Appendix C:
Independent Reports and Documents

C-2

OFFICE OF PERFORMANCE MANAGEMENT & OVERSIGHT FISCAL 2012 ANNUAL REPORT

The Office of Performance Management & Oversight (OPMO) measures the performance of all public and quasi-public entities engaged in economic development. All agencies are required to submit an Annual Report. The annual reports of each agency will be published on the official website of the Commonwealth, and be electronically submitted to the clerks of the senate and house of representatives, the chairs of the house and senate committees on ways and means and the house and senate chairs of the joint committee on economic development and emerging technologies.

1) AGENCY INFORMATION

Agency Name	Massachusetts Life Sciences Center		
Agency Head	Susan Windham-Bannister, Ph.D.	**Title**	President & CEO
Website	www.masslifesciences.com		
Address	1000 Winter Street, Suite 2900, Waltham, MA 02451		

2) MISSION STATEMENT

Please include the Mission Statement for your organization below.

The Massachusetts Life Sciences Center (MLSC) is a quasi-public agency of the Commonwealth of Massachusetts tasked with implementing the Massachusetts Life Sciences Act, a ten-year, $1 billion initiative that was signed into law in June of 2008. The Center's mission is to create jobs in the life sciences and support vital scientific research that will improve the human condition. This work includes making financial investments in public and private institutions that are advancing life sciences research, development and commercialization as well as building ties among sectors of the Massachusetts life sciences community.

3) OPERATIONS AND ACCOMPLISHMENT DETAILS

Please provide details on the agency's operations and accomplishments for Fiscal Year 2012 as **Attachment A.** Questions 5 through 10 will provide guidance on the type of information required under Chapter 240 of the Acts of 2010. (**Please see attached FY12 MLSC Annual Report)**

4) Accounting

Please provide financial information for your agency. Below please give a summary of *Receipts and Expenditures* during the fiscal year, and include the *Assets and Liabilities* at the end of the fiscal year. Please include the most recent audited financial report for the agency as **Attachment B**.

(Please see attached MLSC Audit Report)

	Amount
Receipts	**$**
Expenditures	**$**
Assets	**$**
Liabilities	**$**

5) Investments or Grants to Businesses or Individuals

Does your agency make **investments** and/or provide **grants** to businesses or individuals? **Yes X** **No** ☐
If **Yes**, please provide detailed information on investments and/or grants made during FY12 in the Operations and Accomplishments Section of this report. Information should include the number, nature and amounts of investments made and grants awarded by your agency along with job, investment and/or other economic development impact. Please list the name(s) of the investment and/or grant programs offered by your agency in the space provided below:

Please see attached MLSC FY12 Annual Report

6) Debt or Equity Investment Details

Is your agency involved in **debt** or **equity investments** for businesses? **Yes X No** ☐
If **Yes**, please provide detailed information on debt and/or equity investments made during FY12 in the Operations and Accomplishments Section of this report along with job, investment and/or other economic development impact. Please list the name(s) of the debit and/or equity investments programs offered by your agency in the space provided below:

Please see attached MLSC FY12 Annual Report – Accelerator Loan Program

7) Loan Details

Is your agency involved in **real estate loans**, **working capital loans**, or any **other type of loan** or **guarantee**? **Yes X** **No** ☐
If **Yes**, please provide detailed information on loan(s) and/or guarantee(s) made during FY12 in the Operations and Accomplishments Section of this report along with job, investment and/or other economic development impact. Please list the types of loan(s) and/or guarantee(s) offered by your

agency in the space provided below:

Please see attached MLSC FY12 Annual Report. Please also note that the Center is not involved in real estate loans.

8) Other forms of Financing or Financial Assistance?

If your agency provides any other form of financing or financial assistance please include FY12 details in the Operations and Accomplishments Section of this report along with job, investment and/or other economic development impact. Please list the types of other forms of financing offered by your agency in the space provided below:

Please see attached FY12 Annual Report

9) Patents or Products

Does your agency track **patents** or **products** resulting from agency-funded activities? **Yes** ☐ **No X**
If **Yes**, please include details in the Operations and Accomplishments Section of this report along with job, investment and/or other economic development impact. Please list the agency-funded activities of your agency that promote patent and product advancement in the space provided below:

[Please enter the details on patents or products here.]

10) Technical Assistance

If your agency provides technical assistance, please provide detailed information on technical assistance provided during FY12 in the Operations and Accomplishments Section of this report along with job, investment and/or other economic development impact. Please list the name(s) of the technical assistance programs offered by your agency in the space provided below:

N/A

Please note:

The Fiscal Year 2013 Annual Report will require details of above mentioned categories as well as performance to plan as outlined in your Agency's Fiscal 2013 Business Plan. The Office of Performance Management and Oversight will annually re-evaluate the goals and measures established by the agencies. The Office will recommend changes to goals and measures as are appropriate to align with the statewide economic development policy and plan.

Filing Instructions:

THE FISCAL YEAR 2012 REPORT IS DUE NO LATER THAN MONDAY, OCTOBER 1ST. AN ELECTRONIC COPY OF THE REPORT AND ATTACHMENTS A & B SHOULD BE E-MAILED TO ROB.ANDERSON@STATE.MA.US. THE OFFICE OF PERFORMANCE MANAGEMENT AND OVERSIGHT WILL REVIEW REPORTS PRIOR TO FILING WITH LEGISLATURE AND POSTING TO THE WEBSITE.

MASSACHUSETTS LIFE SCIENCES CENTER

Fiscal Year (FY) 2012 Annual Report

OUTPACING THE COMPETITION

U.S. sprinter Allyson Felix leads the field on her way to winning the women's 200-meter gold medal in the London 2012 Olympics

MASSACHUSETTS LIFE SCIENCES CENTER

To: Governor Deval Patrick
Secretary of Administration and Finance Jay Gonzalez
Senate President Therese Murray
Speaker of the House Robert DeLeo
State Comptroller Martin Benison
Clerk of the Senate William Welch
Clerk of the House of Representatives Steven James

By forward: House and Senate Committees on Ways and Means and the Joint Committee on Economic Development and Emerging Technologies

From: Susan Windham-Bannister, Ph.D.

Date: September 28, 2012

Re: FY 2012 Annual Report of the Massachusetts Life Sciences Center

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The Massachusetts Life Sciences Center (the "Center") respectfully submits this Annual Report detailing our operations and accomplishments during FY 2012.

We are the hub of the Commonwealth's thriving life sciences community and proudly serve as stewards of the $1 billion Massachusetts Life Sciences Initiative, which was passed by the state legislature and signed into law in June 2008. In FY 2012, through investments made by the Center, Massachusetts pulled away from its major competitors and emerged as the undisputed global leader in the life sciences.

This report and the accompanying FY 2012 Audit Report are submitted in fulfillment of the requirements mandated by the General Court pursuant to the Center's enabling statute of the Massachusetts General Laws, Chapter 23I (formerly Section 7, now Section 15), as amended by Chapter 130 of the Acts of 2008. Financial statements are contained in the accompanying FY 2012 Audit Report by PricewaterhouseCoopers.

As always, we appreciate your continued interest and support.

Sincerely,

SWindhamBannister

Susan Windham-Bannister, Ph.D.
President & CEO

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Outpacing the Competition

Four years ago, Massachusetts was a recognized leader in the life sciences, but the state faced stiff competition, both domestic and international. Inaction have diminished our leadership position – with negative repercussions for the state's scientific reputation as well as our economy.

At the 2007 BIO International Convention, Governor Deval Patrick proposed the Massachusetts Life Science Initiative, a 10-year, $1 billion investment to secure and strengthen the state's leadership in the life sciences, and to bolster the life sciences as an economic engine for the Commonwealth. This initiative was passed by our state legislature and signed into law in June 2008.

The Center is charged with implementing the Life Sciences Initiative. The Center's strategic priorities include funding translational life sciences research, making financial investments in promising new technologies, ensuring that the next generation of life sciences workers has skills that are well-aligned with industry needs, and building unique partnerships between sectors of the local and international life sciences communities. Since 2008, we have not only been investing in innovation, we have been innovating – creating new programs, tools and partnerships that create jobs, drive business growth and accelerate the commercialization of good science that holds the potential to improve the human condition.

President & CEO
Dr. Susan Windham-Bannister

Since the enactment of the Initiative in 2008, the Center has made numerous investments that have secured and strengthened Massachusetts' leadership in the life sciences. The Commonwealth has pulled ahead of the competition – Massachusetts is now **the** recognized life sciences leader in the U.S. and across the globe. This past December, independent studies once again rated Massachusetts number one for life sciences in the U.S. by a wide margin (Jones, Lang, Lasalle, 2011) and the number-one region for biotech construction (Richards, Barry, Joyce, 2011).

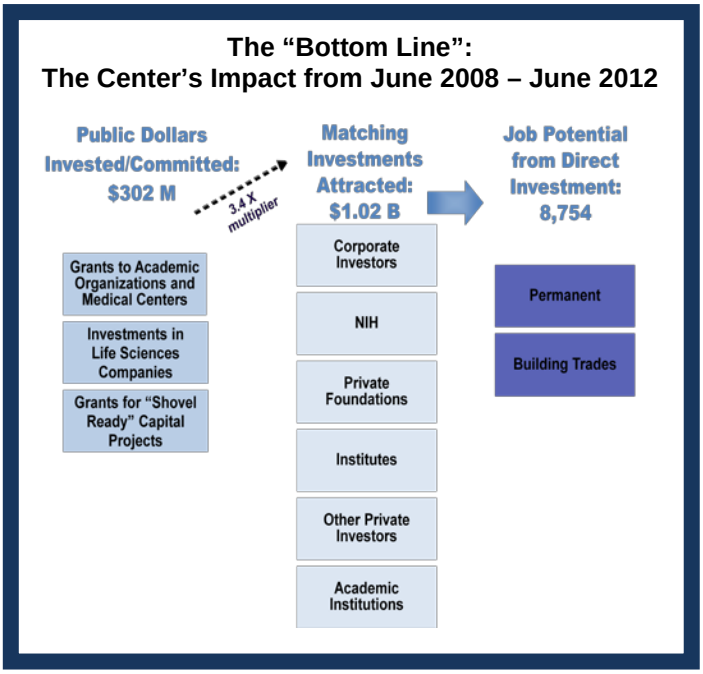
The Bottom Line

The Center's investment strategy is based on public-private collaboration to leverage public tax dollars. This strategy has proven effective; since 2008, the Center has directly invested or committed more than $300 million and leveraged more than $1 billion in third-party investment. In other words, for every $1 of taxpayer money that the Center has invested, Massachusetts has attracted $3.40 in additional, outside investment – creating a public-private investment fund of more than $1.3 billion for the state's life sciences ecosystem that would not have existed without the Life Sciences Initiative.

For every $1 of taxpayer money that the Center has invested, Massachusetts has attracted $3.40 in additional, outside investment.

The Center uses a portfolio of tools and investments to achieve its goals and objectives. To ensure that all investments are evaluated on the basis of merit and "relative best use" of the Commonwealth's funds, the Center makes its awards based on competitive solicitations and a rigorous, transparent review process that draws on experts from the life sciences sectors across the state. The broad expertise that informs the Center's decisions has enabled us to make smart, strategic investments that attract matching investment capital and highly leverage the public dollars that have been entrusted to the Center.

The Center's direct investments to date are projected to create thousands of jobs across Massachusetts. According to MassBio's "2012 Biopharma Industry Snapshot," biopharma employment has grown 42 percent in Massachusetts since 2002, and the new jobs being created are not only for scientists. Most of these new jobs are for people with skills in manufacturing, IT, sales and marketing, and other fields. A large percentage of the available jobs are open to workers with a Bachelor's degree or less.



Furthermore, the Center's investments are made with the goals of improving health-care quality for and reducing the health-care costs of patients. A substantial portion of our portfolio represents investments both in translational research with strong potential for commercialization and in companies that are bringing new products to the marketplace.

During these challenging economic times, the Center is proud to play such a prominent role in Massachusetts' economic recovery.

Investment Portfolio

The Center's investments in FY 2012 included six new capital projects, grants or loans to nine early-stage companies and tax incentive awards to 26 companies.

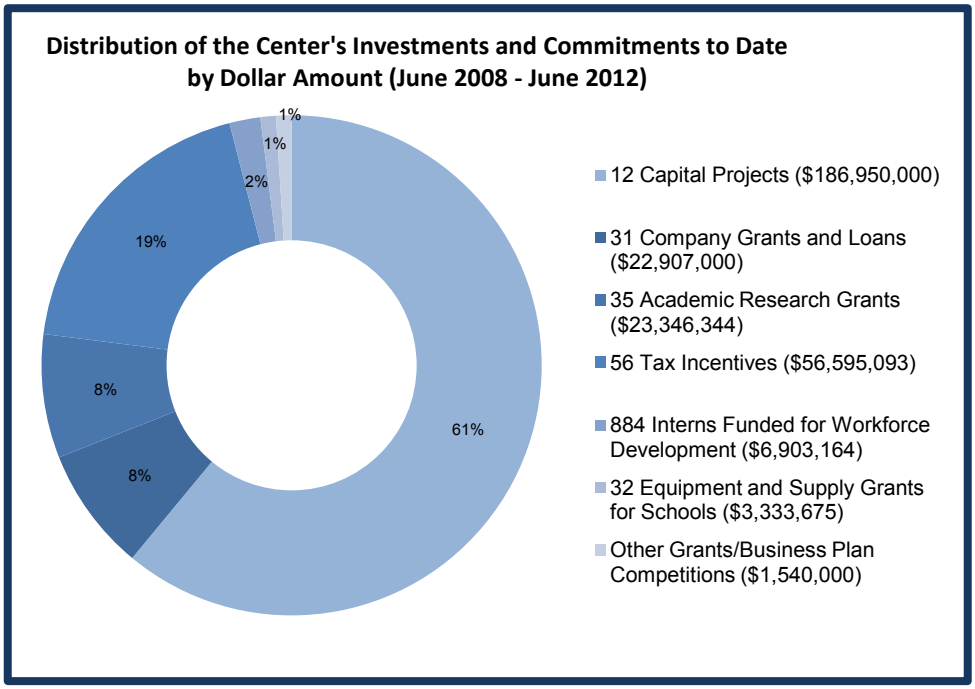
In FY 2012, more than 1,600 students applied for the Life Sciences Internship Challenge, and the Center placed 405 interns at 203 companies across Massachusetts. The Internship Challenge is now in its fourth year of investing in the next generation of talented life sciences workers in Massachusetts.

FY 2012 was also a strong year for company recruitment to Massachusetts. Motivated by the Center's tax incentives and investments in the state's life sciences ecosystem, several global life sciences leaders significantly expanded their presence in the state. The Center welcomed companies, large and small, to the Massachusetts life sciences community, helping to organize their ribbon-cutting events and collaborating on their press announcements.

The Center plays an important role as a convener across the life sciences industry at the global, national and state levels. One manifestation of these efforts is the creation of the Massachusetts Neuroscience Consortium ("the Consortium"). This pioneering model for supporting pre-clinical research, announced at the 2012 BIO International Convention, is designed to leverage the rich research environment in Massachusetts and build on the Commonwealth's status as a global leader in neuroscience. Charter sponsors of the Consortium are Abbott, Biogen Idec, EMD Serono, Janssen Research & Development LLC, Merck, Pfizer and Sunovion Pharmaceuticals Inc. The Consortium announced its first solicitation for research projects in September of 2012.

The Center currently manages a portfolio of approximately 200 grants, loans and tax incentives.

The Center currently manages a portfolio of approximately 200 grants, loans and tax incentives.



Concluding a great fiscal year, in June the Center co-hosted with MassBio Massachusetts' presence at the 2012 BIO International Convention in Boston. This convention was a landmark opportunity to showcase the accomplishments in Massachusetts since the inception of the Life Sciences Initiative and all that Massachusetts has to offer as the global leader in the life sciences.

Investing in Infrastructure

Massachusetts has demonstrated its commitment to the life sciences community through investments in infrastructure to accelerate promising science as well as to create a business-friendly environment. Half of the resources, $500 million, committed via the Life Sciences Initiative are dedicated to capital projects designed to ensure that more institutions and regions of the state have the necessary infrastructure to be "life-sciences ready." The Center's investments in infrastructure are funded through our capital fund, which received $43.5 million in bonding capacity in FY 2012 as part of the state's overall capital plan. Grants from the Center not only make possible the creation of the cutting-edge infrastructure needed for scientific advancement but also support basic infrastructure upgrades that often are needed for biomanufacturing and company expansion. Additionally, the Center is committed to funding the development of novel resources that companies and researchers will be able to find only in Massachusetts.

The Center's Board of Directors approved six new infrastructure projects in FY 2012, totaling $56 million:

- **Joslin Diabetes Center** was awarded $5 million to support the construction of its comprehensive **Translational Center for the Cure of Diabetes**. According to Joslin officials, the Center's grant is the largest single grant ever awarded to support diabetes-related research in Massachusetts. This new facility will enable the Joslin Diabetes Center to accelerate its clinical and research endeavors through the creation of cutting-edge labs and platforms. The work at this new facility will lead to the development of translational studies for curing Type 1 and Type 2 diabetes and their complications, as well as to the advancement of

Lilly Branka, a Type 1 diabetes patient, prepares to knock down a wall of the old Joslin Clinical Research Center at the groundbreaking of the Translational Center for the Cure of Diabetes, as Governor Patrick and Dr. Windham-Bannister look on.

Joslin's work in diabetes prevention and obesity. Joslin will renovate nearly 20,000 square feet of space, and the project is projected to create approximately 50 construction jobs beginning in FY 2013 and approximately 50 new permanent jobs in the life sciences. At the 2012 BIO International Convention, the biopharma giant, Sanofi, and the Joslin Diabetes Center announced a new collaboration to promote the development of medicines for the treatment of diabetes and related disorders. The creation of Joslin's new Translational Center will enable this partnership.

Over the past four fiscal years, the Center has committed $187 million to 12 capital projects, which have so far created more than 2,000 jobs in the building trades and 425 permanent jobs in the life sciences.

- **Dana-Farber Cancer Institute** was awarded $10 million to support the expansion of its Molecular Cancer Imaging Facility, a pioneering $20-million research initiative to develop new molecular imaging probes. The facility will ultimately allow physicians to better diagnose and characterize cancer, choose targeted therapies, monitor treatment efficacy and improve the outcomes of patients with cancer. This project is expected to create 100 construction jobs and 15 permanent positions in the facility.

- The **Boston Museum of Science** was awarded $5 million for the construction of its "Hall of Human Life." Envisioned as one of the museum's largest and most far-reaching exhibits, the "Hall of Human Life," opening in July of 2013, aims to revolutionize the way people understand their own biology and manage their health. Designed to evolve with the increasing number of breakthroughs in biology and biotechnology, this 10,000 square-foot exhibit will spark visitors' curiosity about innovations in the life sciences, address their concerns about health care and help them develop the thinking skills needed to make informed choices. The Center's grant has leveraged $11 million in project funding from other sources, and the project is expected to create 75 jobs in the construction trades and 20 permanent new jobs at the museum.

- **UMass Dartmouth** was awarded $14.6 million to build its new Massachusetts Biomanufacturing Center in Fall River. Designed to accelerate the development of the life sciences industry in the region, the 32,000 square-foot building will provide emerging companies with a place to prove the feasibility of their products to investors and will feature R&D laboratories and educational space. The new facility will anchor the recently established Fall River Biopark. This $28-million project is expected to create 120 construction jobs, 10 permanent positions and additional jobs within the biomanufacturing industry.

The Center's infrastructure investments have contributed to the creation of more than one *million* square feet of new life sciences research and manufacturing space across the Commonwealth.

- **UMass Lowell** was awarded $10 million to equip laboratories within its new Emerging Technologies and Innovation Center. The 84,000 square-foot facility builds on UMass Lowell's unique expertise in plastics engineering, nanotechnology, bioprocessing, electro-optics and advanced manufacturing. The grant will fund research facilities at the new center, providing the university and companies access to clean-room capabilities that are unparalleled in this region of the Commonwealth and a state-of-the-art lab focused on developing new medical applications and other capabilities tied to nano, bio-optics and other technologies. This $70-million project is expected to create 100 construction jobs.

- **UMass Dartmouth** was awarded $11.4 million to purchase the land and finance improvements, previously funded by Massachusetts Development Finance Agency, needed to establish the Advanced Technology Manufacturing Center (ATMC). This facility is designed to leverage university resources for regional economic development on the South Coast. The ATMC engages in research and works with industry partners to provide opportunities for technology exchange, while providing educational opportunities for students, and research and commercialization opportunities for faculty. The facility also includes a Technology Venture Center that incubates early-stage companies. The Center's funding has allowed UMass

Dartmouth to accelerate its investment in campus labs by approximately five-to-eight years through the investment of $13.2 million in internal funds.

Three of the six aforementioned projects – the Dana-Farber Cancer Institute, Joslin Diabetes Center and the Museum of Science – were funded through the Center's first-ever Capital Project Matching Grant solicitation. The Center received 22 applications for infrastructure projects from across the state through this program. In FY 2013, the Capital Project Matching Grant program will make $40 million available for life-sciences-related capital projects around the state.

Over the past four fiscal years, the Center has committed $187 million to 12 capital projects, which have thus far created more than 2,000 jobs in the building trades and 425 permanent jobs in the life sciences, with many more jobs projected as the projects are completed and the facilities become operational:

Investments in Infrastructure

Project	Award Amount	Year of Award	Status at End of FY 2012
Framingham Wastewater and Pumping Station	$14.3 million	FY 2009	Substantial completion and under-budget
Marine Biological Laboratory in Woods Hole	$10 million	FY 2009	Project completed in FY 2010
Tufts/Cummings School of Veterinary Medicine, NE Regional Biosafety Lab in Grafton	$9.5 million	FY 2009	Project completed in FY 2010
Albert Sherman Center at UMass Medical School	$90 million	FY 2010	Project to be completed in Winter 2013
Worcester Polytechnic Institute/Gateway Park	$5.15 million	FY 2010	Project construction well underway
UMass Boston/Dana Farber Center for Personalized Cancer Therapy	$2 million	FY 2011	Project construction to begin in FY 2013
UMass Dartmouth Biomanufacturing Center	$14.6 million	FY 2012	Project underway
Dana Farber Molecular Cancer Imaging Center	$10 million	FY 2012	Project underway
Joslin Translational Center for the Cure of Diabetes	$5 million	FY 2012	Project underway
Museum of Science "Hall of Human Life"	$5 million	FY 2012	Project underway
UMass Lowell Emerging Technologies and Innovation Center	$10 million	FY 2012	Project underway
UMass Dartmouth Advanced Technology Manufacturing Center (ATMC)	$11.4 million	FY 2012	Project authorized for FY 2015

The Center's infrastructure investments have contributed to the creation of more than one *million* square feet of new life sciences research and manufacturing space across the Commonwealth.

Incubating the Companies of the Future

Accelerating the Growth of Early-Stage Companies

From the Accelerator program's inception through the end of FY 2012, the Center has funded or committed to a total of $11.2 million in Accelerator Loans.

In FY 2012, the Center continued its commitment to building the pipeline of new life sciences companies in Massachusetts by committing to a total of $3.1 million in Accelerator Loans to six early-stage companies. The Center's Accelerator Loan program provides working capital to early-stage life sciences companies at a critical stage in their development. This program seeks to de-risk these companies for future – usually private -- investors by funding the necessary steps to achieve critical milestones. Some of these companies may hold the promise of becoming the next Vertex or Boston Scientific, while others may be acquired by large companies that are increasingly depending on the creativity of entrepreneurs to find the next promising technology. These young companies help to create an exciting environment in Massachusetts for life sciences entrepreneurs. They also make Massachusetts a fertile environment for mature life sciences companies, whose business models are increasingly reliant on "external innovation."

During FY 2012, the Center expanded the Accelerator program from one round per year to two, with the goals of reaching more prospective applicants and reducing the "wait time" for companies that miss the deadline on a particular round of the program. Over the past year, the Center received a total of 67 applications, of which 63 were eligible for review by experts selected from among the Center's 200-plus *pro bono* volunteer peer reviewers. The Center's peer reviewers recommended 33 of these applicants for review by the Center's Scientific Advisory Board (SAB – see Appendix B). Eight companies were recommended by the Investment Subcommittee of the Center's Board of Directors ("the Board" – see Appendix A), approved by the Board and designated by the Center as certified life sciences companies, as required by the Life Sciences Act. However, one company exited the program prior to receiving an award because it was acquired by a larger company. Another one of the eight recommended companies became ineligible because of a change in its strategic direction. The Center committed to a total of six loans during FY 2012, as indicated below:

To date, Accelerator companies have raised more than $100 million in funding subsequent to receiving a loan from the Center.

Accelerator Loans in FY 2012

Company	Location	Area of Development	Loan Amount
Allurion	Wellesley	Developing a novel medical device designed to induce significant weight loss by displacing volume in the stomach	$750,000
Alcyone Lifesciences, Inc.	Ayer	Developing novel micro-catheter approach for treating neurological conditions	$750,000
Christcot Medical	Sudbury	Developing an innovative and unique device for rectal medication delivery to enhance the lives of patients with chronic diseases	$257,000
HepatoChem	Beverly	Developing difficult-to-synthesize small molecules based on chemical reactions allowed by porphyrins and other catalysts	$330,000
Sample6 Technologies	Boston	Building the world's first "near-real-time" microbial monitoring system with first application in food safety	$750,000
Strohl Medical	Weymouth	Creating a new medical device for triaging potential stroke patients to accelerate their time to treatment	$245,000

From the Accelerator program's inception through the end of FY 2012, the Center has funded or committed to a total of $11.2 million in Accelerator Loans.

In FY 2012, two companies repaid Accelerator Loans with interest early, after achieving significant success in private fundraising or the sale of the company. As of the close of FY 2012, a total of four companies have pre-paid their loans: two in FY 2012 and two in prior fiscal years.

Pluromed and 4s3 Bioscience, Inc., prepay their Accelerator Loans during FY 2012.

Pluromed, recipient of an Accelerator Loan in 2009, repaid its loan in FY 2012 after being acquired by Sanofi. Pluromed's product, a new and simple device for clampless vascular and cardiovascular surgery, will now be marketed globally by Sanofi's Biosurgery Division. In addition, 4s3 Bioscience, recipient of an Accelerator Loan in 2010, prepaid its Accelerator loan after raising $20 million in private financing. To date, Accelerator companies have raised more than $100 million in funding subsequent to receiving a loan from the Center.

Support for Small Businesses

From left to right: Lydia Villa-Komaroff, Ph.D., Director and CSO, Cytonome/ST; Davide Marini, Co-Founder and CEO, Firefly BioWorks; Susan Windham-Bannister, Ph.D., President and CEO, Massachusetts Life Sciences Center; Edward Benz, M.D., President and CEO, Dana-Farber Cancer Institute

The Small Business Matching Grant (SBMG) program builds on federal investments Massachusetts companies have received through grants from the National Institutes of Health (NIH), the National Science Foundation (NSF) and the Department of Defense (DOD). One of the goals of this program is to create jobs in Massachusetts based on the commercialization of products with high potential for market adoption and penetration.

In FY 2012, 19 small businesses applied for the SBMG program. The Center awarded a $500,000 SBMG grant to Firefly Bioworks, Inc., based in Cambridge, after extensive review by the Center's peer reviewers, the SAB and the Board. Per statute, companies receiving a SBMG award are not required to be certified.

Firefly BioWorks, Inc.'s first product was recently launched and is designed to detect microRNAs, an

emerging class of biomarkers that has shown great promise in the diagnosis of cancer, neurological disorders and many other diseases. This product consists of a high-performance, universal technology platform for multiplexed biomarker detection, with applications in life sciences research and diagnostics. The platform enables detection of clinically relevant biomolecules with an unprecedented combination of performance, throughput and cost.

Small Business Matching Grants in FY 2012

Company	Location	Area of Development	Amount Awarded
Firefly Bioworks, Inc.	Cambridge	High-performance, universal technology platform for multiplexed biomarker detection for life sciences research and diagnostics	$500,000

From the time of the SBMG program's inception through the close of FY 2012, the Center has awarded $4 million to eight companies. To date, SBMG awardees have raised more than $20 million from other grants, investments or sale of the company.

