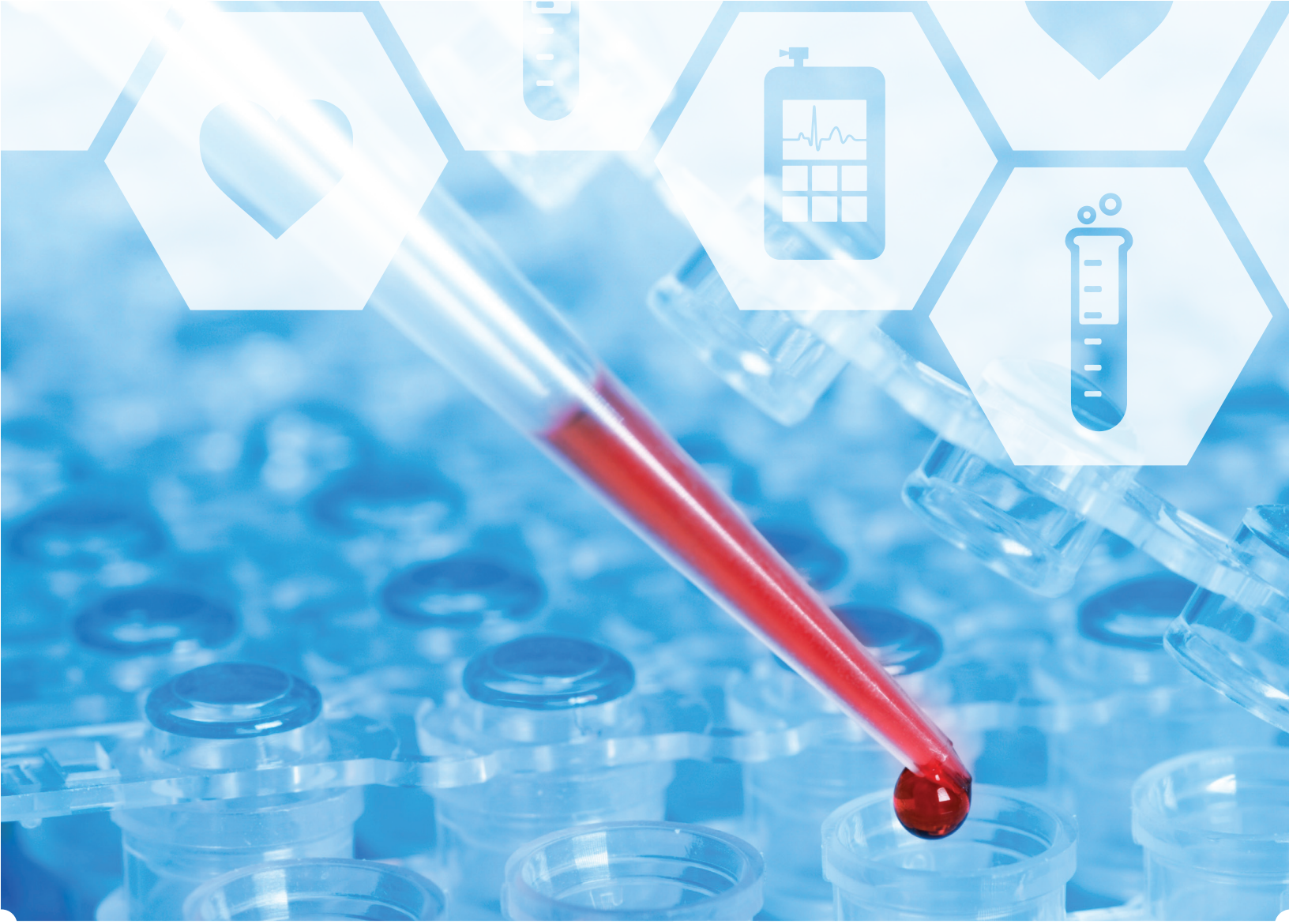

CENTRAL MARYLAND BIOHEALTH INNOVATION INDEX

FULL OF OPPORTUNITY

EAGB
Economic Alliance of Greater Baltimore

EDA
U.S. ECONOMIC DEVELOPMENT ADMINISTRATION

BioHealth Innovation℠
Maryland's Commercialization Collaborative

Letter from EAGB and BHI

The Economic Alliance of Greater Baltimore and BioHealth Innovation Inc. are pleased to present this BioHealth Innovation Index for Central Maryland. This Index report was developed to assess and articulate the performance of the BioHealth industry sector contributing to the region's world-class innovation economy. The Index is a comprehensive analysis that examines the region's strengths along with those areas which present opportunity for economic growth.

Innovation is a defining feature of economic growth in the modern economy. Indeed, one of the fundamental facts of innovation-based growth is that it is possible most anywhere when fostered with patience and creativity. Innovation comes in many forms and occurs differently in markets throughout the world. It is a fundamental element of social progress and economic growth, and is only possible thorough our quest for knowledge and our willingness to collaborate and share experiences.

According to the 2013 State Science & Technology Institute Report "Trends in Tech-Based Economic Development: Local, State and Federal Action," promoting economic growth in targeted sectors through research and commercialization are visionary, long-term investments that generate significant returns over time. Boosting entrepreneurship is crucial for long-term economic development. Entrepreneurs innovate, create jobs, and build businesses – and it is crucial these individuals are embraced, nurtured, and empowered.

The most competitive and resilient markets embrace innovation and in turn have seen a new era in high-value and sustained growth. This Index reflects such innovation occurring in Greater Baltimore and Central Maryland and provides the proper basis for a strategic analysis relevant to other U.S. markets such Boston, New York, Philadelphia, Pittsburgh, Raleigh-Durham, San Diego, and San Francisco.

By taking a comprehensive inventory of our assets and pinpointing the key opportunities for future growth, this Index will serve as a guide to the continued development of our BioHealth sector. We invite you to read the Index and engage in our ongoing efforts to grow the BioHealth industry in Central Maryland.

Respectfully,

Tom Sadowski
President and CEO
Economic Alliance of Greater Baltimore

EAGB
Economic Alliance of Greater Baltimore

Rich Bendis
President and CEO
BioHealth Innovation, Inc.

BioHealth Innovation℠
Maryland's Commercialization Collaborative

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Prologue

The Rise of the Next Great BioHealth Cluster

Within the Central Maryland region, there are more than 800 life sciences companies, 70 federal labs including the main campus of the National Institutes of Health, regulatory agencies such as the U.S. Food and Drug Administration (FDA), and elite academic, medical and research institutions. The region has reached a critical tipping point and is poised to become the next great BioHealth industry cluster not just within the United States, but throughout the global industry.

Recent expansions and relocations have favored Greater Baltimore and Central Maryland: In April 2015, pharmaceutical GlaxoSmithKline announced a new global vaccines research-and-development center in Rockville, MD., as the drug makers restructuring will shift more than 1,000 jobs from North Carolina to Maryland. In 2013, AstraZeneca's Delaware location was shifted, along with 300 jobs, to Gaithersburg, MD, home of AstraZeneca's MedImmune research and development division.

Based on these major shifts, a strong foundation of strategic programs and investments to support the BioHealth industry in Maryland, and the growth of many emerging Biohealth firms, Greater Baltimore and Central Maryland is now the home of the prominent BioHealth cluster in the Mid-Atlantic and is earning more national recognition:

- Fierce Biotech ranks the Baltimore-Washington region fourth for biotechnology investment, behind San Francisco, Boston and San Diego.
- Genetic Engineering & Biotechnology News ranks Maryland and the D.C. region as the country's fifth-largest biotech hub, behind Boston, San Francisco, New York-New Jersey and San Diego.

Based on recently collected data, the Central Maryland BioHealth Innovation Index shows that the region is on the brink of surpassing Research Triangle and other competitive markets for prominence in its capacity to innovate. Note that, because of standard lag in data reporting, very recent announcements and employment shifts may not be reflected in this data. Organizations in Greater Baltimore and Central Maryland have collaborated to address the areas of opportunities identified in this report, and the region is already realizing positive results.

The Central Maryland region and its many committed stakeholders believe that through collaboration, investment, and building a shared vision, the rich BioHealth cluster will continue to expand through the formation and support of new businesses, growth and retention of existing businesses, and will provide continued economic growth to the region through corporate tax revenues, job creation, global recognition and more. Greater Baltimore and Central Maryland's goal is to become a top three BioHealth industry cluster by 2023, and the region is well on its way.

Introduction

Executive Summary

The Economic Alliance of Greater Baltimore and Bio-Health Innovation Inc. have partnered to develop the first Central Maryland BioHealth Innovation Index. The Innovation Index will detail the Region's Innovation Economy in the BioHealth sector. The components of this index are designed to represent the connected elements of a strong entrepreneurial culture and the critical assets required for a successful BioHealth industry.

The Innovation Economy, the portion of economic activity driven by new technologies and ideas, including the creation processes in the sciences, is becoming more important as regions compete for stature in the global economy. The Innovation Economy is about creativity: technology-based research, development, and commercialization in the life and physical sciences.

The Index is based on the Greater Baltimore and Central Maryland region as the center of BioHealth activity within the state and acts as the central hub for the majority of life sciences innovation in the State of Maryland. Through a series of key comparable indicators, we have assessed how well the region is doing relative to a select group of regional markets that have a high concentration of BioHealth activity.

Regional innovation requires the following key elements:

- Identification of the region's most critical opportunity areas—People, Process, Markets, and Guidelines;
- Knowledge of the capabilities, assets, and processes needed for success and;
- Selecting the right long-term performance indicators to drive the activities that create repeatable results. The Innovation Economy has already begun to usher in a new period of economic growth, with new opportunities — new companies, new jobs, higher wages and more rapid wage growth.

In all cases, the key is competition. Regions compete for resources - human and financial capital - to generate ideas that grow to fruition as commercially successful ventures.

The Central Maryland BioHealth Innovation Index compares the Greater Baltimore Central Maryland region in the United States to seven other regions through a series of key metrics in four categories: Talent, Research and Development, Entrepreneurship, and Capital Investment.

Regions selected for comparison are recognized as leaders in the BioHealth industry in talent, research, commercialization, and financing and include Boston, New York, Philadelphia, Pittsburgh, Raleigh-Durham, San Diego, and San Francisco.

This Index is distinguishable from other regional measurement efforts because it focuses on the inputs that support the creation, retention and resources required of innovative businesses in their early stages of development to be successful. Metrics in the four key areas of innovation are used to benchmark Greater Baltimore and Central Maryland's comparative innovation position with peer regions. In order for a region to stimulate growth, the region must reinforce its strengths and address its weaknesses through a collaborative development strategy.

For rapid and sustainable economic growth, Greater Baltimore and Central Maryland must focus its efforts on innovation and commercialization. While Greater Baltimore and Central Maryland has laid a strong foundation for the BioHealth industry, few of the region's research projects enter the commercial marketplace. The opportunity exists for professionals in Greater Baltimore and Central Maryland's BioHealth industry to capitalize on the market's leadership in research and development in ways that build a more robust ecosystem that generates new companies and new jobs.

Maryland ranks second on the Milken Institute's State Science and Technology Index; the region is already stocked with impressive science and technology talent and firms. This area has a very significant opportunity to join or rise in the list of nationally-recognized and often-emulated BioHealth leaders like Boston.

Indeed, the path to successful commercialization is a challenging one, but Greater Baltimore and Central Maryland and its residents can reap tremendous benefits from ensuring that a robust infrastructure is in place to encourage and support entrepreneurs as they move a new product from concept to the commercial market.

Introduction

Defining the Greater Baltimore and Central Maryland Region

While Greater Baltimore is a clearly defined geographic area, the region is part of a larger economic area that extends across traditionally defined statistical areas. Firms in Greater Baltimore employ talent from all around the Washington-Baltimore region, and the transportation network allows a fluid relationship with the two intertwined markets.

Baltimore MSA

With a 2014 population of 2,785,874, the Baltimore MSA ranks 20th in size among all US MSAs. It is comprised of Baltimore City and the surrounding counties of Anne Arundel, Baltimore, Carroll, Harford, Howard and Queen Anne. Cecil County is a partner of the Economic Alliance, but is not included in the official metro data for Greater Baltimore. For this report, data on Cecil County employment is included in Baltimore MSA, Central Maryland, and Washington-Baltimore CSA employment figures where noted. MSAs that are comparable in size include San Diego and Pittsburgh metropolitan regions

Central Maryland

This report uses Central Maryland as the primary region for comparison to peer markets. Commuting patterns reveal a strong network of commuters to and from the Baltimore MSA and the Maryland DC Suburbs. This region is comprised of the Baltimore MSA and the counties of Frederick, Montgomery, and Prince George's. The Greater Baltimore and Central Maryland region is home to 4,918,905 residents, and is similar in population to the Boston and San Francisco metropolitan areas.

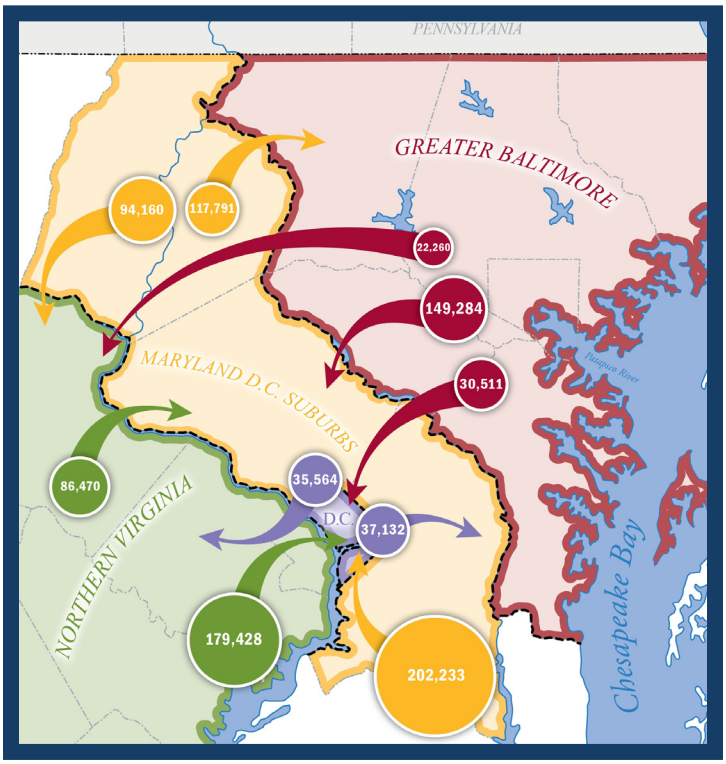
Washington-Baltimore CSA

With a 2014 population of 9,443,180, the Washington-Baltimore-Arlington CSA ranks 4th in size among all US CSAs. The CSA region is comprised of the Baltimore MSA, the Washington, DC MSA, the Winchester, VA-WV MSA, the California-Lexington Park, MD MSA, the Chambersburg-Waynesboro, PA MSA, the Hagerstown-Martinsburg, MD-WV MSA and the Cambridge, MD and Easton, MD Micropolitan Statistical Areas. The Baltimore-Washington CSA is much larger than the Philadelphia MSA, but only half the size of the New York MSA. Information regarding the Baltimore-Washington CSA's level of BioHealth talent, research, entrepreneurship, and capital is available in Appendix A.

Introduction

Commuting Patterns

Nearly 120,000 DC metro area residents commute to Greater Baltimore for work in public and private firms daily. Additionally, more than 200,000 Greater Baltimore residents commute to the DC metro area. Commuters from the Maryland suburbs that are traditionally defined as the DC Metro constitute more than one-tenth of the Greater Baltimore labor pool. Combined, these two regions create Central Maryland, a dense and well-traveled commuter corridor and a strong BioHealth workforce.



The Baltimore-Washington region is well connected internally and to the East Coast through comprehensive interstate, rail, and air networks and hubs. Amtrak trains go from New York to three stations in Baltimore and Central Maryland in less than 2.5 hours. The MARC Train offers low cost travel between Greater Baltimore and the DC Metro. BWI is one of the fastest growing airports in the US and offers frequent flights to cities nationally and internationally.

These regional connections allow for the fluid movement of residents from one market to the next, which expands the talent pool and market of Greater Baltimore far into the DC Metro area.

Regional Commuters

	From Greater Baltimore to:	From MD Suburbs of DC to:	From DC to:	From Northern VA to:
Greater Baltimore	945,626	117,791	7,150	20,563
MD/DC Suburbs	149,284	471,745	37,132	86,470
DC	30,511	202,233	169,915	179,428
Northern VA	22,260	94,160	35,564	941,196

Source: US Census Bureau

Introduction

Understanding the BioHealth Industry

BioHealth is the cluster of industries that drive the new innovation economy in Central Maryland region. It is the intersection of healthcare, life sciences, biosciences, information technology and manufacturing. Industry sectors include biotechnology, biopharma, medical devices, contract research organizations, clinical and regulatory services, healthcare services, health IT, e-health, mobile health, electronic medical records, health informatics and biohealth security.

According to a recent report from the Biotechnology Industry Organization (BIO), US bioscience companies employed 1.62 million personnel across more than 73,000 individual business establishments. Looking back over the past decade reveals a national industry that has added nearly 111,000 new jobs, or 7.4 percent, to its employment base.

Other highlights of the report:

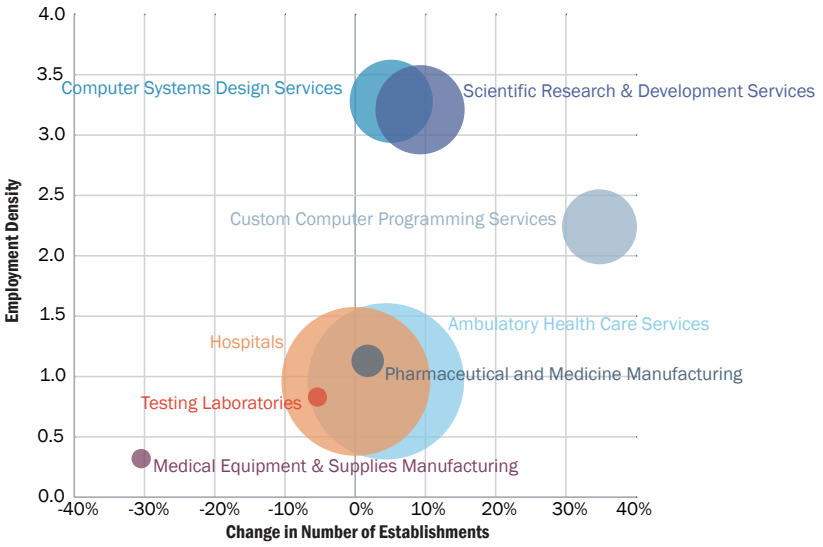
- The long-term trend of employment gains from 2001 to 2012 shows strong performance of the bioscience industry as a job generation engine for the U.S. Over this time period total private sector employment grew by only 1.0 percent, whereas the bioscience industry grew at a rate more than seven times as high (7.4 percent).
- As reported in 2014, the industry-wide average annual wage for bioscience workers reached $88,202, a figure that's nearly $40,000 more, or 80 percent greater, than that for the average worker in the nation's private sector.

