last decade, Chicago has seen capital, talent, and innovation, move to the coasts, leading to lackluster performance in one of the city's key industries. In this report, we explore the competitiveness of the biotechnology clusters through the cluster theory framework, and evaluate national, regional, and cluster-specific causes. To conclude, we offer eight recommendations to enhance the competitiveness of the cluster and the region.

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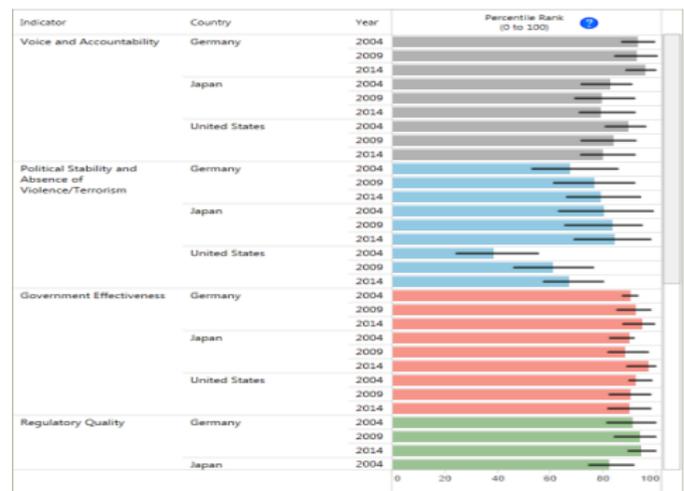
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UNITED STATES: BACKGROUND & COMPETITIVENESS

The United States of America (U.S.) is the third largest country in the world in terms of area¹ and population.² The U.S. economy is also the largest national economy in the world with one of the highest GDP per capita.³ However, the long-run productivity of the U.S. and its overall competitiveness are threatened by “weaknesses in the tax code, basic education, macroeconomic policies, and regulations.”⁴

GOVERNMENT OF THE UNITED STATES: The U.S. is one of the oldest existing constitutional democracies in the world. It is composed of 50 states and several dependent territories.⁵ The federal government, comprised of an executive, legislative and judicial branch, is in charge of defense, foreign policy, international trade policies, and federal taxation. The federal government is also in charge of determining the import and export policies and regulations.



Moreover, the U.S. is also a founding party to numerous international organizations and treaties, including the UN, World Bank, IMF, NATO, WTO, NAFTA, and most recently the TPP.

GEOGRAPHY, DEMOGRAPHICS, AND ENDOWMENTS: The U.S. is the third largest country in the world by area after Russia and Canada, and the third largest by population (323 million) after

¹ “The World Factbook.”

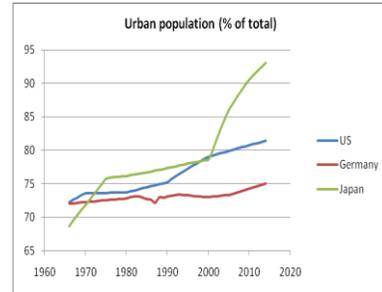
² “Population by Country (2016) - Worldometers.”

³ “The World Bank DataBank.”

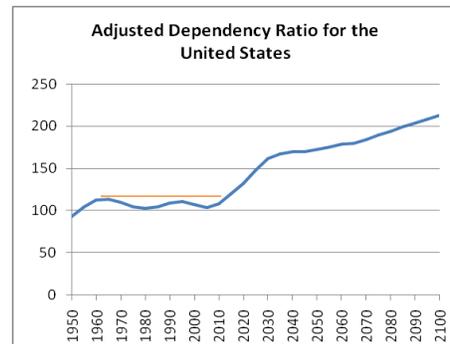
⁴ Michael Porter and Jan W. Rivkin, The Looming Challenge to U.S. Competitiveness, Harvard Business Review, March 2012, <https://www.globalinnovationindex.org/content/page/data-analysis/>

⁵ “The World Factbook.”

China and India. The U.S. is considered to be “geographically lucky” as it is located in one of the world’s most stable regions, and among the most geographically and geologically diverse countries in the world.⁶ Agricultural land amounts to 44% of overall land, forest land is almost 33%.⁷ The diverse climate of the U.S. also lends itself to a wide range of biodiversity, making the U.S. one of the “megadiverse countries” in the world.⁸ The U.S. is also endowed with a wide variety of natural resources including petroleum, natural gas, copper, gold, iron, coal, lead, nickel, timber, and uranium.⁹ The discovery of shale gas and oil in the US has also made it less dependent on foreign oil imports.¹⁰



With a population of 323 million, the U.S. is endowed with a highly skilled labor force that has enabled the US to maintain high productivity and economic prosperity.¹¹ However, the U.S. only ranks 16 on the Human Capital Index due to weaknesses in the “health and wellness”



and “education” indicator where it ranks 44 and 11 respectively.¹² The size of the population also provides a competitive market for products and services. In 2014, population growth rate was around 0.7%, a rate that has remained relatively stable over the previous five years.¹³ However, the dependency ratio is increasing, and it is projected that after 2020 this ratio will increase at an even higher rate. According to the projections of the Population Division of the United Nations, the next

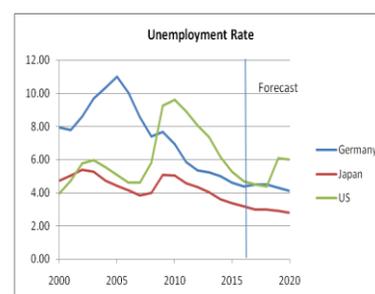
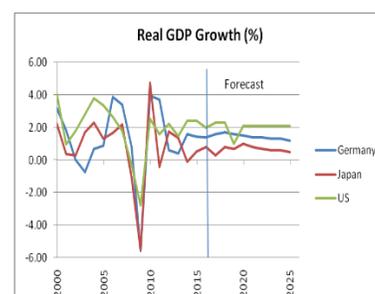
⁶ “United States Facts, United States Flag -- National Geographic.”
⁷ “The World Factbook.”
⁸ “Megadiverse Countries Definition| Biodiversity A-Z.”
⁹ “The World Factbook.”
¹⁰ Zhang, “US Seen Becoming Less Dependent On Foreign Oil.”
¹¹ Bureau, “Population.”
¹² “The Human Capital Report.”
¹³ “The World Bank DataBank.”

few decades will witness a decrease in the working age proportion of the U.S. population and an increase in the dependent portion. This demographic transition will pose challenges to the overall productivity of the U.S.