From the time of the SBMG program's inception through the close of FY 2012, the Center has awarded $4 million to eight companies. To date, SBMG awardees have raised more than $20 million from other grants, investments or sale of the company.

Also, the Center supported entrepreneurship and company creation by co-sponsoring two important business plan competitions in FY 2012: MassChallenge received a $100,000 contribution, and the WPI Venture Forum received a $10,000 contribution for its annual business plan competition.

From Bench to Bedside: Academic Research Matching Grant Programs

The promise offered by innovation begins with "discovery," usually in an academic setting. Thus, the Center's key priorities are to preserve the strong competitive position of Massachusetts' academic institutions and medical centers, support translational research in the life sciences, and accelerate the discovery and transfer of technology out of academic settings. To accomplish these objectives, the Center has created several research matching grant programs. During FY 2012, 19 of the 34 grants awarded through these programs concluded, and most of the remaining grants will conclude by December 31, 2012.

New Investigator Research Matching Grants

The New Investigator Research Matching Grant program is designed to spur innovative research and advance the careers of new investigators working in the life sciences at research institutions in the Commonwealth. To date, the Center has awarded 21 grants, totaling $5.1 million to early-career investigators.

To date, the Center has awarded 21 grants, totaling $5.1 million to early-career investigators.

As of September 2012, 62 percent of the Center's New Investigators (13 of 21) have leveraged their grants from the Center with awards of follow-on funding from other sources (i.e. federal agencies, private foundations, academic institutions, etc.). The Center's investment in these 13 investigators totaled $3.25 million. Since being awarded the Center's New Investigator Grant, these 13 investigators have won at least 28 additional research awards and grants from other sources, totaling over $13 million — leverage of 4-times the Center's initial investment.

The New Investigator Grants have also enabled the awardees to advance science. Ninety percent of the Center's New Investigators (19 of 21) have published articles based on the projects funded by the Center.

These 19 grantees have published a combined total of 80-plus articles in more than 50 scientific, peer-reviewed journals, including the following:

Advanced Materials
Cell
EMBO Journal
Gastroenterology
Genes & Development
Journal of Cell Biology
Journal of Bacteriology
Journal of Infectious Diseases
Lab on a Chip
Nature
Nature Biotechnology
Nature Materials
New England Journal of Medicine
Optics Express
PLoS One
Proceedings of the National Academy of Sciences (PNAS)
Science

These publications include top-tier journals – the most prestigious, high-impact publications in the life sciences, such as *Nature*, *Science* and *Cell*.

The case study below provides an illustrative example of the scientific impact enabled by the New Investigator Grants:

Case Study: Dr. Matthias Marti

A $200,000 New Investigator Grant was awarded to Harvard School of Public Health's Dr. Matthias Marti in 2009 to establish a high throughput screen focused on preventing the development of gametocytes, which mediate transmission of malaria. No current drugs target the sexual part of the parasite's lifecycle and the therapeutic value of these drugs is decreasing.

- **2010**
  - Generated a fluorescent-reporter parasite line.
  - Established , optimized, and validated screen assay in 96-well format, using known bioactive malaria compounds.
- **2011**
  - Performed small-scale screen targeting a pathway that had been implicated in sexual-conversion of malarial parasites. This standardized screen addressed conflicting evidence in the literature regarding the role of pathway components in malaria.
- **Current**
  - Pursuing additional small-scale screens with collaborators targeting other pathways
  - Developing a new screening assay with higher throughput and increased sensitivity.

Dr. Marti's work is creating a screening assay that has the potential to identify the next generation of malaria drug candidates.

Cooperative Research Grants

The Center's Cooperative Research Grants encourage industry-sponsored research at Massachusetts academic institutions and accelerate translational research. Between 2008 and 2011, the Center has awarded eight grants, totaling $4.78 million.

As of September 2012, two of the eight, or one quarter, of the Cooperative Research Grants' academic researchers have leveraged their grants from the Center with follow-on funding. The Center's investment in these two investigators totals $1.35 million. These two investigators have won three additional research grants from other sources, totaling more than $8.6 million — leverage of approximately 6.4 times

the Center's investment. Moreover, one investigator has received follow-on funding from the project's industry partner to continue his translational research project.

Four of the eight, or half, of the Cooperative Research investigators have published articles based on the work conducted through their cooperative research projects funded by the Center. These grantees have published a combined total of at least 10 articles that have been presented in six scientific journals. Moreover, through their sponsored research projects, of the eight investigators, one has been granted a full U.S. patent, and another has filed a U.S. provisional patent application and international PCT provisional patent application.

The case study below provides an illustrative example of the scientific impact of the Cooperative Research Grants:

Case Study: Baxter Healthcare and the Immune Disease Institute

A $750,000 Cooperative Research Matching Grant was awarded to the Immune Disease Institute's Dr. Judy Lieberman in 2008 (matched by Baxter Healthcare) to develop an siRNA-based microbicide for viruses, such as herpes, HPV, and HIV.

- **2009:**
  - Improved siRNA's effectiveness and targeting for multiple species, including human
  - Optimized conditions for formulation of siRNA-based microbicide
  - Developed an human *ex vivo* system for testing infection and siRNA-based microbicide
- **2010:**
  - Optimized conditions for formulation of siRNA-based microbicide
  - Optimized methods for human *ex vivo* system
  - **Awarded 5-year grant from NIAID of NIH based in part on these studies**
- **2011:**
  - Assessed optimized siRNA-based microbicide's effectiveness against herpes virus in mice, and characterized the mechanism by which protection was achieved
  - Published on siRNA-conferred protection from HIV infection in mouse and *ex vivo* human studies
- **2012:**
  - US Patent granted for "siRNA microbicides for preventing and treating diseases"
  - Characterized HIV-targeted siRNA efficiency and protection from infection in humanized mice and human explants

Developing the Next Generation of Life Sciences Leaders

The Internship Challenge Program

The Internship Challenge is a workforce development program focused on enhancing the talent pipeline for life sciences companies in Massachusetts while simultaneously providing interns with practical, "hands-on" experience that prepares them to step into the workforce ready to meet the job requirements of life sciences employers. The program provides paid internships to sophomores, juniors and seniors; community college students; graduate students; and recent college graduates. Since the program first launched in 2009, 884 interns representing 124 different colleges and universities

Since the program first launched in 2009, 884 interns representing 124 different colleges and universities, have been placed at 290 companies across the state.

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In this program, host companies commit to providing a dedicated mentor and a meaningful internship opportunity related to the academic focus of eligible students. The Center uses a web-based interface to connect student candidates and the host companies; there, students post resumes, and host companies can match skills with their needs. Host companies then contact and interview candidates, select interns for their programs and notify the Center of their desire to provide an internship to a qualified student.

On August 30, 2012, SouthCoast participants in the Massachusetts Life Sciences Center's Internship Challenge gathered at UMass Dartmouth's Advanced Technology and Manufacturing Center to present on their summer internship experiences.

The Internship Challenge is designed to expand the pool of prospective employees who have practical experience, enhance opportunities for mentoring, enable more students to explore career opportunities despite the challenging economic environment, and provide students interested in working in the life sciences with a peer network through educational and informational exchange events. The Center's interns usually work in smaller and younger companies, so they also receive exposure to the dynamic environment of entrepreneurship.

The Internship Challenge is also a human-capital subsidy program for small and early-stage companies. The Center only reimburses student stipends for companies with 100 or fewer employees. Life sciences companies with more than 100 employees and research institutions can recruit students from the Center's database, but do not receive reimbursement for the interns that they hire. Host companies represent a broad spectrum of the life sciences industry, including pharmaceuticals, medical devices, biotechnology and contract research organizations.

Based on the success of the program, on May 25, 2011 the Center's Board of Directors authorized its expansion from a summer-only program to a year-round program, allowing greater flexibility for students and companies.

More than 1,645 students submitted applications for review by 274 life sciences companies across Massachusetts in FY 2012. The program placed a total of 405 interns with 203 host companies, a substantial increase over prior years. Interns were demographically diverse and represented 79 different colleges and universities.

As a result, FY 2012 brought additional growth, funding and recognition for the Center's Internship Challenge program. More than 1,645 students submitted applications for review by 274 life sciences companies across Massachusetts. The program placed a total of 405 interns with 203 host companies, a substantial increase over prior years. (See Appendix C for a complete list of the FY 2012 Internship Challenge host companies.) Interns were demographically diverse and represented 79 different colleges and universities. Nearly all of the interns selected for the Internship Challenge were hired for a 12-week work period, with a maximum reimbursement from the Center of $15 per hour, up to $7,200 total per intern.

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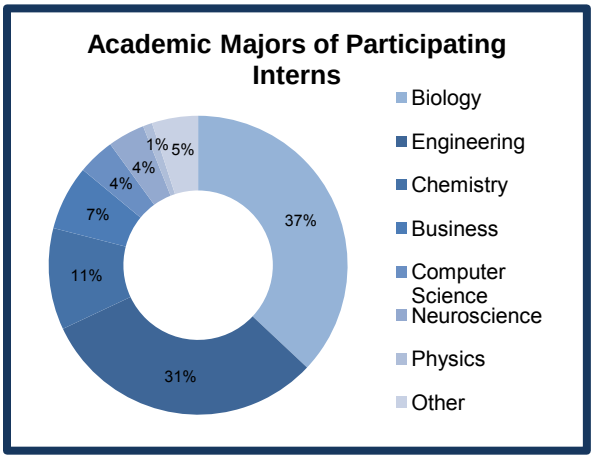
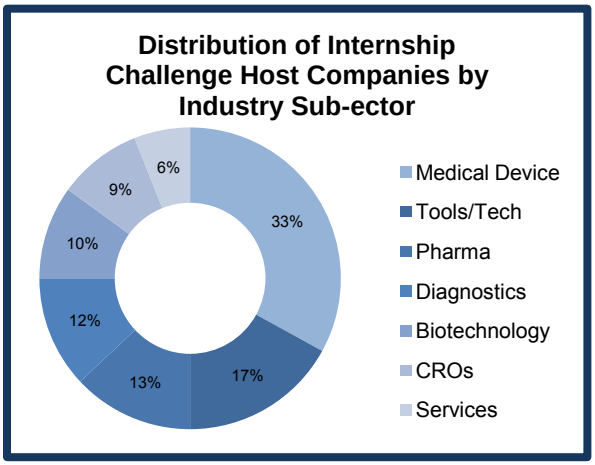
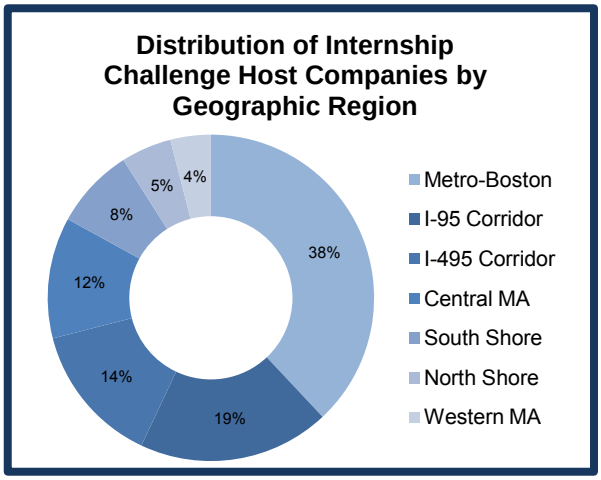
The Center's Internship Challenge program is broadly inclusive, as the following data on participating interns and sponsoring companies illustrates:







Feedback about the Internship Challenge Program

The Center conducts a survey of both interns and sponsors at the conclusion of the internship period because we believe that the Internship Challenge participants themselves provide the best evidence of the program's value and impact.

Surveys of participating interns show that nearly 30 percent of the interns that were entering the workforce (recent graduates) found immediate full-time employment as a result of their internships. In most cases, these interns were hired by the company that hosted their respective internships.

Additional feedback from participants, both interns and host companies, is included below:

"This summer internship has been much more than I expected. Working at a biotech start-up has opened my eyes to the great potential there is in the life sciences industry right here in Massachusetts."

– Juan Betanzo, Babson College

"Interning with NuOrtho Surgical has enhanced my understanding in both the marketing and financial fields. The opportunity to work with such upbeat and intuitive professionals has been an exceptional introduction to the business world. I feel as though I have already become a more confident and skilled individual thanks to the practical training this internship has provided."

– Tamer Plourd, UMass Dartmouth

"We were fortunate to have two interns this past summer, [and one] has proven to be a great addition to our team and was recently promoted to a project engineer. All four of our engineers started as interns, two of them as part of the Internship Challenge. Their hard work and dedication contributed to a 30 percent growth in 2011."

– David Comeau, President, Albright Technologies

"We are very pleased with the biology and analytical students that have worked with us. The program gives us the opportunity to hire talented students that we would otherwise not have access to. It's a win-win situation: We are extremely impressed with the contributions the students make, and it's great work experience for them."

– Shana Dobson, Operations Manager, Tetraphase Pharmaceuticals

"Comprising of five full-time employees, the company at which I interned allowed me to thrive through regular contributions to several different projects and has introduced me to the intricacies of running a biopharmaceutical company. This experience has inspired me to pursue a career in the business sector of the biopharmaceutical industry."

– Renee McKell, Massachusetts Institute of Technology

The Skilled Careers in Life Sciences (SCILS) Initiative

In March of 2012, the Center competed for and received for the first time federal grant funding, with the funds going to supplement the Internship Challenge program. The Center will be receiving $800,000 over the next four years as part of a $5 million grant to the City of Boston from the U.S. Department of Labor intended to grow and maintain the area's life sciences workforce. The SCILS Initiative is being implemented in collaboration with the City of Boston's Department of Jobs and Community Services, as well as with the Metro North, Metro Southwest and South Coastal workforce regions. This program will serve more than 80 cities and towns in greater Boston.

The Center will be receiving $800,000 over the next four years.

Boston Mayor Thomas Menino speaks at the SCILS Initiative announcement at Boston University.

Supporting STEM (Science, Technology, Engineering, and Math) Education and an Inclusive Workforce

The Center awarded grants totaling $180,000 to four programs focused on STEM education and diversity in the life sciences workforce during FY 2012. The grants build upon the Patrick/Murray Administration's strategy for enhancing STEM educational opportunities across Massachusetts, and on the Center's commitment to ensuring an inclusive life sciences workforce. Dr. Windham-Bannister serves on the Governor's STEM Council.

The four organizations that received grants focus on different strategies for enhancing STEM education and diversity:

- **Women in Engineering, Science and Technology (WEST)** was awarded $30,000. WEST is primarily focused on workforce development for women at all career stages in science and technology: students, early career, mid-career and executive. WEST's programs are designed to develop skills, build and expand professional relationships, and empower women to achieve full leadership potential. The purpose of the Center's grant was to expand WEST's offerings to regions of Massachusetts outside of Cambridge and Boston. The WEST organization is using the Center's funds to add 12 programs, targeting two main corridors – Route #128/Suburbs and Route #495/Worcester – and cities and towns along these corridors. These two corridors are home to more than 230 life sciences companies and 18 colleges.

The Center awarded grants totaling $180,000 to four programs focused on STEM education and diversity in the life sciences workforce during FY 2012.

- The **Urban Massachusetts Louis Stokes Alliance for Minority Participation (UMLSAMP) program at UMass Boston** was awarded $50,000 to expand its offerings. The UMLSAMP program is a consortium of eight Massachusetts academic institutions of higher learning: UMass Boston, UMass Dartmouth, UMass Lowell, Wentworth Institute of Technology, and Bristol, Bunker Hill, Middlesex and Roxbury Community Colleges. The mission of the NSF UMLSAMP grant under which this consortium has operated for the last five years has been to establish best practices and innovative approaches to increase the number of STEM bachelor-degree graduates, especially those from underrepresented minority communities. The Center's funds will be used for the design, development and implementation of two undergraduate Biotechnology Research

Skills Development workshops that will be delivered in April of 2012 for the Boston and New Bedford/Fall River metropolitan areas.

- Consistent with the Center's emphasis on promoting diversity in the life sciences workforce, the Center awarded a $50,000 grant to the **Girl Scouts of Eastern Massachusetts (GSEM)** in November 2011 to support girls and their involvement in STEM education and careers. GSEM serves 178 communities composed of 41,000 girls ranging in age from five to 18 and more than 17,000 adult volunteers. One of every seven girls in eastern Massachusetts is a Girl Scout. In particular, this grant will fund a 10-week module in STEM within the FaB Factor program, which is an early intervention and prevention program for at-risk, low-income, inner-city girls ranging in age from five to 17 years old, designed to address the fact that women are underrepresented in the majority of STEM fields.

- **Search4STEM** was awarded $50,000 that will be put toward creating a "one-stop" portal for STEM education – to connect teachers, educational leaders, businesses and other stakeholders with STEM programs, projects, products, initiatives, collaborations and services. Millions of dollars are appropriated every year for STEM initiatives throughout the nation, but existing STEM data warehouses, inventories and other resource lists are disconnected, disparate and difficult to use, and challenging to find. Search4STEM is an interactive, searchable "one-stop" portal for resource and knowledge exchange. The Center's funds will be used to develop the interactive web-based portal; fund the programming activities and technical consultant; and pay for materials and supplies.

The Center will continue to seek additional opportunities to expand access to STEM education and to ensure an inclusive life sciences workforce in the fiscal year ahead.

Investing in Industry and Job Creation

The Life Sciences Tax Incentive Program

In calendar year 2012, the Center awarded $20.3 million in tax incentives to 26 life sciences companies under the Center's 2011 Life Sciences Tax Incentive program. The companies receiving tax incentive awards have committed to creating more than 900 new jobs in the Commonwealth during calendar year 2012.

The Life Sciences Act authorizes up to $25 million in tax incentives each year for companies engaged in life sciences research and development, commercialization and manufacturing. The primary goal of the program is to incentivize life sciences companies to create new long-term jobs in Massachusetts. Companies receiving incentives must commit to the creation of a specific number of net new jobs during the following calendar year and also to the retention of those jobs for a five-year period.

The 2011 round of the program featured 10 different incentives, which address the significant capital expenditures associated with the life sciences R&D cycle and the high costs of translating research into commercially viable products. A total of 45 companies applied for tax incentives in 2011. Details of the 26 tax incentive awardees are below:

Tax Incentives Awarded Under the Center's 2011 Life Sciences Tax Incentive Program			
Company	Location	Tax Incentive Amount Awarded	Jobs Committed
Aegerion Pharmaceuticals, Inc.	Cambridge	$661,122	27
AVEO Pharmaceuticals, Inc.	Cambridge	$2,301,683	94
Biogen Idec MA, Inc.	Weston	$1,836,449	75
Blueprint Medicines Corporation	Cambridge	$160,750	15
Boston Heart Diagnostics Corporation	Framingham	$220,000	31
Cell Signaling Technology	Danvers	$489,720	20
Courtagen Life Sciences, Inc.	Woburn	$125,000	13
DePuy Othopaedics, Inc.	Raynham	$1,224,300	50
Ironwood Pharmaceuticals, Inc.	Cambridge	$1,836,449	75
Knome, Inc.	Cambridge	$49,000	12
LightLab Imaging, Inc.	Westford	$636,636	26
Metamark Genetics, Inc.	Cambridge	$269,346	11
Moderna Therapeutics, Inc.	Cambridge	$138,270	13
Momenta Pharmaceuticals, Inc.	Cambridge	$1,224,300	50
New England Biolabs, Inc.	Ipswich	$244,860	10
NinePoint Medical, Inc.	Cambridge	$313,483	15
Nova Biomedical Corporation	Waltham	$244,860	10
Organogensis, Inc.	Canton	$857,010	35
PAREXEL International Corporation	Billerica	$150,000	32
PerkinElmer, Inc.	Waltham	$1,224,300	50
Pharmalucence, Inc.	Bedford	$293,832	12
Quanterix Corporation	Cambridge	$465,234	19
Ra Pharmaceuticals, Inc.	Cambridge	$161,270	10
Shire HGT, Inc.	Lexington	$3,000,000	100
T2 Biosystems, Inc.	Lexington	$244,860	10
Vertex Pharmaceuticals	Cambridge	$2,448,599	100

In FY 2012, Shire HGT, Inc., of Lexington received an additional $3.5 million of tax incentives under an existing tax commitment by the Commonwealth.

The Center takes its stewardship of these resources seriously and has built in strong accountability measures to ensure that the program has "teeth." The Center is carefully monitoring the performance of companies that have received tax incentives to ensure compliance with the tax incentive agreements they are required to execute with the Center. Headcount requirements must not only be met in the year following receipt of the award, but also maintained for the following five years. Under agreements by awardees, recipients of tax incentives are required to report job creation results to the Center by the end of the calendar year. Under the Life Sciences Act, the Department of Revenue has the authority to recover or "claw back" incentives from companies that the Center determines will not meet the minimum job creation threshold in their tax incentive agreement.

Through three rounds of the program, the Center has provided 86 awards to 71 companies at an aggregate amount of $73.6 million. Ten awardees declined their awards due to changes in their business or general economic conditions. Eighteen awardees determined that they were unlikely to reach their job creation commitment under the statutory guidelines and opted to voluntarily terminate their agreements, either by foregoing taking the tax benefits at all or by returning the benefits to the Commonwealth if they had already received them. The Center decertified two awardees for not achieving the statutory thresholds. As of June 20, 2012, the Center had provided 56 active awards across all program years to 44 different companies. Eight active companies have received two or more active awards, illustrating their continued commitment to grow their headcount in the Commonwealth.

To date, the tax program has resulted in a combined net new hire commitment of more than 2,000 jobs among active awardees.

In FY 2012, awardees from the 2009 and 2010 tax programs were required to report their headcount as of December 31, 2011. As of December 31, 2011, reporting awardees from the 2009 and 2010 programs had hired or maintained 1,899 new employees, representing a 145 percent attainment of their commitment.

As of June 30, 2012 there were 30 active awards from the 2009 and 2010 program years, with a combined commitment of maintaining or fulfilling their 1,150 new hire commitment under the program. The 26 active awardees from the 2011 Tax Incentive program will provide their initial headcount reports – reflecting headcount as of December 31, 2012 – in January of 2013, as required under the program. The 2011 awardees have committed to creating an additional 915 jobs within the Commonwealth in calendar year 2012. To date, the tax program has resulted in a combined net new hire commitment of more than 2,000 jobs among active awardees.

Attracting Companies to Massachusetts

Massachusetts continues to be a magnet for growing companies, both domestic and international. The Commonwealth is a great place for life sciences companies to do business because it is home to cutting-edge research, a superior workforce, a vibrant investment community and a supportive environment for growth. The Center actively recruits new companies to the state through extensive marketing efforts and our portfolio of tools and programs, and supports the integration of these companies into our life sciences community.

FY 2012 was an active year for the Center -- we helped organize numerous grand openings and press announcements for new or expanding life sciences companies in Massachusetts:

- Thermo Fisher celebrated the opening of its new manufacturing facility in Tewksbury, a project that will bring approximately 100 new jobs to Massachusetts.
- Lieutenant Governor Murray helped to celebrate the grand opening of Forma Therapeutics' new headquarters in Watertown.
- Spanish life sciences company Progenika opened its expanded facilities in Medford.

On June 11, 2012, Governor Deval Patrick and other officials celebrated the grand opening of Thermo Fisher Scientific's Center for Excellence for portable analytical instruments in Tewksbury.

- U.K.-based Xenetic announced plans to relocate its drug discovery operations to Massachusetts, a direct return on investment for the Governor's trade mission to the U.K., in which the Center participated.
- H3 Biomedicine, a start-up drug discovery company funded by Japan-based Easai, located its facilities in Cambridge.

Other recent arrivals include Batavia Bioservices from the Netherlands, Izon from New Zealand, Ohio-based Navidea and California-based BioSurplus; these companies opened new facilities in Woburn, Cambridge, Andover and Boston, respectively.

In addition, U.K.-based IDBS celebrated a significant expansion in Burlington, including the designation of its Burlington office as the company's U.S. healthcare headquarters. Ipsen-Biomeasure, based in France, announced a $45-million expansion of its facilities in Milford. Ipsen, Izon and IDBS all came as a direct result of a meeting that each company had with Governor Patrick at the BIO Convention in 2011. These companies continue to cite the Life Sciences Initiative, along with the state's talented workforce, world-class academic institutions and industry-leading companies, as their primary reasons for locating or expanding in Massachusetts.

Company officials cite Massachusetts' Life Sciences Initiative, talented workforce, and leading research institutions as important reasons for choosing the state. A sampling of companies that have expanded or located in Massachusetts over the past four years is shown below:

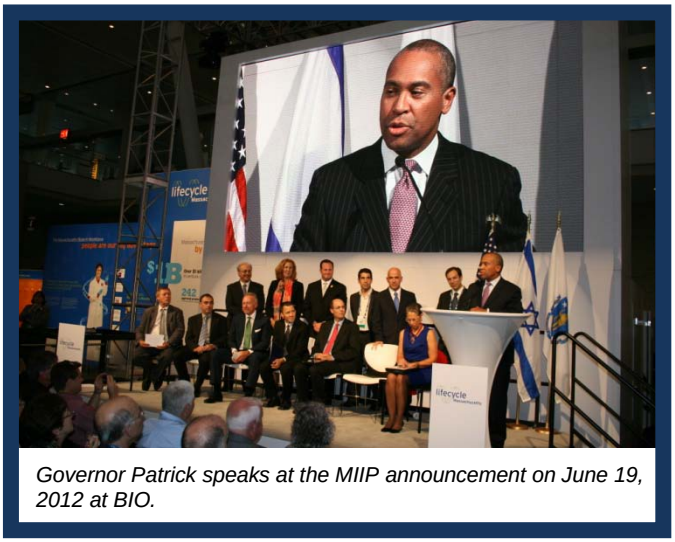
The Center continues to engage companies across the nation and around the world, in order to encourage them to invest and locate in Massachusetts. We anticipate many more announcements in FY 2013.

Building Partnerships

International Partnerships

The Center continues to solidify Massachusetts' global life sciences leadership. In 2012, we further expanded relationships with companies and governments around the world by cultivating important new relationships in Brazil as a result of the Governor's trade mission to this emerging life sciences leader.

Another significant international collaboration for the Center emerged through the Northern Ireland Massachusetts Connection (NIMAC): a new multi-national research study that will develop non-invasive procedures to detect pre-malignant lesions. An international contingent of academic and economic development officials representing Finland, Northern Ireland and Catalonia have also made commitments to be part of the study. The study, which is being supported by the Center with a $300,000 grant, will look at samples from all of the participating regions and will also utilize the most effective, cutting-edge applications to analyze the data collected. The result will be to determine at-risk patients without unnecessary surgery.



Governor Patrick speaks at the MIIP announcement on June 19, 2012 at BIO.

At the 2011 BIO International Convention, Governor Patrick joined Avi Hasson, the Israeli Chief Scientist, the U.S.-Israel Science and Technology Foundation (USISTF), and three Massachusetts economic development agencies, including the Center, to announce a formal collaboration between the State of Israel and the Commonwealth of Massachusetts to encourage and support innovation and entrepreneurship between Massachusetts' and Israel's life sciences, clean energy and technology sectors.

During FY 2012, this partnership, known as the Massachusetts-Israel Innovation Partnership (MIIP), launched a joint solicitation seeking Industrial R&D collaborations between Massachusetts and Israeli companies. After an eight-month process, Governor Patrick and Chief Scientist Hasson announced the award winners at the 2012 BIO International Convention in Boston.