According to the 2013 Economic Alliance of Greater Baltimore 2013 reported titled BioHealth in Greater Baltimore, a State of the Market Report, there are over 300,000 employed in BioHealth in the Baltimore-Washington region, and Central Maryland accounts for 50% of all BioHealth employees. In addition to biotechnology, diagnostics and clinical laboratories, and contract research organizations, the region is home to significant information technology, government contracting firms, and insurance and financial services with an intensive focus on health and healthcare markets.

The following chart shows some of the major sectors in the BioHealth industry and the growth in the number of firms in each major sector in Greater Baltimore and Central Maryland from 2009 to 2013. It also demonstrates the total employment in each sector, represented by the size of each point. Firms in the most densely concentrated sectors, like research and development and technology-based industries, account for more than 30 percent of total firms and the number of firms in these industries has grown by more than 15 percent in the last five years.

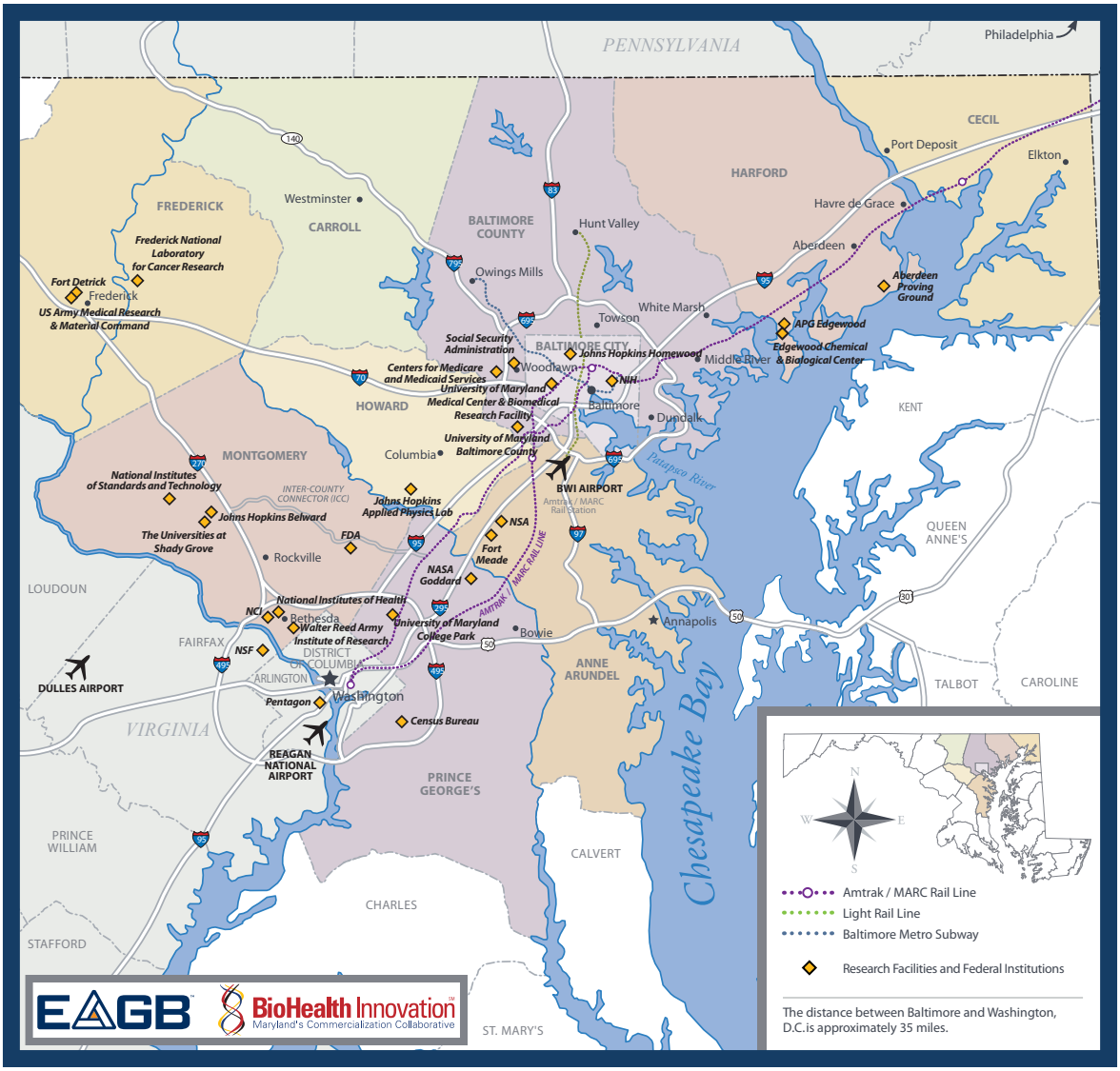
The primary BioHealth sectors are made up of various subsectors that grow at different rates. The number of research and development establishments focused on biotechnology, for example, has grown rapidly enough to outpace the more general umbrella of scientific research and development services.

BioHealth Firm Growth and Employment Density in Greater Baltimore
2009-2013



Introduction

Regional BioHealth Assets



Within Greater Baltimore and Central Maryland are many of the country's premier research facilities. Because of the region's proximity to Washington, DC, a number of federal research facilities and BioHealth-focused agencies are located throughout the region.

Additionally, many universities with strong research departments and faculty focused on novel development are found in Greater Baltimore and Central Maryland. From globally-renowned schools like Johns Hopkins University to national leaders in research and development like the schools in the University System of Maryland, the quality of research conducted in the Greater Baltimore and Central Maryland region is unparalleled.

The region is home to a rapidly growing number of private BioHealth enterprises, as well as some of the country's largest and most successful BioHealth firms.

The universities, federal facilities, and firms located throughout Greater Baltimore and Central Maryland are collaborative, often sharing research needs and technologies with one another, and are quickly moving to become more engaged in commercializing their research.

BioHealth Innovation Index

The BioHealth Innovation Index combines the previously described Talent, Research and Development, Entrepreneurship, and Capital indices. This composite ranking provides a clear indicator of the markets that have the greatest success in commercializing innovations in the BioHealth industry.

Rankings in each category are determined by averaging the relative rankings of indicators that measure aspects in a given category. The final Biohealth Innovation Index averages the index scores calculated for each category. As such, equal weight is given to a region's ability to research new BioHealth technologies and its ability to begin firms around new technologies.

Greater Baltimore and Central Maryland rank sixth among peer markets for its overall ability to produce and bring to market novel BioHealth technologies. There is certainly room for improvement, but Greater Baltimore and Central Maryland compares favorably on a number of components that indicate a strong foundation for the BioHealth industry.

The region is already home to a strong contingent of BioHealth talent, which is the necessary foundation for novel innovation and commercialization. Greater Baltimore and Central Maryland is also home to world-class universities with long histories of research and educational excellence.

For rapid and sustainable economic growth, Greater Baltimore and Central Maryland must focus its efforts on commercialization. While Greater Baltimore and Central Maryland has laid a strong foundation for the BioHealth industry, few of the region's research projects enter the commercial marketplace. The opportunity exists for professionals in Greater Baltimore and Central Maryland's BioHealth industry to capitalize on the market's leadership in research and development in ways that build a more robust ecosystem that generates new businesses and new jobs.

Innovation requires a pool of talented, ambitious professionals with a deep knowledge of the industry, the desire to solve problems, and the funding and dedication to chase down novel ideas. Commercialization needs a certain entrepreneurial spirit, a willingness to take risks to construct a growing business with a meaningful impact, and an ability to earn financing from investors that believe in the company and its product.

BioHealth Innovation Index

Rank	Region	Index
1	Boston	2.73
2	San Francisco	3.63
3	New York	3.77
4	San Diego	4.13
5	Raleigh-Durham	4.80
6	Baltimore/CMD	4.85
7	Philadelphia	5.14
8	Pittsburgh	6.91

Young firms create a majority of new jobs because they grow rapidly as demand for their product increases. High-tech companies, to include those in fields like Health IT and Biotechnology, are particularly important to job creation. Over 9% of average annual net job creation from 1990-2011 is due to high-tech firms younger than 5 years old. Innovation and commercialization is linked to increases in output, corporate revenue, and employee productivity. In short, novel ideas and products build a stronger, more robust regional economy.

By focusing the energy of the organizations and institutions throughout Greater Baltimore and Central Maryland operating in BioHealth on improving access to novel technologies, risk capital, and generally cultivating a culture of entrepreneurship, the region can grow to become a national leader in the production of innovative BioHealth firms.

BioHealth Innovation Index

Detailed Ranking

The following table summarizes the Innovation Index metrics used to compare the Greater Baltimore and Central Maryland region to the seven peer benchmark regions. These are represented as relative rankings; a score of 1 indicates a better performance in a given measure of innovation. Indicators are grouped according to category.

Indicator	Baltimore/CMD	Boston	New York	Philadelphia	Pittsburgh	Raleigh-Durham	San Diego	San Francisco
Talent	***1***	***3***	***1***	***7***	***8***	***5***	***6***	***4***
Residents with a Bachelor's Degree or Higher	5	4	1	3	7	8	6	2
Percent of Residents with a Bachelor's Degree or Higher	4	2	5	7	8	3	6	1
Residents with a Graduate or Professional Degree	3	2	1	5	7	8	6	4
Percent of Residents with a Graduate or Professional Degree	2	1	5	6	8	4	7	3
Residents with BioHealth Degrees	3	4	1	5	8	7	6	2
Percent of Residents with BioHealth Degrees	2	5	8	6	7	1	4	3
Number of BioHealth Workers	4	2	1	3	7	8	6	5
Density of BioHealth Workers	3	2	4	5	7	1	8	6
Young Professional Population Growth	2	5	3	8	6	4	1	7
Young Professional with a Bachelor's Degree or Higher Population Growth	2	6	1	8	4	7	3	5
Research & Development	***6***	***1***	***3***	***7***	***8***	***5***	***2***	***3***
BioHealth Research and Development Expenditure at Universities	2	4	1	7	8	3	6	5
BioHealth Research and Development Expenditure at Universities per Graduate Student	5	6	8	7	4	1	3	2
Invention Disclosures at Universities	5	1	4	6	8	7	2	3
Invention Disclosures at Universities per $100 of Sponsored Research	7	3	5	1	2	6	4	8
Patent Awards at Universities	5	1	4	6	8	7	2	3
Patent Awards at Universities per $100 of Sponsored Research	7	1	4	3	5	6	2	8
Utility Patent Awards	5	3	1	6	8	7	4	2
Utility Patent Awards per 10,000 Residents	6	3	5	7	8	4	2	1

BioHealth Innovation Index

Detailed Ranking

A category index score is determined by averaging the relative rankings of each indicator within that category. A final benchmark ranking is determined by averaging the category indices.

Indicator	Baltimore/CMD	Boston	New York	Philadelphia	Pittsburgh	Raleigh-Durham	San Diego	San Francisco
Entrepreneurship	***7***	***1***	***1***	***3***	***8***	***6***	***4***	***4***
Startups at Universities	7	1	4	5	8	6	2	3
Startups at Universities per $100 of Sponsored Research	7	5	6	1	2	3	4	8
License Income at Universities	7	4	1	5	8	6	2	3
License Income at Universities per $100 of Sponsored Research	8	5	1	4	7	6	3	2
Health and IT Firms on the Inc. 5000	4	2	1	2	8	6	7	5
Health and IT Firms on the Inc. 5000 per 10,000 Residents	3	2	6	4	7	1	8	5
Capital	***6***	***1***	***5***	***7***	***8***	***4***	***5***	***2***
SBIR and STTR Award Funding	2	1	5	6	8	7	4	3
SBIR and STTR Award Funding per 10,000 Residents	5	1	8	6	7	4	2	3
NIH SBIR and STTR Award Funding	4	1	5	7	8	6	2	3
NIH SBIR and STTR Award Funding per 10,000 Residents	5	2	7	6	8	1	3	4
Total BioHealth Venture Capital Investment	6	2	4	5	8	7	3	1
Average BioHealth Venture Capital Deal Size	6	1	4	7	8	5	3	2
Total BioHealth Seed and Early Stage Venture Capital Investment	4	2	6	5	8	7	3	1
Average BioHealth Seed and Early Stage Venture Capital Deal Size	5	1	6	7	8	4	3	2
Initial Public Offerings	6	3	1	4	7	5	8	2
Initial Public Offerings per 10,000 Residents	6	1	5	7	8	4	3	2
BioHealth Initial Public Offerings	8	2	5	7	6	3	4	1
BioHealth Initial Public Offerings per 10,000 Residents	5	2	7	6	8	1	4	3
Market Capitalization of BioHealth IPOs on First Day of Trading	5	3	1	6	8	2	7	4
BioHealth Innovation Index Overall Rank	**6**	**1**	**3**	**7**	**8**	**5**	**4**	**2**

Key Findings

While Greater Baltimore and Central Maryland rank sixth among peer markets for its overall ability to commercialize BioHealth technologies, the reality is that the region is among one of the nation's leaders in BioHealth. This report compared Greater Baltimore and Central Maryland to the most prolific and oft-cited examples of BioHealth innovation in the United States; to compare as well as it does is a positive sign for the Greater Baltimore and Central Maryland region. The fundamentals for successful BioHealth innovation are in place:

- More than 275,000 people in the region work in BioHealth industries.
- Greater Baltimore and Central Maryland are densely concentrated with BioHealth degree holders and BioHealth professionals.
- Universities in Greater Baltimore and Central Maryland spend more on research and development than most peer markets.
- Small businesses in Greater Baltimore and Central Maryland earned over $92 million through government-funded SBIR and STTR awards in 2013, more than most peer markets.

There is, however, a tremendous opportunity to improve commercialization outcomes in the Greater Baltimore and Central Maryland region. Currently, the region exhibits a relative lack of the entrepreneurial elements of innovation:

- Greater Baltimore and Central Maryland universities earn fewer patents and launch fewer startups than those in peer markets.
- $1 billion was invested in Greater Baltimore and Central Maryland BioHealth companies by venture firms in 2014, which lags nearly all peer markets.
- Universities in Greater Baltimore earn just over $0.50 through income from licensing their technologies, ranking among the worst among peer markets and nationally.
- Just three BioHealth firms in Greater Baltimore and Central Maryland have held IPOs in the last two years, fewer than most peer markets.

The status of these outcomes is potentially symptomatic of a more general difference in culture between the Greater Baltimore and Central Maryland region and the markets studied in this report that are recognized and lauded for their ability to generate companies. Greater Baltimore and Central Maryland's path toward improved innovation outcomes may be a broader change in culture that encourages existing residents to pursue entrepreneurial endeavors that would thereby attract other entrepreneurial people.

To become a national and worldwide leader in the complete innovation cycle of BioHealth technologies, the region must shift towards an industry-led and less risk-averse entrepreneurship. Greater Baltimore and Central Maryland is not lacking for the human capital or the technologies required to form an innovation hub. Rather, the region needs the right people to catalyze the virtuous cycle by which entrepreneurs find success, exit, and re-engage by means of mentoring and investing in the next generation of BioHealth entrepreneurs.

Fortunately, this report is far from the first mention of the existing opportunity for radical, rapid improvement. Much has been made of the need for improved entrepreneurial outcomes to raise the profile of Greater Baltimore and Central Maryland and to better support the regional economy. For example, Institutions like Johns Hopkins University and the University System of Maryland are actively working to commercialize more of the research done by faculty.

The future of BioHealth may favor the areas in which Greater Baltimore and Central Maryland have a competitive advantage. As personalized care becomes the norm, things like unique medical devices created by additive manufacturing processes and the accurate forecasting of patient outcomes represent areas of opportunity and growth. Greater Baltimore and Central Maryland is already home to a robust medical device community, and the tremendous technology workforce in the region are already engaged in predictive analysis. As always, engaging, educating, and training students with the tools needed for the jobs of the future is key to long-term success of the Greater Baltimore and Central Maryland region.

Talent

Research expertise, intellectual talent, and innovation are the foundation of the expanding BioHealth industry. Central Maryland is home to preeminent corporations and research institutions leading the way. The National Institutes of Health (NIH), John Hopkins University, and University System of Maryland, are among the top research centers in the country. Maryland is also home to leading global companies across the healthcare value chain, which include pharmaceutical and medical products; manufacturing and distribution; healthcare payers; research and development; and testing laboratories.

A talented workforce is the base from which all economic productivity, not just innovation, stems. A metropolitan region with many skilled professionals in a particular field is expected to hold a competitive advantage in that field. The presence of many educated, skilled workers in one field proves that the area is an advantageous place for those professionals to be - there must be opportunity in that field - and increases the probability of productive idea-sharing.

The key to igniting innovation is the natural construction of a network of professionals. By bringing together groups of people working on similar projects, a dialogue emerges that leads to information sharing, collaboration, cross-pollination, and a rapid rate of problem-solving.

The Central Maryland region is dedicated to developing an environment that maximizes the resources available to foster the commercialization of health products and growing innovating companies of the future. Supporting young innovators that will become tomorrow's leaders is of critical importance.

In the BioHealth industry, this necessary human capital is found in universities, laboratories, hospitals, and commercial companies, and often in multiple settings. Introducing life science academics and professionals in fields like pharmacology, surgery, or general patient care to one another and to professionals in fields like software design and engineering or advanced manufacturing introduces the possibility that each person can learn from one another or introduce a new idea from another industry into their own. Bringing people with these different backgrounds together often, thereby building networks across industry lines, and establishing a culture of collaboration leads to the construction not only of new companies but of entirely new fields: health IT, one outgrowth from industries intersecting, introduces technology and predictive analytics to health care in a way that improves patient outcomes.