The U.S. remains a highly urbanized country. In 2014, 81.4% of the population was urban, surpassing other developed countries such as Germany. The US also ranks 8th on the Human Development Index.¹⁴ Average life expectancy is 79.1 years, and expected years of schooling is 16.5. The US, however, ranks 46 in Health and Primary Education.¹⁵ While it ranks 1st in the quantity of higher education, the US ranks 29th in the quality of primary education, 18th in the quality of higher education, and 44th in math and sciences. These figures are alarming and pose challenges to growth and labor productivity in the long term.

ECONOMY OF THE UNITED STATES:

MACROECONOMIC ENVIRONMENT: With a nominal GDP of \$18.6 trillion in 2016, the U.S. remains the largest national economy in the world.¹⁶ It is projected to maintain this status in the next 5 years, reaching \$22 trillion by 2020.¹⁷ The U.S. also has one of the highest GDP per capita in the world reaching \$57,000 in 2016, and it is projected to reach \$67,000 by 2020.¹⁸ Inflation has remained stable over the last three years, ranging between 0.8% - 0.9%. However, income inequality in the U.S. remains amongst the highest in the world, with a



¹⁴ "Human Development Reports."

¹⁵ "Global Competitiveness Report 2015-2016."

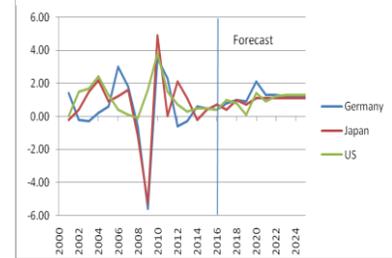
¹⁶ "The Economist Intelligence Unit - United States."

¹⁷ Ibid.

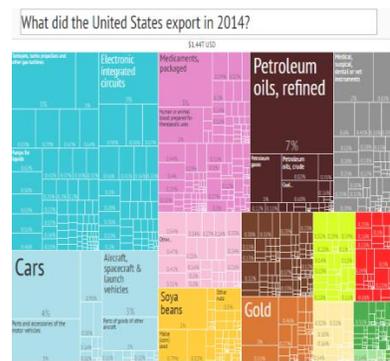
¹⁸ Ibid.

Gini coefficient of 0.4.¹⁹ Around 14.8% of the population remains below the poverty line.²⁰ Economic growth in the U.S. has suffered during the financial crisis, plummeting to -2.78% in 2009. Growth has since recovered and maintained a positive growth rate, exceeding those of other advanced economies. It is also projected that the U.S. will maintain a positive growth rate in the next 10 years.

Figure 1: Total Productivity Growth + Projected

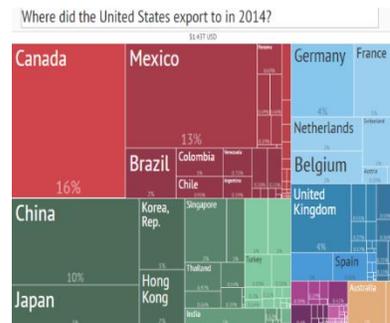


Unemployment also rose from 5.8% in 2008 to 9.3% in 2009, and managed in 2015 to return to pre-recession unemployment rates. Unemployment is projected to reach 6% in the next 5 years. Unlike other advanced economies, total factor productivity growth in the US remained relatively stable during the recession, and it is projected to remain stable in the next five years.



EXPORTS, CLUSTERS AND COMPETITIVENESS CHALLENGES:

Whereas in 2014 U.S. exports in goods amounted to \$1.44 trillion, imports were almost double that value at \$2.13 trillion.²¹ Main export partners include Canada, Mexico, China, Japan, and the EU. Main exports by cluster in which the U.S. has Revealed



Comparative Advantage (RCA) include nuclear reactors and boilers (15%), electrical machinery (10%), automotive industry (9%), aircrafts and spacecraft (6%), chemicals and allied industries (12%), and mineral products (11%).²² Pharmaceutical products constitute 4% of exports, with an

¹⁹ “OECD Income Distribution Database (IDD): Gini, Poverty, Income, Methods and Concepts - OECD.”

²⁰ US Census Bureau, “US Census Bureau Poverty Main Page.”

²¹ “What Did the United States Export in 2014?”

²² Ibid.

RCA value of 1.52.²³ As of 2010, the U.S. ranks 4th in biopharma exports.²⁴ The U.S. current account balance (BoP, current US\$) in 2014 was -\$389B. The U.S. ranks 14 on the Economic Complexity Index, with an overall Economic Complexity Value of 1.356961.²⁵

The U.S. has a strong innovative culture that supports cluster development. It leads the world in biotech R&D spending \$26.9B in 2014²⁶, and has also improved significantly in Company Operations and Strategy, moving from the 8th place in 2010 to 3rd place in 2015.²⁷ It also ranks 3rd on the Global Competitiveness Index²⁸, 4th in capital market and innovation infrastructure, 2nd in patent applications,²⁹ and 5th on the Global Innovation Index.³⁰ The U.S. however is lagging behind in several other indicators that are key to maintaining the competitive position of the U.S. in the long term. For example, the U.S. scores of 44/100 on the International Tax Competitiveness Index Ranking,³¹ 134th in Government Debt % GDP (104.5),³² 49th on the Ease of Starting a Business,³³ and 96th on the overall macroeconomic environment.³⁴ The U.S. also ranks 87th in Gross National Saving rates and 119th in Government Budget Balance % GDP. The latter figures suggest pro-cyclical fiscal policies, which make the US economy more responsive to shocks and fluctuations. It is for this reason that the U.S. has been performing poorly on the monetary and fiscal policy indicators, dropping from 25 in 2010 to 40 in 2015.³⁵ Maintaining competitiveness and productivity

²³ Ibid.

²⁴ Ibid.

²⁵ Ibid.

²⁶ “Key Biotechnology Indicators - OECD.”

²⁷ “Institute For Strategy And Competitiveness - Harvard Business School.”

²⁸ “Global Competitiveness Report 2015-2016.”

²⁹ World Intellectual Property Indicators, http://www.wipo.int/edocs/pubdocs/en/wipo_pub_941_2014.pdf

³⁰ “Data Analysis | The Global Innovation Index.”

³¹ Pomerlau and Lundeen, “International Tax Competitiveness.”

³² “Global Competitiveness Report 2015-2016.”

³³ “Ranking of Economies - Doing Business - World Bank Group.”

³⁴ “Global Competitiveness Report 2015-2016.”