The Center, along with the Massachusetts Technology Collaborative (MTC) and the Massachusetts Clean Energy Center (MassCEC), awarded a total of more than $600,000 to fund four partnerships between Massachusetts and Israeli companies. The two projects awarded by the Center, for a total of $300,000 in expected grant funding, are as follows:

MIIP Projects in Round 1

Companies	Massachusetts Location	Project Description	Amount Awarded
Automated Medical Instruments (AMI) and STI Lasers (Israel)	Needham	Emerging medical device company developing new radio frequency energy-based approach to perform circumferential ablation of the pulmonary veins	$116,000
SBH Sciences and Improdia (Israel)	Natick	Developing and planning to manufacture chronic inflammation-dependent immunosuppression prognostic kit using a novel biomarker, which predicts changes in patient's immune system response as an indicator of disease status	$184,000

The Center also participated in Massachusetts Senate President Therese Murray's announcement at the 2012 BIO International Convention that the first-ever United States-European Union (U.S.-E.U.) Conference on Connected Health would be held not in Washington, D.C., but in Boston in October of 2012. The European Commission selected Massachusetts to hold this conference to further develop and implement the U.S.-E.U. Memorandum of Understanding on e-Health between the E.U. and the U.S. Department of Health and Human Services. Senate President Murray is hosting the E.U.; other states; and biotechnology, medical device and e-health companies from across the globe. This two-day event will include a business marketplace that will provide opportunities for companies, health care providers, research institutions and others from both sides of the Atlantic to encourage business relationships, research and collaboration.

Pursuing a Strategy for Biomanufacturing

The Center's priorities include making investments that strengthen Massachusetts' ability to compete for biomanufacturing jobs. In August of 2011, the Center provided a second $50,000 grant to support the Massachusetts Biomanufacturing Roundtable ("the Roundtable"), a partnership between the Center and Massachusetts Institute of Technology's Industrial Performance Center to work with industry and academic biomanufacturing leaders and experts from across the state. The Roundtable is co-chaired by Eleven Biotherapeutics, Inc., CEO Abbie Celniker; Acceleron Pharma Senior Vice President of Manufacturing Bob Steininger; and former Pfizer Vice President Mickey Koplove.

Current priority areas include biomanufacturing technology innovation, workforce development and business development. To further these priorities, the Center worked with members of the Roundtable to host a panel at BIO 2012 on Massachusetts' leadership in biomanufacturing. In addition, the Center worked with the Roundtable to develop a brochure to showcase biomanufacturing innovation in Massachusetts, the global leadership role played by Massachusetts companies in biopharmaceutical manufacturing and technology, and the strength and depth of biomanufacturing experience in academic institutions as they collaborate with industry partners.

The Massachusetts Neuroscience Consortium

Beginning in 2009, the Center began work to create a Massachusetts Neuroscience Consortium ("the Consortium") to accelerate pre-clinical research available to the pharmaceutical industry, introduce academic researchers to the challenges of targeted research and facilitate industry-academic partnerships. We were thrilled when Governor Patrick joined the Center to announce the formalization of this new Consortium at the 2012 BIO International Convention. The Consortium is comprised of seven global pharmaceutical leaders that recognize the value of leveraging the rich Massachusetts environment in the field of neuroscience. Consortium members are seeking an

The charter Consortium members are Abbott, Biogen Idec, EMD Serono, Janssen Research and Development, Merck, Pfizer, and Sunovion Pharmaceuticals Inc.

On June 20, 2012, Massachusetts Governor Deval Patrick, the Massachusetts Life Sciences Center and seven global biopharmaceutical companies announced the formation of the Massachusetts Neuroscience Consortium (the "Consortium").

opportunity to advance our collective understanding and treatment of neurological diseases through engagement with researchers representing all major fields of neurobiology and neurology.

The charter Consortium members, Abbott, Biogen Idec, EMD Serono, Janssen Research and Development, Merck, Pfizer, and Sunovion Pharmaceuticals Inc., have pooled their resources to fund the identification and validation of novel targets for the symptomatic treatment and modification of chronic and debilitating neurological diseases. Each Consortium member has agreed to contribute $250,000, for total first-year funding of $1,750,000.

During FY 2012, the Center grew its email list from 3,900 to more than 4,700 contacts.

The Center had more than 2,200 media mentions during FY 2012.

During FY 2012, Center staff participated as presenters, speakers or panelists at more than 50 public events.

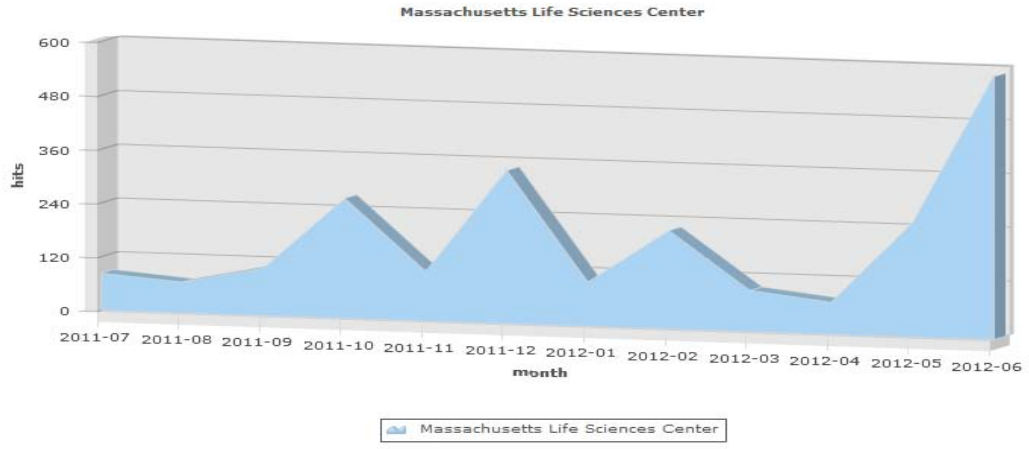
Staying Connected

The Center's communications program keeps our stakeholders and the general public informed about the Center's investments of public dollars, promotes public accountability for the Center's progress in accomplishing our mission, and provides ongoing updates and information exchange with the life sciences community in order to encourage its involvement and input. Communication and outreach have been integral to the Center's success in attracting a robust and diverse pool of applicants for Center programs.

During FY 2012, the Center grew its email list from 3,900 to more than 4,700 contacts. We used our website as both a clearinghouse for information about the Center and a portal for applying to the Center's programs.

The Center had more than 2,200 media mentions during FY 2012. Publications across the nation and around the world covered our activities. The chart below shows the monthly distribution of the Center's media coverage during FY 2012. Periods of greater coverage tended to coincide with the announcement of new programs or investments, with a substantial increase resulting from the 2012 BIO International Convention in June.

Monthly Distribution of MSLC Media Mentions
(July 1, 2011 – June 30, 2012)



During FY 2012, Center staff participated as presenters, speakers or panelists at more than 50 public events.

Massachusetts Takes BIO 2012 by Storm

One noteworthy event is the 2012 BIO International Convention, which was an important moment for Massachusetts that provided an opportunity to showcase all that the Commonwealth has to offer. More than 16,500 people participated from 48 states and 65 countries. The Massachusetts Pavilion experienced heavy traffic throughout the event. More than 100 business development meetings took place with companies from all over the world, and new relationships were forged with regions across the globe, including the signing of formal agreements with the Medicon Valley region (Denmark and Sweden) and the Catalonia region (Spain).

Pulling Ahead and Taking the Lead

In FY 2012, Massachusetts emerged as the clear global leader in life sciences. The Center made enormous strides in fulfilling our mission and delivering on the promise of the Life Sciences Initiative to create jobs, advance good science and coalesce the state's life sciences community.

The year ahead will present major opportunities to showcase Massachusetts' leadership in the life sciences, with the AdvaMed and International Society for Stem Cell Research annual conferences both coming to Boston during FY 2013.

The state budget calls for a FY 2013 investment fund appropriation of $15 million, a $5-million increase over the course of FY 2012, contingent on the comptroller's declaration of a consolidated net surplus for FY 2012. We are appreciative and excited about this vote of confidence by Governor Patrick, Lt. Governor Murray and the State Legislature, under the leadership of Senate President Murray and Speaker of the House DeLeo. We look forward to delivering another productive and impactful year.

Appendix A - The Board of Directors of the Massachusetts Life Sciences Center as of June 30, 2012

- **Gregory Bialecki, Co-Chair**
  Secretary, Executive Office of Housing and Economic Development

- **Jay Gonzalez, Co-Chair**
  Secretary, Executive Office for Administration and Finance

- **Edward J. Benz, Jr., M.D.**
  President and CEO, Dana-Farber Cancer Institute

- **Josh Boger, Ph.D.**
  Founder & CEO (retired), Vertex Pharmaceuticals

- **Robert L. Caret, Ph.D.**
  President, University of Massachusetts

- **Abbie Celniker, Ph.D.**
  CEO, Eleven Biotherapeutics, Inc.

- **Lydia Villa-Komaroff, Ph.D.**
  Director and Chief Scientific Officer, Cytonome/ST

Appendix B - Massachusetts Life Sciences Center Scientific Advisory Board Members as of June 30, 2012

- **Harvey Lodish, Ph.D., Chair**
  Whitehead Institute for Biomedical Research and Professor of Biology and of Bioengineering, Massachusetts Institute of Technology

- **James Barry, Ph.D.**
  Executive Vice President and COO, Arsenal Medical

- **Gary Borisy, Ph.D.**
  Director and CEO, Marine Biological Laboratory

- **Dalia Cohen, Ph.D.**
  Chief Scientific Officer, Asterand, Inc.

- **James Collins, Ph.D.**
  Professor of Biomedical Engineering, Boston University

- **John Collins, Ph.D.**
  Chief Operating Officer, Center for Integration of Medicine & Innovative Technology

- **T. (Teo) Forcht Dagi, M.D.**
  Partner, HLM Venture Partners

- **Robert D'Amato, M.D., Ph.D.**
  Judah Folkman Chair in Surgery and Director, Center for Macular Degeneration Research, Children's Hospital, Boston

- **Jonathan Fleming, M.P.A.**
  Managing General Partner, Oxford Bioscience Partners

- **Rainer Fuchs, Ph.D.**
  Chief Information Officer, Harvard Medical School

- **Richard A. Goldsby, Ph.D.**
  John Woodruff Simpson Lecturer and Professor of Biology, Amherst College

- **Dale Larson**
  Director of Biomedical Systems, Draper Laboratory

- **Lita Nelsen**
  Director, Technology Licensing Office, Massachusetts Institute of Technology

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- **Carmichael Roberts, Ph.D.**
  Partner, North Bridge Venture Partners

- **Lauren Silverman, Ph.D.**
  Managing Director, Novartis Option Fund

- **Alan Smith, Ph.D.**
  Former Chief Scientific Officer, Genzyme Corporation

- **Allison Taunton-Rigby, Ph.D.**
  Co-founder, CEO and Director, RiboNovix, Inc.

- **David Walt, Ph.D.**
  Robinson Professor of Chemistry and Howard Hughes Medical Institute Professor, Tufts University School of Medicine

- **Philip Zamore, Ph.D.**
  Professor, Biochemistry and Molecular Pharmacology, UMass Medical School

Appendix C - FY 2012 Internship Challenge Host Companies

480 Biomedical, Inc.
A Chemtek Inc.
AB Biosciences, Inc.
Abazyme LLC
AbPro Labs
Acceleron Pharma, Inc.
Addgene, Inc.
Advanced Research and Development
AdvanDx, Inc.
Advantagene, Inc.
Aegerion Pharmaceuticals
Agilux Laboratories
Agrivida, Inc.
Akaza Research, LLC
Alacrita LLC
Albright Technologies
Allied Minds Devices, LLC
Alzheimers Disease Center
Antagen Pharmaceuticals, Inc
Antigen Targeting & Consulting Services Inc
Appembler, Inc.
Arsenal Medical
Arteriocyte Medical Systems
Aushon BioSystems
Avaxia Biologics, Inc.
Averica Discovery Services Inc
Bach Pharma, Inc
BIND Biosciences
Bio2 Technologies
Biomedical Research Models, Inc.
BIOS2 Medical, Inc.
BioSensics LLC
BioSurfaces, Inc.
BioTechnic Products, Ltd
Biotrofix, Inc.
Blossom Innovations
Blue Ocean Biomanufacturing, Inc.
Blue Sky Biotech, Inc.
Blue Stream Laboratories, Inc.
Boston Biomedical Associates
Boston MedTech Advisors
Boston Microfluidics Inc.
Boston Micromachines Corporation
Boston Open Labs
Cambridge Biolabs LLC
Cambridge Biomedical, Inc.
Cambridge Polymer Group, Inc.
CBT Advisors
Cellay, Inc.
Celldex Therapeutics, Inc.
CellMosaic LLC
Celltreat Scientific Products
Cephos Corp.
CeQur Corporation
ChemGenes Corp.
Christcot Medical Company
Clover Medical LLC
Constellation Pharmaceuticals
Convergence Medical Devices, Inc.
Court Square Group, Inc.
Courtagen Life Sciences, Inc.
CreaGen Biosciences, Inc
Cytonome/ST, LLC
Daktari Diagnostics, Inc.
Dentovations Inc
Differential Proteomics, Inc.
Digilab, Inc.
DMI Dx, LLC
DNA Medicine Institute
DocBox Inc
Ekam Imaging, Inc.
Emergent Inc.
EndoDynamix, Inc.
EndoSim, LLC
Energesis Pharmaceuticals, Inc.
Ensemble Therapeutics Corporation
Enumeral Biomedical
EpigenDx, Inc.
Essential Life Solutions Ltd.
Eutropics Pharmaceuticals
Excellims Corporation
First Light Biosciences
Five Star Manufacturing, Inc.
Five Star Surgical, Inc.
FloDesign Sonics
Flow Forward Medical, LLC
G&F Industries, Inc.
G&F Medical Inc.
Genocea Biosciences, Inc.
Giner, Inc.
Ginkgo BioWorks, Inc.
Global Business Support, Inc.
GlycoSolutions Corporation
Glycosyn Inc.
Grove Instruments, Inc.
Harvard Apparatus
Hemedex Inc.
Hepatochem, Inc.
Hepregen Corporation
HighRes Biosolutions Inc
HPA Ventures
Hstar Technologies Co.
HydroCision, Inc
Imgen BioSciences, Inc.
Immunetics, Inc
Immunotrex Biologics Inc.

InCrowd, Inc.
incTANK Ventures Management LLC
InfoBionic
Infraredx, Inc.
Institute for Pediatric Innovation, Inc.
Interactive Motion Technologies
Interscope, Inc.
inviCRO
InVivo Therapeutics Corporation
IonSense
iQuartic, Inc.
Janus Biotherapeutics
JEF Core, Inc.
JNK Healthcare Inc
KeraFAST
LaVoie Strategic Communications, Inc.
Ligon Discovery
MagneMotion Inc.
Massachsetts Medical Devices Journal, LLC
Matrigen LLC.
Matrivax R&D Corporation
Maxiom Consulting Group Inc.
Med Techna, Inc.
MedChem Partners LLC
MedPanel
Metis Manufacturing LLC
Microbiotix, Inc.
Microtest Laboratories, Inc.
Most Corporation
MOSTMED, Inc.
Mouse Specifics, Inc.
MSM Protein Technologies
MX Orthopedics
Myomo, Inc.
Nemucore Medical Innovations, Inc.
Neo-Advent Technologies, LLC
New England Peptide LLC
Nexcelom Bioscience LLC
NKT Therapeutics Inc.
Northeast Biomedical, Inc.
NovoBiotic Pharmaceuticals, LLC
Nuclea Biotechnologies, Inc.
Ocean Genome Legacy
OnSite Therapeutics, Inc.
OpenClinica, LLC
Ora, Inc.
PharmaHealth Clinical Research Services
Pharmalucence, Inc.
Phosphorex, Inc.
Phylonix Pharmaceuticals, Inc.
pION INC
Pluromed, Inc
Pressure BioSciences, Inc.
Privo Technologies
Progenika Inc
Quanterix Corporation
Reflectance Medical Inc.
Relay Technology Management, Inc.
Respiratory Motion, Inc.
ReSurfX LLC
Safe Food Scientific, LLC.
Safety Partners, Inc.
Sage Science, Inc.
Sample6 Technologies, Inc.
SBH Sciences, Inc.
Scientia Advisors, LLC
Segterra Inc.
Selecta Biosciences, Inc.
SemiNex Corporation
Senscio Systems, Inc.
Sentien Biotechnologies, Inc.
Seventh Sense Biosystems
Sharp Edge Labs, Inc.
SonyaSoft
Sproxil, Inc.
STAR Analytical Services
STC Biologics, Inc.
Targeted Cell Therapies, LLC
TDC Medical, Inc.
Tetraphase Pharmaceuticals, Inc.
TheraTorr Medical, Inc.
THINQ Pharma
TRA360
Two Square Science, LLC
Union Biometrica, Inc.
VasoTech, Inc.
VelQuest Corporation
Vista Scientific LLC
VitaThreads Inc.
VivoPath, LLC
WaterSep Technology Corp
WaveGuide Corporation
White Systems, Inc.
WorldCare Clinical, LLC
X-CHEM, Inc.
Xtal BioStructures Inc.
ZeptoMetrix Corporation

Appendix D - List of Active Certified Life Sciences Companies as of June 30, 2012

Company	Location
4s3 Bioscience, Inc.	Medford
Aegerion Pharmaceuticals, Inc.	Cambridge
AesRx, LLC	Newton
Aura Medsystems, Inc.	Duxbury
Avaxia Biologics, Inc.	Burlington
AVEO Pharmaceuticals, Inc.	Cambridge
Bind Biosciences, Inc.	Cambridge
Biogen Idec MA, Inc.	Cambridge
Bluebird Bio, Inc.	Cambridge
Blueprint Medicines Corporation	Cambridge
Boston Heart Diagnostics Corporation	Framingham
Cell Signaling Technology	Danvers
Christcot Medical, Inc	Sudbury
Constellation Pharmaceuticals, Inc.	Cambridge
Courtagen Life Sciences, Inc	Woburn
Cubist Pharmaceuticals, Inc.	Lexington
DePuy Othopaedics, Inc.	Raynham
Dyax Corporation	Cambridge
Eutropics Pharmaceuticals, Inc.	Dorchester
Foundation Medicine, Inc	Cambridge
Good Start Genetics, Inc.	Boston
Grove Instruments, Inc	Worcester
Infinity Pharmaceuticals, Inc.	Cambridge
InfraReDx, Inc.	Burlington
Instrumentation Laboratory Company	Bedford
InVivo Therapeutics, Inc.	Cambridge
Ironwood Pharmaceuticals, Inc	Cambridge
Knome, Inc	Cambridge
LeMaitre Vascular, Inc.	Burlington
Lightlab Imaging, Inc.	Westford
Merrimack Pharmaceuticals, Inc.	Cambridge
Metamark Genetics, Inc	Cambridge
Mevion, Inc.	Littleton
Moderna Therapeutics, Inc	Cambridge
MoMelan Technologies, Inc	Cambridge
Momenta Pharmaceuticals, Inc	Cambridge
Myomo, Inc	Cambridge
New England Biolabs, Inc	Ipswich
NinePoint Medical, Inc	Cambridge
Nova Biomedical Corporation	Waltham
NxStage Medical, Inc.	Lawrence
OmniGuide, Inc.	Cambridge
Organogenesis, Inc.	Canton
PAREXEL International Corporation	Lowell

PerkinElmer, Inc	Waltham
Pharmalucence, Inc	Bedford
Pluromed, Inc.	Woburn
Quanterix Corporation	Cambridge
Ra Pharmaceuticals, Inc	Cambridge
Sanofi-Aventis, Inc.	Cambridge
Shire Human Genetic Therapies, Inc.	Lexington
STD Med, Inc.	Stoughton
Sunovion, Inc.	Marlboro
T2Biosystems, Inc	Lexington
Valeritas, Inc.	Shrewsbury
Vertex Pharmaceuticals, Inc	Cambridge
Wadsworth Medical Technologies, Inc	Westborough
Wolfe Laboratories, Inc.	Watertown

Massachusetts Life Sciences Center

Financial Statements with Management's Discussion and Analysis
June 30, 2012 and 2011

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pwc

Report of Independent Auditors

To the Board of Directors of the
Massachusetts Life Sciences Center:

In our opinion, the accompanying balance sheets and the related statements of revenues, expenses and changes in net assets and of cash flows of the Massachusetts Life Sciences Center (the "Center") (a component unit of the Commonwealth of Massachusetts), present fairly, in all material respects, the financial position of the Center at June 30, 2012 and June 30, 2011, and the related changes in financial position and cash flows for the years then ended, in conformity with accounting principles accepted in the United States of America. These financial statements are the responsibility of the Center's management. Our responsibility is to express an opinion on these financial statements based on our audits. We conducted our audits of these statements in accordance with auditing standards generally accepted in the United States of America. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements, assessing the accounting principles used and significant estimates made by management, and evaluating the overall financial statement presentation. We believe that our audits provide a reasonable basis for our opinion.

The accompanying management's discussion and analysis on pages 2 through 5 is required by accounting principles generally accepted in the United States of America to supplement the basic financial statements. Such information, although not a part of the basic financial statements, is required by the Governmental Accounting Standards Board who considers it to be an essential part of financial reporting for placing the basic financial statements in the appropriate operational, economic, or historical context. We have applied certain limited procedures to the required supplementary information in accordance with auditing standards generally accepted in the United States of America, which consisted of inquiries of management about the methods of preparing the information and comparing the information for consistency with management's responses to our inquiries, the basic financial statements, and other knowledge we obtained during our audits of the basic financial statements. We do not express an opinion or provide any assurance on the information because the limited procedures do not provide us with sufficient evidence to express an opinion or provide any assurance.

PricewaterhouseCoopers LLP

September 26, 2012

PricewaterhouseCoopers LLP, 125 High Street, Boston, MA 02110
T: (617) 530 5000, F: (617) 530 5001, www.pwc.com/us

Massachusetts Life Sciences Center
Management's Discussion and Analysis (unaudited)
June 30, 2012 and 2011

As the Board of Directors of the Massachusetts Life Sciences Center (the "Center") we offer the following narrative overview and analysis of the financial activities of the Center for the fiscal years ended June 30, 2012, 2011 and 2010. This unaudited management discussion and analysis should be read in conjunction with the audited financial statements and the notes thereto, which follow this section.

The Center was created on June 24, 2006 in the Economic Stimulus Bill, Chapter 123, Section 24 of the Acts of 2006 and codified in the Massachusetts General Laws, Chapter 23I. The Center is a body politic and corporate. Exercise of the powers conferred by Chapter 23I is considered to be the performance of an essential governmental function. The purpose of the Center is to promote the life sciences within the Commonwealth of Massachusetts (the "Commonwealth"). It is tasked with investing in life sciences research and economic development initiatives. This work includes making financial investments in public and private institutions growing life sciences research, development and commercialization, as well as building ties between sectors of the Massachusetts life sciences community.

On June 16, 2008, the Life Sciences Act enacted by the Massachusetts Legislature was signed into law by Governor Deval Patrick. The Commonwealth committed to investing $1 billion over a ten year period to create jobs, drive innovation and promote biomedical breakthroughs that improve people's lives. The Center is the steward of the $1 billion and uses three statutory funding vehicles to achieve the Commonwealth's mission: the Life Sciences Investment Fund (the "Investment Fund"), the Capital Program and the Life Sciences Tax Incentive Program.

The Life Sciences Investment Fund is to be used in making appropriations, allocations, grants or loans to leverage development and investments in life sciences in Massachusetts. The Capital Program is for municipalities and institutions for buildings, upgrades to roads, equipment, sewer lines and other infrastructure that supports growth in the life sciences sector. The Life Sciences Tax Incentive Program allows the Center to award tax incentives to companies at every stage of development.

The Center is governed by a seven member Board of Directors (the "Board of Directors") consisting of: the Secretary of Administration and Finance or her/his designee; the Secretary of Housing and Economic Development or his/her designee; the president of the University of Massachusetts or his/her designee; and four members appointed by the Governor, one of whom is a physician licensed to practice medicine in Massachusetts and affiliated with an academic medical center, one of whom is a CEO of a Massachusetts-based life sciences corporation that is a member of the board of directors of the Massachusetts Biotechnology Council, one of whom is a researcher involved in the commercialization of biotechnology, pharmaceuticals or medical diagnostic products and one of whom has significant financial experience in the life sciences sector.

Using the Financial Statements

The Center's annual report includes three basic financial statements: the balance sheet; the statement of revenues, expenses and changes in net assets; and the statement of cash flows. The basic financial statements are prepared in accordance with accounting principles generally accepted in the United States of America ("GAAP") as promulgated by the Governmental Accounting Standards Board ("GASB").

Massachusetts Life Sciences Center
Management's Discussion and Analysis (unaudited)
June 30, 2012 and 2011

Financial Highlights
The balance sheet is presented to illustrate both the current and non-current balances of each asset and liability. All revenues and expenses are classified as either operating or non-operating activities in the statement of revenues, expenses and changes in net assets. Operating activities are those that support the mission and purpose of the Center. Non-operating activities represent transactions that are capital, investing, legislative or regulated in nature. The GASB requires that resources be classified into three categories of net assets. Net assets represent the residual interest in the Center's assets after liabilities are deducted and consist of: invested in capital assets, net of related debt; restricted; and unrestricted.

Total assets of the Center fluctuate year to year mainly based on timing of receipts of reimbursements due to the Center for Investment Fund and Capital Program expenses incurred by grantees in addition to contributions received from the Commonwealth of Massachusetts. Total liabilities fluctuate year to year mainly due to the timing of related payments for the Investment Fund and Capital Program passed through the Center payable to the grantees. Net assets of the Center are all unrestricted, aside from those invested in capital assets. Ending net assets as of June 30, 2012, 2011 and 2010 is $27,201,578, $26,271,099 and $25,452,148, respectively. Changes in net assets year over year is driven by the changes in revenues and expenses by the Center. The significant components of change in revenues and expenses year over year are discussed in the remainder of the management discussion and analysis of this document.

Fiscal year 2012 is the fourth year of the initiative and reflects a year of significant operating activities of the Center as grants were made both from the Investment Fund and Capital Programs and a third round of awards under the Life Sciences Tax Incentive Program were made.

Investment Fund
Section 24 of Chapter 123 of the Acts of 2006 established the Massachusetts Life Sciences Investment Fund to be administered by the Center to finance its activities. The Life Sciences Act of 2008 contemplates an annual appropriation from the legislature totaling $250 million over 10 years. The Investment Fund is also to be used to support the administrative expenses and investment in property and equipment of the Center.

The legislature appropriated $10 million in fiscal year 2012, $10 million in fiscal year 2011 and $10 million in fiscal year 2010.

In fiscal year 2012, the Board of Directors authorized $5.1 million in commitments as compared to $4.5 million in fiscal year 2011 and $4.4 million in fiscal year 2010. The commitments were for research grants, workforce development programs, and programs that support innovation in life sciences. The increase in fiscal year 2012 from fiscal year 2011 is due to an expansion of existing programs and a new international innovation program. The slight increase in commitments in fiscal year 2011 from fiscal year 2010 was due to an expansion of existing programs. In fiscal year 2012, the Center incurred $6.8 million of grant expense compared to $6.6 million in fiscal year 2011 and $9.1 million in fiscal year 2010. The slight increase in expense in fiscal year 2012 from fiscal year 2011 is due to the timing of programs. The decrease in fiscal year 2011 from fiscal year 2010 is due to fewer grants in 2011 and grants obligations that were fulfilled in fiscal year 2010. Remaining payment commitments as of June 30, 2012 on the outstanding grants are approximately $9.2 million.

In fiscal year 2012, the Board of Directors authorized $6 million for early stage company loans under the Life Sciences Accelerator Loan program for fiscal year 2013. The loan program provides working capital to early stage companies at a critical stage of development. From prior year authorizations, the Center awarded $3.1 million in fiscal year 2012 and $3.75 million in fiscal year 2011. Of the $3.1 million in investment funds awarded in fiscal year 2012, none have been disbursed as of June 30, 2012.