Talent Index

Rank	Region	Average Rank
1	Baltimore/CMD	3.0
	New York	3.0
3	Boston	3.3
4	San Francisco	3.8
5	Raleigh-Durham	5.1
6	San Diego	5.3
7	Philadelphia	5.6
8	Pittsburgh	6.9

By comparing the relative ranking of each BioHealth region, it is possible to determine the rank of the overall talent base in Greater Baltimore and Central Maryland.

Greater Baltimore and Central Maryland is very dense with BioHealth degrees and workers. The BioHealth industry forms a substantial part of the region's economic foundation, and, as a result, many residents have an education or work experience that leads to an ability to support a BioHealth firm and greater BioHealth industry.

A constant stream of BioHealth workers, from leading scientists to postdoctoral fellows, cycle through renowned regional institutions like the National Institutes of Health, University of Maryland, Baltimore, and Johns Hopkins University and land in emerging companies or launch new firms in Greater Baltimore and Central Maryland. Increased efforts to retain these innovators are being made by organizations like BioHealth Innovation, Inc. Efforts to engage the ecosystem have spawned events like the Maryland Regional Biotech Forum, an annual event celebrating the robust assets in Central Maryland that continues to build a shared vision, brand, and set of ongoing collaborative activities for the region.

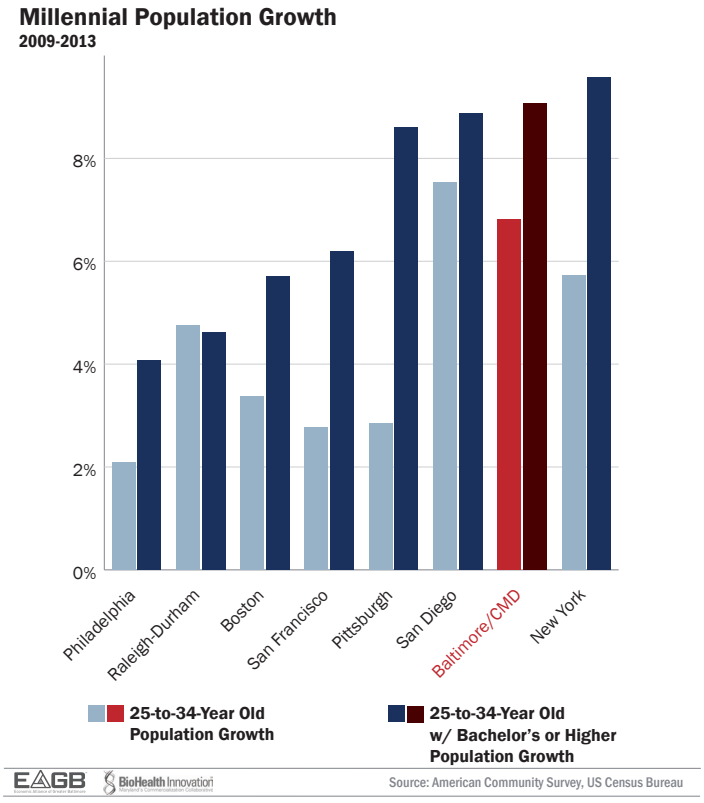
Talent

Millennial Population Growth

Relevance

A growing segment of young professionals represents a lifestyle and workplace needs that the metropolitan area in question is meeting. As such, the growth of the 18-to-34-year-old demographic is important for the continued wellness and energy of an innovative region. This is the population that will soon be leading the area's largest and most productive firms, as well as creating and commercializing the next wave of disruptive BioHealth technologies.

Results



Among peer markets, Greater Baltimore and Central Maryland ranks fourth for the five-year growth of all 18-to-34-year-olds. 6.11% more 18-to-24-year-olds live in Greater Baltimore and Central Maryland in 2013 than in 2009. However, the 18-to-34-year-old demographic may be affected by student relocation for college. Those in the earliest segment of this demographic, 18-to-22-year-olds, are considered residents of the town in which their university is located, but may move again for employment after graduation.

The 25-to-34-year-old demographic is more representative of stable growth in the young professional population. This demographic is less likely to move rapidly and the residence of 25-to-34-year-olds is based more on employment and job opportunities than education. Greater Baltimore and Central Maryland ranks second among peer BioHealth markets for 25-to-34-year-old population growth.

Greater Baltimore and Central Maryland also ranks second in the growth of the college-educated 25-to-34-year-old demographic. The number of residents in this demographic who hold a Bachelor's Degree or higher has risen 9.07% since 2009.

The rapid growth in educated 25-to-34-year-olds in Greater Baltimore and Central Maryland is meaningful for businesses located in the region. The pipeline of talent available to these companies is constantly growing, and at a rate faster than nearly any other area with a large BioHealth industry.

Areas of Opportunity

Baltimore-Washington has also experienced a 10,000 person increase among 18-to-24-year-olds with a Bachelor's degree or higher, indicating that the corridor is a popular college destination. Regional businesses have the opportunity to engage university students and prepare them for careers in BioHealth before they enter the labor force.

By engaging young professionals in meaningful internships and careers, the Greater Baltimore and Central Maryland region can retain more of the students that come to the region for college. Introducing the future of the workforce to important BioHealth networks will ensure that staying in the region affords them a great deal of social capital that is lost upon relocation after college. One such program, the Biomedical Careers Initiative at Johns Hopkins University School of Medicine places some of the institutions brightest Ph.D. students with companies and organizations providing valuable work experience.

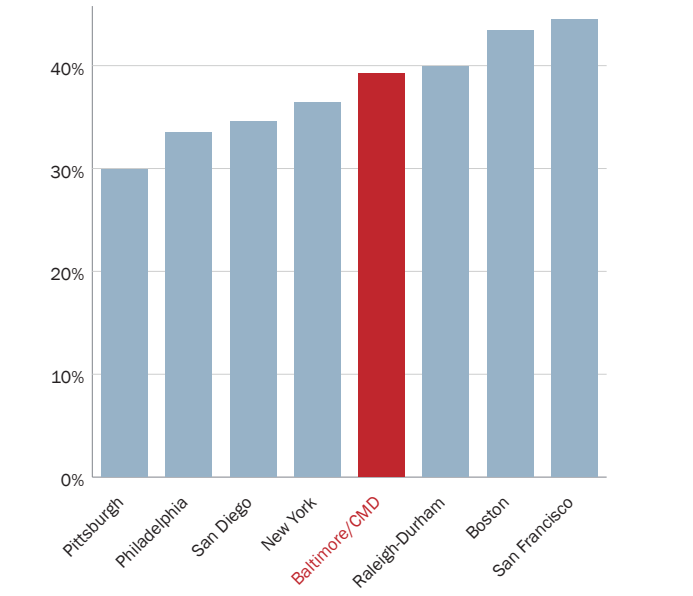
Talent

Educated Labor Force

Firms in any industry desire to be a part of a community of educated residents. A deep pool of skilled workers provides firms options for hiring and expansion. The Baltimore and Central Maryland region is densely populated with well educated residents, and firms in the region benefit from the high quality of the local labor force.

Results

Percent of Residents with a Bachelor's Degree or Higher
2013



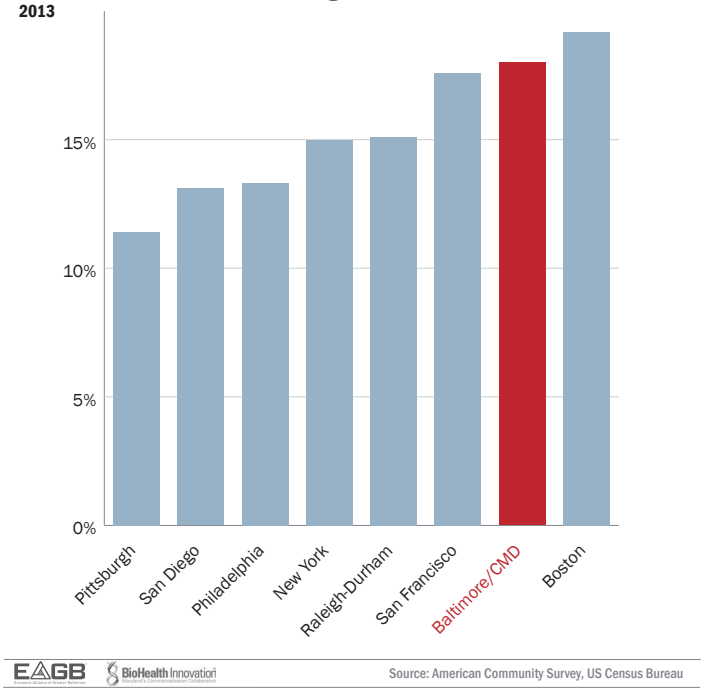
EAGB BioHealth Innovation Source: American Community Survey, US Census Bureau

Baltimore and Central Maryland ranks fourth among peer BioHealth markets for the percentage of its residents holding a Bachelor's Degree or higher. Over 1.2 million residents, or 39.2%, of the Baltimore and Central Maryland region over the age of 25 have a four-year degree.

592,007 residents hold a Graduate or Professional Degree. Baltimore and Central Maryland ranks second among peer markets for the percentage of residents with Graduate or Professional Degrees.

It is important to note the number of educated residents in the Baltimore-Washington commuter corridor as well. While some of these residents live and work outside of the Baltimore and Central Maryland region, they are geographically capable of working for a BioHealth firm in Baltimore and Central Maryland should the opportunity arise. There are over 2.6 people over the age of 25 in the Baltimore-Washington corridor with four-year degrees, and 1.2 million of those residents hold a Graduate or Professional Degree as their highest level of education.

Percent of Residents with a Graduate or Professional Degree
2013



EAGB BioHealth Innovation Source: American Community Survey, US Census Bureau

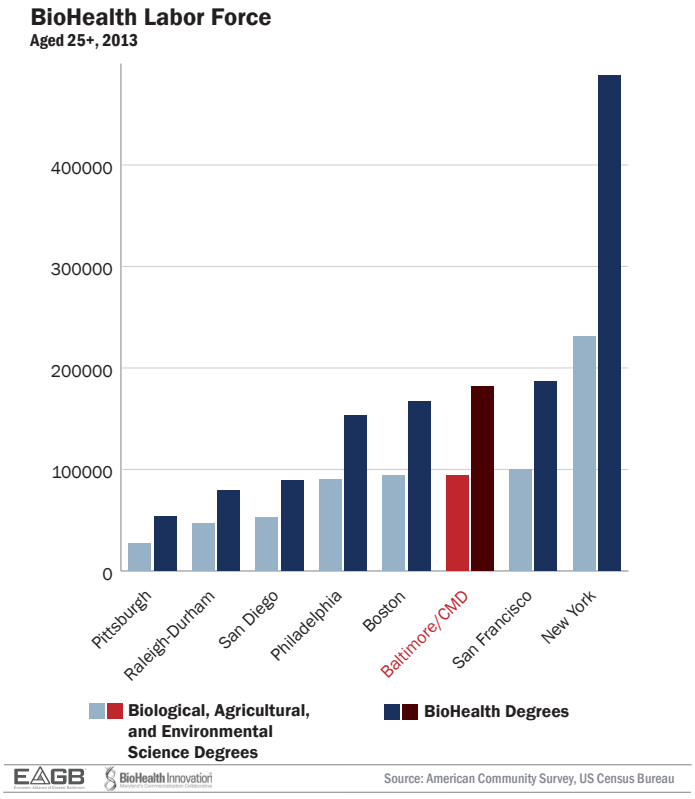
42.6% of Baltimore-Washington corridor residents hold a four-year degree, and 19.8% of residents hold a Graduate or Professional Degree. Based on the concentration of residents with Graduate or Professional Degrees, the Baltimore-Washington corridor is arguably the best educated region in the United States.

Talent

BioHealth Labor Force

The skilled labor force available to BioHealth firms in Greater Baltimore and Central Maryland can be measured first by the population of individuals with degrees in relevant fields. This includes degrees in Biological, Agricultural, and Environmental Sciences as well as Computers, Mathematics, and Statistics.

Degrees in Computers, Mathematics, and Statistics are included in the total number of BioHealth degrees because BioHealth includes an important technology component. Professionals with a background in Computers, Mathematics, and Statistics are the driving technical force in fields like Health IT, Health Care and Hospital Cyber Security, Electronic Medical Records, and Health-Related Data Science.

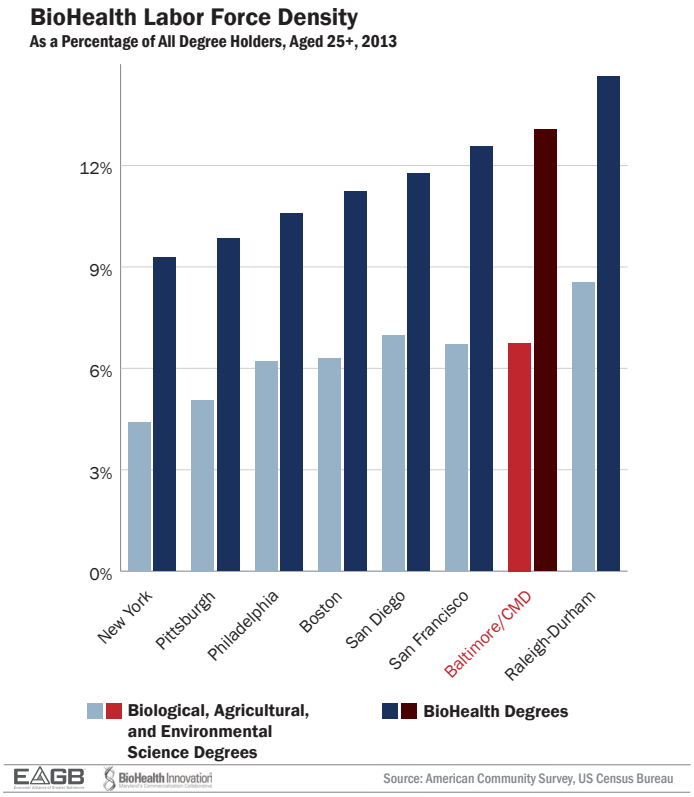


Relevance

The number of professionals holding degrees in BioHealth fields provides an accurate depiction of the potential labor market. Those holding degrees in Computers, Mathematics, and Statistics and Biological, Agricultural, and Environmental Sciences may not currently work in BioHealth fields, but can be expected to have the skills necessary to do so should a BioHealth company wish to employ them.

Results

Greater Baltimore and Central Maryland is home to 94,151 residents over the age of 25 with a Bachelor's Degree or higher in Biological, Agricultural, and Environmental Science fields. 6.4% of Greater Baltimore and Central Maryland residents with a college education hold a degree in these fields, the second highest concentration among peer markets.



The Baltimore and Central Maryland region has a particular strength in technical education. The University of Maryland, College Park and the University of Maryland, Baltimore County are both widely recognized as excellent institutions for educating future technical professionals.

Talent

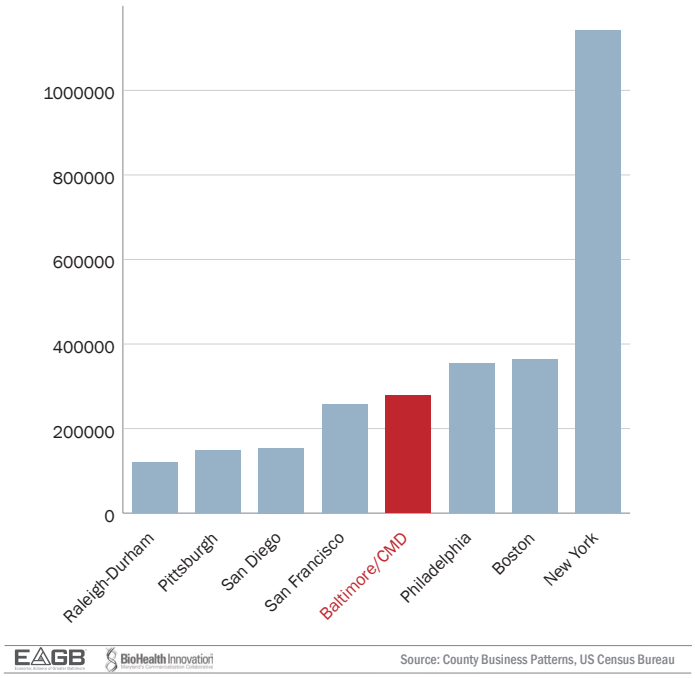
BioHealth Labor Force

Including the 45,003 Greater Baltimore and Central Maryland residents with Computer Science degrees brings the total potential BioHealth workforce according to degree field to 182,259 residents, or 13.1% of the region's degree-holding population.

The Greater Baltimore and Central Maryland region is home to the fourth largest population of BioHealth degree holders among peer markets, and the second most concentrated population of those educated in BioHealth fields.

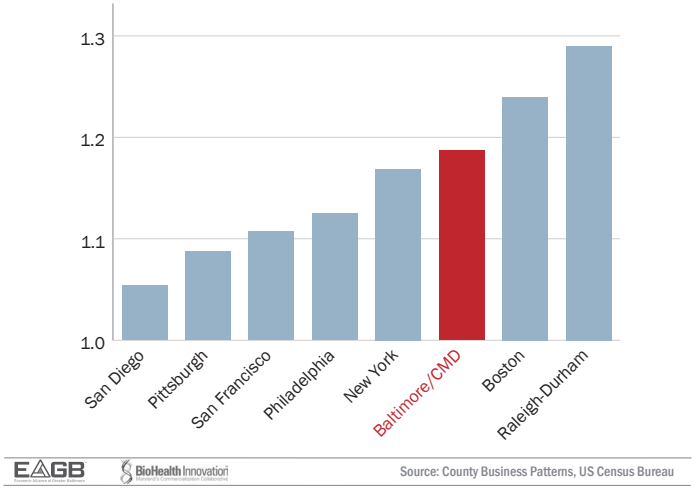
It is also possible to measure the BioHealth labor force available in Greater Baltimore and Central Maryland using current industry employment. Not all occupations in BioHealth require a four-year degree. The BioHealth industry can be estimated by using a number of industries defined by the US Census Bureau, encompassing Health Care, Life Sciences, and Computer Sciences. A full definition of the BioHealth industry used is shown in Appendix C.

BioHealth Workforce
2012



There are currently 278,470 people working in the BioHealth industry in Greater Baltimore and Central Maryland, the fourth largest BioHealth workforce among peer markets. Greater Baltimore and Central Maryland also has 19% more BioHealth workers than average, making it the third most densely concentrated BioHealth workforce among its peers.