³⁵ “Institute for Strategy And Competitiveness - Harvard Business School.”

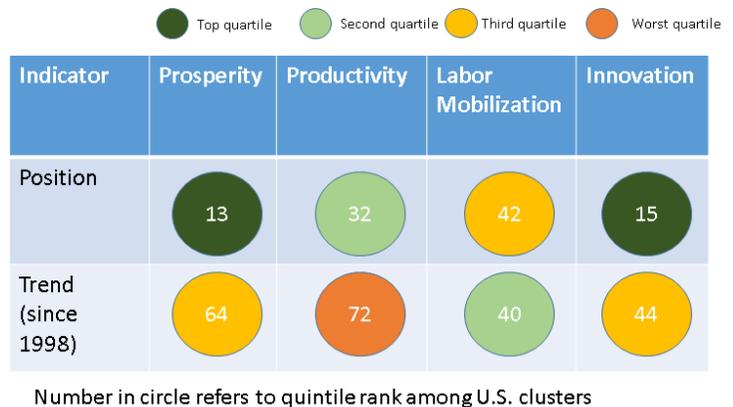
will require addressing the areas of weakness in the tax code, basic education, macroeconomic policies, and regulations”³⁶.

THE CHICAGO METROPOLITAN REGION

The Chicago metropolitan area is the third largest metro region in the United States, behind New York and Los Angeles both in population and economic size. With a population of nearly 10,000,000 and a highly diversified economy with many major industry clusters producing a GDP of nearly \$700 Bn annually, Chicago is the leading economic anchor in the Midwest.³⁷ Chicago developed from its initial endowments to establish a leading role in transportation and logistics, finance, telecommunications, business services and biotech.

CHICAGO’S PERFORMANCE

Chicago ranks among the top quartile in prosperity overall, but since 1998, median incomes have been falling. The region is nationally ranked 64th in terms of prosperity growth and 72nd in wage growth.³⁸ A contributing factor to declining wages has been declining productivity: the



region is in the 2nd quartile for productivity but is ranked 72nd in the country for productivity growth.³⁹ At the same time, the loss of manufacturing jobs in the city has pushed up unemployment

³⁶ Porter and Rivkin, “The Looming Challenge to U.S. Competitiveness.”

³⁷ Bureau, “Population.”

³⁸ “Chicago, IL Economic Area | U.S. Cluster Mapping.”

³⁹ Ibid.

to 9%, making the Chicago region 95th in the country for unemployment levels and 94th in terms of unemployment decreases.⁴⁰

The region's strength continues to be its high innovation levels (275 start-ups launched per year) and relatively strong productivity levels.⁴¹ Chicago also has rich business ecosystem of suppliers and buyers through a highly diversified local economy where no sector claiming more than 14% of the workforce.⁴²

ENDOWMENTS

One core reason for emergence of Chicago as a major metropolitan center can be traced to the city's development of its location advantage sitting at the divide of the Mississippi River and Great Lakes watersheds. For centuries before the city's founding, Native Americans and European fur traders used to convene at the mouth of the Chicago River and Lake Michigan to exchange goods.⁴³ As the nation expanded westward in the 1800s, Chicago's position as a water transportation link at the eastern edge of United States' highly productive agricultural heartland led to a concentration of manufacturing and wholesaling activity.⁴⁴ The city continued to make investments in this location advantage by creating a port on Lake Michigan (which eventually attracted steel and heavy industry manufacturing), becoming a rail hub, investing in canal transport, and transitioning to interstate and air transport as opportunities arose.⁴⁵

⁴⁰ Ibid.

⁴¹ "Chicago's Business Climate."

⁴² Ibid.

⁴³ "Economic Geography."

⁴⁴ Ibid.

⁴⁵ Ibid.

CHICAGO'S PERFORMANCE DRIVERS: LAGGING MAJOR PEERS ON KEY DRIVERS

Despite its key position in the Midwest and strong economic heft, Chicago is lagging behind its major metropolitan peers in many key economic drivers. Thus, while Chicago has outperformed other rust-belt cities such as Cleveland and Detroit, its economic growth has lagged behind regions such as Raleigh-Durham-Chapel Hill and Dallas-Ft. Worth with stronger macroeconomic and developmental fundamentals.

We look at Chicago's competitiveness drivers through the framework of its Human Development & Effective Public Institutions, Fiscal & Monetary Policy, and the Quality of the Business Environment.

HUMAN DEVELOPMENT & EFFECTIVE PUBLIC INSTITUTIONS

Unequal access to education, job opportunities, and quality healthcare continue to be major challenges for the city. For biotech, technical and scientific training is one of the key performance drivers, but when we look into the training of technical workers, we find a paradox of both incredible strengths in technical training but many weaknesses in terms of access. Large racial disparities in educational achievement and economic success have persisted despite policy interventions.⁴⁶ Research point to gaps in math and reading as forces that sustain such inequality, especially as Chicago's labor market shifts more toward technical, cognitive work.⁴⁷

TRAINING SKILLED WORKERS: Illinois ranks 8th among all states in the number of advanced scientific and engineering degrees awarded, with nearly 42,000 awarded annually.⁴⁸ This large

⁴⁶ "Chicago Workshop on Black-White Inequality: A Summary (Special Issue) - Federal Reserve Bank of Chicago."

⁴⁷ Ibid.

⁴⁸ "US National Science Foundation (NSF)."

number of potential employees is a key input to biotech and is incredibly important to the cluster overall.

POST-SECONDARY ATTAINMENT: At 41% of the 25+ population holding a Bachelor’s Degree, Chicago has one of the most highly educated populations of any metropolitan area, providing a strong human capital base for its firms.⁴⁹

BRAIN DRAIN: The Chicago metro area has faced a significant brain drain of top talent over the last decade. In 2009, while Chicago gained 3,500 Bachelor’s degree holders, essentially mirroring population growth, San Francisco gained nearly 100,000 as it accumulated talent from across the United States.⁵⁰

EDUCATION SYSTEM: Fragmentation in governmental oversight over the city’s education system and high variation in basic public education led to some severe consequences. In the bottom 10% of Chicago Public Schools, only 5% of students met state standards for their grade level.⁵¹ Worse than that, only 31% of students at any public school in Chicago met state standards.⁵²

FISCAL & MONETARY POLICY

BUDGET IMBALANCE: Both the City of Chicago and the State of Illinois have had years of structural imbalances in their budgets, leading to significant unfunded pension liabilities and indebtedness. For FY15, projected revenues fell short of projected expenditures by nearly 10%

⁴⁹ US Census Bureau, American Communities Survey

⁵⁰ Anderson, Sacks, and Tilton, “Plan for Economic Growth & Jobs.”