Capital Programs
The Capital Program was created by the Life Sciences Act and is for municipalities and institutions for buildings, upgrades to roads, sewer lines and other infrastructure that supports growth in the life sciences sectors. The Life Sciences Act provides for $500 million to the Capital Program over 10 years. The Capital Program is funded by the Commonwealth of Massachusetts. In fiscal year 2012, the Center entered into six new commitments for $56 million. In fiscal year 2012, the Center incurred $42.5 million of grant expense compared to approximately $29.1 million in fiscal year 2011 and $28.5 million in fiscal year 2010. The increase in fiscal year 2012 from fiscal year 2011 is due to prior commitments incurring greater expense in fiscal year 2012. The increase in fiscal year 2011 from fiscal year 2010 is due to prior commitments incurring greater expense in fiscal year 2011. The Life Sciences Act also provides for a Life Sciences Education fund for providing grants for purchasing or leasing equipment to train students in life sciences and research. In fiscal year 2011, the Center made 32 grants for a new program to vocational/technical high schools, community colleges and other workforce development programs totaling nearly $3.4 million and incurring expense of $2.9 million. In fiscal year 2012, no new awards were made and the Center incurred $483,000 of grant expense under the program from prior year awards.

The Life Sciences Act also provides for a small business matching grant fund under the Capital Program. Under the program companies that have received Phase II or later small business innovation research ("SBIR") grants can receive up to $500,000 in grants from the Center to assist the awardee with commercializing their product. In fiscal year 2010, three companies received awards and the Center incurred $1,500,000 of expense in fiscal year 2010. In fiscal year 2011, four companies received awards and the Center incurred $2,000,000 of expense in fiscal year 2011. In fiscal year 2012, the Center made one award totaling $500,000 under the program.

Life Sciences Tax Incentive Program
The Life Sciences Tax Incentive Program was created by the Life Sciences Act and allows the Center to award tax incentives to companies at every stage of development. The Center has the ability to award ten different tax incentives with a cumulative cap of $25 million per year for 10 years. The tax incentives have no financial impact on the Center. The Center awarded $20.3 million to 26 companies in fiscal year 2012, $20.9 million to 24 companies in fiscal year 2011, and $24.4 million to 26 companies in fiscal year 2010.

Investment Income
Investment income in fiscal year 2012 was $73,000 compared to $86,000 in fiscal year 2011 and $113,000 in fiscal year 2010. Investment income relates to interest earned throughout the fiscal year on the Center's cash and cash equivalent balance. The decrease in fiscal year 2012 from fiscal year 2011 is due to a lower average balance. The decrease in fiscal year 2011 from fiscal year 2010 is due to a lower average balance.

Massachusetts Life Sciences Center
Management's Discussion and Analysis (unaudited)
June 30, 2012 and 2011

Administrative Expenses and Investments in Property and Equipment
In accordance with the Act, administrative expenses and purchases of property and equipment are provided by the Investment Fund. In fiscal year 2012, the Center incurred approximately $2.2 million of administrative expenses and purchases of property and equipment. In fiscal year 2011 and 2010 the Center incurred approximately $2.2 million and $2.3 million, respectively, of administrative expenses. The same level of expenditures in fiscal year 2012 from fiscal year 2011 is due to higher staffing costs as a result of a full year of costs for open positions filled during fiscal year 2011 and lower fiscal year 2012 communications programs, professional fees and administrative expenses. The decrease in expenditures in fiscal year 2011 from fiscal year 2010 is due to lower staffing costs as a result of open positions and lower communications programs. For the fiscal years ended June 30, 2012, June 30, 2011 and June 30, 2010, the headcount of the Center was ten, nine, and nine, respectively.

Liquidity of the Investment Fund
From inception through June 30, 2012, the Investment Fund has received appropriations from the Commonwealth of $70 million. In addition, the Center has received investment income of approximately $2.1 million and in loan repayments, sponsorship and corporate consortium revenues of approximately $3.8 million during the corresponding period for total inflows of approximately $75.9 million. The Center reserves all the funds required for a grant or loan commitment at the time of the Board of Directors' authorization. From inception through June 30, 2012, the Center has disbursed or reserved approximately $72.2 million resulting in approximately $3.7 million of available funds as of June 30, 2012.

Massachusetts Life Sciences Center
Balance Sheets
June 30, 2012 and 2011

	2012	2011
Assets		
Current assets		
Cash and cash equivalents	$ 27,513,436	$ 27,279,085
Accounts receivable	-	64,900
Grant reimbursement from the Commonwealth	17,464,289	19,715,000
Interest receivable, net	351,674	198,126
Prepaid expenses and other current assets	49,646	38,517
Total current assets	45,379,045	47,295,628
Loans receivable, net	2,503,500	2,012,500
Property and equipment, net	31,683	100,018
Total noncurrent assets	2,535,183	2,112,518
Total assets	$ 47,914,228	$ 49,408,146
Liabilities		
Current liabilities		
Accounts payable and accrued expenses	$ 201,371	$ 231,438
Grants payable and accrued grant expense	20,466,488	22,717,961
Other current liabilities	-	125,000
Total current liabilities	20,667,859	23,074,399
Deferred rent	44,791	62,648
Total liabilities	20,712,650	23,137,047
Net Assets		
Invested in capital assets	31,683	100,018
Unrestricted net assets	27,169,895	26,171,081
Total net assets	27,201,578	26,271,099
Total liabilities and net assets	$ 47,914,228	$ 49,408,146

The accompanying notes are an integral part of these financial statements.

Massachusetts Life Sciences Center
Statements of Revenues, Expenses, and Changes in Net Assets
Years Ended June 30, 2012 and 2011

	2012	2011
Operating income		
Capital program revenues from the Commonwealth	$ 43,500,000	$ 34,000,000
Sponsorship/corporate consortium revenues	131,300	607,567
Interest income	392,911	178,864
Total operating income	44,024,211	34,786,431
Operating expenses		
Grant expense	50,265,235	40,564,217
Salary and related employee expenses	1,438,984	1,277,158
Professional and consulting fees	180,152	202,576
Communications programs, sponsorships and contributions	224,874	326,516
General and administrative expenses	368,248	383,184
Loan loss reserve expense, net	616,000	1,212,500
Depreciation	73,386	87,659
Total operating expenses	53,166,879	44,053,810
Operating loss	(9,142,668)	(9,267,379)
Nonoperating revenues		
Investment income	73,147	86,330
Total nonoperating revenues	73,147	86,330
Loss before capital contributions	(9,069,521)	(9,181,049)
Contributions from the Commonwealth	10,000,000	10,000,000
Increase in net assets	930,479	818,951
Net assets		
Beginning of year	26,271,099	25,452,148
End of year	$ 27,201,578	$ 26,271,099

The accompanying notes are an integral part of these financial statements.

Massachusetts Life Sciences Center
Statements of Cash Flows
Years Ended June 30, 2012 and 2011

	2012	2011
Cash flows from operating activities		
Receipts for reimbursements from the Commonwealth	$ 45,750,711	$ 23,952,583
Payments for grants	(52,516,708)	(30,312,008)
Payments for salary and related employee expenses	(1,424,832)	(1,268,000)
Payments for professional consulting fees	(161,574)	(173,363)
Payments for general and administrative expenses	(389,814)	(437,340)
Payments for communication programs, sponsorships and contributions	(295,091)	(253,894)
Receipts for interest income	239,363	130,587
Receipts for sponsorships	71,200	662,767
Net cash used in operating activities	(8,726,745)	(7,698,668)
Cash flows from capital financing activities		
Receipt of contributions from the Commonwealth	10,000,000	10,000,000
Net cash provided by capital financing activities	10,000,000	10,000,000
Cash flows from investing activities		
Purchase of property and equipment	(5,051)	(2,676)
Issuance of loans	(2,207,000)	(2,775,000)
Repayment of loans	1,100,000	1,000,000
Receipt of investment income	73,147	86,330
Net cash used in investing activities	(1,038,904)	(1,691,346)
Net increase in cash and cash equivalents	234,351	609,986
Cash and cash equivalents		
Beginning of year	27,279,085	26,669,099
End of year	$ 27,513,436	$ 27,279,085
Reconciliation of cash flows from operating activities		
Operating loss	$ (9,142,668)	$ (9,267,379)
Adjustments to reconcile operating loss to net cash used in operating activities		
Depreciation expense	73,386	87,659
Loan loss reserve	616,000	1,212,500
Loan interest reserve	215,599	186,484
Changes in assets and liabilities		
Accounts receivable	64,900	346,867
Grant reimbursement from the Commonwealth	2,250,711	(10,047,417)
Interest receivable	(369,147)	(234,761)
Prepaid expenses and other current assets	(11,129)	(17,956)
Accounts payable and accrued expenses	(30,067)	86,796
Grants payable and accrued grant expense	(2,251,473)	10,252,209
Deferred rent	(17,857)	(12,003)
Other current liabilities	(125,000)	(291,667)
Total adjustments	415,923	1,568,711
Net cash used in operating activities	$ (8,726,745)	$ (7,698,668)

The accompanying notes are an integral part of these financial statements.

Massachusetts Life Sciences Center
Notes to Financial Statements
June 30, 2012 and 2011

1. Organization

On June 24, 2006, the Commonwealth of Massachusetts (the "Commonwealth") enacted Section 24 of Chapter 123 of the Acts of 2006, creating the Massachusetts Life Sciences Center (the "Center") and establishing the Massachusetts Life Sciences Investment Fund (the "Investment Fund") to financially support its activities.

On June 16, 2008, the Life Sciences Act enacted by the Massachusetts Legislature was signed into law by Governor Deval Patrick. The Commonwealth committed to investing $1 billion over a ten year period to create jobs, drive innovation and promote biomedical breakthroughs that improve people's lives. The Center is the steward of the $1 billion and uses three statutory funding vehicles to achieve the Commonwealth's mission: the Life Sciences Investment Fund (the "Investment Fund'), the Capital Program and the Life Sciences Tax Incentive Program.

The Life Sciences Investment Fund is to be used in making appropriations, allocations, grants or loans to leverage development and investments in life sciences in Massachusetts. The Capital Program is for municipalities and institutions for buildings, upgrades to roads, equipment, sewer lines and other infrastructure that supports growth in the life sciences sector. The Life Sciences Tax Incentive Program allows the Center to award tax incentives to companies at every stage of development.

All investments to be made by the Center require approval by its Board of Directors.

The Center is a component unit of the Commonwealth of Massachusetts.

2. Significant Accounting Principles

Accounting and Reporting Standards
These financial statements have been prepared in accordance with accounting principles generally accepted in the United States of America, as prescribed by the Governmental Accounting Standards Board.

The Center applies all Governmental Accounting Standards Board ("GASB") pronouncements and Financial Accounting Standards Board ("FASB") pronouncements issued before November 30, 1989 that do not conflict with GASB pronouncements, under the provisions of GASB Statement No. 20, *Accounting and Financial Reporting for Proprietary Funds and Other Governmental Entities That Use Proprietary Fund Accounting*.

The GASB defines the basic financial statements of a business type activity as the: balance sheet, statement of revenues, expenses and changes in net assets, the statement of cash flows, and management's discussion and analysis as required supplemental information. The balance sheet is presented to illustrate both the current and noncurrent balances of each asset and liability. All revenues and expenses are classified as either operating or nonoperating activities in the statement of revenues, expenses and changes in net assets. Operating activities are those that support the mission and purpose of the Center. Nonoperating activities represent transactions that are capital, investing, legislative or regulated in nature. The GASB requires that resources be classified into three categories of net assets. Net assets represent the residual interest in the Center's assets after liabilities are deducted and consist of: invested in capital assets, net of related debt; restricted; and unrestricted. Those assets are defined as follows:

Invested in Capital Assets
Invested in capital assets, net of related debt, includes capital assets, net of accumulated depreciation and outstanding principal balances of debt attributable to the acquisition, construction or improvement of those assets.

Restricted
Restricted assets are those net assets subject to externally imposed stipulations that can be fulfilled by actions of the Center pursuant to those stipulations or that expire by the passage of time.

Unrestricted
Unrestricted assets are those net assets that are not subject to externally imposed stipulations. Unrestricted net assets may be designated for specific purposes by action of management or the Board of Directors or may be otherwise limited by contractual agreements with outside parties. The Center's unrestricted net assets include appropriations received from the Commonwealth that are restricted for the general purposes of the Center. Per its enabling legislation, the Center may not expend more than fifteen percent of the amounts to be expended from the Life Sciences Investment Fund for the fiscal year for administrative expenditures and property and equipment.

Use of Estimates
The preparation of financial statements in conformity with accounting principles generally accepted in the United States of America requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and disclosure of contingent assets and liabilities at the date of the financial statements and the reported amounts of revenues and expenses during the reporting period. Actual results could differ from those estimates.

Cash and Cash Equivalents
Cash and cash equivalents consist of amounts on hand and highly liquid interest investments with maturities of three months or less at acquisition.

Revenue Recognition
Investment income is recognized as earned. Sponsorship revenues are related to the Center providing tradeshow booths and other space for companies for a trade show. Sponsorship revenues are recognized when earned upon occurrence of the event. Consortium revenues are fees paid by corporations to sponsor and participate in the Center's small business matching grant and accelerator loan programs. Fees are for a specific time period. Revenues are recognized over the specified time period.

Interest income on loans is recognized as earned. Interest income is net of any interest income loss reserve.

Capital program revenues are amounts due to the Center by the Commonwealth for related capital program expenditures by the Center for grantees of the Center. Capital program revenues are recognized in the period earned.

Contributions From the Commonwealth of Massachusetts
Contributions from the Commonwealth are recognized when received from the Commonwealth.

Loans Receivable and Interest Receivable, Net
Loans receivable, net, consists of loans issued by the Center to facilitate research, development, manufacturing and commercialization in life sciences by early stage companies. The loans have repayment terms of the earlier of 5 years or a qualified financing greater than $5,000,000. The stated interest rate on each loan is 10% compounded annually.

As of June 30, 2012, $11,207,000 of loans receivable has been authorized and $8,382,000 has been disbursed. During fiscal year 2012, two borrowers repaid back their loans in full with a combined repayment of principal of $1,100,000. On a periodic basis, the Center assesses the collectability of each loan and establishes a loss reserve. As of June 30, 2012, $5,782,000 of loans receivable are outstanding and $3,278,500 has been reserved for losses, resulting in net loans receivable of $2,503,500. The Center has no write-offs or recoveries in fiscal years 2012 and 2011.

As of June 30, 2012, the gross interest receivable balance was $903,607. On a periodic basis, the Center assesses the collectability of the interest receivable and establishes a loss reserve. As of June 30, 2012, $551,933 has been reserved resulting in net interest receivable of $351,674. Interest is due at the end of the loan term or upon repayment of the loan due to a qualified financing of these companies of greater than $5,000,000.

Grant Expense and Grants Payable
Grant expenses are related to grant awardees in the period incurred. The Center had grant expense of $50,265,235 and $40,564,217 for fiscal year 2012 and 2011, respectively. As of June 30, 2012 and 2011, $20,466,488 and $22,717,961, respectively, was recorded as grants payable, representing grant expense incurred but not yet paid.

Income Taxes
Pursuant to Massachusetts General Laws chapter 23I §6(a), the operations of the Center constitute the performance of an essential government function and are therefore exempt from taxation by and within the Commonwealth.

Defined Contribution Plan
All employees of the Center participate in either the Commonwealth of Massachusetts State Retirement systems or the statutorily prescribed optional defined contribution plan provided by the Center. The Center makes no contributions for employees participating in the Commonwealth of Massachusetts State Retirement systems' pension plan. In fiscal year 2010, as provided by the 2008 Statute, the Center established the optional defined contribution plan. The Center annually contributes an amount equal to 12% (5% statutorily mandated) of an employee's annual gross salary less the cost of life and disability insurance. Total optional defined contribution expense by the Center for the years ended June 30, 2012 and 2011 was $94,715 and $80,536, respectively. Vesting is immediate upon contribution. The Center pays administrative expenses of the Plan for the plan participants and ING is the custodian of the plan's assets. The balances of the plan are not included in the financial statements of the Center.

Massachusetts Neuroscience Consortium
In June 2012, the Center announced the formation of a separate initiative, the Massachusetts Neuroscience Consortium (the "Consortium), a collaboration between seven global pharmaceutical companies. The Consortium will fund pre-clinical neuroscience at Massachusetts academic and research institutions. Each Consortium member has agreed to contribute $250,000 to the Consortium for the first year membership contribution. The Center is not a member of the Consortium and makes no financial contribution to the Consortium. The financial burden and administrative control does not reside with the Center. The designated members of the Consortium are responsible for all decisions regarding disbursement of funds. The Center acts solely as a custodian of the Consortium funds which are segregated in a separate bank account, the Center does not receive any fees for custodial services provided. No amounts due to the Consortium were received by the Consortium as of June 30, 2012. Subsequent to year end, the Consortium has received $1,500,000 from membership contributions to date held within the segregated bank account of the Center. The balances of the Consortium are not included in the financial statements of the Center as of June 30, 2012. If the Consortium was to terminate, all remaining funds would be due back to the contributing members on a pro-rata basis.

3. Related Party Transactions

Certain of the Center's Board of Director's members have relationships with institutions that have received grants. Absent any statutory exemptions to the conflict of interest law, in circumstances where approval of such votes would create a conflict of interest, the Center's Board members are required to rescue themselves.

4. Cash and Cash Equivalents

The following summarizes the cash and cash equivalents of the Center and identifies certain types of investment risk as defined by GASB Statement No. 40, *Deposit and Investment Risk Disclosures*, at June 30, 2012 and 2011.

June 30, 2012	Carrying Amount	Fair Value
Cash deposits	$ 2,913,399	$ 2,913,399
Massachusetts Municipal Depository Trust (MMDT) Cash Portfolio	24,600,037	24,600,037
Total at June 30, 2012	$ 27,513,436	$ 27,513,436

June 30, 2011	Carrying Amount	Fair Value
Cash deposits	$ 3,748,111	$ 3,748,111
Massachusetts Municipal Depository Trust (MMDT) Cash Portfolio	23,530,974	23,530,974
Total at June 30, 2011	$ 27,279,085	$ 27,279,085

Massachusetts Life Sciences Center
Notes to Financial Statements
June 30, 2012 and 2011

Custodial Credit Risk—Deposits
The custodial credit risk for deposits is the risk that in the event of a bank failure, the deposits may not be recovered. The Center's cash and cash equivalents are held by financial institutions, and exceed generally insured limits. All deposits are uninsured and uncollateralized.

Interest Rate Risk
Interest rate risk is the risk that changes in interest rates will adversely affect the fair value of an investment. The Center manages its exposure to interest rate risk by so that investments mature to meet cash requirements for ongoing operations and investing operating funds primarily in cash equivalents.

As of June 30, 2012 and 2011, the Massachusetts Municipal Depository Trust investment maturities are summarized as follows:

2012		Investment Maturities (in Years)			
Investment Type	**Fair Value**	**Less Then 1**	**1-5**	**6-10**	**More Then 10**
Certificates of deposit	$ 8,589,201	$ 8,589,201	$ -	$ -	$ -
Commercial paper	6,191,431	6,191,431			
U.S. Government and government agency obligations	1,327,076	1,327,076			
U.S. Treasury obligations	2,869,529	2,869,529			
Medium-term notes	783,606	783,606			
Repurchase agreements	4,827,653	4,827,653			
Total investment	24,588,496	24,588,496	-	-	-
Net other assets/liabilities	11,541	11,541			
Net assets	$ 24,600,037	$ 24,600,037	$ -	$ -	$ -

2011		Investment Maturities (in Years)			
Investment Type	**Fair Value**	**Less Then 1**	**1-5**	**6-10**	**More Then 10**
Certificates of deposit	$ 11,529,131	$ 11,529,131	$ -	$ -	$ -
Commercial paper	3,676,039	3,676,039			
U.S. Government and government agency obligati	68,100	68,100			
Federal agencies					
U.S. Treasury obligations	1,439,120	1,439,120			
Assets-backed securities	125,464	125,464			
Medium-term notes	1,195,979	1,195,979			
Municipal securities	162,217	162,217			
Repurchase agreements	5,323,346	5,323,346			
Total investment	23,519,396	23,519,396	-	-	-
Net other assets/liabilities	11,578	11,578			
Net assets	$ 23,530,974	$ 23,530,974	$ -	$ -	$ -

5. Property and Equipment, Net

Property, equipment, and leasehold improvements are all stated at cost. Depreciation is recorded over the estimated useful lives of the assets by the straight line method. Expenditures for maintenance and repairs are charged to expense as incurred. Depreciation expense totaled $73,386 and $87,659 for the years ended June 30, 2012 and 2011, respectively. Estimated useful lives used for computing depreciation on property, equipment and leasehold improvements are as follows:

Computer equipment and software	3 years
Office equipment	3 years
Office furniture	3 years
Leasehold improvements	shorter of the remaining term of lease or asset life

Property and equipment, net, at June 30, 2012 and 2011 consisted of the following:

	2012	2011
Computer equipment	$ 96,803	$ 92,537
Office furniture	133,561	132,776
Leasehold improvements	73,459	73,459
	303,823	298,772
Accumulated depreciation	(272,140)	(198,754)
Property and equipment, net	$ 31,683	$ 100,018

6. Accounts Payable and Accrued Expenses

As of June 30, 2012 and 2011, accounts payable and accrued expenses totaled $201,371 and $231,438, respectively. Those expenses primarily accounted for accrued salary, professional and consulting fees and reimbursements owed for services provided by the Massachusetts Technology Collaborative.

7. Grants and Commitments

Investment Fund
The following grants were made out of the Massachusetts Life Sciences Investment Fund (the "Investment Fund"):

In October 2007, the Board of Directors voted to approve two grants for the University of Massachusetts Medical School: 1) $570,000 for funding for a stem cell registry; and 2) $7,665,000 for a stem cell bank. In June 2009, the Board of Directors voted to approve an additional $695,000 for the stem cell registry. In September 2010, the Board of Directors voted to approve an additional $440,000 for the stem cell registry. In January and May 2012, the Board of Directors voted to approve an additional $950,000 for the stem cell bank. For the year ended June 30, 2012, the Center expensed $994,149, of which $519,011 was not paid as of June 30, 2012 and is included in

grants payable and accrued grant expense on the balance sheet. For the year ended June 30, 2011, the Center expensed $1,117,081. Remaining payments under the authorized grants are $1,166,544 as of June 30, 2012.

In July 2008, the Board of Directors voted to approve $6,918,378 in funding for two research matching grant programs to attract top scientific talent, spur new research opportunities and increase industry-sponsored research. Specifically, the Board of Directors awarded five new faculty grants totaling $3,750,000 to various Massachusetts universities. The Board of Directors also awarded eleven new investigator grants totaling $3,168,378 to a variety of research centers. For the year ended June 30, 2012, the Center expensed $1,558,045 of which $449,216 was not paid as of June 30, 2012 and is included in grants payable and accrued grant expense on the balance sheet. For the year ended June 30, 2011, the Center expensed $2,207,626. Remaining payments under the authorized grants are $1,485,533 as of June 30, 2012.

In December 2008, the Board of Directors voted to approve $3,786,867 for six cooperative research grants over a three-year period to foster collaborations between scientists, academic institutions and industry. In fiscal year 2012, one of the awards was mutually terminated due to a change in focus by the industry sponsor. The amount remaining on the terminated grant was $658,779. For the year ended June 30, 2012, the Center expensed $1,061,638 of which $650,811 was not paid as of June 30, 2012 and is included in grants payable and accrued grant expense on the balance sheet. For the year ended June 30, 2011, the Center expensed $832,739. Remaining payments under the authorized grants are $831,623 as of June 30, 2012.

In April 2011, the Board of Directors voted to approve $1,000,000 for two cooperative research grants. For the year ended June 30, 2012, the Center expensed $127,897 of which all was not paid as of June 30, 2012. For the year ended June 30, 2011, the Center did not incur any expense or make any payments under the grants. Remaining payments under the grants are $1,000,000 as of June 30, 2012.

In December 2011 and June 2012, the Board of Directors authorized $3,200,000 for the 2012 Internship Challenge Program which is a year round program. For the year ended June 30, 2012, the Center expensed $949,876 of which all was not paid as of June 30, 2012 and is included in grants payable and accrued grant expense on the balance sheet. Remaining payments under the authorized program are $3,200,000. In the winter and spring of 2011, the Board of Directors authorized up to $2,200,000 for the expenditures for the 2011 Internship Challenge Program. For the 2011 program $1,327,048 was expensed of which $107,448 was not paid as of June 30, 2012 and is included in grants payable and accrued grant expense on the balance sheet. For the year ended June 30, 2011, the Center expensed $535,665. Remaining payments under the authorized program are $444,735. For the 2010 Internship program, $615,400 was expensed and paid in fiscal year 2011 with no remaining payments as of June 30, 2012.

In June 2009, the Board of Directors voted to approve $1,380,256 for seven new investigator grants to various research centers. For the year ended June 30, 2012, the Center expensed $210,597 of which $122,681 was not paid as of June 30, 2012 and is included in grants payable and accrued grant expenses on the balance sheet. For the year ended June 30, 2011, the Center expensed $603,783. Remaining payments under the authorized program are $177,524 as of June 30, 2012.

In July 2009, the Board of Directors voted to approve $600,000 for three new investigator matching grants. For the year ended June 30, 2012, the Center expensed $144,606 of which $36,657 was not paid as of June 30, 2012 and is included in grants payable and accrued grant expense on the balance sheet. For the year ended June 30, 2011, the Center expensed $278,591. Remaining payments under the authorized program are $45,485 as of June 30, 2012.

Other Grants
The Center has also made $1,325,000 of grants to various business plan competitions, international collaborations and workforce development and educational programs to foster company development foster collaboration between Massachusetts and international organizations and expand life sciences education and workforce within the Commonwealth. For the year ended June 30, 2012, the Center expensed $354,586 of which $40,104 was not paid as of June 30, 2012 and is included in grant payable and accrued grant expense on the balance sheet. For the year ended June 30, 2011, the Center expensed $139,371. Remaining payments under the authorized grants are $751,148 as of June 30, 2012.

In fiscal 2012, the Center made an additional $50,000 grant to the Massachusetts Life Sciences Collaborative to launch and develop a formal Massachusetts Biomanufacturing Roundtable to support and promote the retention and growth of biomanufacturing in Massachusetts. The total amount of awards provided to the Massachusetts Biomanufacturing Roundtable is $100,000. For the year ended June 30, 2012, the Center expensed $36,792 of which $36,792 was not paid as of June 30, 2012 and is included in grant payable and accrued grant expense on the balance sheet. Remaining payments under the authorized grant are $55,042 as of June 30, 2012.

Pursuant to the Massachusetts fiscal year 2011 state budget, the Center made a $210,000 grant to the Massachusetts Biomedical Initiative which shall be expended for the operation and maintenance of the Massachusetts Biomedical Initiatives for the purpose of promoting the commercialization of new, academic-based research and development and raising the scientific awareness of the communities of the Commonwealth. The award amount was expensed and paid in the year ended June 30, 2011. There are no remaining payments as of June 30, 2012 under the authorized grant.

Total remaining payments for all Investment Fund grants as of June 30, 2012 are $9,157,634.

Capital Program Grants
The following grants were made under the Capital Program:

In October 2008, the Board of Directors voted to approve $5,200,000 for the replacement of a wastewater pump station that will help support the expansion of Genzyme Corporation's manufacturing facility in Framingham, Massachusetts. This grant is the first installment of approximately $12,900,000 that has been allocated to the Framingham project in connection with the Life Sciences Statute. In October 2009, the Board of Directors voted to approve the second installment of $7,700,000 for the $12,900,000 grant. In May 2011, the Board of Directors voted to approve an additional $1,400,000 for the town of Framingham. For the year ended June 30, 2012, the Center expensed $4,328,321 of which $1,255,322 was not paid as of June 30, 2012 and is included in grants payable and accrued grant expense on the balance sheet. For the year ended June 30, 2011, the Center expensed $2,883,475. Remaining payments under the authorized grant are $2,694,788 as of June 30, 2012.

In September 2009, the Board of Directors voted to approve $90,000,000 for the design, construction, development and related infrastructure improvements for an advanced therapeutics cluster to be constructed at the University of Massachusetts Medical School in Worcester. The payments are to be paid over four fiscal years beginning in fiscal year 2010 and concluding in fiscal year 2013. For the year ended June 30, 2012, the Center expensed $34,196,102 of which $12,434,062 was not paid as of June 30, 2012 and is included in grants payable and accrued grant expense on the balance sheet. For the year ended June 30, 2011, the Center expensed $25,888,094. Remaining payments under the authorized grant are $29,069,809 as of June 30, 2012.