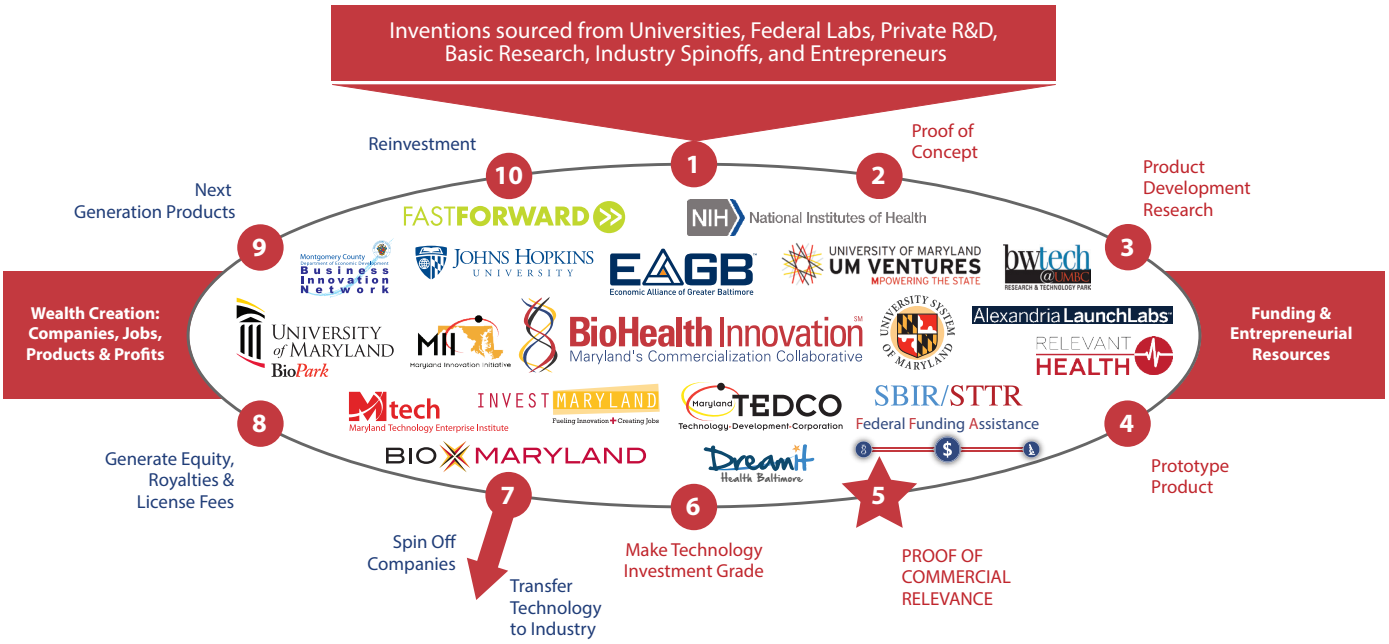
BioHealth Workforce Density
2012



Greater Baltimore and Central Maryland have a strength in Scientific Research & Development: the region is home to more than three times the average number of R&D professionals.

As with the region's population growth, it is important to note the number of BioHealth degree holders and current professionals in the Baltimore-Washington commuter corridor. There are 346,036 people over the age of 25 in the Baltimore-Washington corridor with BioHealth degrees, and 573,699 people working in BioHealth Industries.

Research and Development



With a strong talent base in place, the next step in the innovation process is research and development. The most celebrated outcomes of innovation - business formation, employment growth, and wealth generation - begin in the research and development stage, where novel answers to difficult questions are sought and produced.

The comparative rankings for each research and development indicator allows for the determination of the overall research and development ranking for the country's leading BioHealth markets. In competitive markets, research enterprises provide the appropriate handoffs to private sector commercial development and ultimately regional economic development through new corporate growth, profitability, and job creation. The research enterprise provides new discovery for additional collaborative research, potential transfer or licensing to industry partners.

The Commercialization Lifecycle chart developed by BioHealth Innovation and shown above provides a complete depiction of the process of product commercialization in which a region seeks to maximize returns for both the researcher and inventor and the local economy.

Once a company is viable or a technology is transferred, it begins to generate royalties, profits, or equity. BioHealth Innovation, Inc. helps successful entrepreneurs utilize those gains to reinvestand begin work on the next generation of technology spinouts. Such reinvestment improves the entrepreneur's private benefits, as well as keeping spillover benefits within the Greater Baltimore and Central Maryland region.

Greater Baltimore and Central Maryland companies and universities should continue to pursue market-relevant research projects. Encouraging regional businesses to focus on projects and products with commercial relevance leads to myriad positive economic outcomes, including job and productivity growth and employment reduction.

Research & Development Index

Rank	Region	Average Rank
1	Boston	2.75
2	San Diego	3.13
3	New York	4.00
	San Francisco	4.00
5	Raleigh-Durham	5.13
6	Baltimore/CMD	5.25
7	Philadelphia	5.38
8	Pittsburgh	6.38

Research and Development

Higher Education Research and Development

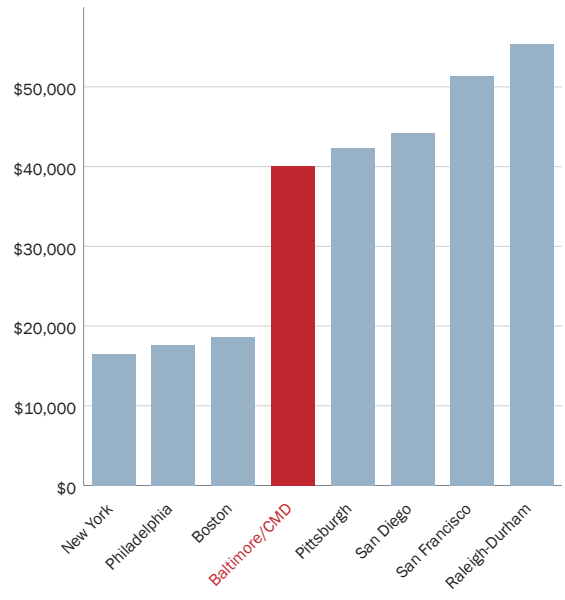
A great deal of technological innovation takes place in higher education. Universities are the beneficiaries of federal and industry grants for research and development, and faculty projects often incorporate students. In addition to generating commercially relevant products and practices, academic research exposes the next generation of entrepreneurs and professionals to practical experience in innovation.

Relevance

As such, higher education research and development benefits local economies immediately and in the long run, as students learn the skills and methods to become the next generation of creators. Incorporating research and development expenditure per graduate student allows for insight into the level of access and quality of research students are afforded; universities that spend more per graduate student on BioHealth research and development are likely to have larger or more projects that students are involved in.

Results

BioHealth Research and Development Expenditures
per Graduate Student at Universities, 2013



EAGB BioHealth Innovation Source: National Science Foundation, National Center for Education Statistics

Universities in Greater Baltimore and Central Maryland tend to spend a great deal on BioHealth research and development. Johns Hopkins University in Baltimore City spends the second most money in the United States on life sciences research development, and ranks in the top five schools nationally for biological sciences and medical sciences research and development expenditure.

In fiscal year 2013, the most recent year for which data is available, universities in Greater Baltimore and Central Maryland spent over $1.7 billion on BioHealth research and development, the second greatest expenditure among peer markets. Only the much larger New York metropolitan region spends more on BioHealth research and development.

Greater Baltimore and Central Maryland universities spent $40,070 per graduate student on BioHealth research and development in fiscal 2013, fifth among peer markets. The Raleigh-Durham Research Triangle ranks first and spends over $55,000 per graduate student.

Areas of Opportunity

The universities in the Greater Baltimore and Central Maryland market are already national leaders in research in BioHealth and other fields. These institutions and their faculty are deeply invested in not only the merits of the research but connecting with collaborators to ultimately see the research applied to wider practices in business, industry, and society. Institutions like the University of Maryland, College Park continue to invest in endowed chairs placing the region at the forefront of recruiting and retaining talent. In April 2014, the Maryland General Assembly passed the E-Nnovation program that offers matching State funding for the recruitment of endowed chairs across a set of disciplines that include fields that significantly impact the development of the State's BioHealth industry. Funding will be apportioned annually by the Governor of Maryland from fiscal 2016 through 2021.

Research and Development

Invention Disclosures and Patents at Universities

The transfer of university technology to the marketplace is a critical component to the BioHealth ecosystem. The movement of the results of research into the commercial space not only validates the years of work and funding required to perform the initial research, but also results in highly desirable outcomes for the region in which the innovative product or idea was born and moved into the commercial sector

Invention Disclosures

An invention disclosure is a confidential document written by a scientist or engineer for use by a legal department at a university or company that defines the nature, composition, structure, or process that may be important to protect through the patent process. Not all invention disclosures make their way to patent filings, and nor should they. However, multitudes of invention disclosures can speak to the dynamism and culture of discovery. As such, invention disclosures serve both as an indicator of the novel conclusion of research and the level of engagement between research professionals and shepherds of commercialization.

By transferring valuable technologies into the commercial marketplace, universities are able to partner with entrepreneurs to build businesses and create employment opportunities around these new technologies. In doing so, the university of origin is able to generate income through licensing and royalty agreements.

Greater Baltimore and Central Maryland universities have spent a great deal on research and development, but have so far failed to realize regional outcomes that match.

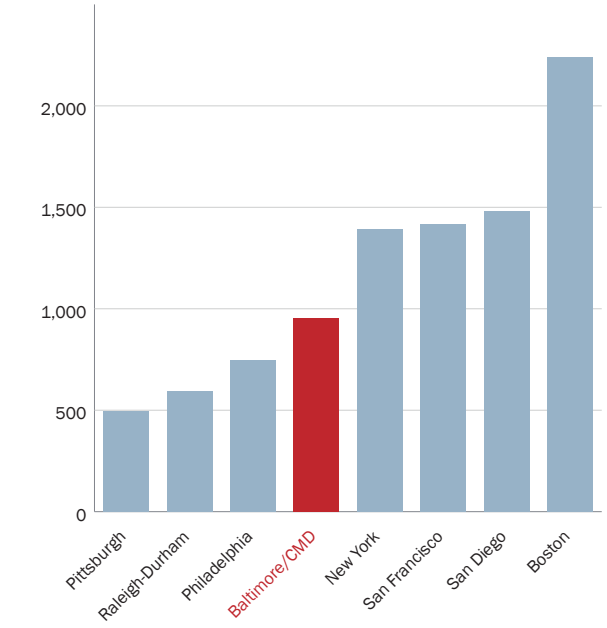
Relevance

Invention disclosures are one means of measuring technology transfer. This step is considered the first in the collaboration between the inventor and the university staff responsible for technology transfer. As such, invention disclosures serve both as an indicator of the novel conclusion of research and the level of engagement between research professionals and shepherds of commercialization.

Results

In fiscal year 2013, 953 inventions were disclosed to technology transfer professionals at Greater Baltimore and Central Maryland universities, fifth most among peer markets. Notably, Boston, which captures a tremendous amount of SBIR and STTR capital for funding commercially-relevant research and development, leads peer BioHealth markets in invention disclosures by a wide margin.

Invention Disclosures at Universities
Fiscal Year 2013



EAGB BioHealth Innovation Source: Association of University Technology Managers

Important to the invention disclosure ranking, and to all later steps in the technology transfer process, is controlling for the amount of money spent by universities on research and development. Universities bringing in more research funding should be expected to generate more novel inventions, as well as more patents, startup companies, and licensing income. For ease of comparison, each market is ranked according to the number of inventions, patents, and startups it generates per $100 of research expenditure, but for ease of understanding, is described in this text as the amount of dollars spent to create one invention, patent, or startup.

Research activity that leads to positive economic outcomes may take years to develop. Inventions disclosed

Research and Development

Invention Disclosures and Patents at Universities

by universities in 2013 may have been part of ongoing research for many years prior. Universities that spent great sums on research in fiscal year 2013 have a long history of innovative research and consistent research expenditure patterns. While the dollars spent in 2013 may not directly impact the inventions disclosed in the same year, the level of expenditure indicates what should be expected to have come from that university in past years. As such, the relationship between research expenditures and the outcomes of technology transfer can be seen to represent relationships that span many years and are valid in the evaluation of a region's ability or willingness to commercialize university research.

Greater Baltimore and Central Maryland universities rank seventh for the number of inventions disclosed in fiscal 2013 when compared to the money spent by those universities on 2013 research. It requires an estimated $4 million in research and development expenditure at Greater Baltimore and Central Maryland universities to arrive at the disclosure of one invention, which is only the beginning of the technology transfer process. Certainly a great deal of opportunity for disclosing the results of more research exist within the Greater Baltimore and Central Maryland region: Johns Hopkins University is one of only eight universities or university systems to have recorded more than 400 invention disclosures in fiscal 2013.

Philadelphia leads peer markets in invention disclosures as a ratio of research expenditure. It requires an estimated $2 million of research at universities in Philadelphia to arrive at an invention disclosure.

Patents

Patents are recognized as the outcome of novel research that have the potential to reward innovative development and subsequent commercialization with sole ability to generate income for a specific period of time.

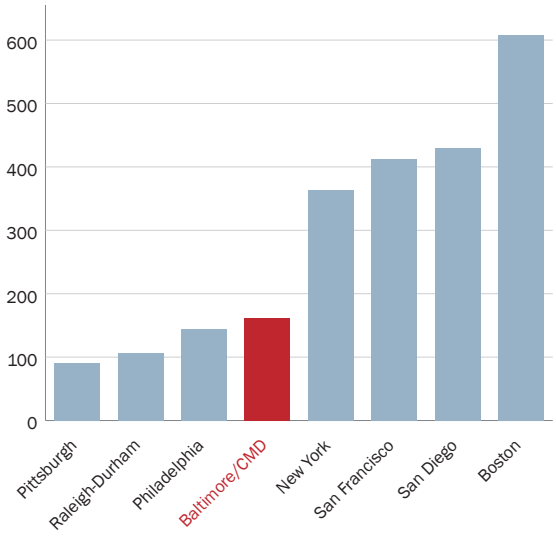
Relevance

Patents issued can be used as a proxy for the level of research and innovation in a region. While patents are not necessary for business creation, they create a strong competitive advantage in that they grant a limited-time monopoly on the production of a new product and the associated marketplace.

Results

Greater Baltimore and Central Maryland universities fall in the middle of peer markets, ranking fifth for the total number of United States patents awarded in fiscal 2013 with 162 patent awards. Boston again leads peer markets with 608 patents awarded during the fiscal year.

Patent Awards at Universities
Fiscal Year 2013



EAGB BioHealth Innovation Source: Association of University Technology Managers

Like with invention disclosures, the efficiency of universities in BioHealth markets can be measured by controlling for the amount each region spends on higher education research and development. Greater Baltimore and Central Maryland universities are among the most prolific in research and development, but again fail to capitalize on this leadership position. The Greater Baltimore and Central Maryland region ranks seventh in patent generation per university research expenditure, with just over $20 million of research expenditure in fiscal 2013 resulting in one patent award in fiscal 2013. Universities in Boston, the most efficient at translating research expenditure into patent awards, achieved one patent award for every $10 million spent in fiscal 2013.

Research and Development

Utility Patent Awards

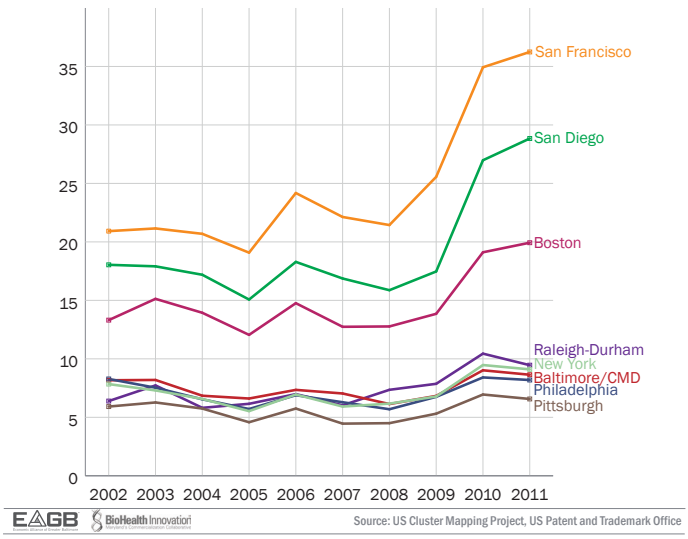
Relevance

Like at the university level, patent awards measure a region's propensity to protect intellectual property for the purposes of business creation, growth, and maturity. A region with a greater number of patent awards has the ability to create more new businesses and new jobs, all of which are provided a first-mover advantage in a nascent market or allow for larger companies to protect their product lines.

Utility patents are traditionally defined patents, granting a 20-year monopoly on production and sale of a unique product to its creator. Because of the nature of utility patents as solid protectors of intellectual property, these are tracked as indicators of innovation, entrepreneurship, and economic potential, particularly in relation to startup companies.

Results

Utility Patents Awarded
per 10,000 Residents, 2002-2011



With over 18,000 United States patents being awarded to inventors in 2011, New York ranks first among peer markets for the total number of utility patents. Greater Baltimore and Central Maryland inventors were awarded 4,250 utility patents in 2011, ranking sixth among peer markets.

San Francisco leads peer markets in patent award density, with over 36 patents awarded per 10,000 residents. Patent awards in San Francisco have risen dramatically since the late 1990s. It is possible that San Francisco's dominance in utility patent capture is due in part to the increase in software patents awarded by the United States Patent and Trademark Office in addition to the region's proclivity for innovation and entrepreneurship.

Greater Baltimore and Central Maryland ranks sixth among peer markets for the region's per capita rate of utility patent generation. For every 10,000 residents of Greater Baltimore and Central Maryland, more than 8 patents were awarded in 2011, a rate very similar to that of Philadelphia.

Areas of Opportunity

Academic researchers and technology transfer offices should strive to file utility patents. Because of the cost and speed of provisional patents, they are popular among junior researchers demonstrating the novelty of their work. By assisting in and encouraging the submittal of utility patent applications among students and staff, universities can better defend intellectual property created in its laboratories and form revenue-generating licensing opportunities for entrepreneurs who are interested in commercializing research.

Entrepreneurship

The results of entrepreneurial activity are critical for economic development. New businesses increase per capita productivity and expand employment faster than older, established firms, such that a majority of new jobs are created by firms less than five years old.

However, entrepreneurship is not without risk. Regions with a strong culture of entrepreneurship tend to see rapid growth in prosperity, and markets can foster that activity by establishing effective innovation infrastructure with few barriers.