⁵¹ “Trapped in Chicago’s Worst Schools.”

⁵² Ibid.

for the State, and the city was able to balance its budget only through gimmicks and utilizing capital budgets for operating expenses.⁵³

HIGH ABSOLUTE RATES: The Chicago metropolitan area faces some of the highest total taxation rates of any metropolitan region in the United States. With a total tax burden over 11%, higher than almost all non-oil producing states (which distorts tax figures).⁵⁴

FRAGMENTED RATES: Beyond high overall rates, there are 1,723 governmental entities in the Chicago metro area, leading to high tax zone fragmentation and increased compliance costs for businesses.⁵⁵

QUALITY OF THE BUSINESS ENVIRONMENT

Business executives in Chicago are torn on the quality of the business environment. According to World Business Chicago, a leading IFC in the city, “businesses rate the region highly on location, talent, quality of life, and cost of living, but low on taxes, incentives, and permitting/regulations.” In other words, there are significant benefits of locating your enterprise in Chicago as well as significant drawbacks.

We identified the factor, demand, supporting/related industry and context for rivalry and strategy conditions that support the business environment.

FACTOR CONDITIONS

AIR TRANSPORTATION: Chicago is home to the second busiest airport in the world, with more arrivals and departures than any other airport in the United States except Atlanta. As of September

⁵³ “City of Chicago.”

⁵⁴ US Census Bureau, American Communities Survey

⁵⁵ Anderson, Sacks, and Tilton, “Plan for Economic Growth & Jobs.”

2015, O'Hare offered direct flights to over 215 destinations, including 50+ international destinations.⁵⁶ However, O'Hare suffers from significant distance from downtown and poor connectivity due to significant traffic congestion and poorly maintained public transportation between the airport and downtown.

FREIGHT TRANSPORTATION: As the largest rail hub in the United States, more than 25% of all domestic rail freight transits the Chicago metropolitan area, twice second place Kansas City, MO.⁵⁷ This access is key for biotech manufacturing inputs including chemicals and for inexpensive and fast delivery to other major metropolitan areas after manufacturing. Despite its strength as a hub, years of underinvestment in basic infrastructure have led to significant bottlenecks in the metro area, with transit times exceeding several days at times.

ROAD TRANSPORTATION: More major interstate highways enter the Chicago metropolitan area than any other metropolitan area in the United States. However, due to a location mismatch between job locations and living locations (Chicago ranks 76th for transit access for jobs) traffic congestion ranks among the highest in the country.⁵⁸

VENTURE CAPITAL: While Chicago has very strong and established enterprise capital markets, access venture capital is a significant constraint. Chicago's per capita venture capital invested, at \$39, is half the United States average of \$76 and less than 5% of the San Francisco metro area's average annual investment.⁵⁹

COMMERCIALIZATION FUNDING: In other major innovation hubs, a key driver of innovation is the commercialization of patents from the primary research institutions. However, in Chicago, the

⁵⁶ "Facts & Figures - O'Hare International Airport."

⁵⁷ Ibid

⁵⁸ Tomer et al., "Missed Opportunity."

⁵⁹ "US National Science Foundation (NSF)."

primary research is misaligned with the existing cluster infrastructure and as a result there is little available commercialization funding locally, and universities search for non-local partner.

R&D INVESTMENT: Per capita R&D investment is just \$1,100 in the Chicago metro area, vs. the U.S. average of \$1,200 and \$1,500 in other major metropolitan areas.⁶⁰

PATENTS: The Chicago metro ranked in the bottom half of all cities on utility patents per capita for the past decade, indicating the underlying structural underinvestment in innovation.

CONTEXT FOR STRATEGY & RIVALRY

MARKET DOMINANCE: 33 of the largest Fortune 500 companies are located in Chicago, along with headquarters for many multinational firms. There is an open question as to whether these large firms help or hinder small and medium sized firms in tradeable goods sectors for flourishing.

LABOR MOBILITY: With only 14% of the workforce dedicated to any one sector, Chicago has one of the most mobile and deep labor pools. One of the key challenges, as noted before, is retaining technical and scientific talent who are leaving Chicago for better opportunity in Boston and San Francisco.

INTERNATIONAL FOCUS: Chicago's status as a hub city, educational institutions, and its explicit strategy of attracting FDI from global multinational corporations means that it has robust inflows of goods, people, and investment from other countries.

DEMAND CONDITIONS

⁶⁰ Anderson, Sacks, and Tilton, "Plan for Economic Growth & Jobs."

LARGE LOCAL DEMAND: If Chicago were a country, it would be the 23rd largest country in the world by GDP.⁶¹ This large local demand allows for a diverse mix of buyers and sellers to meet.

SOPHISTICATED BUYERS: Chicago is an attractive location for global headquarters for many multinational corporations, providing access to a large base of suppliers and professional service firms who support them.

RELATED & SUPPORTING INDUSTRIES

RESEARCH INSTITUTIONS: The University of Chicago, Northwestern, Rush University, University of Illinois-Chicago are all world-class research institutions generating an enormous amount of primary research. Similarly, the Argonne National laboratory is conducting amazing research in early stage technology. However, all of these universities have significant gaps at the commercialization stage of research, where economic growth is driven.

SHIFTING CLUSTERS: Since 1998, Chicago has seen a shift in food processing, wholesaling, and manufacturing clusters to business services, global HQ, and transportation services.⁶² This shift has led to new business service supports for the biotech cluster, but also sustained job losses for semi-skilled workers in manufacturing.

KEY ISSUES FOR BIOTECH

Overall, Chicago's weaknesses far outweigh its strengths as it relates to the key drivers of biotech cluster performance. Key gaps on research commercialization and capital availability act as key constraints on cluster growth, and as a result key talent continues to leave the city for other innovation and research centers such as San Francisco or Boston. Despite the presence of immense

⁶¹ "Chicago's Business Climate."