In February 2010, the Board of Directors voted to approve $6,600,000 towards the next phase of development of Gateway Park in Worcester. The grant was subsequently reduced to $5,150,000 due to a reconfiguration of the project. The grant supports the development of WPI's Biomanufacturing Education and Training Center (BETC) and a new incubator for Massachusetts Biomedical Initiatives (MBI). For the year ended June 30, 2012, the Center expensed $2,447,395 of which $1,691,208 was not paid as of June 30, 2012 and is included in grants payable and accrued grants expense on the balance sheet. For the year ended June 30, 2011, the Center expensed $377,536. Remaining payments under the grant are $4,016,278 as of June 30, 2012.

In January 2011, the Board of Directors voted to approve $2,000,000 for the purchase of state-of-the-art equipment, renovations and related expenses to support the Center for Personalized Cancer Therapy at the University of Massachusetts at Boston and the Dana-Farber/Harvard Cancer Center. For the years ended June 30, 2012 and 2011, the Center did not incur any expense or make any payments under the grant. Remaining payments under the grant are $2,000,000 as of June 30, 2012.

In February 2011, the Board of Directors voted to approve $3,466,158 for thirty-two equipment grants for purposes of providing grants for purchasing or leasing equipment to train students in life sciences technology and research. For the year ended June 30, 2012, the Center expensed $482,780 of which all was paid prior to June 30, 2012. For the year ended June 30, 2011, the Center expensed $2,850,896. There are no remaining payments as of June 30, 2012 under the authorized grant.

In January 2012, the Board of Directors voted to approve $14,600,000 for the construction of the Bio-Manufacturing Center at the University of Massachusetts at Dartmouth to enable companies to set up small scale manufacturing operations for bio-processing operations. For the year ended June 30, 2012 the Center expensed $971,003 of which all was not paid as of June 30, 2012 and is included in grants payable and accrued grant expense on the balance sheet. Remaining payments under the grant are $14,600,000 as of June 30, 2012.

In January 2012, the Board of Directors voted to approve $20,000,000 to three awardees under the Center's FY12 Capital Project Matching Grant Program. These grants will be used to fund the Molecular Cancer Imaging Facility at the Dana Farber Cancer Institute which systematically examines patient tumors and matches targeted therapy to specific molecular changes in cancer cells; the Transitional Center for the Cure of Diabetes at the Joslin Diabetes Center, which focuses on the acceleration of basic discoveries into clinical research and care; and the Hall of Human Life Exhibit at the Museum of Science Boston, allowing the public a view into the innovative work being carried out in the life sciences community and inspire the next generation of researchers. For the year ended June 30, 2012 the Center expensed $574,400 of which all was not paid as of June 30, 2012 and is included in grants payable and accrued grant expense on the balance sheet. Remaining payments under the grants are $20,000,000 as of June 30, 2012.

In April 2012, the Board of Directors voted to approve $10,000,000 to construct and equip Nanomedicine and Nanobiomedical laboratories within the Emerging Technologies and Innovation Center at the University of Massachusetts at Lowell to be utilized for hands on student learning, research, development and industry partnership activities. For the year ended June 30, 2012, the Center did not incur any expense or make any payments under the grant. Remaining payments under the grant are $10,000,000 as of June 30, 2012.

In April 2012, the Board of Directors voted to approve $11,400,000 for the benefit of the University of Massachusetts at Dartmouth for the acquisition of land, improvements and related parking for the Advance Technology Manufacturing Center in Fall River from the Massachusetts Development Finance Authority in fiscal year 2015, pursuant to the Life Sciences Act. For the year ended June 30, 2012, the Center did not incur any expense or make any payments under the grant. Remaining payments under the grant are $11,400,000 as of June 30, 2012.

In May 2012, the Center's Board of Director awarded $500,000 in a Small Business Matching grant to one life sciences company in Massachusetts. To qualify for the program companies must have received a Phase II or Post Phase II small business innovation research (SBIR) or small business technology transfer (STTR) grant from federal agencies such as the National Institutes of Health (NIH), National Science Foundation (NSF), or Department of Defense (DOD). For the year ended June 30, 2012 the Center expensed $500,000 of which all was not paid as of June 30, 2012 and is included in grants payable and accrued grant expense on the balance sheet. Remaining payments under the grant are $500,000 as of June 30, 2012. In May 2010, the Board of Directors awarded $1,500,000 in Small Business Matching Grants to three life science companies in Massachusetts. In May 2011, the Center's Board of Director awarded $2,000,000 in Small Business Matching grants to four life sciences companies in Massachusetts. For the year ended June 30, 2011 the Center expensed $2,000,000. There no remaining payments under the grants as of June 30, 2012.

Total remaining payments for all capital program grants as of June 30, 2012 are $94,280,875.

Facility Lease

In December 2008, the Center entered into a 5 year noncancelable operating lease through March 2014 for its facilities in Waltham, Massachusetts. The lease agreement provides for certain months of nonpayment of rent ("free rent") and includes escalating rent payments. Rent expense is recorded on the straight line basis, and therefore, as of June 30, 2012 and 2011, deferred rent in the amount of $44,791 and $62,648, respectively, has been recorded. Rent expense under the operating lease was $159,256 for the year ended June 30, 2012 and 2011.

Future minimum lease payments under all operating lease agreements are approximately:

	Amount
2013	$ 183,000
2014	141,000
2015	-
2016	-
2017	-
Thereafter	$ 324,000

8. Subsequent Events

Management has evaluated subsequent events through September 26, 2012.

In July 2012, the Center disbursed $750,000 to one of the April 2012 Accelerator loan program awardees.

In August 2012, the Center disbursed $1,080,000 to two of the April 2012 Accelerator loan program awardees.

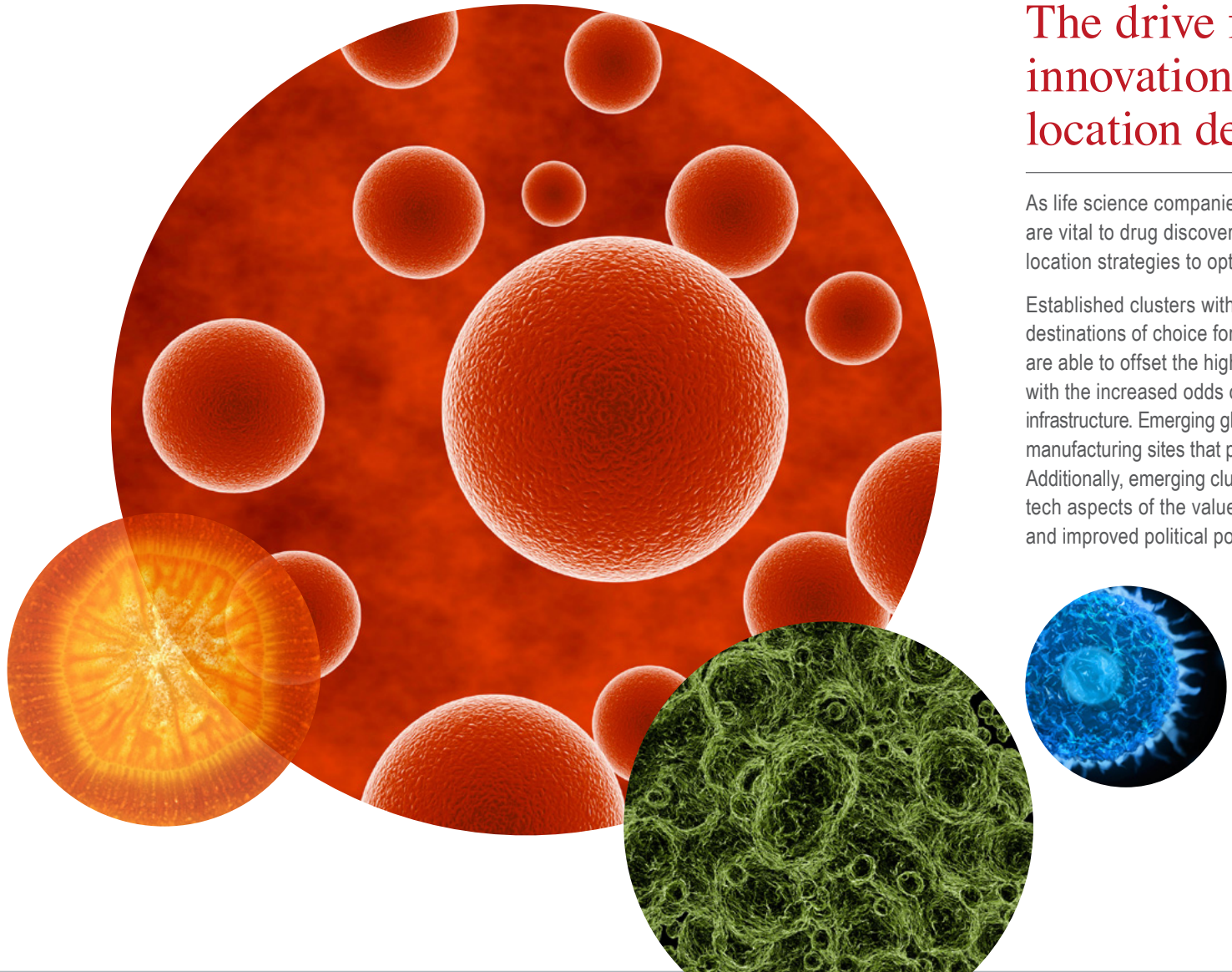
In September 2012, The Center entered into a Memorandum of Agreement (MOA) with the Economic Development and Industrial Corporation of Boston to operate an internship program. The MOA provides up to a maximum of $800,000 through March 2016.

Jones Lang LaSalle

Real value in a changing world

Life sciences cluster report

Global . 2011



The drive for discovery and innovation is shifting how location decisions are made

As life science companies determine which aspects of the business are vital to drug discovery and innovation, they are bifurcating their location strategies to optimize the cost versus output equation.

Established clusters within the United States and Europe remain destinations of choice for core aspects of drug discovery. Companies are able to offset the high costs of operating in established clusters with the increased odds of innovation due to deep, rich talent pools and infrastructure. Emerging global clusters, however, offer cost-advantageous manufacturing sites that provide both revenue and margin opportunities. Additionally, emerging clusters are becoming more competitive in high-tech aspects of the value chain, due to significant capital investments and improved political policies.

Jones Lang LaSalle

Life sciences cluster report

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A message from Bill Barrett

Complex macro and micro factors have forced the life sciences industry to re-examine traditional business models and location strategies.

William Barrett
Executive Managing Director, Life Sciences

Impacts of the global economic recession, increased competition, pricing pressure, depleted new-product pipelines and heightened regulatory processes all strain profitability and influence the industry's facility and location decisions. They produce an environment of change and the opportunity that comes with it for all market clusters.

As life sciences companies seek to balance their operations among the three global regions of the Americas, Europe/Middle East/Africa (EMEA) and Asia Pacific, and they have to evaluate the financial equation surrounding innovation and production. By honing in on the efficiency of R&D and manufacturing models and determining what aspects of drug discovery are core and essential to a product's lifeline and which are not, companies can use this knowledge to influence their location decisions.

As we'll see in this report, expansion into emerging clusters around the globe is at the forefront of most companies' location strategies due to market share opportunities and favorable cost structures for manufacturing and other operations. Not to be discounted, however, are the plans to remain in critical established clusters where deep and mature talent pools increase innovation efficiency.

Focus of the report

Given the importance of location, we thought it critical to examine industry-relevant global markets on a variety of data points that historically define a life sciences "cluster":

- Educated workforce
- Venture and investment capital
- Centers of excellence and innovation
- Industry-friendly political structures
- Institutions of higher learning
- Target economic development incentives
- Patent protection
- Other associations and supporting infrastructure

Although cluster infrastructure is not the only determinant of a city or country's viability as an industry hub, we think it serves as a good measuring stick and baseline point of comparison.

While we maintain a broad view of the life sciences industry, considering various sub-sectors such as pharmaceuticals, bio-technology, medical device technology, agricultural biotechnology and biofuels, the two most important sub-sectors for investment are pharmaceuticals and biotechnology. Consequently, we focus more of our attention on those two sub-sectors.

William Barrett leads the Life Sciences business at Jones Lang LaSalle. A seasoned veteran and leader in the pharmaceutical industry, Mr. Barrett is widely known as an expert in streamlining and transforming complex technical operations and for providing clients with overall global real estate and integrated facility management solutions.

Prior to his tenure at Jones Lang LaSalle, Mr. Barrett served over two decades with Pfizer, Inc., and its legacy companies, directing operations; research and development manufacturing operations around the world.

Mr. Barrett holds a Bachelors of Science in Chemistry from the University of Oklahoma and a JD from the John Marshall Law School. He is a member of the Illinois and Federal Bar Associations.

By Matt Jackson & Shannon Curley

The drug and pharmaceuticals global direct investment landscape

A focus on key areas with the greatest growth potential.

The location footprint for drug and pharmaceutical companies has been under ongoing transformation for an extended period. In response to seismic shifts within the industry, companies have been on a journey to realign the enterprise operating footprint with the new realities for *a)* how revenue will be generated, and *b)* margin preserved. Combined with a heightened focus on improved asset efficiency and more effective research and development, these factors have led to a shift in how enterprises configure operations around the world. This structural shift is closely tied to expectations about how the industry will create shareholder value and reflects the need to rebalance the portfolio of assets among regions of the world.

Some countries have emerged during the last decade as major recipients of foreign direct investment (FDI), while in others, the industry talks of rationalization or consolidation. For investors, it is important to understand trends that affect the industry and how they transform facility planning and foreign direct investment in the drug and pharmaceutical sector.

Focus of the discussion

The life sciences industry is commonly characterized as containing four major segments, including, *a)* agricultural feedstock and chemicals, *b)* drugs and pharmaceuticals, *c)* medical devices and equipment, and *d)* research, testing and laboratories. Within each segment, there are discrete sub-segments that span 27 industry classification codes. For purposes of this discussion, we will focus primarily on the drug and pharmaceuticals industry segment because of its size, its position with investor and the significant changes that companies have faced in recent years.

Drivers of operating footprint transformation

Like all systemic changes in business, the core driver for a new location footprint for drug and pharmaceuticals is the ongoing search for ways to create increased shareholder value. The network of locations have been reconfigured to place greater emphasis on locations with the best potential for revenue growth, improved operating margins, improved return on installed assets, changes in technology and production lines, and investor expectations. This has led to a shift in facility configuration and adaptations leading to improved competitiveness.

About the authors

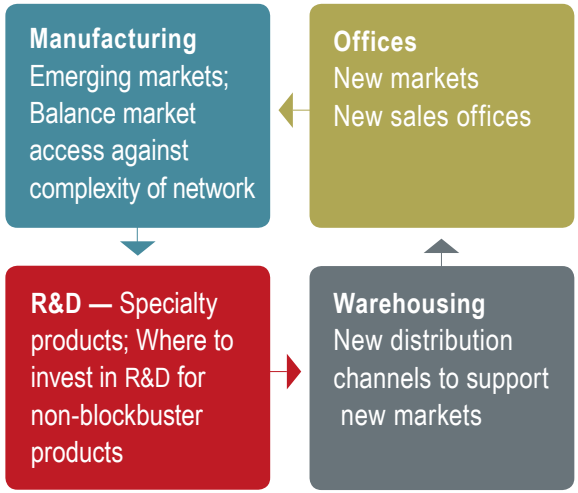
Matt Jackson serves as Jones Lang LaSalle's Strategic Consulting lead to the life sciences industry. He specializes in business configuration and cross border location strategy services and has worked for many leading companies in the life sciences industry.

Shannon Curley is a member of Jones Lang LaSalle's Strategic Consulting group and specializes in foreign direct investment strategy, cross border investment and business configuration.

Revenue growth

To increase revenue, the industry has shifted its focus to regions and countries with the greatest growth potential. Less emphasis will be placed on sales in North America and Europe — which today represent about 70 percent of industry revenue — and more emphasis will be placed on areas likely to experience double-digit revenue growth, such as Asia, Africa and Latin America.

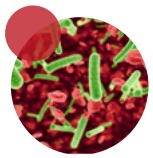
Figure 1
Revenue model impact on the location footprint



Growth in all three areas will result from increased health-care spending, demographic trends and shifting disease patterns. As a consequence, drug and pharmaceutical companies have rebalanced manufacturing, distribution, sales, and to some extent R&D operations among regions. Investments in Asia, in particular, have been significant. *(Reference, figure 1)*

Operating margin

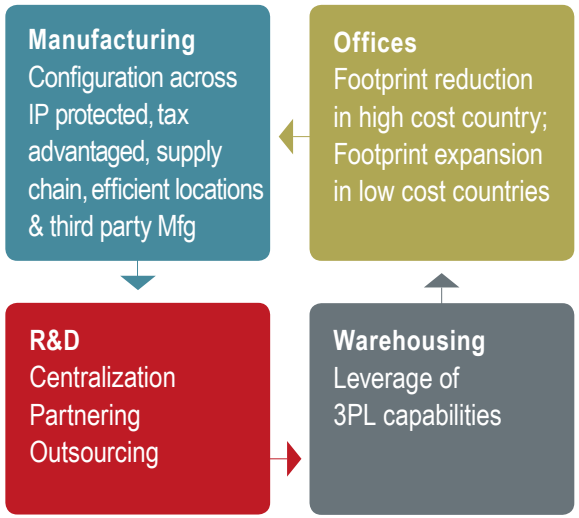
Drug and pharmaceutical facility locations and configurations have been altered as companies seek to improve or maintain operating margins (and net after tax profit) during a period characterized by patent expirations and an onslaught of generic drug alternatives. Notably, companies have invested in a number of low-cost platforms in efforts to preserve operating margins. An illustration of such a shift is the 80 percent share of global active pharmaceutical ingredient (API) now manufactured in India and China.



Companies in the sector are also reevaluating their businesses to identify core processes that must remain under their direct control, and non-core processes that can be performed by others. As a consequence, there is new emphasis on the use of third parties to reduce costs and improve margins across functional areas of the business in R&D, manufacturing, distribution and general and administrative processes. For functions that remain under direct control, companies seek alternative operating platforms to lower structural costs attributable to location. Many companies have migrated non-core activities and/or low margin products away from legacy Western European and North American locations to lower-cost destinations around the world (in particular India and China). Others have shifted to lower cost regions with shared services in support of the finance, tax, HR, IT, procurement and customer service organizations. While some companies in the industry have been slow to adopt shared service models, many companies now use low-cost locations to help support the business in high-cost countries.

Another approach has been to seek locations with a favorable tax structure. More companies seek locations in the attractive tax environments of Ireland and Singapore, for example, and there has been a corresponding move to divest assets in areas with poor or declining tax advantages. One example is Puerto Rico where there has been a significant decline in inward investment since 2007 as the tax benefits sunset for pioneer investors. It is fair to say that tax incentives were a powerful tool to develop the sector in countries where, a decade ago, the industry was embryonic. *(Reference, figure 2)*

Figure 2
Operating margin impact on the location footprint



Asset efficiency

A turbulent decade has also led to more focus on asset efficiency, in particular for manufacturing and research and development operations. Whereas in a period of economic growth the industry was highly incented to install excess capacity to ensure there were no constraints to revenue growth, the economic downturn

Figure 3
Asset efficiency impact on location footprint

resulted in a notable decline in capacity requirements and entire buildings becoming idle. From a manufacturing perspective, the drop in throughput requirement, shift of production capacity to emerging markets and the decline in the number of doses patients require per day all reduced capacity utilization at many plants. This is not easy to resolve, partly because of the unique nature of drug and pharmaceutical manufacturing facilities and technologies, and partly because of the need to separate entities and manufacturing technologies within a country to reduce legal risk. Many companies have been forced to dispose of under-utilized manufacturing operations at a fraction of replacement cost. In contrast, in emerging markets with significant growth potential, there is evidence that companies are rethinking the use of third-party manufacturers to improve asset utilization and bring more capacity under the direct control of the company.

Research and Development is the other area of focus for asset efficiency. R&D portfolios have been consolidated, and in high-cost countries, more work has been reallocated to research hubs. Investments have been made in existing world-class locations, while satellite locations have been divested. At the same time, more R&D facilities have been established in low-cost countries such as India, China and Singapore, permitting overall cost reductions, or larger research headcounts at an equivalent cost. *(Reference, figure 3)*

Direct investment landscape

Data compiled for this report demonstrates the extent of the shift in foreign direct investment (FDI) to include not only the United States and Western Europe, but also low-cost markets such as India and China. For this report, foreign direct investment data was analyzed for the period from 2003 to 2010, with a view of activity before and after the global economic downturn.

The global view

Figures 4 and 5 provide an overview of the global investment landscape, comparing pre-downturn (2003–2006) with (roughly) post-downturn (2007–2010) investments. The United States, with the world's largest economy remains the number one country for attracting investment. While many of the largest drug and pharmaceutical companies have disposed of assets in the United States to diversify into the world's emerging markets, the available assets have been acquired by other United States companies, or European, Japanese and Taiwanese investors, among others. The result was that the United States received close to 20 percent of all global investment between 2003 and 2010. *(Reference, figure 4 & 5)*

Other countries representing a significant percentage of overall global investment included Ireland, China and Singapore, each individually attracting seven to nine percent of all global direct investment. Project experience suggests that China's emergence as a leading destination for FDI is due to both the revenue and operating margin opportunities there. Ireland and Singapore are sought-after locations because of their tax advantages. Ireland maintains a 12 percent flat corporate income tax rate, and Singapore offers a very desirable income tax-based incentive program that can reduce the rate to zero for a period of 10 years or longer for select investments.

The next group of top performers, with FDI of less than five percent of all global investment, includes India and Germany, with other locations of relevance including France, Spain, Puerto Rico (although declining) and Italy. The prominence of Ireland, Singapore and Puerto Rico in the top 10 list for both time periods is a clear indicator that tax-based incentives are a highly effective way to attract investment.

Figure 4
Drug and pharmaceutical inward direct investment flow by country
2003–2006

Top 10 receiving countries
(in billions)

United States $38.7
Ireland $37.1
Singapore $27.6
China $19.7
Germany $14.8
Spain $14.8
France $14.2
Puerto Rico $14.1
India $12.2
Sweden $8.6

Figure 5
Drug and pharmaceutical inward direct investment flow by country
2007–2010

Top 10 receiving countries
(in billions)

United States $73.3
China $29.8
Singapore $17.7
India $16.8
Ireland $16.0
Italy $13.1
Germany $11.9
Switzerland $11.1
Canada $9.9
Brazil $8.9

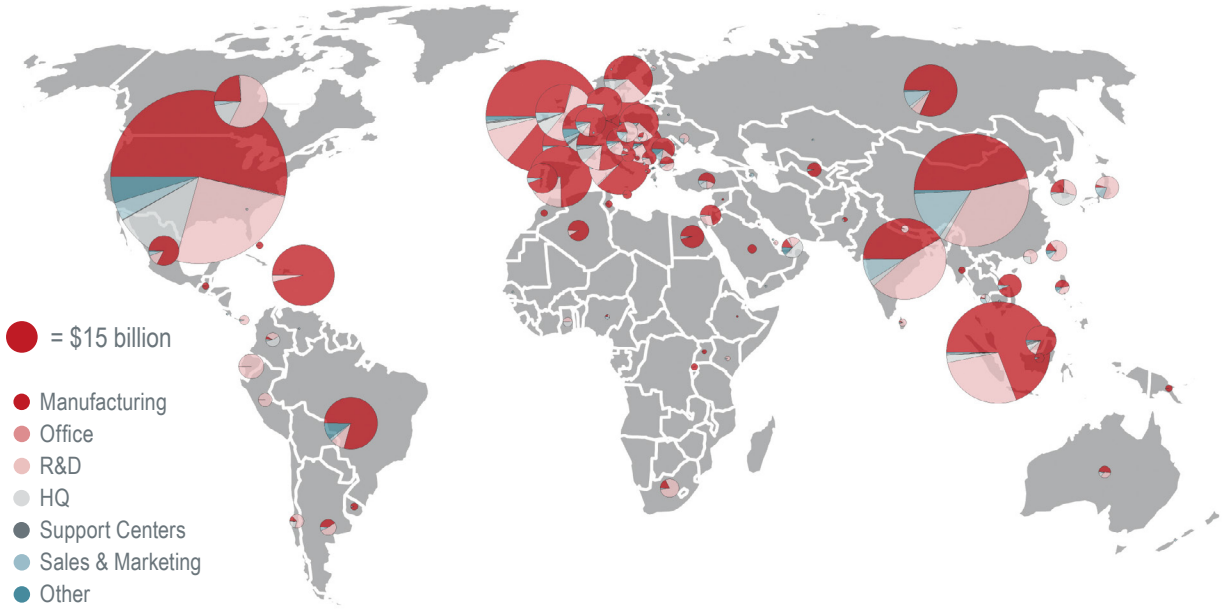
All monetary values in United States dollars

Source: FDI Intelligence from Financial Times Ltd, JLL analysis

In the period immediately following the global economic downturn (2007 to 2010), a noteworthy point is the significance of investment in Asia, where China, Singapore, and India are ranked second, third and fourth on a global basis. Only the United States received more inward investment. Switzerland, Canada and Brazil climbed into the top 10 global destinations for direct investment for the period. Also of note was the declining level of investment in Ireland, Puerto Rico, France and Spain, with the latter three falling out of the top 10 list during the period.

Manufacturing represents the most significant portion of direct investment flows. Manufacturing investment is also distributed to a larger degree than R&D, the other capital-intensive activity. The R&D investment landscape is significantly more concentrated in a few countries, with the United States, China, India, Singapore, Ireland, Canada and the United Kingdom representing the vast proportion of global activity. *(Reference, figure 6)*

Figure 6
Composition of drug and pharmaceutical direct investment by country
2003–2011



Regional patterns

The Americas

The United States was the leading destination for direct investment in the Americas (also globally), receiving more than $38 billion[1] in inward investment between 2003 and 2006 (13 times the global average for the period), and an even larger $73 billion between 2007 and 2010 (a figure 22 times the global average). The growth in the level of investment was 91 percent between 2003 and 2006, and a slower but still impressive (given the existing level of investment) 34 percent between 2007 and 2010. A somewhat unique characteristic of investment in the United States was the sizable levels of investment across the functional spectrum, with manufacturing representing only 54 percent of the total. Approximately 25 percent of the investment in the United States was in R&D, which translates to a notably large absolute figure given the total size of inward investment between 2003 and 2010.

Puerto Rico took second place in inward direct investment levels. Between 2003 and 2006, Puerto Rico received just over $14 billion in direct investment, a figure almost five times the global average. The growth between 2003 and 2006 was 68 percent. During the 2007–2010 period, investments dropped significantly, to just over $3.5 billion, the net result of lower inward investment and also divestiture activities by legacy drug and pharmaceutical companies. Manufacturing constituted 97 percent of all investment in Puerto Rico. Although Puerto Rico is trying to organize around R&D and advance its value proposition, the data suggests it has not yet been successful.