Greater Baltimore and Central Maryland ranks seventh among peer markets for entrepreneurship activity, but the region is full of possibility. Greater Baltimore and Central Maryland are hotbeds of research and development. Changes in culture and existing mechanisms can help the region translate its success and leadership in research to entrepreneurship.

Boston and San Diego can be models for the Greater Baltimore and Central Maryland BioHealth community in terms of encouraging commercialization of new technologies. Boston and San Diego lead peer BioHealth markets in research and development and both are able to carry that into the realm of entrepreneurship, where each is a leader in producing novel inventions, patent awards, and generating startup companies at universities. Notably, both Boston and San Diego lean heavily on their universities and research institutions for entrepreneurial activity. Greater Baltimore and Central Maryland, home to the University System of Maryland, which includes the University of Maryland, Baltimore, Johns Hopkins University, and multiple health care and research facilities, has a comparable stock of potential birthplaces for entrepreneurial activity.

Greater Baltimore and Central Maryland is also similar in existing outcomes as Raleigh-Durham. The home to Research Triangle Park, one of the largest and most impressive research parks in the world, suffers in some respects due to its relatively small population. However, Raleigh-Durham has proven to be adept at generating successful startups, ranking well in both the efficiency of business creation at universities and the per-capita number of fast-growing Health and IT firms.

Entrepreneurship Index

Rank	Region	Index
1	Boston	3.17
	New York	3.17
3	Philadelphia	3.50
4	San Diego	4.33
	San Francisco	4.33
6	Raleigh-Durham	4.70
7	Baltimore/CMD	6.00
8	Pittsburgh	6.67

Raleigh-Durham's success in business creation stems from its purposeful grouping of like companies, thereby creating a dense community of potential collaborators that includes significant operations of some of the world's largest technology and life sciences firms. While Greater Baltimore and Central Maryland may not be in a position to replicate the exact structure of Research Triangle Park, porting some of the specialized incentives designed for Research Triangle Park to local research parks and incubators will help improve the region's ecosystem. Further emphasizing the benefits of dense colocation and collaboration at the region's already-successful incubator and accelerator programs may continue to help the trajectories of young businesses.

Opportunity exists to transform Greater Baltimore and Central Maryland into a region with a greater propensity to exhibit entrepreneurship and to reap the rewards of business formation. In order to capture the benefit of entrepreneurial activity, steps must be taken to ensure that the region is safely moving toward a more risk-tolerant culture that commends and supports the formation of new business ventures.

Entrepreneurship

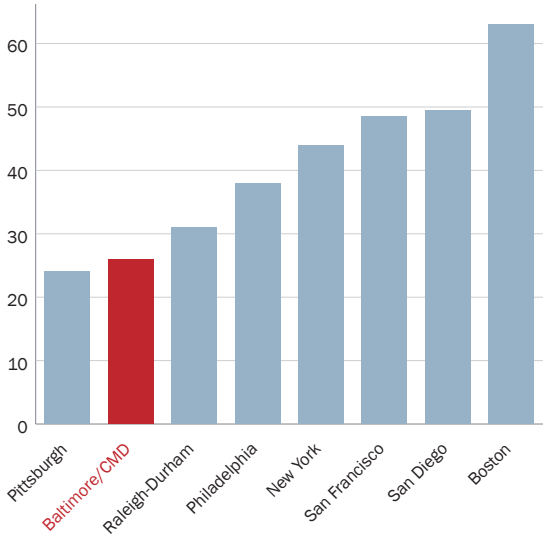
Startups

Relevance

Startup companies can be an effective means for transferring novel technologies from the research environment into the commercial marketplace. Measuring the number of startups formed around university research indicates not only a propensity to commercialize technology, but also the potential for job growth within a region. Small firms younger than five years old generate a majority of the new jobs in the United States. While many startups fail after a few years of operation, startups formed around university technology have demonstrated greater success rates than average. Therefore, a market's ability to generate startups is indicative of its ability to generate new jobs, and a market's ability to form new business around university research is indicative of its ability to create sustainable new jobs.

Results

Startups at Universities
Fiscal Year 2013



EAGB BioHealth Innovation Source: Association of University Technology Managers

In fiscal 2013, 26 new businesses were formed around the research and technology of Greater Baltimore and Central Maryland universities. In this measure, Greater Baltimore and Central Maryland ranks seventh, ahead of only Pittsburgh, where 24 startups were formed with university technology. Again, Boston ranked first among peer BioHealth markets with 63 startups formed in fiscal 2013.

Pittsburgh was the most efficient market at turning research expenditure into startup companies, where less than $50 million in fiscal 2013 research expenditure generated one startup. Greater Baltimore and Central Maryland ranked seventh in startup efficiency, with over $140 million being required to generate one startup. In this metric, the most prolific research markets ranked the lowest.

Areas of Opportunity

While most other markets ranked in the same position for inventions, patents, and startups from technology transfer, Greater Baltimore and Central Maryland dropped from fifth to seventh. Clearly, the region has a significant opportunity to increase the number of startups formed around university research even before considering steps to improve invention disclosure and patent applications and awards. Incentivizing business creation among university researchers may catalyze the rapid realization of economic benefit outside of the university structure.

A number of programs aimed at building a community of entrepreneurs, scientists, investors and professionals that can support, mentor and educate fellow fledgling start-ups and budding entrepreneurs has been assembled in Greater Baltimore. Maintaining a culture of support for entrepreneurial activity will sustain the development and growth of the regional economy.

Programs like the Maryland Innovation Initiative administered by TEDCO, provides three phases of funding for technology development at select Maryland universities. Faculty at schools in the University System of Maryland may receive credit in tenure for the generation and application of intellectual property through technology transfer, and Johns Hopkins University has established - and continues to build - FastForward accelerator facilities.

Supporting and facilitating the growth of programs like these is important to the continued improvement of entrepreneurial activity in Greater Baltimore and Central Maryland. By ensuring that risk is minimized and infrastructure for business formation is in place, more research may be moved into the commercial sector.

Entrepreneurship

License Income

Entrepreneur-in-Residence programs like those maintained by BioHealth Innovation, Inc., Startup Maryland, and many regional universities assist budding entrepreneurs to recognize and carry emerging technologies through the startup process. BioHealth Innovation's EIR program is the only widespread BioHealth EIR program and works in partnership with federal, academic, and corporate laboratories.

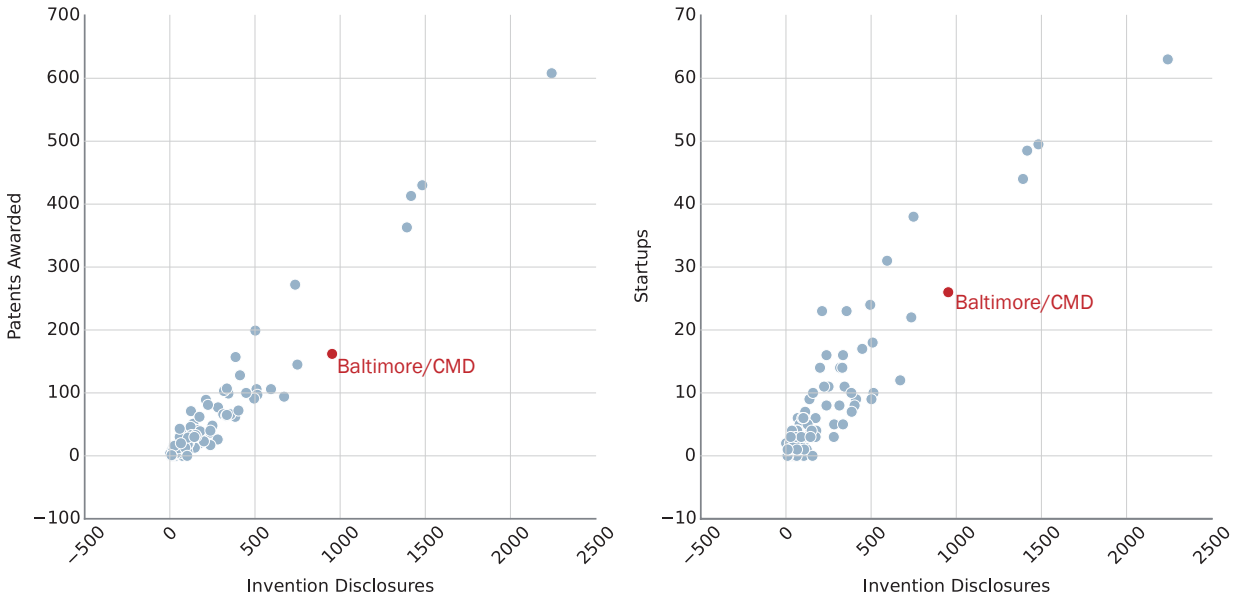
Companies engage in technology transfer for a number of reasons. Firms look to transfer technologies from other organizations because it may be cheaper, faster, and easier to develop products or processes based on an existing technology rather than to start from scratch. Transferring technology may also be necessary to avoid a patent infringement lawsuit, to make that technology available as an option for future technology development, or to acquire a technology that is necessary for successfully commercializing a technology the company already possesses. Companies look to transfer technologies to other organizations as a potential source of revenue, to create a new industry standard, or to partner with a firm that has the resources or complementary assets needed to commercialize the technology.

For government laboratories and universities, the motivations for technology transfer are somewhat different. Governments or universities may transfer technology from outside organizations if it is needed to accomplish a specific goal or mission or if it would add value to another technology that the government or university is hoping to transfer out to a company. Government laboratories and universities commonly transfer technologies to other organizations to stimulate economic development, as an alternate source of funding, or to establish a relationship with a company that could have benefits in the future.

Relevance

Because research, development, technology transfer, and commercialization stages are dependent on one another, a high degree of correlation between novel product development and intellectual property protection is to be

Invention Disclosures, Patents Awarded, and Startup Companies
at Universities, Fiscal Year 2013



EAGB Economic Alliance of Greater Baltimore
BioHealth Innovation Maryland's Commercialization Collaborative

Source: Association of University Technology Managers

Entrepreneurship

License Income

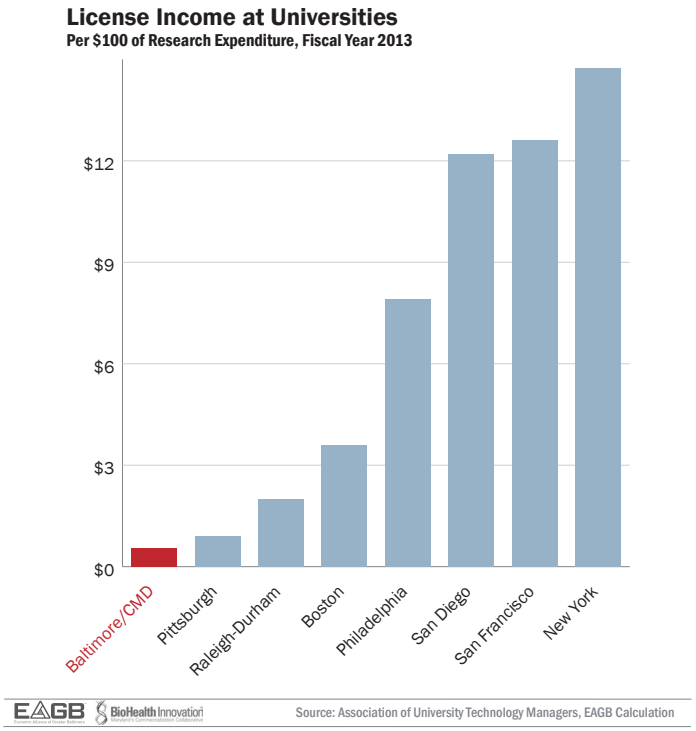
expected. That is, as shown on page 27, the markets that disclose the most inventions should also be the markets that receive the most patents and start the greatest number of businesses from university research.

However, the product development resulting from research is not necessarily equal. While one region may produce a number of successful but small businesses, another may produce very few but very successful businesses. As such, the amount of license income earned by a university may not be as strongly linked to invention disclosure and patent activity, and instead can be used to measure the quality of technology or startup launched by university research rather than the quantity. Additionally, university technology may be licensed to medium and large companies, such that license income is driven not strictly by startup companies.

Results

License income can take the form of running royalties, cashed-in equity, and other. Other payments include upfront payments, annual maintenance fees, or milestone payments. Greater Baltimore and Central Maryland universities earned nearly $20 million in license income in fiscal 2013. New York ranked first, where universities earned $608 million from license income in fiscal 2013 alone.

License income efficiency is the amount of income generated per $100 of research expenditure at universities in each market. Here, New York again ranks first with $14.74 earned from licensing agreements per $100 of research, and is followed by San Francisco and San Diego. This is likely due to universities in these regions having produced tremendously successful startups that generate licensing income for their origin universities that is not only unusual, but likely not repeatable. New York and San Francisco, and to a lesser extent, San Diego, are also noted for product development and company formation in high-tech industries that have little to do with BioHealth. It is possible that the success of a company like Google, which was born at Stanford University, not only boosts the license income of San Francisco universities in a way that is not only unrepeatable, but irrelevant to BioHealth. Greater Baltimore and Central Maryland Universities received $0.53 per $100 of research expenditure in fiscal 2013, ranking last among peer BioHealth markets.



Areas of Opportunity

While it may be tempting to consider Greater Baltimore and Central Maryland one massively successful company away from a competitive license income to research expenditure ratio, this would be a poor plan for ensuring continued, sustainable success in university technology transfer. By enacting measures that make technology licenses more easily obtained and more desirable, such as the aforementioned cost reduction or a streamlined licensing process, more entrepreneurs and businesses should be encouraged to pursue business ventures using university technologies, thereby increasing the opportunities for license income receipt by Greater Baltimore and Central Maryland universities.

Entrepreneurship

Inc. 5000 Companies

Relevance

An important hallmark for markets leading industry innovation is the existence of rapidly growing companies. The presence of fast-growing, typically young, successful companies in a region is a measure of relevant activity worth celebrating, but also indicates more broadly that the region has constructed a market that fosters rapid growth and expansion.

Results

On the Inc. 5000 list, Inc. magazine ranks the 5,000 fastest-growing private companies in the United States according to their three-year revenue growth. 121 of the fastest-growing companies in the United States are located in Greater Baltimore and Central Maryland.

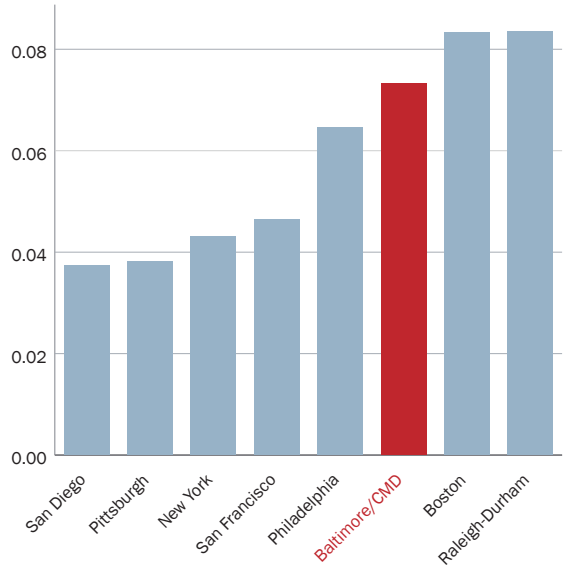
Among the fastest-growing companies from all industries, the fastest-growing companies in Health exhibited an average rate of revenue growth. However, the fast-growing Health sector is the largest of all fast-growing industries by total revenue: fast-growing Health companies earned $21.8 billion of revenue in 2013, while IT Services ranked second with $19.3 billion in revenue.

Both Health and IT Services companies on the Inc. 5000 list were used to measure the number of fast-growing BioHealth companies as well as each market's ability to enable the rapid growth of BioHealth companies. Not all IT Services companies operate in the BioHealth space, but their products have the potential to serve BioHealth companies, and their presence indicates the presence of an ecosystem that can support tech-focused BioHealth companies.

New York, the largest metropolitan region in the United States, leads peer markets with 86 Health and IT Services companies on the Inc. 5000. Because of its size relative to other peer markets studied, this is not particularly surprising. Greater Baltimore and Central Maryland rank fourth, with 36 fast-growing Health and IT Services companies operating in the region.

Raleigh-Durham ranks first among peer markets in terms of fast-growing Health and IT Services on a rate basis. The market containing Research Triangle Park is home to 0.08 fast-growing Health and IT Services companies per 10,000 residents. Greater Baltimore and Central Maryland ranks third in this measure, with 0.07 fast-growing Health and IT Services companies per 10,000 residents.

Health and IT Inc. 5000 Companies
per 10,000 residents, 2014



EAGB BioHealth Innovation Source: Inc.

Greater Baltimore and Central Maryland is very similar to Boston in both the total number of fast-growing Health and IT Services companies and the number of fast-growing Health and IT Services companies per capita. Boston ranks second in both the total number and the rate of Health and IT Services companies, and is home to only 3 more Health and IT Services companies than the similarly-sized Greater Baltimore and Central Maryland region.

The makeup of the Inc. 5000 list is expected to fluctuate, but Greater Baltimore and Central Maryland's competitiveness with peer BioHealth markets points to the existence of the pieces necessary to grow BioHealth companies with rapid expansion trajectories.

Areas of Opportunity

Collaboration is key to continue to invest in programs to support the growth of the next wave of successful and fast-growing companies. A number of BioHealth accelerator programs have been launched through regional partnerships, and their success has been due to leaders

Entrepreneurship

Inc. 5000 Companies

in industry, government, and higher education supporting the programs and the companeis taking part in them. Some of the BioHealth-focused support organizations include:

- The first focused Health Technology accelerator program in Baltimore, named DreamIt Health Baltimore, was established in 2013 in partnership with DreamIt Ventures. Since its opening, DreamIt Health Baltimore has completed two successful cohorts of 15 companies. Participating companes have joined DreamIt Health Baltimore from around the world and, in Baltimore, found customers and investors and piloted implementation projects. Many of the 15 companies to graduate from DreamIt Health Baltimore have found permanent office space in Baltimore following the completion of the accelerator program.
- The University of Maryland BioPark, operated by the University of Maryland, Baltimore, is home to a rapidly expanding community of life science companies and translational research centers.
- A partnership between BioHealth Innovation, Inc. and Montgomery Country has formed the Relevant Health accelerator program. This new venture is designed to provide an intensive focus on product development for a variety of health technology entrepreneurs.
- The University of Maryland, Baltimore County operates a nationally-recognized life sciences incubator that currently houses over 40 bioscience and technology companies. The Life Sciences Incubator@bwtech was founded in 1989 and has graduated over 50 companies, many of whom have found success operating in Greater Baltimore and Central Maryland.
- The Science + Technology Park at Johns Hopkins University has space for bioscience, medical device, and other emerging technology companies to build their products and new firms. Startups located in the Science + Technology Park have access to the Johns Hopkins Medical Campus and have increased opportunities to collaborate with the university.