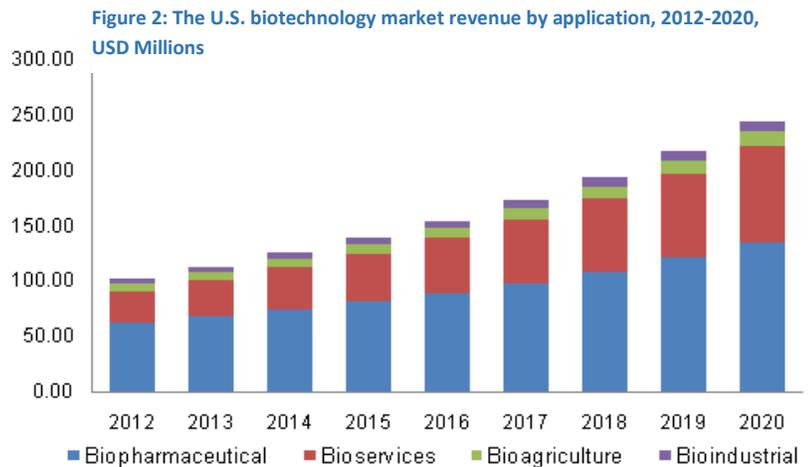
⁶² "Chicago Area Employment — February 2016."

endowments such as world-class research institutions and a central location, both the macroeconomic environment and innovation pipeline stymie growth, and as a result we have seen negative growth in the Chicago biotech cluster over the last decade.

US BIOTECH: GLOBAL TO REGIONAL FACTORS

For a better grasp of the industry’s profile, it is important to review some key global economic factors in relation to its current and future business trajectory both in the US and outside. Life sciences sector growth correlates highly with a country’s general economic strength and healthcare spending levels. In 2013, global healthcare

spending increased around 2.8 percent after decreasing in 2012; the Economist Intelligence Unit (EIU) expects that growth to accelerate by an annual average of 5.2 percent in 2014-2018 as the global economy continues to recover from recession.⁶³ However, healthcare



spending is likely to rise more slowly than in the past decade — when growth averaged seven percent a year — due to intensifying government and investor pressure to reduce costs and demonstrate value. The EIU also projects healthcare spending as a percentage of GDP to decline, from around 10.6 percent in 2013 to 10.3 percent in 2018. Recent reports project the global biotech

⁶³ “Global Outlook: Healthcare.”

market to grow 4.1 percent annually between 2014 and 2020, reaching \$477.5 billion by the end of the decade.⁶⁴

On a regional basis, global biotechnology market is segmented into North America, Europe, Latin America, Asia-Pacific, and MEA. North America accounted for the largest share of the overall industry in 2013, accounting for over 42.30% of the revenue share, as a result of increasing initiatives in R&D by various pharmaceutical companies.⁶⁵ Asia Pacific is expected to gain substantial market share and reach around USD 145.9 billion by 2020. Escalating awareness about the advantages associated with adoption and introduction of healthcare benefits by the government are driving forces for this region. Domestic healthcare spending in North America is expected to increase, on average, 4.9 percent between 2014 to 2018. Growth is being driven, in part, by expanded consumer access to healthcare in the United States through the 2010 Patient Protection and Affordable Care Act (ACA). Evidently, the U.S. Food and Drug Administration (FDA) granted 33 first-time device approvals – PMAs, HDEs, and PDPs – in 2014, a 43 percent increase over the 2013 total (23).

WHAT IS BIOTECHNOLOGY

According to Article II in the UN Convention on Biological Diversity, biotechnology is the use of living systems and organisms to develop or make products, or "any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use." There are three distinct categories within biotechnology: medical; the focus of Chicago's cluster, agricultural; and industrial.

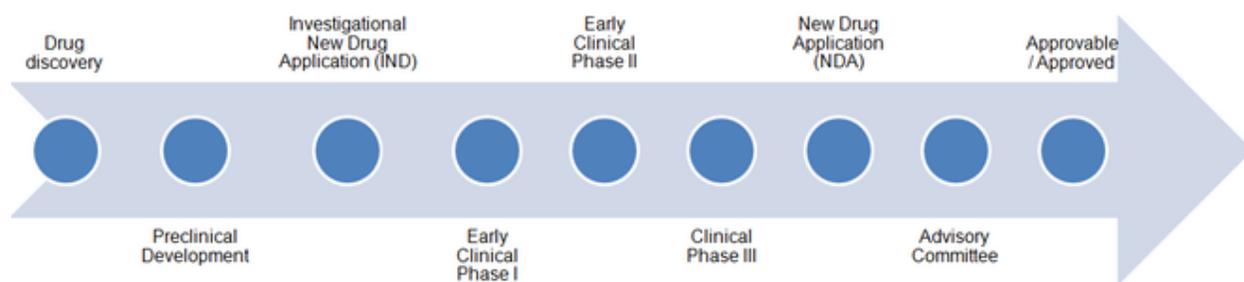
⁶⁴ "2015 Global Life Sciences Outlook: Adapting in an Era of Transformation."

⁶⁵ Ibid.

- **Medical biotechnology** largely consists of health care products, vaccines, and diagnostics available to patients for previously untreatable diseases. With an increase in both personal and global health awareness as a result of technological advances, medical *biotech* has become a dominant field of its own.
- **Agricultural biotechnology** continues to expand as there are more than 18 million farmers around the world who implement its applications to increase yields, prevent damage from insects and pests and reduce farming's impact on the environment.
- **Industrial biotechnology**, also known as the *third wave*, is a rapidly growing concept applied to daily operations of manufacturing plants to average households with products ranging from biofuels to eco-friendly cleaning solutions. There are currently around 100 biorefineries built across North America to test and refine technologies to produce biofuels and chemicals from renewable biomass, which can help reduce greenhouse gas emissions in light of recent climate change policies.

As of 2016, the US biotech market revenue is valued at 150 billion USD with medical biotech representing 86%, roughly equal to 130 billion USD.

Figure 3: The FDA Approval Process



Market Realist[®]

Source: Market Realist

With respect to medical biotech, it takes about 10-15 years for a new drug to go from the discovery phase to final distribution and sales in the market by large corporate pharmaceutical companies. The process begins with drug discovery, an extremely capital-intensive, risky phase – it is estimated that about one in 10,000 drug molecules in the drug discovery phase complete the approval process to enter the market. In the preclinical development phase, the drug is studied in animals to ensure that it can be safely tested on humans. The biotech company then submits to the FDA an Investigational New Drug (or IND) Application with findings from the preclinical studies. Research has proved that out of 100 drugs that enter Phase I clinical studies, 70 will pass to Phase II, 33 will pass to Phase III, and about 25 will clear the last phase.

In Phase I, the drug is tested for safety, dose ranges, and side effects on a small number of healthy humans. Phase II aims to evaluate the efficiency of the drug and the dosage required as it is being tested on a large number of the drug's targeted audience. Phase III aims to confirm that the drug is effective and safe for the treatment of the targeted disease and that the dosage pattern is established.