1. All monetary values in United States dollars

Source: FDI Intelligence from Financial Times Ltd, JLL analysis

Tof C

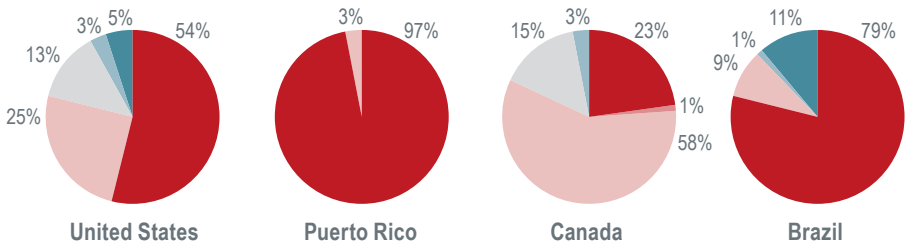
Figure 7
Composition of drug and pharmaceutical inward investment in the Americas

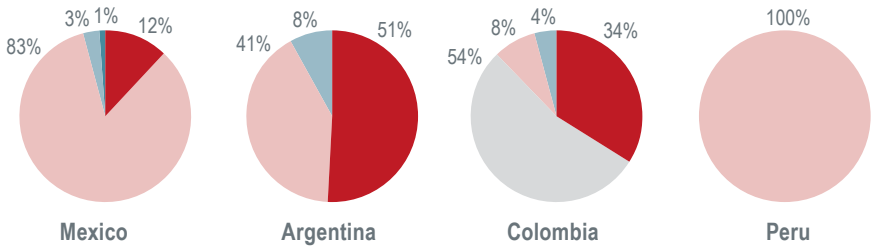
Dominant Recipients

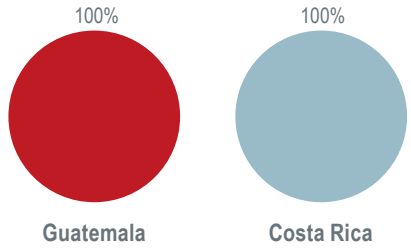
	Total Investment (in millions)		LQ (world average = 1)		Growth (average annual)	
Country	2003–2006	2007–2010	2003–2006	2007–2010	2003–2006	2007–2010
United States	38,669	73,322	13.04	22.51	91%	34%
Puerto Rico	14,068	3,630	4.70	1.12	68%	–18%
Canada	4,052	9,850	1.33	2.82	33%	143%
Brazil	4,504	8,865	1.42	2.76	–72%	4,659%

Up & Coming Recipients

	Total Investment (in millions)		LQ (world average = 1)		Growth (average annual)	
Country	2003–2006	2007–2010	2003–2006	2007–2010	2003–2006	2007–2010
Mexico	542	4,687	0.21	1.53	75%	101%
Argentina	308	1,488	0.12	0.49	751%	554%
Colombia	1,046	435	0.36	0.14	306%	160%
Peru	0	1,152	0.00	0.38	66%	38%
Guatemala	0	402	0.00	0.15	25%	14%
Costa Rica	0	28	0.00	0.01	0%	0%







- Manufacturing
- Office
- R&D
- HQ
- Support Centers
- Sales & Marketing
- Other

Canada was the next largest recipient of inward investment over the period, receiving just under $14 billion in direct investment between 2003 and 2010. Like the United States, Canada received more inward investment between 2007 and 2010 and in the prior period (close to 3 times the global average). Like the United States, Canada was a beneficiary of a large percent of R&D investment. While lower than the United States in total dollars, R&D represented a very large 58 percent of total inward investment.

Brazil rounded out the top four countries in the Americas with inward investment levels just slightly lower than Canada. Similar to Canada, Brazil received a notably larger amount of investment between 2007 and 2010 compared to the prior period. The more than $8 billion in inward investment between 2007 and 2010 represented roughly 2.75 times the global average. Like Puerto Rico, a significant percentage of Brazil's inward activity was for manufacturing, possibly a direct outcome of its mandatory market presence policy.

Investment levels decline significantly for the remaining countries in the region, with only Mexico achieving investment levels above the global average (for the period between 2007 and 2010). *(Reference, figure 7)*

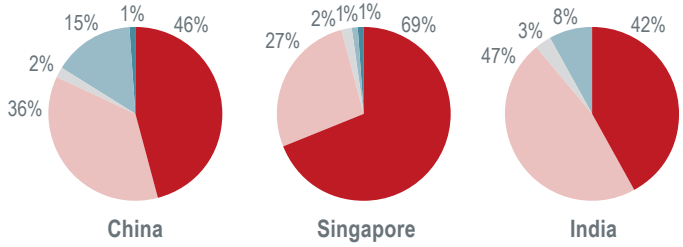
Figure 8
Composition of drug and pharmaceutical inward investment in Asia Pacific

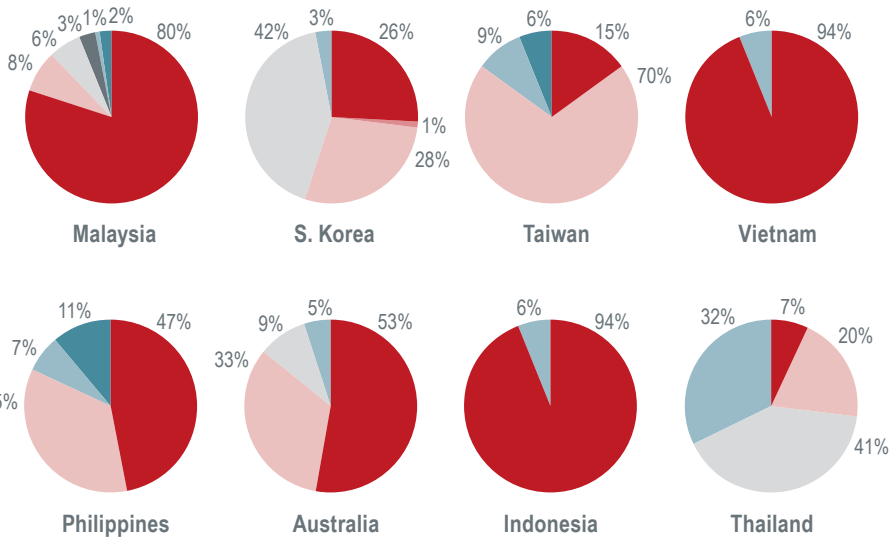
Dominant Recipients

	Total Investment (in millions)		LQ (world average = 1)		Growth (average annual)	
Country	**2003–2006**	**2007–2010**	**2003–2006**	**2007–2010**	**2003–2006**	**2007–2010**
China	19,709	29,831	6.87	9.66	77%	14%
Singapore	27,540	17,738	9.53	5.59	24%	–5%
India	12,166	16,814	4.46	5.61	109%	–3%

Up & Coming Recipients

	Total Investment (in millions)		LQ (world average = 1)		Growth (average annual)	
Country	**2003–2006**	**2007–2010**	**2003–2006**	**2007–2010**	**2003–2006**	**2007–2010**
Malaysia	1,995	2,776	0.69	1.06	66%	1190%
S. Korea	742	2,884	.025	0.82	–16%	239%
Taiwan	1,274	1,437	0.42	0.44	–69%	7630%
Vietnam	867	656	0.28	0.22	146%	45%
Philippines	799	528	0.26	0.19	–84%	556%
Australia	298	534	0.09	0.20	–33%	25%
Indonesia	268	515	0.10	0.16	–33%	175%
Thailand	223	410	0.08	0.14	4%	336%





- Manufacturing
- Office
- R&D
- HQ
- Support Centers
- Sales & Marketing
- Other

Asia Pacific

Like the Americas, inward investment in Asia between 2003 and 2010 was concentrated in a few countries, with FDI in China, Singapore and India exploding onto the global landscape. Investment in other countries in the region was significantly lower, with only Malaysia, South Korea and Taiwan really seeing any activity of note.

China, from 2003 to 2010, saw increasing levels of investment. Between 2003 and 2006, inward flows amounted to just under $20 billion a figure approximately seven times the global average, and just under $30 billion from 2007 and 2010, a figure just over 9.5 times the global average. The growth in inward investment for the 2003 to 2006 period was a solid 77 percent, but slowed between 2007 and 2010 to 14 percent. Just over 36 percent of investment in China was for research and development, a figure second only to India.

Between 2003 and 2006, Singapore received more than $27 billion in inward flows (approximately 9.5 times the global average), and between 2007 and 2010, just under $18 billion (approximately 5.5 times the global average). A large percentage of investments in Singapore were in manufacturing, likely the direct result of its extremely positive tax incentives, but 27 percent of sector investments in Singapore were in R&D operations, an illustration of the success it is seeing in its push for R&D investment.

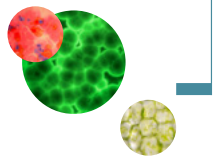
India ranked third for inward direct investment flows. Between 2003 and 2006, just over $12 billion was invested (a figure approximately five times the global average) and between 2007 and 2010, just under $17 billion was invested (a figure presenting more than 5.5 times the global average). India's growth over the first period was more than 100 percent, yet like other countries impacted by the global economic recession, India saw a decline in year-to-year investment levels between 2007 and 2010. Some 47 percent of investment in India went for R&D, one of the best research investment performances by any of the top FDI nations.

Investment levels declined significantly outside of the top three Asian countries. Even while some of the countries put up very sizable percentage growth figures, the absolute dollar value of the inward flows was a fraction of the top three countries. *(Reference, figure 8)*

Europe, Middle East and Africa (EMEA)

Ten countries in the EMEA region received significant investments in the drug and pharmaceutical sector. EMEA countries also generally received a larger percentage of R&D investment than those of countries in other regions.

Ireland was the largest recipient of inward direct investment in the region, receiving more than $50 billion from 2003 to 2010. From 2003 to 2006, Ireland received just over $37 billion in inward flows (approximately 14 times the global average), and between 2007 and 2010, just under $16 billion (approximately 5 times the global average). Direct investment in manufacturing facilities represented close to 90 percent of all investment in the country, probably because of related tax incentives.



Germany was the second largest recipient in the region with more than $25 billion in inward investment between 2003 and 2010. Like Ireland, Germany also received more investment between 2003 and 2006 than between 2007 and 2010, but when viewed from a global perspective, Germany received just over five times the global average between 2003 and 2006 and just under four times the global average between 2007 and 2010. Most investment in Germany was in the manufacturing sector.

France was third in the region for inward investment flows, receiving just under $23 billion between 2003 and 2010. Between 2003 and 2006, France received just over $14 billion in inward investment, a figure just over five times the global average, and approximately $8.5 billion between 2007 and 2010, a figure 2.75 times the global average. R&D investment represented just over 30 percent of total investment in France.

Spain and Italy rounded out the top five destinations for direct investment in Europe. Spain received a significant amount of inward investment between 2003 and 2006, but slowed notably after 2006. Italy was the opposite.

Other countries of significance in EMEA included the United Kingdom, Russia, Belgium, Switzerland and Sweden. While seeing lower levels of investment than the top five, each still received notable investment at levels generally above the global average. Of this group of countries, at more than 30 percent, the United Kingdom, Belgium and Sweden all stood out in terms of the total investment represented by R&D.

As a general rule, investment in the Middle East and Africa remains very low relative to other countries in the region. *(Reference, figure 9)*

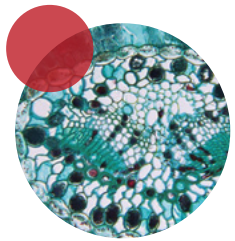


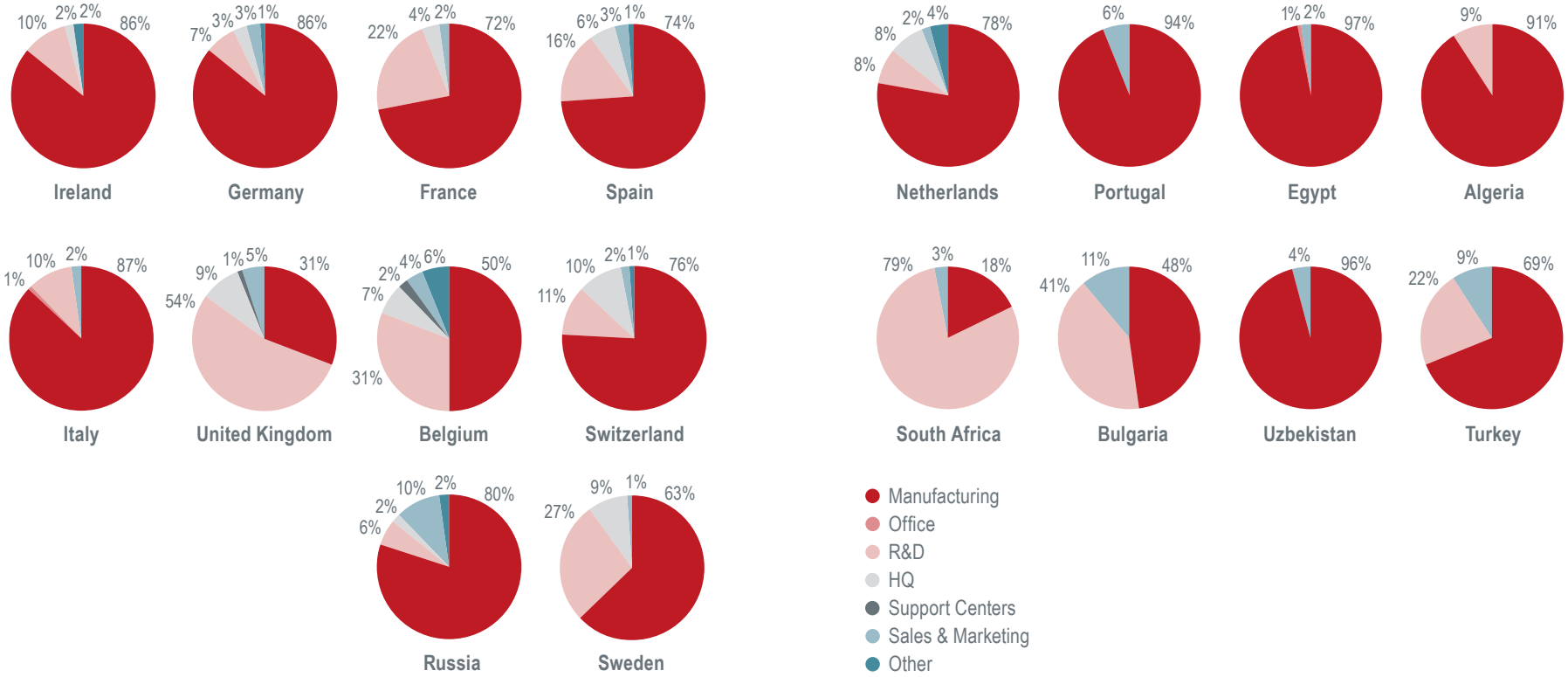
Figure 9
Composition of drug and pharmaceutical inward investment in Europe, Middle East and Africa

Dominant Recipients

	Total Investment (in millions)		LQ (world average = 1)		Growth (average annual)	
Country	2003–2006	2007–2010	2003–2006	2007–2010	2003–2006	2007–2010
Ireland	37,065	15,982	13.8	4.96	60%	−34%
Germany	14,848	11,909	5.15	3.93	−40%	31%
France	14,231	8,510	5.28	2.75	45%	−19%
Spain	14,807	3,900	5.34	1.16	−12%	−47%
Italy	4,180	13,109	1.49	3.67	119%	314%
United Kingdom	7,454	7,349	2.6	2.34	30%	6%
Belgium	4,605	8,257	1.75	2.68	326%	78%
Switzerland	1,569	11,103	0.54	3.77	18%	147%
Russia	3,895	8,664	1.38	2.94	27%	63%
Sweden	8,557	3,238	3	1.04	116%	116%

Up & Coming Recipients

	Total Investment (in millions)		LQ (world average = 1)		Growth (average annual)	
Country	2003–2006	2007–2010	2003–2006	2007–2010	2003–2006	2007–2010
Netherlands	2,937	1,930	0.94	0.64	−59%	33%
Portugal	3,045	1,799	1.20	0.60	−15%	94%
Egypt	458	2,499	0.18	0.74	−9%	1256%
Algeria	822	1,900	0.29	0.69	−61%	85%
South Africa	303	1,903	0.12	0.7	4%	589%
Bulgaria	389	1,009	0.15	0.32	33%	445%
Uzbekistan	21	1,320	0.01	0.45	33%	400%
Turkey	388	891	0.15	0.34	0%	185%



Conclusion

As we emerge from a period of notable turbulence in the drug and pharmaceuticals sector, investment patterns would seem to illustrate how companies are now thinking about their global operating configuration and where new investments are likely to be made.

Asia is clearly an area of focus, particularly India and China. The scale and breadth of investment over the last decade in India and China suggests companies are looking to these countries as both revenue and margin opportunities, and as a destination for both manufacturing and R&D activities. Both have gained notable ground on the legacy Western European and North American locations over the last decade. Singapore is also a success story in Asia because of its targeted incentives and infrastructure development. The data also suggest that while companies are testing the value propositions of other countries in the region, only Malaysia, South Korea and Taiwan have emerged as locations of interest to the industry.

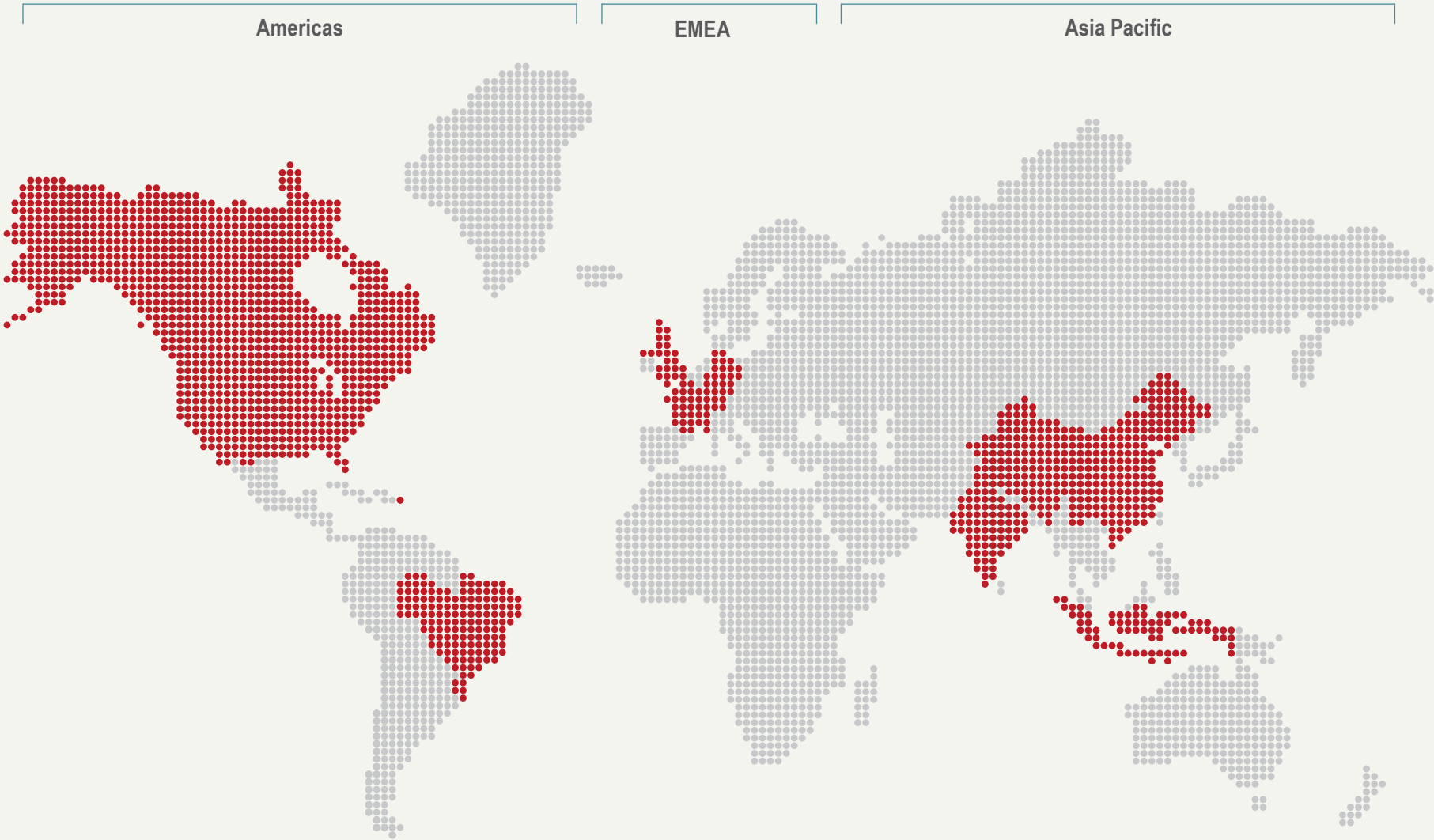
In the Americas, the United States is likely to continue to attract investment capital. Canada is emerging as a R&D location and Brazil for manufacturing. The data also suggests that Puerto Rico, the second largest investment destination in the region, struggles to retain a viable value proposition to companies with incentives that have, or are about to, end. Outside of these countries, only Mexico, Argentina, Colombia and Peru are being tested as platforms for either manufacturing or R&D, but all are far behind the others in investment activity.

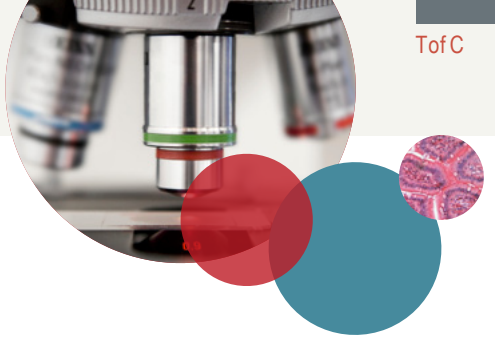
A number of the higher cost locations in EMEA are starting to see the balance of investment shift away from manufacturing to R&D. The United Kingdom is clearly such a location. France, Belgium and Sweden would also appear to be heading in this direction. The data also suggests that a broad number of European locations will continue see healthy levels of inward investment. Investment levels in the Middle East and Africa are however, nominal compared with Europe, and the data suggest the industry has not yet turned to either region as a platform for operating margin improvement or revenue growth.

The scale and breadth of investment over the last decade in India and China suggests companies are looking to these countries as both revenue and margin opportunities, and as a destination for both manufacturing and R&D activities.

Global clusters

A review of established and emerging clusters within the three global regions of the Americas, EMEA and Asia Pacific.



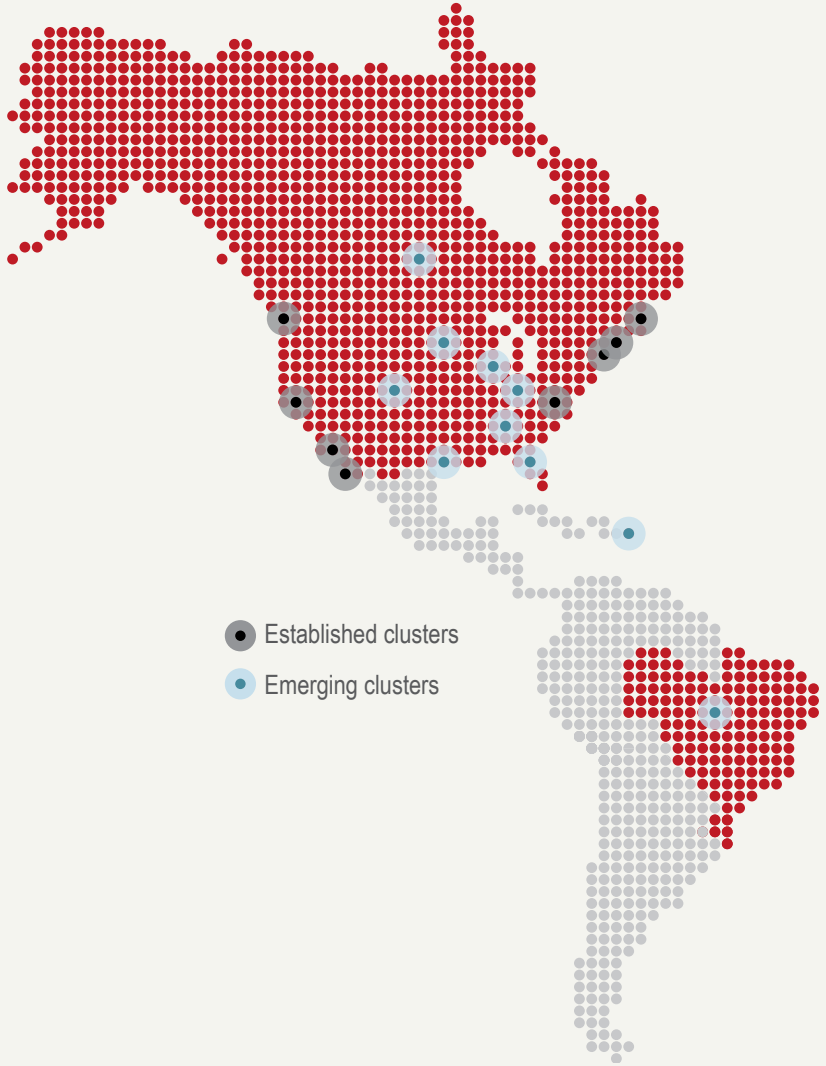


Americas

In this section we will review established and emerging clusters within the United States, Canada and Latin America.

Within the United States, life science-focused clusters are at various stages in their evolution. While coastal hubs in the Northeast and California represent cornerstone locales and will forever play an important role as the headquarters cities for many of the industry's largest players, other markets are steadily emerging as locations of interest.

Canadian submarkets largely mirror those of emerging clusters within the United States due to comparable tenants, types of facilities and product types, while clusters in Latin America are more geared towards agricultural biotech and pharmaceutical manufacturing.



United States

Established	Emerging
Bay Area	Atlanta
Boston	Chicago
Los Angeles	Denver
New York/New Jersey	Florida
Philadelphia	Houston
Raleigh-Durham	Indianapolis
San Diego	Minneapolis
Seattle	
Washington DC/Suburban MD	

Emerging

Canada

Brazil

Puerto Rico

Cluster methodology

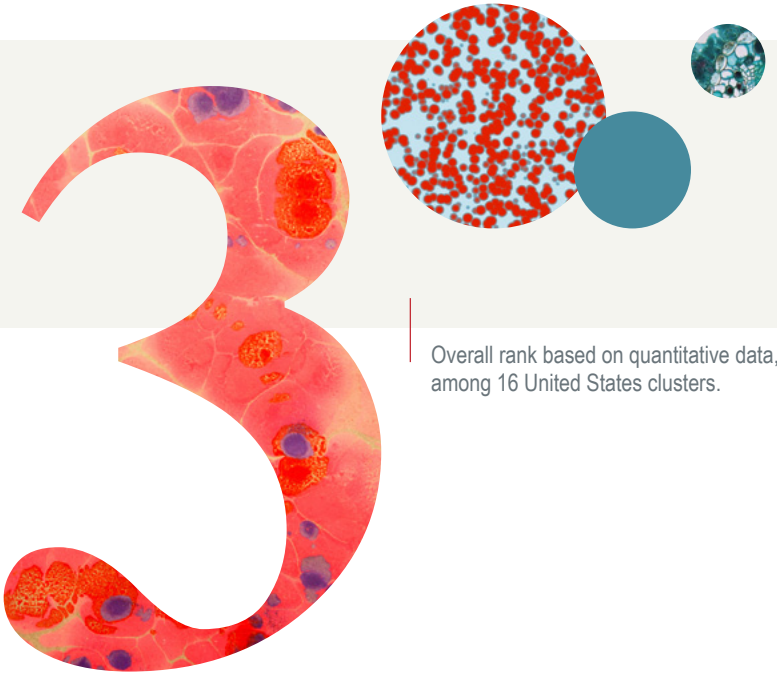
The determination of United States life science clusters as "established" or "emerging" was formed through an analysis of both quantitative and qualitative data. Data points reflecting key components of cluster development were gathered for each of the 16 clusters. Results were ranked with a score of "1" being most favorable to the industry and a score of "16" being least favorable. Each cluster's scores for the six data points were amalgamated to form a composite score. These scores were ranked and taken into consideration along with market intelligence to determine categorization.