Maintaining the success and growth of these tremendously important programs is vital to the health of the local BioHealth industry and the regional economy. The support provided by these accelerator and incubator programs helps young firms to establish themselves and grow into the next generation of fast-growing and industry-leading firms. Regional organizations supporting the accelerators and incubators in Greater Baltimore and Central Maryland are helping to provide the infrastructure necessary for entrepreneurship.

Capital Investment

Entrepreneurs often rely on outside investment to rapidly scale their businesses. Expanding production and iteration of software or of a medical device typically means expanding staff to manage the increasing demands of operating a young business.

Following the earliest stages of investment capital, businesses seek other forms of cash investment and means of expansion. As such, capital investment can take many forms. As a company grows, it may seek to acquire other firms in related fields to improve its core product or to expand into new product or geographic markets. More mature businesses may offer shares of the company for sale, allowing the public to bet on their success in exchange for more cash to expand in the short term.

Greater Baltimore and Central Maryland ranks sixth among peer BioHealth markets on measures that indicate the availability of risk capital. Boston and San Francisco, two markets widely renowned for their ability to fund new ventures, rank first and second, respectively. Raleigh-Durham and San Diego, both similar to Greater Baltimore and Central Maryland as leaders in BioHealth research, tie for third on this ranking of BioHealth Capital availability.

Entrepreneurs and support organizations in Greater Baltimore and Central Maryland readily recognize the need for an influx of risk capital for new businesses. That so many have expressed this is an important first step towards correcting the issue itself. Armed with the knowledge and demonstrated market need for additional funds, the region and State of Maryland are in a position to build frameworks for increased exposure to sources of capital and the opening of new channels for investment.

Availability of capital is important to the formation of companies as well as retaining them once they've reached a certain stage. Institutional investors often encourage or require companies accepting their funding relocate to be more easily accessed, or to have physical access to the investor's social capital. Bringing additional capital into the Greater Baltimore and Central Maryland region will make it easier for companies that recognize the value of the existing BioHealth network in Greater Baltimore and Central Maryland to remain in the region.

Capital Index

Rank	Region	Index
1	Boston	1.69
2	San Francisco	2.38
3	San Diego	3.77
4	Raleigh-Durham	4.30
5	New York	4.92
6	Baltimore/CMD	5.15
7	Philadelphia	6.08
8	Pittsburgh	7.70

The first infusion of capital into a business - often in the form of a Small Business Innovation Research award - may even be the hardest. Maryland companies were awarded NIH SBIR funding 14.6% of the time they applied for it in fiscal 2013, noticeably below the success rate for companies in Massachusetts and North Carolina. Much of this discrepancy appears in Phase I awards, where Maryland companies achieved an 11.2% success rate in application awards, indicating that while Maryland companies are equally as proficient in continuing commercially-relevant research and development, beginning the process on a relatively low budget seems to be a challenge.

The Maryland Biotechnology Center and the Biotechnology Investment Incentive Tax Credit are designed to provide direct funding or incentivize the funding of Maryland BioHealth companies, the latter of which has been used by 75 companies since its inception in 2007 to yeild $69 million in credits and $450 million in follow-on investment. Maryland TEDCO and the Maryland Venture Fund also provide direct funding to Maryland BioHealth cimpanies. These programs and others like them may not show up in this Capital Index, but are important to the companies that receive investment that might otherwise have been directed elsewhere.

Capital Investment

SBIR & STTR Awards

The Small Business Innovation Research (SBIR) program encourages domestic small businesses to engage in research and development that has the potential for commercialization. Eleven federal agencies administer SBIR grants, including the Department of Health and Human Services and the National Science Foundation.

The Small Business Technology Transfer (STTR) program is critical to bridging the gap between research and development and commercialization of resulting innovations. The STTR program expands public-private partnerships to include joint venture opportunities for small businesses and nonprofit research institutions, and aims to increase private sector commercialization of federal research and development. To be eligible for an STTR grant award, a small business must formally collaborate with a research institution.

Relevance

SBIR and STTR awards indicate a desire to engage in research and development and to commercialize the results when possible. Regions that lead in SBIR and STTR awards are those that have the knowledge base needed to formulate new ideas and the desire and ability to translate scientific findings into marketable products.

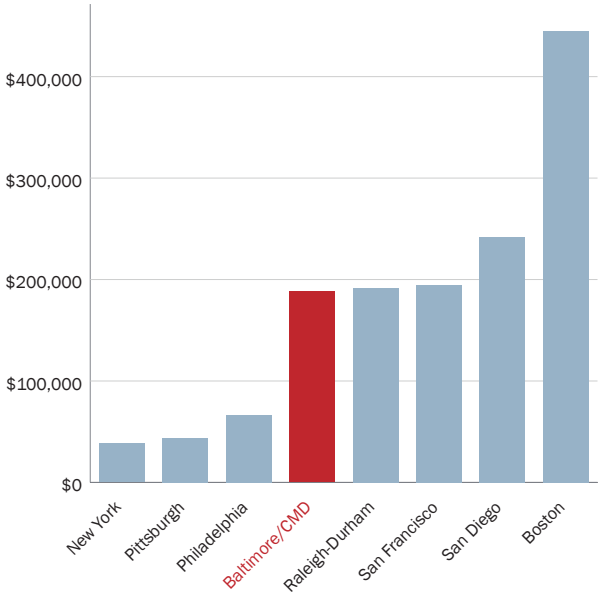
Results

Small businesses in Greater Baltimore and Central Maryland were awarded $92,579,675 via SBIR and STTR programs in 2013, ranking second among peer markets. The total number and value of SBIR and STTR awards to Greater Baltimore and Central Maryland has decreased in recent years. In 2010, Greater Baltimore and Central Maryland companies were awarded over $124 million through the SBIR program alone. As is the case in all peer markets, the total dollar amount awarded to Greater Baltimore and Central Maryland companies via the STTR program is very small compared to the amount awarded via SBIR.

Surprisingly, the largest markets are not necessarily natural leaders in SBIR and STTR funding. Rather than awards being more prominent in markets with a greater number of small businesses alone, most markets appear to capture similar funds. Boston is the only outlier in this case: in every year since 2009, small businesses in Boston have captured over $200 million in SBIR and STTR funding.

Comparing per capita SBIR and STTR funding is useful for stripping the effects of market size. Greater Baltimore and Central Maryland captured $18.82 of SBIR and STTR funding per capita, fifth among peer markets. Boston ranked first, capturing $44.52 of SBIR and STTR funding per capita.

SBIR and STTR Funding
per 10,000 Residents, 2013



EAGB BioHealth Innovation Source: Small Business Innovation Research Program

Boston is particularly dense with storied research universities and scientific research and development professionals, which may be the cause of its ability to capture so many SBIR and STTR awards total and on a per-capita basis.

Note that not all SBIR and STTR awards are won by small businesses researching or commercializing BioHealth technologies. This indicator of innovation measures a market's propensity to engage in market-relevant research and development generally.

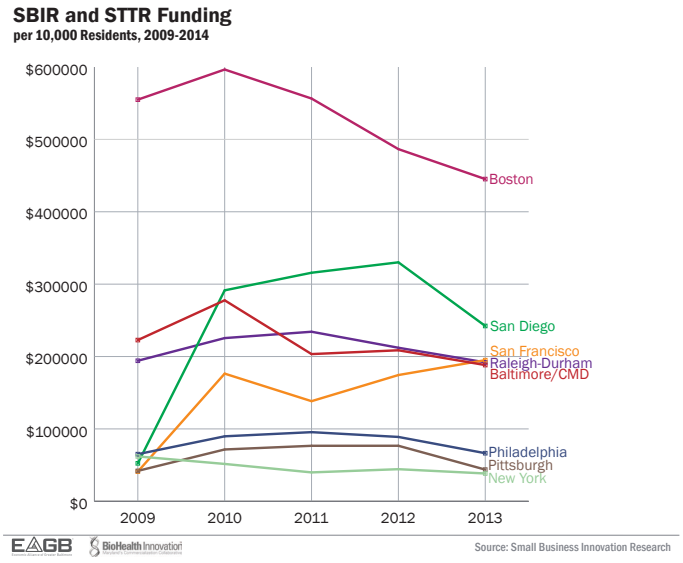
Innovation research funding for small businesses is steady in most peer markets. Only San Diego, Boston, and San Francisco have experienced a notable change in

Capital Investment

SBIR & STTR Awards

SBIR funding per 10,000 residents since 2009. Greater Baltimore and Central Maryland has experienced some fluctuation in SBIR funding over the last five years, and opportunity exists to improve the rate at which the region captures SBIR awards.

Save for Boston, the SBIR funding of most markets is tightly bunched, with the more prolific tier clustered around $200,000 in SBIR funding per 10,000 residents. While Greater Baltimore and Central Maryland ranks fifth in SBIR funding per 10,000 residents, it captures nearly the same amount as Raleigh-Durham and San Francisco, and is very near to the SBIR funding of San Diego.



Areas of Opportunity

Greater Baltimore and Central Maryland has been a prolific winner of SBIR and STTR awards, bringing in the second-most SBIR funding among peer markets and remaining competitive on a per-capita basis. Rather than a focus on increasing SBIR funding, Greater Baltimore and Central Maryland should turn its attention to ensuring that the businesses that earn SBIR awards have enough funding from other sources to continue their work. Because BioHealth is an expensive field in which to operate and the winners of SBIR awards are by definition small businesses, it is often the case that the young SBIR award winners are unable to sustain themselves past the federal SBIR allocation. A matching grant program is the fastest way to ease the search for capital among young SBIR winners, and improving the region's connectivity to investment capital can help SBIR winners find more funding rapidly.

Professional support for SBIR awards may also help small businesses to earn the early capital necessary for research and development. Fortunately, organizations focused on the health of the regional BioHealth industry are already providing such services. BioHealth Innovation, Inc. offers a unique federal funding program known as the Commercial Relevance Program. This program offers BioHealth companies support in preparing applications for federal funding, including SBIRs and STTRs. Companies are afforded feedback before submitting their official proposal to better tailor their applications and improve the likelihood of federal funding.

Promoting the small businesses earning SBIR and STTR awards locally and to investment opportunities nationally may help raise the profile both of the companies that earn SBIR grants and Greater Baltimore and Central Maryland as a region that fosters commercially-relevant research.

Capital Investment

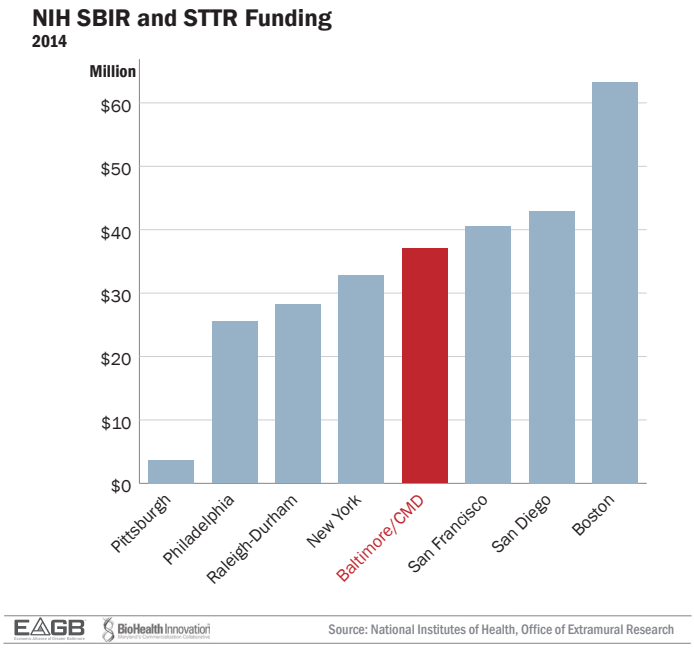
NIH SBIR & STTR Awards

Under the US Department of Health and Human Services, the National Institutes of Health (NIH) awards SBIR and STTR grants to small businesses seeking to commercialize biomedical technologies.

Relevance

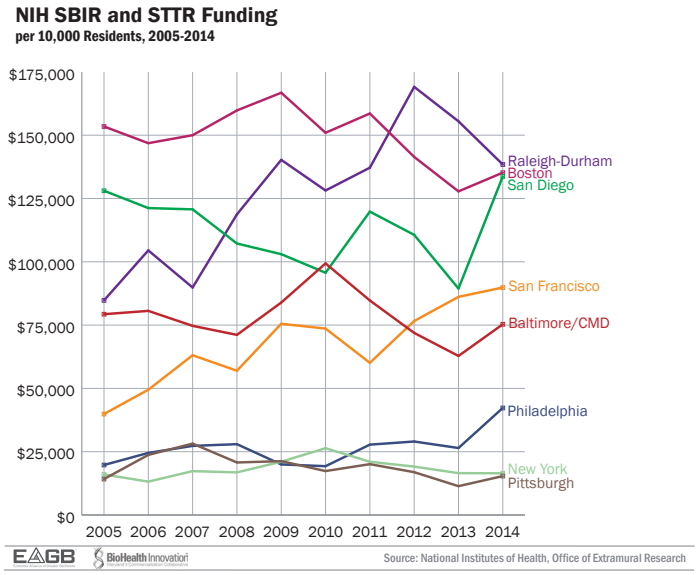
As such, NIH SBIR and STTR awards can be used to measure a market's propensity to engage in market-relevant research and to commercialize innovations in the BioHealth space.

Results



In 2014, over $37 million was awarded to Greater Baltimore and Central Maryland small businesses via the NIH SBIR and STTR programs. Greater Baltimore and Central Maryland ranked fourth among peer markets in total NIH SBIR and STTR funding captured, while Boston again ranked first.

Greater Baltimore and Central Maryland companies captured $75,321 of NIH SBIR and STTR funding per 10,000 residents, ranking fifth among peer markets. Raleigh-Durham, home to Research Triangle Park, ranked first and captured $138,419 of NIH SBIR and STTR funding per 10,000 residents. Boston ranked second, capturing $135,205 of NIH SBIR and STTR funding per 10,000 residents.



NIH SBIR and STTR funding per 10,000 residents in Greater Baltimore and Central Maryland has remained steady since 2003. NIH SBIR and STTR funding per 10,000 residents in Boston has decreased in recent years, while the same in Raleigh-Durham has increased rapidly over the last decade.

Notably, the top three regions for NIH SBIR and STTR award funding per 10,000 residents are tightly bunched together, while other peer regions fall far behind. Greater Baltimore and Central Maryland companies have a significant amount of ground to make up in order to reach a level of NIH SBIR and STTR funding per 10,000 residents that is competitive with the top three markets.

Capital Investment

Venture Capital Investment

Venture capital investors are free to engage with companies at any stage, from the youngest of companies to businesses in an expansion and later stages. However, the traditional VC model is to operate a diversified portfolio to generate a return for investors in their funds. Bringing a venture capital investor into a young firm also gives the company an advisor with experience and a wealth of contacts to help navigate the difficult early stages of startup growth.

Understanding the measure of capital investment in a region serves a dual purpose. First, it describes the belief in market relevance and likelihood of success of companies recently formed and growing in a given region. Second, it describes a willingness of investors to consider researching and investing in that region. Markets without the reputation, investment history, or willing investor population must create innovative ways to attract venture capital.

For entrepreneurs, venture capitalists are a vital source of financing, but the cash infusion often comes at a high price. Venture firms often take large equity positions in exchange for funding and may also require representation on the start-up's board.

The chart on the following page depicts the capital sources available by investment stage from academic research through the translational and proof concept stages, into relevance and pre-seed stages to the start attracting seed and early stage funding. Central Maryland has funding programs to help bridge technologies into functioning companies through a variety of non-dilutive federal and state sources, convertible debt from TEDCO, and state-backed equity capital like the Maryland Venture Fund.

To address the low level of venture funding in the State, Maryland has instituted a number of investment programs designed to ease the capital needs of young businesses in Maryland.

Venture capital investment is one of the most widely sought forms of investment capital. Venture capital investors are free to engage with companies at any stage, from the youngest of companies to businesses in a expansion and later stages. Bringing a venture capital investor into a young firm also gives the company an advisor with experience and a wealth of contacts to help navigate the difficult early stages of startup growth.

The amount of venture capital invested in a region is recorded every quarter; this analysis uses the five previous complete years of information to benchmark peer markets. By doing so, one particularly strong or unusually weak year, often the result of one massive deal, for risk capital capture is not enough to affect the overall understanding of a market's ability to generate interest and receive funding from investors.

This report creates a composite BioHealth industry using the Biotechnology, Healthcare Services, and Medical Devices and Equipment investment industries.

Data is available for states and large regions rather than the metropolitan statistical areas used elsewhere in this report. Instead, the smallest region that can be used to represent each BioHealth market for which data is available is used as a proxy. This is unlikely to cause significant issues, as it is expected that the dense metropolitan region would be the primary location in its home state to capture significant risk capital. Appendix C details how available state and region data was used to represent peer BioHealth markets by proxy.

Relevance

The total dollar amount invested in a market over the previous five years is indicative of the overall quality of companies existing in that market and the quantity of investment-worthy companies. The average amount invested per deal in a market measures average quality of a company born in a region.