Many biologic companies in Chicago such as Therapeutic Proteins Intl (TPI) and Errant Gene Therapeutics (EGT) have various drugs in the late phases of drug approval. These drugs are expected to earn substantial revenues in future years. The company will then submit a New Drug Application (or NDA) to the FDA whereby the FDA decides to review the NDA in the next 60 days to 12 months depending on its breakthrough innovation. Post approval, the FDA sends the NDA to an advisory committee consisting of experts capable of evaluating the drug. Based on the

advisory committee's evaluation, the FDA announces whether the drug is approved or approvable.⁶⁶

CONDITIONS ESSENTIAL FOR BIOTECH

Universities, talent, venture capital and buyers/pharma companies are incredibly important for a successful biotech cluster.

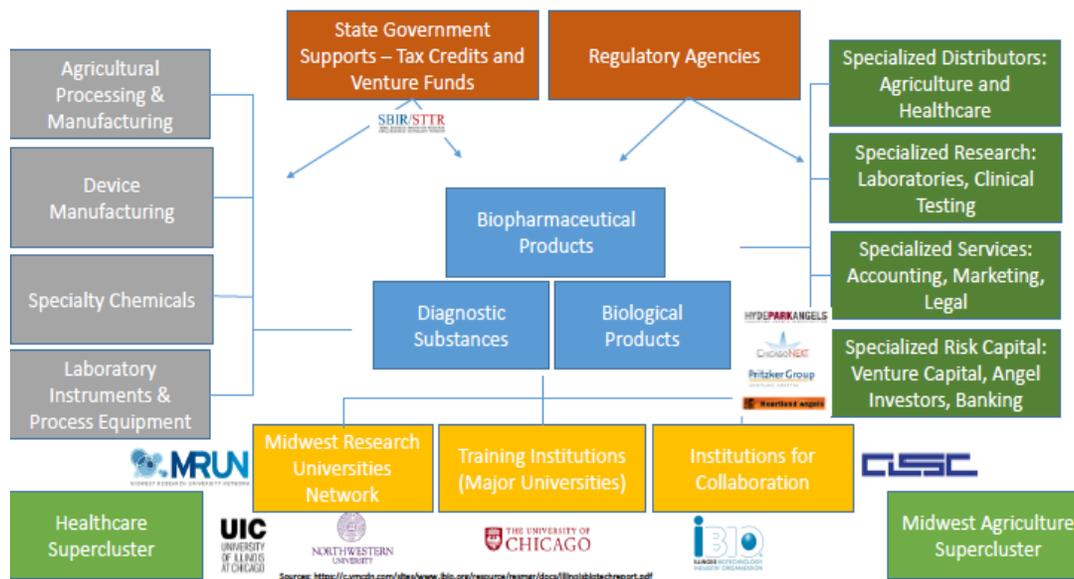
- **Universities** - research universities are key to recruiting top thought leaders, researchers, future entrepreneurs and PhD students to collaborate on problems to which biotech can be a solution
- **Talent** - smart and business-savvy individuals are paramount for business formation and job growth within a local biotech cluster. Further, strong talent helps drive increased focus from potential buyers/pharma companies as well as investors
- **Venture Capital** - a robust venture capital environment is important for incentivizing entrepreneurs and young companies to locate themselves in a particular geography
- **Buyers/Pharma Companies** - major pharma and other healthcare companies are the predominant buyers of biotech start-ups as well as the solutions those companies provide

As one can see in the biotech cluster map below, these four key variables are present throughout the major players in the industry. Specialized providers of R&D, distribution, services and risk capital on the right in conjunction with major research universities and other training institutions at the bottom provide the biotech products and solutions in the middle to major healthcare companies on the left. Further, as described earlier, the complexity of this cluster and its importance to human health require significant regulatory oversight at the top, though the

⁶⁶ Patrick, "Drug Approval Process in the Biotechnology Industry - Market Realist."

government also plays a supporting role providing tax incentives for investors in biotech solutions to fuel growth.

Figure 4: Anatomy of the Chicago Biotech Cluster



HISTORICAL TIMELINE

With respect to medical biotech, it takes about 10-15 years for a new drug to go from the discovery phase to final distribution and sales in the market by large corporate pharmaceutical companies. The process begins with drug discovery, an extremely capital-intensive, risky phase - it is estimated that about one in 10,000 drug molecules in the drug discovery phase enter the market. Animal testing is extensive during the preclinical development phase. The biotech company then submits to the FDA an Investigational New Drug (or IND) Application with findings from the preclinical studies. In Phase I, the drug is then tested for safety, dose ranges, and side effects on a small number of healthy humans. Phase II evaluates the efficiency of the drug and dosage required as it is being tested on a large number of the drug's targeted audience. Phase III confirms the drug's dosage pattern and effects including safety for the treatment of the

targeted disease. Many biologic companies in Chicago such as Therapeutic Proteins Intl (TPI) and Errant Gene Therapeutics (EGT) have various drugs in the late phases of drug approval where these drugs are expected to earn substantial revenues in future years. The company will then submit a New Drug Application (or NDA) to the FDA whereby the FDA then sends the NDA to an advisory committee consisting of experts capable of evaluating the drug. Based on the advisory committee's evaluation, the FDA announces whether the drug is approved or approvable.⁶⁷

KEY CHICAGO BIOTECH COMPANIES

Due to its geographic location and comfortable living conditions, Chicago has long been a hub for major healthcare companies to locate their headquarters. Though none of these companies have offices in downtown Chicago, the companies below are sophisticated major players in biotech with headquarters in the greater Chicagoland area:

- **Abbott Laboratories** – globally diversified healthcare company with approximately 73,000 employees worldwide, \$20.4 billion in annual revenue, market leading positions in many subsectors, and products sold in more than 150 countries. From a strategic perspective, Abbot focuses on nutrition (34% of sales), medical devices (27%), diagnostics (23%) and pharmaceuticals (16%) attempting to provide solutions for all stages of life from infants to the elderly.⁶⁸
- **AbbVie** – specialty-focused, research-based pharmaceutical company with more than 28,000 employees worldwide, \$19.9 billion in annual revenue and products sold in more

⁶⁷ Ibid.