	High tech research & hospital / medical employment (as percent of total employment)[1]		Science & engineering graduate students (per 1,000 individuals aged 25-34)[2]		NIH funding[3]		Venture capital funding[4]		R&D spend as % of GDP[5]		Academic and research institute facilities (in thousands of SF)[6]			
Cluster	%	Score	#	Score	$	Score	$	Score	%	Score	SF	Score	Composite score	Ranking
Boston	16.2%	1	28.7	1	$2,235,904,192	1	$1,142,101,500	2	7.0%	1	5,997	1	7	1
New York / New Jersey	13.2%	5	15.0[7]	4	$1,639,384,464	2	$306,152,900	4	4.2%[8]	7	5,965	2	24	2
Bay Area	13.5%	4	12.9	8	$1,234,346,373	3	$1,825,487,700	1	4.3%	4	4,120	5	25	3
Los Angeles	11.6%	13	12.9	8	$1,001,160,022	5	$250,165,900	6	4.3%	4	4,000	6	42	4
Washington DC / Suburban MD	11.7%	12	15.8	3	$1,011,379,315	4	$172,822,000	11	5.0%[9]	2	3,307	10	42	5
Philadelphia	14.8%	2	14.2	6	$785,214,411	9	$266,927,700	5	2.5%	10	2,953	12	44	6
San Diego	11.9%	11	12.9	8	$823,714,571	6	$560,717,300	3	4.3%	4	2,821	14	46	7
Minneapolis	13.6%	3	18.6	2	$289,110,813	15	$131,354,100	12	3.0%	8	3,530	9	49	8
Raleigh-Durham	12.9%	7	10.8	12	$806,677,028	7	$198,596,500	9	2.4%	11	4,299	4	50	9
Seattle	12.5%	8	7.1	16	$805,613,160	8	$201,399,800	8	4.9%	3	3,668	8	51	10
Chicago	12.3%	9	14.3	5	$633,240,757	10	$175,537,400	10	2.3%	13	3,246	11	58	11
Denver	11.6%	13	13.4	7	$305,872,896	14	$76,727,900	13	2.9%	9	1,664	15	71	12
Houston	10.2%	15	10.0	13	$509,192,059	11	$218,318,000	7	1.6%	14	2,920	13	73	13
Florida	12.1%	10	9.1	14	$356,630,211	12	$15,225,100	15	1.0%	16	3,779	7	74	14
Atlanta	9.8%	16	8.3	15	$343,352,066	13	$71,225,000	14	1.1%	15	4,474	3	76	15
Indianapolis	13.0%	6	11.5	11	$126,527,940	16	$4,356,000	16	2.4%	11	1,353	16	76	16

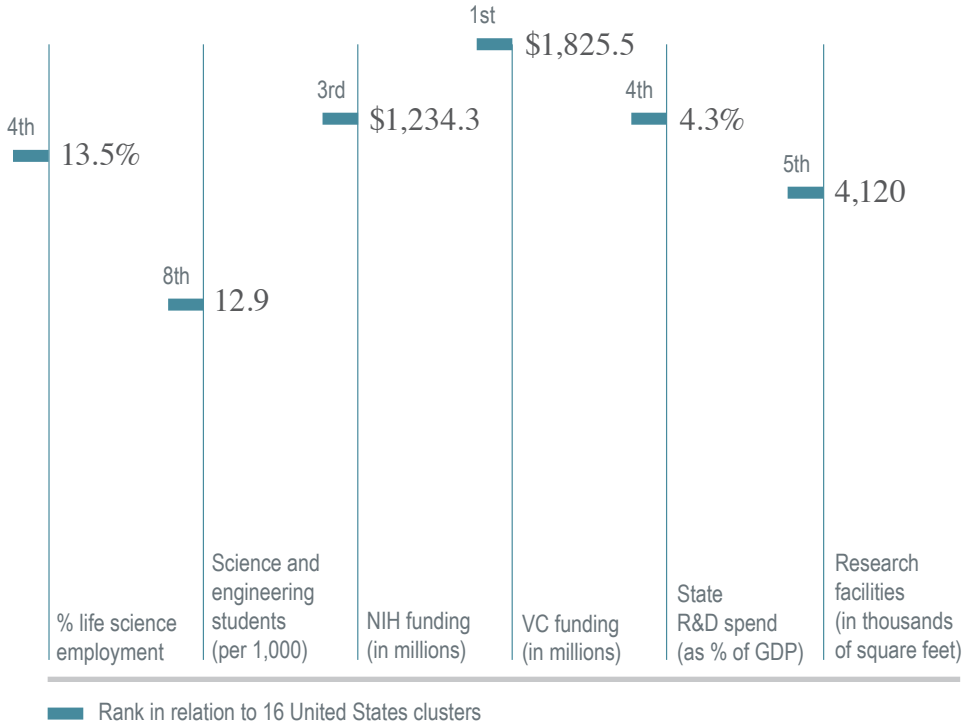
Footnotes:

1. DemographicsNow/Business-Industry Report, by select Metro CBSAs, 2010
2. National Science Foundation/Division of Science Resources Statistics/SEI State Data Tool, 2011
3. National Institute of Health/Awards by Location, by select congressional districts, FY 2010
4. PricewaterhouseCoopers/MoneyTree Report, Biotechnology & Medical Devices and Equipment Industry Reports, 2010
5. National Science Foundation/Division of Science Resources Statistics, Survey of State R&D Expenditures, FY 2007
6. National Science Foundation/Division of Science Resources Statistics, Survey of Science and Engineering Research Facilities, FY 2009
7. Average of NJ (18.2) and NY (11.3)
8. Utilized NJ R&D % as most of this type of activity done in the state of New Jersey
9. Weighted average of MD (5.34%) and DC (4.17%)

Bay Area



Overall rank based on quantitative data, among 16 United States clusters.



Proximate to several world-renowned university research institutions and an impressive roster of tenants, the San Francisco Bay Area continues to reign as one of the premier locales for biotech and other life sciences companies.

Overview

The Bay Area cluster is made up of the three submarkets of San Francisco's Mission Bay/China Bain, South San Francisco and East Bay.

During the last decade, San Francisco's Mission Bay/China Basin submarket has undergone a significant transformation as one of the city's highest priority redevelopment areas. With the University of California at San Francisco anchoring the submarket with a world-renowned research facility and planned hospital, the area quickly generated demand among biotech and pharmaceutical companies. In 2010, Alexandria Real Estate

Bay Area

Equities opened the doors to its most recent development, 455 Mission Bay Boulevard in San Francisco, and welcomed Nektar Therapeutics and Bayer Pharmaceuticals to San Francisco. They occupy 105,000 and 50,000 square feet, respectively. In 2011, Alexandria purchased 409–499 Illinois, a two-building life sciences asset 50 percent occupied by Fibrogen.

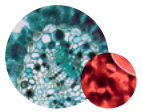
South San Francisco contains the highest concentration of life sciences companies in San Mateo Country and brightest talent pool in Northern California. The restoration of venture capital confidence has resulted in increased demand for space and expansion, spurring some hiring. The life sciences industry in South San Francisco remained resilient throughout 2010 despite heavy losses in employment in the tech industry, and was able to bounce back by the beginning of 2011. Top companies in South San Francisco include Amgen, Elan, Onyx Pharmaceuticals, Takeda Pharmaceuticals, among others. Swiss drug maker Genentech alone currently occupies approximately 5 million square feet in the area. Although there was much speculation as to the state of the South San Francisco submarket when the company was acquired by Roche in 2008, Genentech has expanded through recent construction of a new office building on their campus.

The East Bay's life sciences market is generally clustered in Richmond, Fremont, Newark, Berkeley, and Emeryville, and contains approximately 4.6 million square feet of inventory within office, flex and lab space. In 2009, Bayer's efforts to enlarge the Oakland Enterprise Zone to include Berkeley and Emeryville were paramount to retaining life sciences companies in the region, and should foster future growth in the industry. Significant life science companies include Abgenix, Novartis, Bayer HealthCare, and WaferGen Biosystems.

Industry framework

Intellectual capacity

San Francisco's location, impressive business center and world renowned cultural attractions make the city one of the most attractive places to live in the United States. Both the Mid-Peninsula and Silicon Valley have been at the forefront of innovation and advancement in technology, attracting talent from all around the world. Major corporations such as Genentech continually support academic programs at local universities through grants, scholarships, and internship programs. Specific areas within Palo Alto are dedicated solely to research and development companies to encourage students to work locally once they graduate. The East Bay shares this talent pool, and University of California at Berkeley similarly draws students from around the world to its biology and chemistry programs.



South San Francisco contains the highest concentration of life sciences companies in San Mateo Country and brightest talent pool in Northern California. The restoration of venture capital confidence has resulted in increased demand for space and expansion, spurring some hiring.

Bay Area

Looking ahead, San Francisco can expect the transformation of Mission Bay to be one of its greatest success stories.

Innovation capital
For more than 30 years, the University of California at San Francisco (UCSF), Stanford University, and the University of California (UC) at Berkeley have actively partnered with health-care, biotechnology, and pharmaceuticals experts to develop some of the most cutting-edge advances in medicine. Several large centers of excellence are hosted by the area universities, such as UC Berkeley's Cancer Research Laboratory and Stanford's Genome Technology Center.

Fiscal & political resources
In 1998, the City of San Francisco adopted the Mission Bay Redevelopment plan in an effort to transform the former rail and shipyard into a world class neighborhood and business center. With the development of UCSF's research campus in 2003, Mission Bay/China Basin became a highly coveted market for the biotech and pharmaceutical sectors, attracting tenants and developers to the area. In addition to UCSF, Alexandria Real Estate Equities, a premier life sciences developer, has made significant investments in the area.

The Oakland Enterprise Zone was developed by the California State Legislature in 1993 to stimulate business growth in the East Bay. Businesses located within the zone, which includes Berkeley and Emeryville, are entitled to a variety of tax incentives that promote hiring. Bayer is one of the largest biotech companies located within this enterprise zone and was a major force in expanding the zone in 2009, a move that ensured the retention of thousands of biotech jobs in the region.

San Francisco's Mission Bay community is today at the center of the biotechnology revolution. To support expansion of this flourishing industry and the creation of new jobs, the City of San Francisco offers a payroll tax exclusion for up to 7.5 years to San Francisco-based businesses engaged in biotechnology pursuits.

Outlook

Recent transactions in the Mission Bay/China basin submarket that include new tenants, and the future development plans of UCSF and Salesforce.com, have provided a renewed surge of excitement for the area. Looking ahead, San Francisco can expect the transformation of Mission Bay to be one of its greatest success stories.

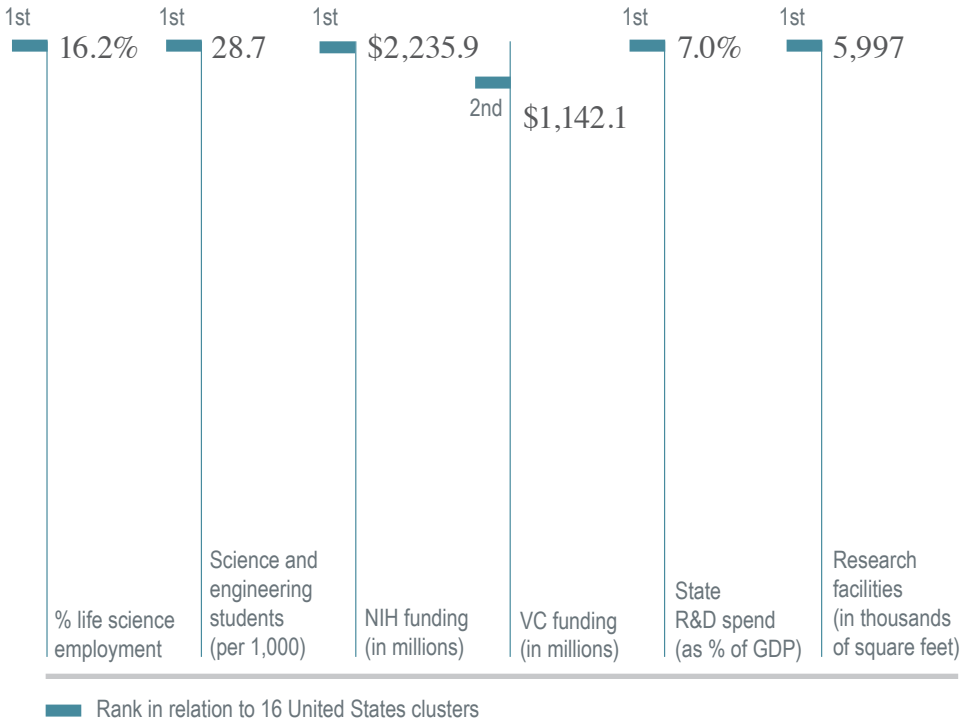
In the Mid-Peninsula, given the moderate leasing activity within the life sciences sector, new development has remained at standstill since 2008. Alexandria continues to be one of the major players in life science product with proposed development of 800,000 square feet in the South San Francisco submarket. In total, there are 6.4 million square feet of speculative space. However, without any genuine interest from a major company looking for at least 250,000 square feet, no progress is expected.

The future of the East Bay life science industry looks bright. The Lawrence Livermore National Laboratory, run by UC Berkeley, wants to expand in the East Bay by 45 acres and has narrowed the search to six sites. One of the sites, a former naval base in Alameda, is offered for free, indicative of the community's desire to foster life sciences research and development growth.

Boston

1

Overall rank based on quantitative data, among 16 United States clusters.



The Greater Boston area is home to major academic institutions and centers of life sciences excellence, all located within minutes of each other to create a global hub.

Overview

The Greater Boston area is a leading global industry cluster that supports all aspects of the life sciences industry including biotechnology, pharmaceuticals, medical devices, diagnostics and bioinformatics. Because of the industry's mature critical mass in the area, new companies and venture capital investments are common.

The cluster has a large life sciences industry focus and includes geographic submarkets that are both established and emerging. The Cambridge submarket is the core of the Massachusetts life sciences industry. Many start-ups begin here and grow until they are acquired or relocate as they outgrow space options.

Boston

Others, however, choose to keep their headquarters and maintain operations in Cambridge as they see the value of co-locating with many other life science companies and prominent academic and research institutions. The most current and prominent example of this is Biogen IDEC's plans to relocate its headquarters back to Cambridge after only a short period in the suburban submarket of Weston. The company plans to occupy two new buildings in East Cambridge, totaling more than 497,000 square feet of office and lab space. Biogen's return will kick-start the development of top-class lab space in the Cambridge area. Biogen leaves the Route 128 submarket, which is home to notable life science tenants such as Genzyme, AstraZeneca, and UMass Medical Center. Despite Biogen's departure, the area will remain relatively stable with a new generation of companies available to backfill varying space options.

More emerging submarkets exist in Boston and Northwest of the city. Boston's Longwood Medical Area is hot spot for life sciences research organizations, and is home to renowned institutions such as Harvard Medical School, Brigham & Women's Hospital, Dana-Farber Cancer Institute, and Merck. The South Boston Waterfront, or Fan Pier, is a more recent development and is beginning to attract life sciences institutions. This year, Vertex Pharmaceuticals announced that it will relocate from Cambridge into 1.1 million square feet of office and lab space at the Fan Pier development. This is the largest private development project in Boston's history. As Vertex expands in Boston, other tenants are looking to the suburbs for more economic options. Many life science tenants seek space in the Northwest submarket in such towns as Lexington and Bedford. The Massachusetts Biotechnology Council rates these towns as Platinum BioReady Communities; in other words, these areas are highly supportive of the biotech industry due to expedited permitting and zoning polices. Notable tenants here include Millipore and Shire.

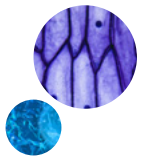
Industry framework

Intellectual capacity

Because the industry is mature in Massachusetts, the labor pool is diverse and no longer merely consolidated to the twenty-somethings living in downtown Cambridge. The Boston MSA features more than 85,000 high tech research employees and more than 340,000 hospital and medical employees with job growth that continues to trend upwards and outpace other life sciences clusters. The area enjoys seven times the number of workers in biotech R&D than the national average.

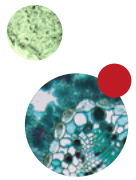
Innovation capital

Massachusetts receives 13 percent of all National Institutes of Health (NIH) funding and historically has trailed only California (the location of three of the country's largest life sciences clusters) as a recipient. Massachusetts is home to five of the top eight NIH-funded hospitals in the United States, and includes Massachusetts General Hospital, Brigham & Women's Hospital, Dana-Farber Cancer Institute, Beth Israel Hospital, and Children's Hospital, each global leaders in biotechnology research. The top five NIH-funded universities (Harvard, University of Massachusetts, Boston University, MIT, and Tufts) anchor this cluster and offer advanced degrees in biosciences, fuel employment in the industry, and add great depth to the development of innovative products.



The Cambridge submarket is the core of the Massachusetts life sciences industry. Many start-ups begin here and grow until they are acquired or relocate as they outgrow space options.

Boston



The area's life sciences sector is well positioned in comparison to its peers. It will continue to fuel employment and attract both companies and investors to the area.

Fiscal & political resources

The State of Massachusetts provides significant tax incentives and other offerings to support the growth of the life sciences industry. The Massachusetts Life Sciences Center (MLSC) is an agency of the Commonwealth of Massachusetts and was designed to administer the state's 10-year, $1 billion life science initiative to support the life sciences cluster through job growth, economic development, and commercialization of treatments and cures.

The initiative includes the following programs:

- Life Sciences Center Research Matching Grant Program: Matches funding for academic institutions
- Internship Challenge Program: Funds interns working at life science companies
- Accelerator Program: Provides capital for early-stage biotech companies
- SBMG Program: Matches funds for federal small business grants
- Tax Incentive Program: Creates incentives for companies to locate and expand in Massachusetts Corporate Consortium Program/Works to attract funds from both the private and non-profit sectors

Outlook

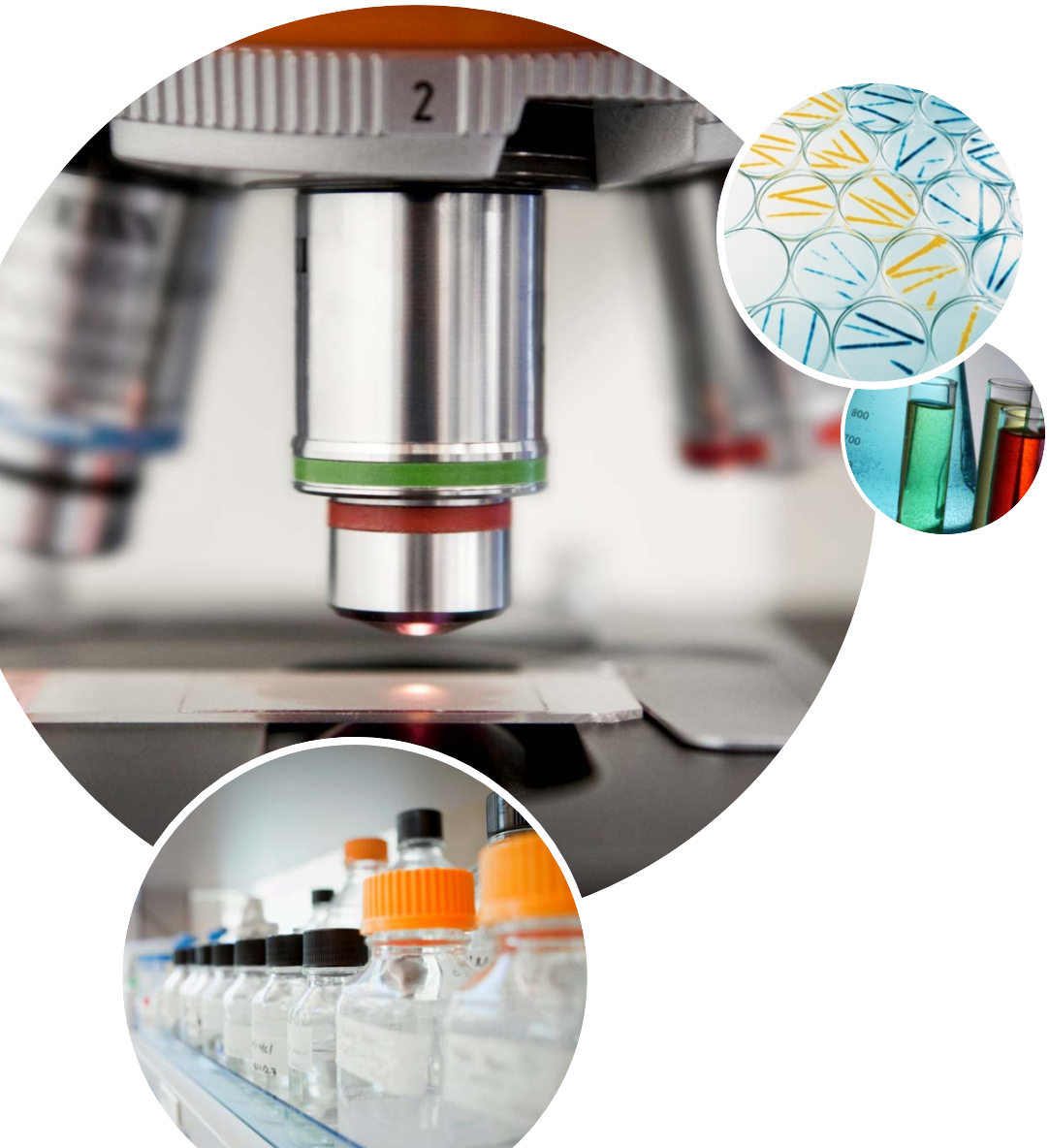
The area's life sciences sector is well positioned in comparison to its peers. It will continue to fuel employment and attract both companies and investors to the area. As the market continues to tighten, there will be additional demand for top-grade laboratory space. As the rents increase in Cambridge, price-conscious life sciences tenants may look to South Boston or the suburbs for more economic options. However, in all areas, developers and owners stress the importance of flexibility of space. As the sociology of drug discovery continues to change, so does the need to design laboratory space to reflect and support collaboration and access to information. This emerging trend will strongly affect the way developers build space or rehab second-generation facilities in Cambridge, Boston, and suburbs.

Jones Lang LaSalle

Real value in a changing world

Life Sciences Cluster Report

Global . 2012



Portfolio optimization and strategic site selection are crucial for success in the industry's new reality

In the new reality for life sciences companies – one where the product development formula of the past no longer applies, where extensive M&A activity is needed to fill pipelines and mitigate risk, and where an increasing amount of attention and opportunity lie in emerging markets – prudent measures and strategic solutions are critical to succeed.

More than ever, it is essential to achieve the ideal portfolio balance, with the proper size and type of facilities in the right locations.

Global clusters

A review of established and emerging clusters within the three global regions of the Americas, EMEA and Asia Pacific

Americas | EMEA | Asia Pacific

Global themes

As the life sciences landscape continues to evolve, opportunities to optimize facility and real estate portfolios and site-select for enhanced innovation efficiencies emerge.

In the new reality for life sciences companies – one where the product development formula of the past no longer applies, where extensive M&A activity is needed to fill pipelines and mitigate risk, and where an increasing amount of attention and opportunity lie in emerging markets – prudent measures and strategic solutions are critical to succeed. Yet with all this change and uncertainty comes an immeasurable amount of opportunity.

Beyond the costs to develop new drugs and treatments, facility and real estate costs are among the highest expenses for life sciences companies, and are therefore top of mind as the industry refocuses and reprioritizes. The industry is challenged by the conflicting need to right size in mature markets, where sales and demand are waning and where M&A activity oftentimes results in excess or duplicative facilities, while strategically growing in emerging clusters in order to capture market share and savings opportunities. More than ever, it is essential to achieve the ideal portfolio balance, with the proper size and type of facilities in the right locations. Given that the industry is contracting in mature markets, creatively positioning dispositions and knowing how and when to hit the market, can greatly impact the timeline, and thus expense, of divestiture. Additionally, knowing in which locations to maintain and expand operations has major bearing on the ability to capitalize on skilled labor force and fiscal resources, and thus, efficiently achieve new product breakthroughs.

Location strategy in mature market clusters hinges on deep resources for innovation excellence

Established clusters in the United States, Europe and to some extent Japan realize that although the industry is increasingly looking to emerging markets for growth opportunities, much of the core R&D functions will remain domestic. It is also apparent that the industry is becoming more strategic with site selection, choosing locales with rich industry resources and capital and higher propensities for discovery and innovation. Although the mature clusters in the United States and Europe continue to be reliable choices, with deep and well-developed resources, emerging clusters within the United States and Canada are working feverishly to bolster their industry infrastructure.

Within the United States, the coastal cornerstone locales and certain mature clusters in EMEA continue to enjoy industry growth, oftentimes due to strong support from their world-class academic, healthcare and private sector institutions. Greater Boston, Philadelphia, New York City and Zurich all reported development activity and demand from partnerships with area universities and hospitals. And although other established global clusters like the San Francisco Bay Area, San Diego, New Jersey, Seattle, Paris and much of the United Kingdom all reported constrained demand due to rampant M&A activity, each remain confident that their supportive industry infrastructure will furnish the resources and environment for new start-ups to backfill vacated space.

Economic development groups and public–private partnerships in emerging United States and Canadian clusters are making efforts to position their markets for success. Clusters like Westchester / New Haven, Central & Southern Florida, Indianapolis and Montréal offer targeted incentive packages and newly constructed, state-of-the-art incubator centers and parks specialized for the industry. Beyond incentives, each of these clusters are bolstered by research institutions and enjoy the same government-instituted regulations and protections; however, real estate in these clusters can be attained at a lower cost.

Emerging global economies strengthen R&D capabilities and infrastructure

Although emerging clusters in Asia Pacific and Latin America have been an industry choice for outsourced manufacturing for some time, the governments of emerging global economies are laser-focused on growing their high technology capabilities, due to increasing local demand and the positive impact they have on the economy and export revenue potential.

One of the biggest ways that emerging global clusters are increasing their competitiveness is through economic incentives and industry-dedicated funds. Clusters such as China, Brazil, India and Singapore all reported recent funding opportunities dedicated to the industry, and although many aim to ramp up the innovation potential of domestic start-ups, multinationals are able to capitalize on these offerings too, and have already done so in many cases. Additionally, nearly all the emerging global clusters cited have reported increased spending on overall public healthcare, widening the prospective patient pool and increasing consumer demand.

Beyond the fiscal resources directly available to industry companies, government and economic development group dollars have also supplied funds for prospective development projects that are

specialized to the needs of life sciences companies and start-ups. China, Singapore and Japan are home to some of the biggest government-funded life sciences parks and incubator centers.

The topic of globalization and movement into emerging economies always raises concerns over consistent and transparent regulations and intellectual property (IP) protection. In the past, emerging governments struggled to effectively outline and govern practices comparable to those in the United States and European Union. Knowing these issues are top of mind for multinational firms, emerging governments are reacting quickly to improve their competitiveness in the global marketplace. India, for instance, has improved its patent protection laws with a signatory to the World Trade Organization's Agreement on Trade-Related Aspects of Intellectual Property Rights, and introduced GMP and ASEAN Common Technical Dossier guidelines to increase quality standards. Colombia continues to expand its Free Trade Agreements with global partners, which has an impact on important trade sectors, such as pharmaceuticals.

Global industry statistics

Cluster	Researchers in science, per thousand total employment[1]	Graduate students in science, engineering, manufacturing & construction, as a % of total graduate students[5]	Gross expenditure on R&D, as % of GDP[7]	Total patent applications, residents only[8]
Brazil	1.4	12.2%	1.2%	2,705
Canada	8.5 [2]	21.1% [6]	1.9%	4,550
China	1.5	N / A	1.7%	293,066
Colombia	0.4	24.2%	0.2%	133
France	8.9	26.2% [2]	2.3%	14,748
Germany	8.1	23.3%	2.8%	47,047
India	0.4 [3]	N / A	0.8% [4]	7,262 [9]
Indonesia	0.2	21.7%	0.1%	N / A
Japan	10.5	21.9%	3.4%	290,081
Mexico	1.0	25.6%	0.4%	951
Netherlands	5.2	14.0%	1.8%	2,575 [9]
Singapore	12.0	N / A	2.3%	895
Switzerland	6.0 [2]	21.6%	3.0% [2]	1,622
United Kingdom	8.8	21.7%	1.9%	15,490
United States	9.5 [4]	15.3%	2.9%	241,977

Footnotes:

1. UNESCO, 2009
2. 2008 data
3. 2005 data
4. 2007 data
5. UNESCO, 2009
6. 2002 data
7. UNESCO, 2009
8. World Bank, 2010; includes total patents from all industries
9. 2009 data

Americas

Established clusters within the United States are undergoing varied effects from industry consolidation, while emerging clusters within the Unites States and the broader Americas region continue to enhance industry infrastructure and R&D capabilities.