Regions may differ in their venture capital capture for many reasons aside from company quality and quantity. Investors may be more willing to invest in markets with a handful of high-profile successes, or in markets where a support network exists for companies in certain fields. There may also be a plainly geographic component to investment: it's easier for investors to uncover, research, and advise companies that exist nearby rather than across the country. For some investors, this may mean requesting companies in their portfolio to relocate. For others, this may mean simply being unaware of opportunities elsewhere in the country, or unwilling to take on risk

Capital Investment

Venture Capital Investment

BioHealth Innovation℠
Maryland's Commercialization Collaborative

Capital Sources by Investment Stage

Pre-Proof of Concept	Translational Research/ Proof of Concept	Proof of Commercial Relevance/Pre-Seed	Seed/ Start-Up	Early Stage	Later Stage
$25,000 - $1,500,000 (over 5 yrs)	$15,000 - $750,000 (over 3 yrs)	$15,000 - $1,500,000	$50,000 - $1,500,000	$200,000 - $2,000,000	$2,500,000+
NIH R01	SBIR/STTR Federal Funding Assistance Program	Maryland Industrial Partnerships (MIPS @ UMD)	Dingman Center Angels (UMD)	Propel Baltimore Fund	Maryland Venture Fund Authority
NIH R03	SBIR/STTR Phase 1	TEDCO Maryland Innovation Initiative - Phase 2	BioMaryland Biotechnology Dev. Award - Translational Research	TEDCO Veterans' Opportunity Fund	Private venture funds
NIH R21	NCATS Cures Acceleration Network (CAN)	Maryland Stem Cell Research Fund (MSCRF) - Pre-Clinical	TEDCO Patent Assistance Program	Invest Maryland: Maryland Venture Fund	
Maryland Stem Cell Research Fund (MSCRF) - Various	Maryland Stem Cell Research Fund (MSCRF) - Various	TEDCO Technology Validation Program - Market Assessment	TEDCO Technology Commercialization Fund	BioMaryland Biotechnology Dev. Award - Commercialization	
	TEDCO Technology Validation Program - Proof of Concept	SBIR/STTR Phase 2	TEDCO Maryland Innovation Initiative - Phase 3	Abell Venture Fund	
	TEDCO Maryland Innovation Initiative - Phase 1		SBIR/STTR Phase 2	Private venture funds	
	JHU - Coulter Translational Research Partnership		BioHealth Gap Fund	BioHealth Gap Fund	

Funding Type Key

- Academic
- State of Maryland
- BioHealth Innovation, Inc.
- Federal
- Economic Development
- Private Capital

Tax Credits

- Maryland Biotechnology Investor Tax Credit
- Montgomery County Biotechnology Investor Tax Credit

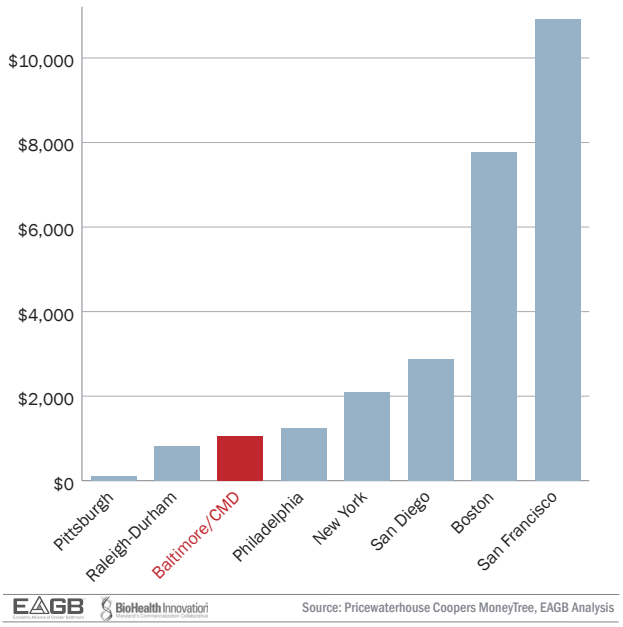
without an ability to regularly engage with the company's management.

Results

Greater Baltimore and Central Maryland companies captured $1.06 billion in venture investment in the BioHealth industry between 2010 and 2014, the sixth-greatest among peer BioHealth markets. San Francisco led peer markets, capturing $10.9 billion over the same time frame. Boston, already identified as a hub of BioHealth research and commercialization, ranks second, capturing $7.8 billion in risk capital.

Boston leads all peer BioHealth markets in dollars invested per deal, with the average BioHealth company receiving $11.8 million per venture capital deal between 2010 and 2014. San Francisco ranked second, with companies earning $11.7 million per deal. These two markets were not just the distant leaders in total dollars invested, but also in number of deals, and average deal size. Boston and San Francisco are, for reasons of both company

Total Venture Capital Investment in BioHealth
in Millions of Dollars, 2010-2014



EAGB BioHealth Innovation Source: Pricewaterhouse Coopers MoneyTree, EAGB Analysis

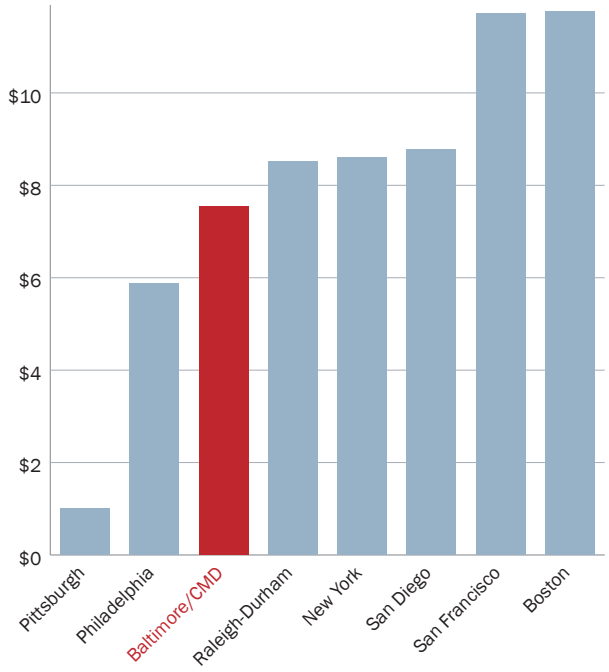
Capital Investment

Venture Capital Investment

quality and otherwise, the two best places in the US to receive BioHealth risk capital.

Greater Baltimore and Central Maryland rank sixth among peer markets in average deal size, with companies in the region capturing $7.5 million per deal. This figure is similar to that of Raleigh-Durham, San Diego, and New York, indicating that while Greater Baltimore and Central Maryland may not have the readily available investment capital of San Francisco and Boston, there is venture capital available for worthy companies.

Average Venture Capital Deal Size in BioHealth
in Millions of Dollars, 2010-2014



EAGB BioHealth Innovation — Source: Pricewaterhouse Coopers MoneyTree, EAGB Analysis

Total BioHealth investment in Greater Baltimore and Central Maryland has been built largely on the strength of the region's Biotechnology industry.

Save for a 2014 that saw relatively little Biotechnology investment, the Biotechnology industry in Greater Baltimore has consistently captured a great deal more risk capital than other BioHealth industries. This is typical of other markets as well; Boston's Biotechnology industry consistently captures over $1 billion in risk capital while its Medical Device and Equipment industry captures $300 million.

Areas of Opportunity

For Greater Baltimore and Central Maryland to improve on its venture capital capture, more and higher-quality companies must first be produced. It's no surprise that the regions earning the greatest amount of venture capital are also those whose universities produce the most startups.

Next, additional information from investors themselves must be sought. Greater Baltimore and Central Maryland has the institutional might to support new BioHealth companies and has produced celebrated BioHealth firms. Greater Baltimore and Central Maryland should learn from investors how best to approach and engage new potential investors and work quickly to tailor both company and regional outreach to financial partners.

The region currently produces great science and strong business management, and is home to some of the country's oldest and largest venture capital firms, many of which have a history of making significant investments in the local BioHealth industry. By taking advantage of these assets, the Greater Baltimore and Central Maryland region can begin to improve upon its current state of relative lack of financing opportunity.

Finally, it's important for Greater Baltimore and Central Maryland to stay the course. Medical device and equipment manufacturing appears to be growing into a popular investment sector. Fortunately, the region is already very strong in this field, and has tremendous opportunity to combine strengths in advanced manufacturing, including additive manufacturing, and BioHealth to become a hub for the growing investment space.

Capital Investment

Venture Capital Investment

Risk capital is arguably at its most effective in the earliest stages of a company's formation. BioHealth, an industry in which products face a considerably longer timeline and greater costs to reach consumers than in other high-tech industries, is particularly dependent on early capital. An early infusion of risk capital can be the difference between the survival and the death of a startup firm. SBIRs are wonderful resources, but cannot be the only source of early capital; competition and the timeline for application and funding can stifle the growth of a promosing young firm.

Private investment from outside the firm can help a new company make it through what is known as the Valley of Death, when clinical and regulatory trials that must be completed is tremendously expensive and time consuming.

Relevance

Measuring risk capital investment in seed and early stage companies provides a sense of how readily funding is available to the youngest of companies.

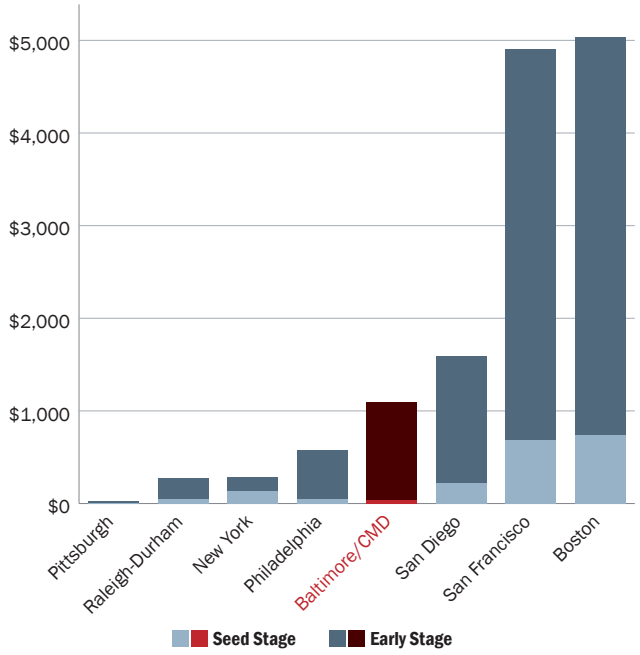
Results

Greater Baltimore and Central Maryland companies capture less early risk capital than those in San Francisco and Boston, but those markets are outliers in both BioHealth and total venture capital investment. The Greater Baltimore and Central Maryland region ranks fourth among peer markets and is more similar to San Diego and Philadelphia in total amount invested in BioHealth companies. The amount of early stage capital was invested in BioHealth Companies in Greater Baltimore and Central Maryland between 2010 and 2014 was very similar to that in San Diego.

There is, however, very little seed stage investment taking place in Greater Baltimore and Central Maryland's BioHealth community. The total amount of seed capital invested into the Greater Baltimore and Central Maryland region between 2010 and 2014 ranks seventh among peer markets, ahead of only Pittsburgh.

The average size of early stage investment deals in Greater Baltimore is $7.5 million, matching the average deal size for all stages. This ranks fifth among peer markets. Boston and San Francisco again rank first and second overall. The average early investment deal size in Greater Baltimore and Central Maryland is similar to that in Raleigh-Durham and Philadelphia.

Seed and Early Stage
Venture Capital Investment in BioHealth
in Millions of Dollars, 2010-2014



EAGB BioHealth Innovation Source: Pricewaterhouse Coopers MoneyTree, EAGB Analysis

Areas of Opportunity

Steps must be taken to ensure that investors are aware of the opportunities that exist in Greater Baltimore and Central Maryland. Introducing investors to the startups produced or operating at Greater Baltimore and Central Maryland universities, hospitals, and incubators via showcases or tours may be a way to build interest and a reputation as a center of new business activity and growth.

Offering financial incentives may also be a means to attract investment. Programs offering matching investment or tax incentives to financiers could make Greater Baltimore and Central Maryland, and the State of Maryland generally, more attractive to venture capitalists.

Capital Investment

Initial Public Offerings

In 2012 and 2013, there were 362 initial public offerings (IPO) by United States firms whose shares were traded on the New York Stock Exchange or the NASDAQ Stock Market. IPOs are designed to raise inexpensive capital for firms looking to expand, and come with increased exposure and prestige both for the company and the market in which it was established.

Relevance

Tracking IPOs over the previous two years for which data is available gives a sense of how many firms in a market reach a mature stage. Companies that reach IPOs generally have track records of success and have been in existence for years. The total number of IPOs in each BioHealth market in 2012 and 2013 indicates the general strength of later-stage companies in each market, while the number of BioHealth IPOs indicates the ability of BioHealth companies to mature in each market. As with other indicators, both total and per capita IPO data is used to accurately measure total and population size-independent firm growth.

Additionally, market capitalization on the first day of trading, or the total value of all outstanding shares of a company, is used to measure the quality of firms becoming publicly available in each market.

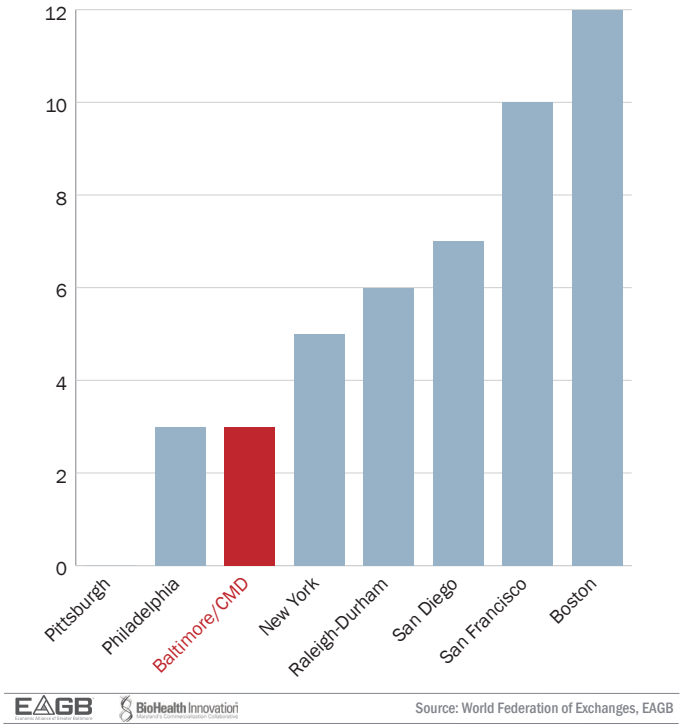
Results

In 2012 and 2013, just 68 BioHealth companies in the US held IPOs, with 46 of those companies in peer BioHealth markets; 68 percent of BioHealth company IPOs in the last two years have come from markets identified in this report as BioHealth leaders.

New York, home to both the New York Stock Exchange and the NASDAQ, led peer markets with 46 total IPOs in 2012 and 2013. Greater Baltimore and Central Maryland and San Diego ranked sixth among peer markets with 8 IPOs over the last two years. San Francisco and Boston, leaders in venture capital and startup rates, ranked second and third, respectively.

Many of the IPOs in New York were by trusts, funds, and advisory companies rather than BioHealth Firms; only five of New York's 46 IPOs were by BioHealth Firms. Boston led peer markets with 12 BioHealth company IPOs, nearly half of all IPOs by Boston firms, over the last two years. Greater Baltimore and Central Maryland and Philadelphia ranked sixth among peer markets with three BioHealth IPOs in the last two years. San Diego had a greater percentage of its IPOs conducted by BioHealth firms than any other peer market: seven of San Diego's eight IPOs were by BioHealth firms.

Initial Public Offerings by BioHealth Companies
2012-2013



San Francisco leads peer markets in IPOs per capita, with 0.080 IPOs conducted in 2012 and 2013 per 10,000 residents. Boston and Raleigh-Durham rank second and third, respectively, for IPOs per 10,000 residents. Greater Baltimore and Central Maryland rank last among peer markets for total IPOs per capita, with 0.016 IPOs per 10,000 residents over the last two years.

Raleigh-Durham, home to Research Triangle Park, leads peer markets with 0.029 BioHealth IPOs per 10,000 residents, a more efficient rate than Greater Baltimore and Central Maryland manages for IPOs in all fields. Boston ranks second among peer markets for BioHealth IPOs per

Capital Investment

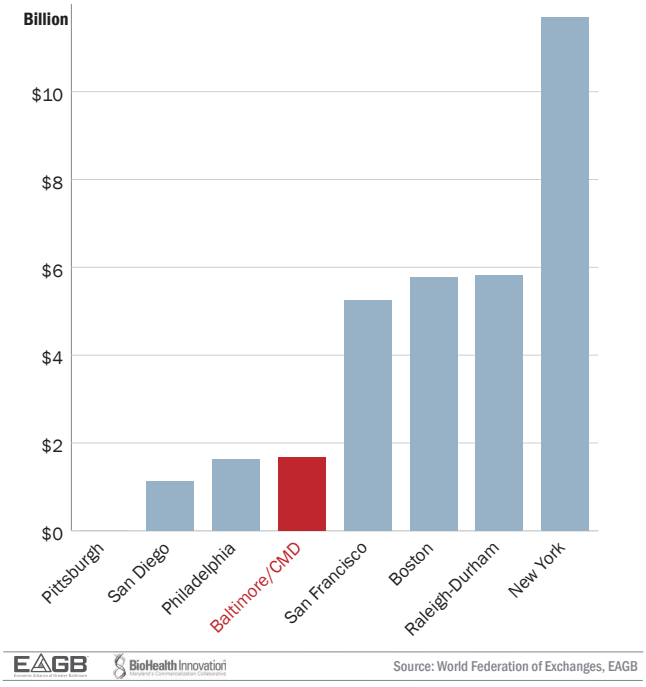
Initial Public Offerings

capita, generating 0.026 BioHealth IPOs per Capita.

Greater Baltimore and Central Maryland rank fifth among peer markets for BioHealth IPOs per 10,000 residents, ahead of New York and Philadelphia. Greater Baltimore and Central Maryland produced 0.006 BioHealth IPOs per capita in 2012 and 2013.

By market capitalization, New York's BioHealth IPOs have been the most lucrative, as the five BioHealth firms to go public have been worth a collective $11.7 billion. This is largely built on the tremendous market capitalization of one pharmaceutical company that was valued at over $10 billion at the time of IPO.

Market Capitalization on 1st Day of Trading in Initial Public Offerings of BioHealth Companies
2012-2013



Raleigh Durham and Boston rank second and third, respectively, in market capitalization of recent BioHealth IPOs. BioHealth firms to go public based in Raleigh-Durham have been worth $5.8 billion at the time of IPO, while those from Boston have been worth $5.7 billion.

Greater Baltimore and Central Maryland rank fifth in market capitalization of BioHealth IPOs, with the three companies to hold such IPOs from 2012 and 2013 being worth $1.6 billion at the time shares were made available to the public.