⁶⁸ “Abbott | Global Healthcare & Research.”

than 120 countries. AbbVie’s core areas of focus include immunology, kidney disease, liver disease, neuroscience, oncology and women’s health, and the company maintains 15 primary research and manufacturing facilities worldwide.⁶⁹

- **Baxter International** – globally diversified healthcare company focused on medical devices, pharmaceuticals and biotechnology with more than 61,000 employees worldwide, \$16.3 billion in annual revenue and products sold in more than 100 countries. Baxter’s two key business units are BioScience, focused on hemophilia and other blood disorders, and medical products, focused on hospitals, pharmacies and renal care.⁷⁰

Additionally, several international biotech companies have located their US-headquarters in Chicago, including the Japanese Astellas Pharma (\$11.1 billion in annual revenue) and Takeda Pharmaceuticals (\$16.2 billion in annual revenue) as well as the Irish Horizon Pharma (\$757 million in annual revenue).

KEY BIOTECH CONDITIONS IN CHICAGO

As described above, universities, talent, venture capital and buyers are the key conditions for a thriving biotech cluster, and while Chicago has significant potential in each of these areas, venture capital and the optimization of existing talent seem to be the weak links preventing Chicago from truly reaching its potential as a biotech cluster.⁷¹

UNIVERSITIES

⁶⁹ “AbbVie | Pharmaceutical Research & Development.”

⁷⁰ “Healthcare, Renal & Hospital Products | Baxter.”

⁷¹ Kahn and Kirkley, Interview with Biotech Experts.

Chicago has a very strong competitive position with universities, which are generally the hardest of the four conditions to achieve as it can take up to 100 years to build a truly great university.⁷² According to the US News & World Report rankings, Chicago has two of the top 20 medical research programs in the US in University of Chicago (11th) and Northwestern University (17th).⁷³ Additionally, there are other major research universities in the city including University of Illinois at Chicago, Rush University and the Illinois Institute of Technology, and if one expands the geographic scope, University of Illinois at Urbana-Champaign is just a couple of hours away. The presence of so many strong universities provides a meaningful incentive for top talent to locate in Chicago while pursuing academic studies.

TALENT

Given the impressive list of academic research institutions described above, it's no surprise that Chicago has impressive talent located within its borders. However, despite the strong research universities, many top students leave the city for Boston or San Francisco upon graduation because of the paucity of work opportunities in Chicago for biotech graduates.⁷⁴ Additionally, despite the presence of institutions for collaboration like the Illinois Biotechnology Industry Organization (iBIO), there is minimal collaboration among key industry players and universities that would cultivate talent and help mitigate the significant brain drain that currently exists. Further, the lack of incubators and other institutional support for early-stage companies and entrepreneurs disincentivizes students from attempting to commercialize their research in Chicago upon graduation. Efforts like MATTER, a downtown-based incubator started in 2014, have attempted to take

⁷² Porter, "Key Concepts in Cluster Theory."

⁷³ "Best Medical Schools | Research Rankings | Top Medical Schools for Research | US News Best Graduate Schools."

⁷⁴ Kahn and Kirkley, Interview with Biotech Experts.

advantage of the strong intellectual capital that exists in the city, but there is still much room for improvement in terms of optimizing and retaining the existing talent in the city.⁷⁵

VENTURE CAPITAL

Though strong compared to the average city, Chicago has a relatively weak venture capital presence as compared to other key biotech clusters with only two major biotech-focused firms, ARCH Venture Partners and Jump Capital.⁷⁶ The lack of venture capital presence contributes to the brain drain described above and will need to be addressed for Chicago to reach its potential as a major biotech hub in the US.

BUYERS

As described above, there are many major biotech companies with a presence in or near Chicago, however, the majority of them are outside of the city. Despite ostensible proximity, the lack of convenient infrastructure and transportation minimizes the opportunity for collaboration between buyers and other key biotech players. The 1-2 hour drive from downtown to major biotech companies in the suburbs does not lend itself to an early-stage biotech company looking to commercialize its research, and this lack of convenient opportunities to monetize ideas further incentivizes brain drain from the Chicagoland area to major biotech hubs like Boston and San Francisco.⁷⁷ iBIO would theoretically be a good organization to provide spaces for collaboration and incentivize better utilization of the major biotech firms that exist within the Chicagoland area

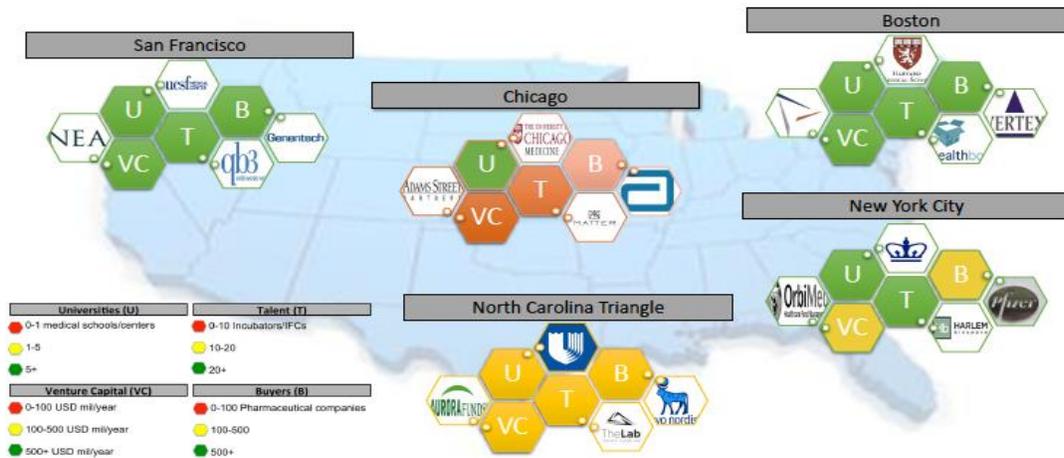
⁷⁵ Carpenter, "Matter Health-Tech Incubator Announces Its First 10 Companies."

⁷⁶ "Illinois Is Heating Up."

⁷⁷ Kahn and Kirkley, Interview with Biotech Experts.

by entrepreneurs and early-stage ventures, but it has historically been incredibly ineffective in terms of fulfilling its stated goals and mission to do so.⁷⁸

CLUSTER PERFORMANCE COMPARISON

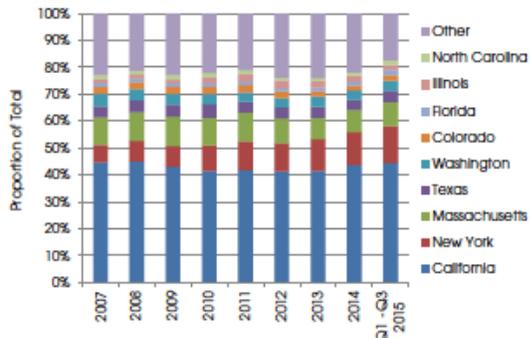


Chicago continues to struggle in becoming a mainstay for biotech talent and lose their competitive edge to the two leading US biotech clusters in San Francisco and Boston. Chicago’s most distinct challenge and significant concern is their relative minor share of the US venture capital market. According to Preqin 2016 reports, the state of Illinois registered less than 5% of the proportion of venture capital deals in the past decade, and even smaller in the proportion of aggregate value in venture capital deals. In comparison, California leads the pack with over 40% and 50% in those categories respectively followed by New York and Massachusetts at over 10% each.⁷⁹

⁷⁸ Ibid.

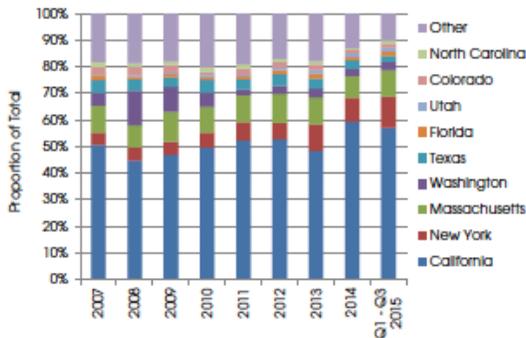
⁷⁹ Elahi, “How Venture Capital Investments Stacked up in Illinois in 2015.”

Fig. 16: Proportion of Number of Venture Capital Deals* in the US by State, 2007 - Q3 2015



Source: Preqin Venture Deals Analyst

Fig. 17: Proportion of Aggregate Value of Venture Capital Deals* in the US by State, Q1 2007 - Q3 2015



Source: Preqin Venture Deals Analyst

In absolute terms, the state of Illinois attracted over \$1.1 billion in venture capital with \$132 million going towards biotech industries after financial services and software technology. California led the nation with more than \$33.7 billion in funding, \$27.3 billion of that in Silicon Valley. New York tallied \$6.2 billion, Massachusetts \$5.7 billion, and Washington and Texas each drew about \$1.2 billion. Currently, Chicago harbors around 9 funded biotech VC firms while Boston and San Francisco have 18 and 63 respectively. Moreover, they have supported 6 incubators for biotech startups while Boston, San Francisco, and New York each support over 20 incubators for life sciences alone. It is important to note, Chicago still holds a relatively higher number of universities specializing in life sciences at 10 compared to 7 in Boston and 9 in New York City. The disconnect between university talent and the transfer and mainstay of that knowledge into the biotech startup culture continues to be a significant barrier to full commercialization in the Midwest as previously discussed.⁸⁰

CHICAGO BIOTECH CLUSTER DIAMOND ANALYSIS

⁸⁰ Ibid.

Throughout this paper, in particular the prior section focused on the cluster, a conclusion about Chicago biotech has become apparent: mixed factor conditions weaken otherwise strong context and related and supporting industries. This conclusion is summarized below via a diamond analysis of Chicago's biotech cluster below.



RECOMMENDATIONS

We have an eight-part plan to address the weaknesses outlined in the diamond analysis. Our recommendations focus on addressing some of the key talent retention, funding, and commercialization obstacles within the cluster.

CONTEXT FOR RIVALRY & STRATEGY

OBJECTIVE 1: To foster collaboration between universities and biotech companies to maximize potential of impressive biotech inputs in Chicago:

- **INCUBATORS:** Foster additional and more powerful biotech-focused incubators in Chicago to compete with other regions like San Francisco and Boston, which
- **COMMERCIALIZATION ECOSYSTEMS:** Create networks between business schools, PhD programs, and funding networks through local biotech business plan competitions, networking, and mentorship.
- **COLLABORATION ECOSYSTEM:** Cross-collaborate on coursework, skills training, laboratory research, and commercialization of IP between mid-sized biotech firms and universities.

DEMAND CONDITIONS

OBJECTIVE 2: To increase economies of agglomeration by deepening ties between biotech companies and downtown Chicago:

- **DOWNTOWN BIOTECH DISTRICT (“DBD”):** Through marketing and branding and recruiting of anchor institutions, foster an area of the downtown branded for biotechnology companies. This area will serve as a more central anchor in the cluster, as opposed to the suburbanized layout that currently exists.

OBJECTIVE 3: To link mid-sized firms to international markets for biotech products.

- **INCREASE ATTRACTIVENESS OF CHICAGO FOR BUYERS:** Continue to emphasize policies to develop sophisticated biotech buyers like healthcare and high-tech agricultural firms through conferences and networking events.

- **PROMOTION TRIPS:** Link mid-sized biotech companies to partners and buyers in international markets through coordinated trips.

FACTOR CONDITIONS

OBJECTIVE 4: To create opportunities and incentives for talent to remain in Chicago post-graduation from university studies:

- **CHICAGO ATTRACTIVENESS FOR NEW GRADUATES:** Macro reforms in budget for Chicago proper needed to make Chicago a more attractive long-term location for talented science and technology graduates. At the same time, social and human development institutions like schools and public safety systems need to be improved to keep these young families in the city.

OBJECTIVE 5: To generate support for biotech start-ups and entrepreneurs by utilizing local universities and pharma companies' advantages in training, commercialization, & funding:

- **INTERNSHIP PIPELINE:** Link both business and technical master's students to paid internships at mid-sized and large biotech firms.

OBJECTIVE 6: To generate venture capital interest in Chicago as a hub for biotech start-ups:

- **CULTIVATE VCS:** Given large number of high-net-worth individuals in Chicago, create program to educate them on becoming angel investors.
- **COMMISSION STUDY TO IDENTIFY PROCESS CHALLENGES FOR INVESTORS:** Identify ways the city and state tax structures, legal process harm VC investment.

RELATED & SUPPORTING INDUSTRIES

OBJECTIVE 7: To improve the efficacy of the iBIO and other cluster organizations

- **REORGANIZATION:** iBIO should create a separate branch or entity focused exclusively on Chicago that brings together participants from biotech companies, universities, venture capital and other key local thought leaders

OBJECTIVE 8: Increase access to specialized professional services firms by new entrants:

- **FIRMS SPECIALIZATION:** Within Downtown Biotech District, market specifically to business service firms with specialties in biotech ventures to increase access to professional services.

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