Areas of Opportunity

The discrepancy between Greater Baltimore and Central Maryland's rate of business IPOs and that of markets like Raleigh-Durham, Boston, and San Francisco is likely rooted in its relatively slow rate of company formation. It should be expected that regions with a greater rate of startup formation see a greater rate of business IPO - there are simply more growing companies each year reaching the stage at which company leadership and investors might consider an IPO. To increase the region's number and rate of overall and BioHealth IPOs, there simply need to be more firms being formed each year.

The most lucrative IPOs in most peer markets have come from pharmaceutical companies. Medical devices are a rapidly emerging market, and capital may shift from the Biotechnology industry and towards Medical Devices and Equipment.

Appendix A

Baltimore-Washington CSA Comparison

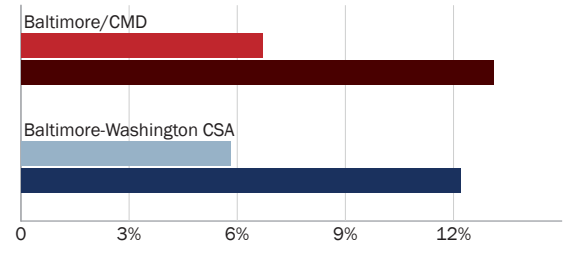
The Baltimore-Washington Combined Statistical Area (CSA) represents an expanded commuting region that stretches from Northern Virginia and Washington, DC through Greater Baltimore and Central Maryland. The Baltimore-Washington CSA is the fourth largest such region, with roughly one million more residents than the San Francisco-San Jose CSA, known commonly as Silicon Valley.

While the majority of this report focuses on the Greater Baltimore and Central Maryland region, BioHealth companies located anywhere in the Baltimore-Washington Corridor have access to this expanded labor force, network, and consumer market. It is therefore important to relate the same information regarding BioHealth capacities for the Baltimore-Washington CSA in comparison to the Greater Baltimore and Central Maryland region.

Talent

The Baltimore-Washington Corridor is home to 573,699 BioHealth professionals, or nearly 300,000 more than Greater Baltimore and Central Maryland. This is expected due to the significant increase in population, and the CSA's labor market is no more densely concentrated than that of Greater Baltimore and Central Maryland. The CSA is home to 18.5% more BioHealth professionals than would be suggested by the national average, while the Greater Baltimore and Central Maryland region is 18.7% more concentrated than average.

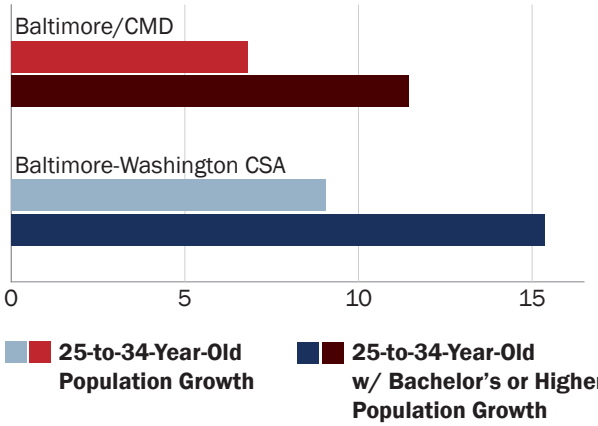
BioHealth Labor Force Density
As a Percentage of All Degree Holders, Aged 25+, 2013



EAGB BioHealth Innovation Source: American Community Survey, US Census Bureau

There are an estimated 165,104 CSA residents with Biological, Agricultural, and Environmental Science degrees. A total of 346,036 BioHealth degree holders live in the Baltimore-Washington corridor, including those holding Computers, Mathematics, and Statistics degrees. The Greater Baltimore and Central Maryland region is home to 94,151 people with degrees in scientific fields and a total of 182,259 people with science and technology degrees relevant to BioHealth. The density of residents holding those degrees is very similar between the CSA and the Greater Baltimore and Central Maryland region: 12.2% of CSA residents and 13.1% of Greater Baltimore and Central Maryland residents hold BioHealth degrees.

Millennial Population Growth
2009-2013



EAGB BioHealth Innovation Source: US Census Bureau

The Baltimore-Washington corridor is a popular place among well-educated adults as well as young professionals. Over 42% of Baltimore-Washington CSA residents hold at least a Bachelor's degree, and 19.8% hold a graduate or professional degree. In Greater Baltimore and Central Maryland, 39% of residents hold at least a four-year degree, and 18% of residents have earned a graduate or professional degree.

The CSA has realized over 11% growth in the population of 25-to-34-year-olds, and over 15% growth in the population of 25-to-34-year-olds with four-year college degrees. Greater Baltimore and Central Maryland have experienced

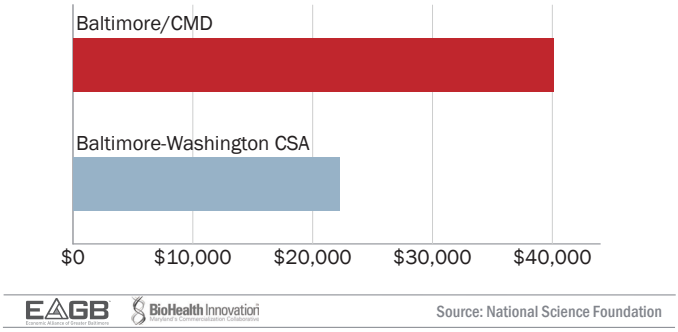
Appendix A

Baltimore-Washington CSA Comparison

6.8% growth in the population of 25-to-34-year-olds and just over 9% growth among college-educated residents of the same age.

Research and Development

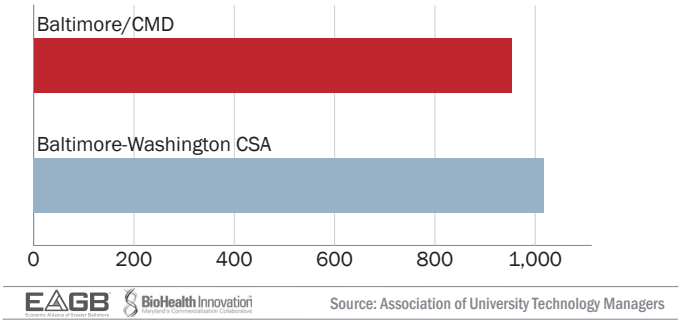
BioHealth Research and Development Expenditures
per Graduate Student at Universities, 2013



Universities in the Baltimore-Washington corridor spent just over $2.0 billion on research and development in BioHealth fields in 2013. Much of that expenditure was by institutions in Greater Baltimore and Central Maryland, where universities spent $1.7 billion on BioHealth research and development. With much of the corridor's higher education research and development localized in Greater Baltimore and Central Maryland, it's not surprising to find that universities throughout the CSA spent less on research and development per graduate student than those strictly in Greater Baltimore and Central Maryland. Universities in Baltimore-Washington corridor spent an average of over $22,000 on BioHealth research and development per graduate student, and universities in Greater Baltimore and Central Maryland spent over $40,000 on the same.

Because many of the universities in the Baltimore-Washington corridor are located in Greater Baltimore and Central Maryland, technology transfer in the CSA is largely the result of activity in the Greater Baltimore and Central Maryland region. In fiscal 2013, researchers at universities in the CSA filed 1,018 invention disclosures. In Greater Baltimore and Central Maryland, 953 invention disclosures were filed during the same time. The CSA saw 182 patents issued and 27 startups generated, while Greater Baltimore and Central Maryland universities earned 162 patents and launched 26 startups. License income at universities is not as concentrated in Greater Baltimore and Central Maryland: universities in the CSA received nearly $29 million in license income, while those in Greater Baltimore received nearly $20 million.

Invention Disclosures
at Universities, 2013



Universities in Greater Baltimore and Central Maryland are roughly as efficient in generating invention disclosures, patents, and startups as universities in the CSA. The difference between generating one invention disclosure in each market is only a $100,000, for instance.

The Greater Baltimore and Central Maryland region was awarded 8.64 utility patents per 10,000 employees in 2011. The more populated CSA was awarded 1.80 patents per 10,000 employees, implying that much of the corridor's patent activity takes place in the Greater Baltimore and Central Maryland region.

Entrepreneurship

Universities in the Baltimore-Washington corridor earned nearly $1 in license income per $100 spent on sponsored research. This is almost twice what universities in Greater Baltimore and Central Maryland earn, indicating a greater ability of universities in Washington, DC to earn income via research commercialization, as Northern Virginia is not home to any universities.

Universities in the CSA launched 27 startups in fiscal 2013, just one more than the Greater Baltimore and Central Maryland region.

The Baltimore-Washington corridor is home to 106 Health and IT Services companies on the Inc. 5000, with 36 of

Appendix A

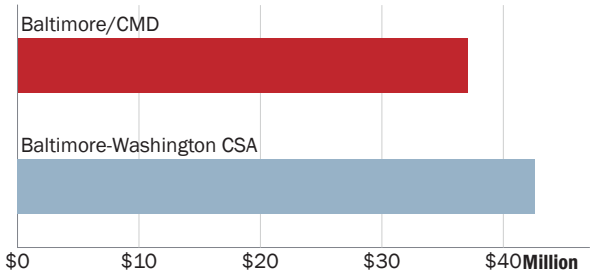
Baltimore-Washington CSA Comparison

those firms located in Greater Baltimore and Central Maryland. There are 0.11 fast-growing BioHealth firms per 10,000 residents in the CSA and just 0.07 of the same per 10,000 residents in the Greater Baltimore and Central Maryland region.

Capital

In 2013, Greater Baltimore and Central Maryland received over $92 million in SBIR and STTR awards. This region accounted for over 50% of SBIR and STTR funding in the CSA, which received over $169 million in 2013 alone. As with many other measured indicators, the large population of the Baltimore-Washington corridor adversely affected the region's SBIR award density. The CSA received $179,600 in SBIR awards per 10,000 residents, while the Greater Baltimore and Central Maryland market received $188,200 in SBIR awards per 10,000 residents.

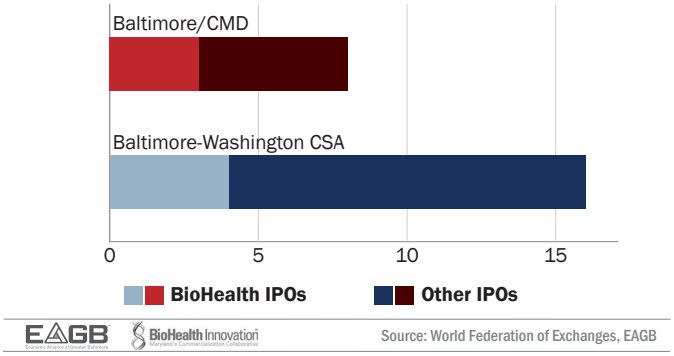
NIH SBIR and STTR Funding
2014



In 2014, the Baltimore-Washington Corridor captured $42 million in SBIR and STTR awards from the NIH, funding that will go directly to BioHealth research. This total was similar to that of San Diego, San Francisco, and the Greater Baltimore and Central Maryland region. As with university BioHealth research and development, BioHealth research by small businesses in the CSA is heavily concentrated in the Maryland portion of the corridor. The Greater Baltimore and Central Maryland region earned $37 million of SBIR awards from the NIH in 2014. On a per-capita basis, the CSA earned much less funding from NIH SBIR awards than the Greater Baltimore and Central Maryland region: businesses in the Baltimore-Washington Corridor were awarded $45,000 per 10,000 CSA residents in 2014, while those in Greater Baltimore and Central Maryland were awarded $75,000 per 10,000 residents.

The Baltimore-Washington Corridor captured $6.7 billion in venture capital to the BioHealth industry between 2010 and 2014. During the same time period, the Greater Baltimore and Central Maryland region captured $3.4 billion in BioHealth investment capital. The discrepancy between the two stems largely from the number of deals occurring in the CSA but outside of Maryland: the average BioHealth venture capital deal in Greater Baltimore and Central Maryland region was worth $6.4 million, whereas the same in the greater CSA was worth $6.3 million.

Initial Public Offerings
2012 and 2013



The CSA captured just $3.7 million in early and seed stage investment in BioHealth industries, while companies in the Greater Baltimore and Central Maryland region captured $7 million in early and seed stage investment.

Sixteen companies in the Baltimore-Washington corridor held IPOs in 2012 and 2013, but just 4 of those are BioHealth companies. 3 of those BioHealth IPOs were by Greater Baltimore and Central Maryland companies. The Greater Baltimore and Central Maryland region saw 8 IPOs total in 2012 and 2013. Market capitalization on the first day of trading by BioHealth companies in the CSA totaled over $3 billion, while the same in the Greater Baltimore and Central Maryland region totaled over $1.6 billion with only one fewer IPO.

Updated Genealogies of Central Maryland BioHealth Ecosystems and Companies

A Report to the

Economic Alliance of Greater Baltimore and

BioHealth Innovation

MRBS LLC
2015

Maryland's BioHealth industry has a rich and diverse history, which has positioned it as a leading industry cluster to build and grow successful enterprises.

The genealogies of Maryland technology companies are intertwined stories of entrepreneurs, technologies, and corporate dynamics. This update describes firms that have emerged out of the State's own unparalleled set of research institutions or their founders' own ingenuity, have grown or shrunk, moved out of or into the State of Maryland, or merged or spun off other firms. It clearly illustrates the successive generations of technology development in core fields like vaccines, genomics, medical devices, and the productive integration of information technologies and engineering into bioresearch, medicine, and health care.

- The number of BioHealth companies in Maryland has grown.
- There are more big companies today and the good news is that acquisitions of the largest two, MedImmune (Astra Zeneca) and Human Genome Sciences (GlaxoSmithKline), led to increased investment in the state.
- Maryland now has the cadre of experienced entrepreneurs and managers it lacked in the early part of the decade. They not only continue to innovate and, in many cases, create new businesses, but also provide a valuable source of business, science, and commercialization expertise for young companies that have followed them.

View the full report at www.greaterbaltimore.org or www.biohealthinnovation.org

Appendix C

BioHealth Industry Delineation

NAICS Definitions from County Business Patterns

The Economic Alliance of Greater Baltimore defines the BioHealth cluster as the following industries, listed below with the NAICS code and official US Census definition of each:

Pharmaceutical and Medicine Manufacturing (3254): This industry comprises establishments primarily engaged in one or more of the following: (1) manufacturing biological and medicinal products; (2) processing (i.e., grading, grinding, and milling) botanical drugs and herbs; (3) isolating active medicinal principals from botanical drugs and herbs; and (4) manufacturing pharmaceutical products intended for internal and external consumption in such forms as ampoules, tablets, capsules, vials, ointments, powders, solutions, and suspensions.

Medical Equipment and Supplies Manufacturing (3391): This industry comprises establishments primarily engaged in manufacturing medical equipment and supplies. Examples of products made by these establishments are surgical and medical instruments, surgical appliances and supplies, dental equipment and supplies, orthodontic goods, ophthalmic goods, dentures, and orthodontic appliances.

Testing Laboratories (54138): This industry comprises establishments primarily engaged in performing physical, chemical, and other analytical testing services, such as acoustics or vibration testing, assaying, biological testing (except medical and veterinary), calibration testing, electrical and electronic testing, geotechnical testing, mechanical testing, nondestructive testing, or thermal testing. The testing may occur in a laboratory or on-site.

Custom Computer Programming Services (541511): This U.S. industry comprises establishments primarily engaged in writing, modifying, testing, and supporting software to meet the needs of a particular customer.

Computer Systems Design Services (541512): This U.S. industry comprises establishments primarily engaged in planning and designing computer systems that integrate computer hardware, software, and communication technologies.

Scientific Research and Development Services (5417): This industry group comprises establishments engaged in conducting original investigation undertaken on a systematic basis to gain new knowledge (research) and/or the application of research findings or other scientific knowledge for the creation of new or significantly improved products or processes (experimental development). The industries within this industry group are defined on the basis of the domain of research; that is, on the scientific expertise of the establishment.

Ambulatory Health Care Services (621): Industries in the Ambulatory Health Care Services subsector provide health care services directly or indirectly to ambulatory patients and do not usually provide inpatient services. Health practitioners in this subsector provide outpatient services, with the facilities and equipment not usually being the most significant part of the production process.

Hospitals (622): Industries in the Hospitals subsector provide medical, diagnostic, and treatment services that include physician, nursing, and other health services to inpatients and the specialized accommodation services required by inpatients. Hospitals may also provide outpatient services as a secondary activity. Establishments in the Hospitals subsector provide inpatient health services, many of which can only be provided using the specialized facilities and equipment that form a significant and integral part of the production process.

Appendix D

Venture Capital Regions and Industries

Regional Definitions from Pricewaterhouse Coopers

The Economic Alliance of Greater Baltimore uses general investment regions to determine venture capital investment in BioHealth industries. The names and official Pricewaterhouse Coopers definitions of the regions used are listed below:

Maryland (Greater Baltimore and Central Maryland): The state of Maryland

Massachusetts (Boston): The state of Massachusetts

New York Metro (New York): Metropolitan New York area, northern New Jersey, and Fairfield County, Connecticut

North Carolina (Raleigh-Durham): The state of North Carolina

Philadelphia Metro (Philadelphia): Eastern Pennsylvania, southern New Jersey, and Delaware

San Diego (San Diego): San Diego area

Silicon Valley (San Francisco): Northern California, bay area, and coastline

Investment in the Pittsburgh market was calculated by EAGB by subtracting investment in the Philadelphia Metro region from investment in the state of Pennsylvania. In rare cases, investment in Philadelphia Metro region exceeded that of Pennsylvania. In those instances, it was assumed that there was no investment in Pittsburgh.

Industry Definitions from Pricewaterhouse Coopers

The Economic Alliance of Greater Baltimore uses select investment industries to define venture capital investment in BioHealth industries. The names and official Pricewaterhouse Coopers definitions of the industries used are listed below:

Biotechnology: Developers of technology promoting drug development, disease treatment, and a deeper understanding of living organisms. Includes human, animal, and industrial biotechnology products and services. Also included are biosensors, biotechnology equipment, and pharmaceuticals.

Healthcare Services: Includes both in-patient and out-patient facilities as well as health insurers. Included are hospitals, clinics, nursing facilities, managed care organizations, Physician Practice Management Companies, child care and emergency care.

Medical Devices and Equipment: Manufactures and/or sells medical instruments and devices including medical diagnostic equipment (e.g., X-ray, CAT scan and MRI), medical therapeutic devices (drug delivery, surgical instruments, pacemakers, artificial organs), and other health related products such as medical monitoring equipment, handicap aids, reading glasses and contact lenses.

Appendix E

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