At a time of overall austerity in the life sciences industry, established clusters within the United States are trending along one of two paths. Several clusters in the Northeast are enjoying impressive growth, demand and resultant real estate development, due in large part to partnership support from academic, healthcare and private sector institutions. Conversely, a larger number of established clusters are experiencing consolidation and diminished demand, in line with the expected aftereffects of M&A activity and streamlining of operations. Emerging clusters within the United States have adopted an "if you build it, they will come" mentality. Be it via targeted incentive packages or the construction of incubator centers and parks, economic development groups and public–private partnerships from emerging clusters are all making strong efforts for a seat at the table.

Canadian markets continue to trend similarly to emerging clusters within the United States as they realize gaps in funding and are trying to create incentives and solutions to support life sciences companies. Clusters within Latin America are acting quickly to meet the demands of the industry and local populations. With increased wealth and access to healthcare, the demand for drugs and medical care is rapidly increasing. Although Latin American clusters are traditionally viewed as manufacturing destinations by multinational firms, particularly due to geographic proximity to the United States, local governments are ramping up domestic R&D capabilities to hopefully increase the amount of drugs and treatments created locally. Additionally, strong efforts are being made to protect IP and to combat smuggling and counterfeit drugs.

United States

Established
- Greater Boston
- San Diego
- San Francisco Bay Area
- Raleigh-Durham
- Philadelphia
- Suburban Maryland / DC / Arlington
- New Jersey / New York City
- Los Angeles / Orange County
- Minneapolis-St. Paul
- Seattle

Emerging
- Westchester / New Haven
- Chicago
- Denver
- Cleveland / Columbus / Cincinnati
- Salt Lake City
- Dallas / Fort Worth
- Southern Wisconsin
- Central & Southern Florida
- Indianapolis
- Southern Michigan
- Atlanta

Emerging
- Canada
- Brazil
- Colombia
- Mexico

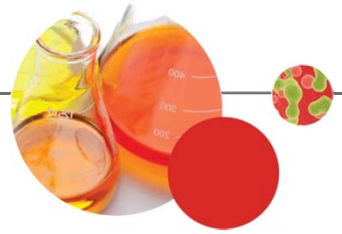
United States cluster methodology

The determination of U.S. industry clusters was first based off of a weighted ranking of state-level data. Qualitative knowledge of industry activity was used to amalgamate metropolitan areas into clusters. Quantitative data was used to rank individual clusters on their existing industry infrastructure and propensity to best support the industry.

	Life sciences employment[1]			Life sciences establishments[2]			Biotechnology & medical device venture capital funding[3]			National Institutes of Health funding[4]				
	30.0%			20.0%			25.0%			25.0%			Weighting	
Cluster	%	Weighted score	Rank	%	Weighted score	Rank	$ (in millions)	Weighted score	Rank	$ (in millions)	Weighted score	Rank	Weighted score	Rank
Greater Boston	3.1%	22.4	2	1.4%	15.9	2	$1,392.7	19.5	2	$2,274.9	25.0	1	82.9	1
San Diego	4.8%	30.0	1	1.3%	14.3	3	$602.0	15.1	3	$871.7	14.0	8	73.3	2
San Francisco Bay Area	2.3%	18.7	5	0.8%	8.3	13	$2,371.8	25.0	1	$1,366.4	17.9	3	69.8	3
Raleigh-Durham	2.8%	21.0	4	1.8%	20.0	1	$154.8	12.6	10	$916.7	14.3	6	67.9	4
Philadelphia	2.1%	17.6	8	1.0%	11.1	6	$246.6	13.1	8	$824.1	13.6	9	55.4	5
Suburban Maryland / DC / Arlington	1.7%	15.9	9	1.0%	11.0	7	$317.8	13.5	7	$965.6	14.7	5	55.1	6
New Jersey / New York City	1.3%	12.3	14	0.7%	3.4	20	$482.2	14.4	5	$1,649.6	20.1	2	50.2	7
Los Angeles / Orange County	2.3%	18.4	7	0.5%	0.0	21	$514.7	14.6	4	$1,045.2	15.4	4	48.3	8
Minneapolis-St. Paul	2.9%	21.2	3	0.9%	10.0	11	$209.3	12.9	9	$290.1	3.7	18	47.8	9
Seattle	1.4%	12.7	13	0.8%	8.0	15	$101.7	8.2	12	$885.3	14.1	7	43.0	10
Westchester / New Haven	2.3%	18.7	5	0.9%	10.0	11	$62.3	4.0	15	$443.5	7.2	14	39.8	11
Chicago	1.2%	9.8	15	0.7%	4.3	18	$141.6	12.5	11	$682.0	12.5	11	39.1	12
Denver	1.7%	15.8	10	1.1%	12.8	5	$79.8	5.9	14	$318.7	4.4	17	38.8	13
Cleveland / Columbus / Cincinnati	1.1%	8.2	17	0.9%	10.1	10	$92.4	7.2	13	$687.3	12.5	10	38.0	14
Salt Lake City	1.5%	14.5	12	1.3%	14.1	4	$25.2	0.0	20	$162.1	0.9	20	29.5	15
Dallas / Fort Worth	0.9%	5.6	19	0.7%	6.0	17	$331.6	13.6	6	$224.4	2.3	19	27.4	16
Southern Wisconsin	1.1%	8.9	16	1.0%	11.0	7	$36.2	1.2	17	$399.1	6.2	15	27.2	17
Central & Southern Florida	1.0%	6.8	18	0.8%	7.1	16	$47.1	2.4	16	$465.5	7.7	13	24.0	18
Indianapolis	1.5%	15.0	11	0.8%	8.3	13	$25.2	0.0	20	$123.8	0.0	21	23.3	19
Southern Michigan	0.5%	0.0	21	0.9%	10.2	9	$27.9	0.3	19	$655.5	11.9	12	22.4	20
Atlanta	0.7%	3.3	20	0.7%	3.7	19	$36.2	1.2	17	$373.0	5.6	16	13.8	21

Footnotes:

1. Bureau of Labor Statistics, 2011
2. Bureau of Labor Statistics, 2011
3. PricewaterhouseCoopers / MoneyTree Report, 2011
4. National Institute of Health / Awards by Location, FY 2011



1

Greater Boston ranks No. 1 among U.S. life sciences clusters, bolstered by its efficiency, collaboration and intellectual prowess.

Global trends

The aftereffects of the recession, coupled with the European sovereign debt crisis, continue to plague business operations in the mature market clusters of North America and Western Europe, including those of life sciences companies of all sizes and maturity levels. Although most life sciences companies continue to enjoy higher profit margins than those of other industry segments, it has become markedly clear that the product development formula of the past no longer applies. As a result, greater emphasis is being placed on the next wave of drugs and treatments – those stemming from biological organisms. Additionally, companies are increasingly diversifying their portfolios to mitigate risk and help fund the lofty costs of innovation, adding generic brands, crop and animal science and even consumer products through mergers and acquisitions.

New product developments have become ever more costly and difficult to achieve. Drug makers are attempting to achieve greater breakthroughs with less funds than in years past. The need to increase a company's likelihood of developing a new treatment continues to steer conversations around location strategy. Although many companies maintain R&D in mature markets rich with people capital and renowned research universities, others are turning to emerging global clusters due to dedicated private and public funding.

Within the United States, life sciences-focused clusters are at various stages in their evolution. The Northeast and California continue to dominate with their extensive university networks and deep labor pools, but, more and more, emerging clusters offer great talent coupled with more competitive real estate opportunities.

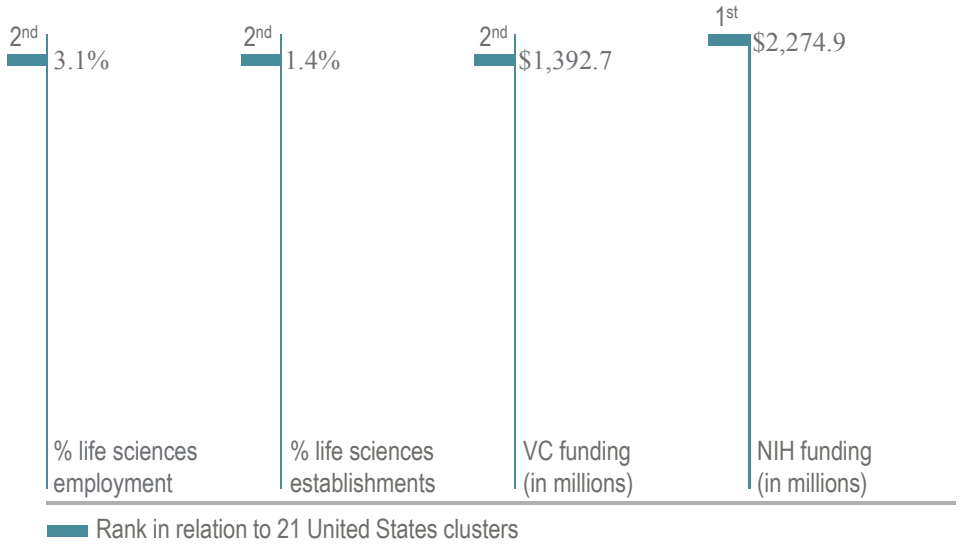
Greater Boston market overview

With the drive for discovery and innovation causing a rebalancing of operations, the Boston market continues to benefit from global realignment. The discovery process demands efficiency, collaboration and intellectual prowess. Boston is the elite provider creating that element of connectivity and is fueled by top-notch universities, innovation centers, research hospitals, venture capital firms and, most importantly, a strong labor force.

The Boston MSA features more than 74,000 employees within the pharmaceutical, biotechnology and medical device subsectors of the industry, trailing only San Diego on a percent of total workforce basis. Additionally, the area is the leading recipient of National Institute of Health (NIH) funding. Massachusetts is home to five of the top eight NIH-funded hospitals in the United States, which act as global leaders in biotechnology research. The top five NIH-funded universities (Harvard, University of Massachusetts, Boston University, MIT, and Tufts) anchor this cluster and offer advanced degrees in biosciences, fuel employment in the industry and add great depth to the development of innovative products.

The Greater Boston life sciences industry includes geographic markets that are both established and emerging. Cambridge is the state's core life sciences cluster. Here, large biopharma companies intermingle with start-ups, who begin here and grow until they are acquired or relocate as they outgrow space options. While Cambridge is a mature market, there are multiple emerging markets outside of the city attracting attention. These emerging clusters include the Greater Boston Suburbs, the Seaport District and the Longwood Medical and Academic Area (LMA).

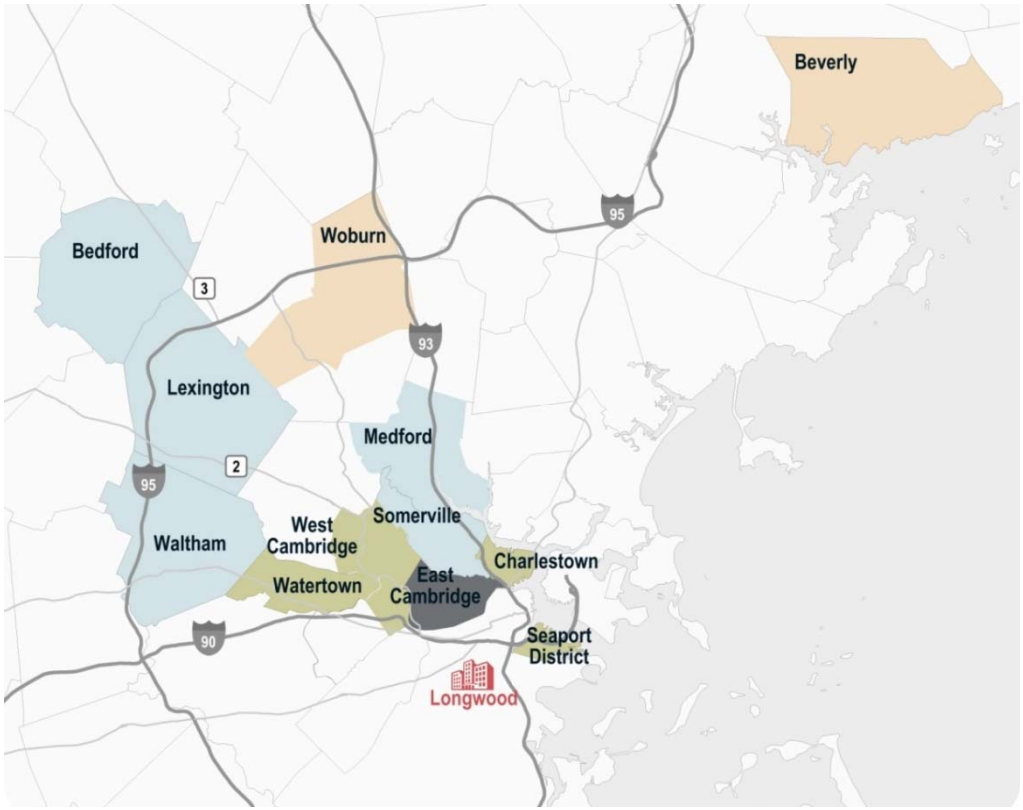
Greater Boston life sciences scorecard

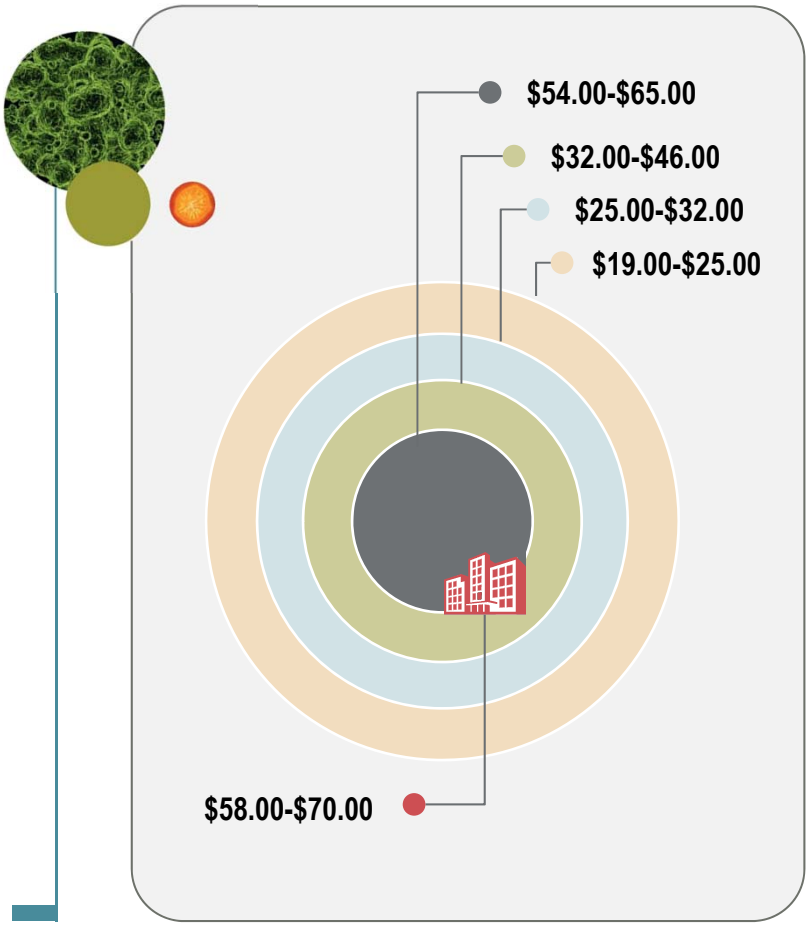


Sources: Bureau of Labor Statistics, PricewaterhouseCoopers, National Institute of Health

The *ripple* effect of East Cambridge

The Jones Lang LaSalle life sciences **rent ring**



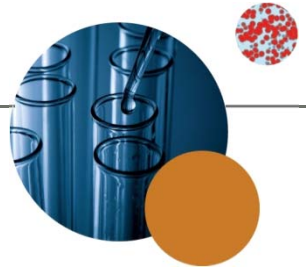


Rent ring

The concept of the rent ring is built on the understanding that the Greater Boston life sciences industry stems from East Cambridge. This market has become incredibly dense, with just over 7 million square feet of lab space in less than a 1.5-mile radius from the Kendall Square MBTA Station. As a result, this market is extremely competitive, with few growth options and asking rents reaching as much as $65.00 per square foot NNN for trophy spaces. East Cambridge represents the bull's-eye, the center of the ring, where rents are highest. Consequently, demand begins to spill outward.

Asking rents are lowered as tenants begin to look right outside of East Cambridge, in West Cambridge and Watertown to the west and Charlestown and the Seaport District to the east. These markets are far less dense and act as emerging clusters. Here, asking rents vary from $32.00 to $46.00 per square foot NNN, still high, but considerably lower than East Cambridge rates. The next step outward are suburban towns of Bedford, Lexington, Waltham, Medford and Somerville. Again the landscape changes dramatically, where lab space is considerably less clustered, but with lower rents ranging from $25.00 to $32.00 per square foot NNN. Farther out sit Woburn and Beverly, where asking rents range from $19.00 to $25.00 per square foot NNN. The Longwood Medical and Academic Area remains a unique outlier in the rent ring, where rents are often higher than those of East Cambridge ($58.00 to $70.00 per square foot NNN) due to its downtown location and proximity to healthcare institutions. However, the size of the leasable lab market in LMA is significantly smaller than East Cambridge, and does not have the same effect on the overall Greater Boston life sciences market.

The next sections present a deeper dive into each of these clusters, and how each falls into the life sciences rent ring.



Cambridge

Overview

At the heart of the Greater Boston life sciences market is Cambridge, holding nearly 7.5 million square feet lab space. The city acts as a global anchor for the industry, making it one of the most competitive and resilient markets in the nation. Cambridge maintains a true advantage as it is home to major academic institutions and centers of excellence, all within minutes of each other. Harvard University and the Massachusetts Institute of Technology fuel a strong labor force. Large private institutions like the Whitehead Institute and the Broad Institute nurture innovation and promote collaboration. Venture capital firms support industry growth and continue to locate in Kendall Square. And intertwined throughout all these entities are the life sciences companies, from start-ups to mature corporations, who continue to benefit from co-locating.

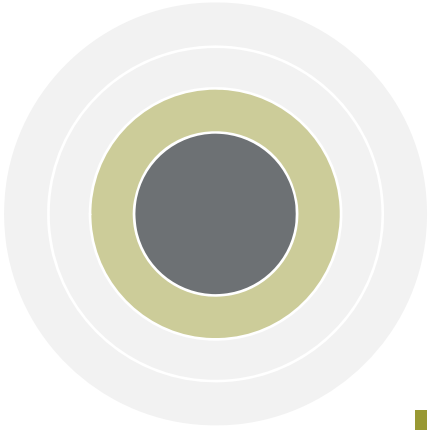
Real estate costs are higher in Cambridge but the proximity to outstanding intellectual capacity and the higher probability of discovering the next profitable drug outweigh the premium. Average asking rents in the Cambridge lab market have now reached levels of the last market peak at $55.00 per square foot NNN. Cambridge lab rents are one of the first in Greater Boston to fully recover, and have proved resilient during the real estate bust, only dipping approximately 16.0 percent off peak.

Cambridge currently holds nearly 2.0 million square feet under construction, all dedicated to the life sciences industry. Although the majority of developments are build-to-suits, the city is home to the only speculative lab development in the country. Skanska is constructing 123,000 square feet of lab space at 150 Second Street. This spec development speaks to the confidence in the market. The remaining 1.7 million square feet, sponsored by large life sciences conglomerates, big pharma and local research institutes, is 95.0 percent preleased. *[Please refer to development map on next page for more details]*. Historically, Cambridge has had minimal options for start-up or niche pharmaceutical companies seeking lab space. More and more developers are looking to meet this demand through the "rent-to-bench" model, where companies requiring very little space can rent turnkey, short-term lab space as their needs require.

All this activity is consolidated to East Cambridge, which already accounts for the vast majority of inventory. Across town, West Cambridge acts as an extension of the East Cambridge life sciences sector and continues to develop its own identity. The area boasts more of a suburban, campus-like feel, compared to the urban East Cambridge. West Cambridge provides a unique opportunity for large or growing tenants who are looking to experience cost savings and still maintain access to the renowned resources in Cambridge. Here, flexible zoning policies have been implemented to facilitate the development of lab space. As West Cambridge continues to form a cohesive identity, the submarket will see greater tenant demand and stronger market fundamentals.

Cambridge rent ring

- Average asking rents across the Cambridge lab market have now reached levels of the last market peak at $54.61 p.s.f. NNN
- Trophy lab rents in East Cambridge can reach up to $65.00 p.s.f. NNN
- West Cambridge asking rates are substantially lower at $34.00 to $46.00 p.s.f. NNN



IRONWOOD
Ironwood Pharmaceuticals signed an amendment to its lease at 301 Binney Street. Due to this lease extension and phased expansion for 93,000 s.f., Ironwood will now occupy a total of 303,000 s.f.

2M SF UNDERWAY
East Cambridge boasts nearly 2M s.f. under construction, including the country's only speculative lab development. The remaining 1.7M s.f. is 95.0 percent preleased.

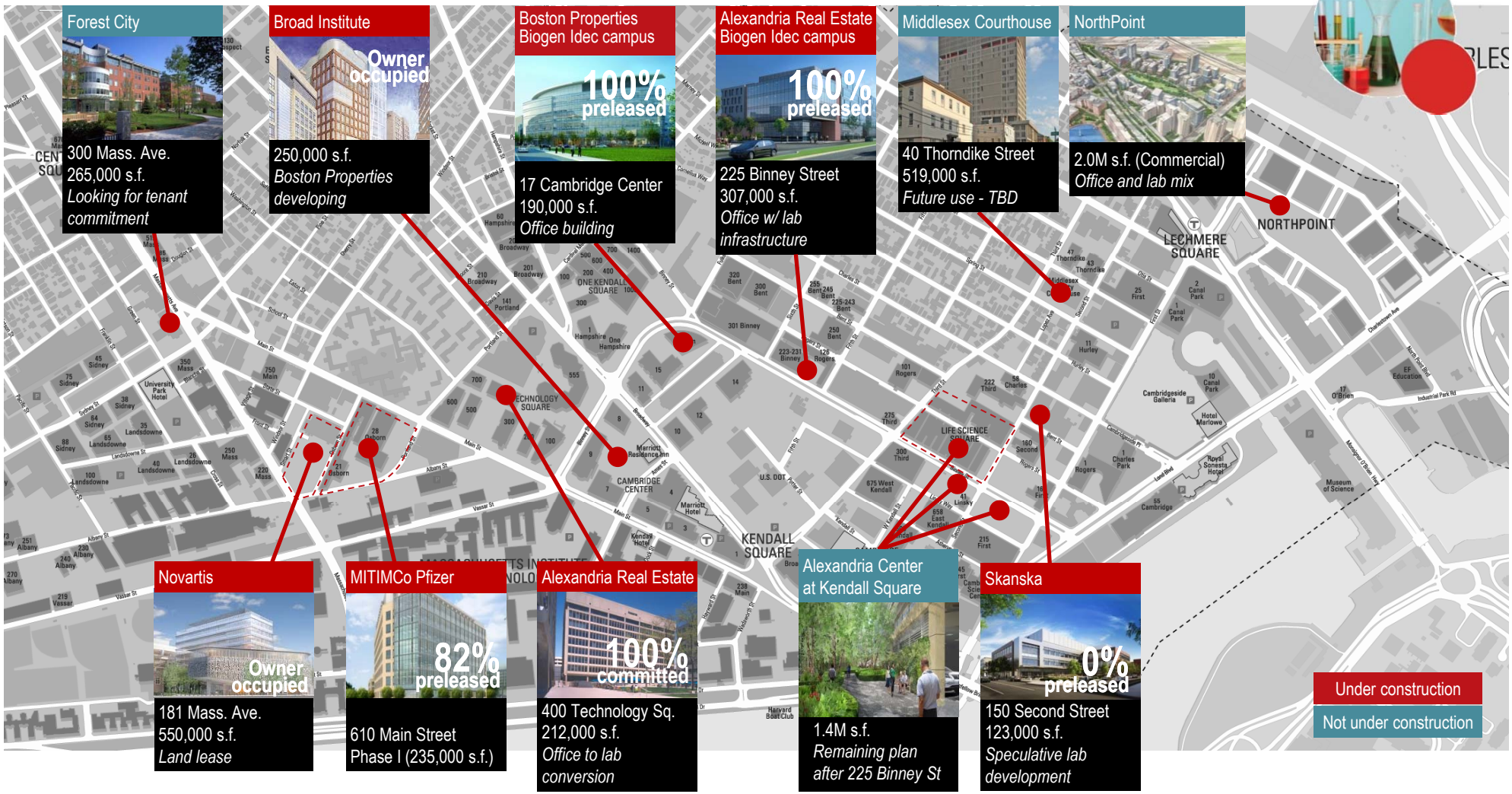
FRESH POND RESEARCH PARK
The Davis Co. bought the mixed-use 207,000 s.f. portfolio from Spaulding & Slye Investments. It sold for $38.4M ($185 p.s.f.); it represents a development opportunity for lab space in West Cambridge.

BOSTON BIOMEDICAL
signed a 63,000 s.f. lease at recently delivered 640 Memorial Drive. The lab building is now 79.0 percent preleased.

Cambridge acts as a global anchor for the industry, making it one of the most competitive and resilient markets in the nation.

Activity key: Leasing | Development | Sales | Tenants in the Market | Large blocks of space

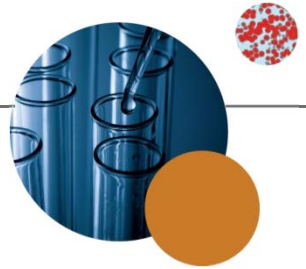
Cambridge development



Outlook

Cambridge will remain a stronghold for the life sciences community, and thus will remain extremely competitive. Although average asking rents are quite strong in the Cambridge lab market, the vacancy rate still remains relatively high (13.0 percent) compared to the Cambridge office market (7.3 percent). There are seven blocks of available space over 100,000 square feet if one includes 150 Second Street which is slated to deliver at the end of this year.

However, it is expected that lab demand will continue to grow and help to fill these spaces. Users seeing 200 to 300 percent growth projections are poised to expand into these larger blocks of space, where start-up and mid-tier organizations will continue to absorb the remaining space within this world class R&D hub.



Suburbs

Overview

Developers and tenants alike have recognized that the suburbs provide an important option for tenants finding space and pricing constraints in Boston and Cambridge biotech markets. As Cambridge presents an inefficient and undesirable supply of second and third generation laboratories, the suburbs provide a sound alternative where developers are delivering office-to-lab conversions as well as ground-up construction. Although less concentrated than the East Cambridge hotbed, there is a definite life sciences identity evolving along Route 128. Historically, the suburbs have served to support growing manufacturing and back-office functions. Today, more and more life sciences tenants are choosing the suburbs as their core location. The following highlights suburban cities that are benefitting from Cambridge spill-over demand.

Watertown acts as an extension of West Cambridge, with Alexandria Real Estate Equities owning the majority of the lab market share. Although technically a suburb, Watertown's existing infrastructure and strong accessibility has allowed a lab market to develop in the Arsenal area. The latest notable transaction was from Forma Therapeutics, who relocated to 45,000 square feet at 500 Arsenal Street.

Farther west sits Waltham, home to both mid-tier and global organizations. Noteworthy companies located in Waltham include AstraZeneca, Genzyme and Alkermes. With an established office market fostered by the high-tech industry, these firms are attracted to the existing amenities provided by the Route 128 corridor.

The Lexington / Bedford area is arguably the most active life sciences market in the suburbs. A number of tenants have recently relocated from Cambridge, taking advantage of the direct connection Route 2 provides to the area from the city. Major companies include Joule Biotechnologies, BioScale, Quanterix, Abpro and T2 Biosystems. Alternatively, Dyax signed a 45,000-square-foot lease at 55 Network Drive in Burlington, which should help connect this city to the Lexington / Bedford life sciences market.

Demand is spilling out of Lexington and Bedford into Woburn and Beverly, where Cummings Properties has developed a critical mass of lab supply. Tenants of all sizes, from start-ups to large companies, can find suitable space to meet their business goals. Farther south, Medford and Somerville are largely driven by start-up activity, where small companies are seeking economic relief in reduction of operating spending.

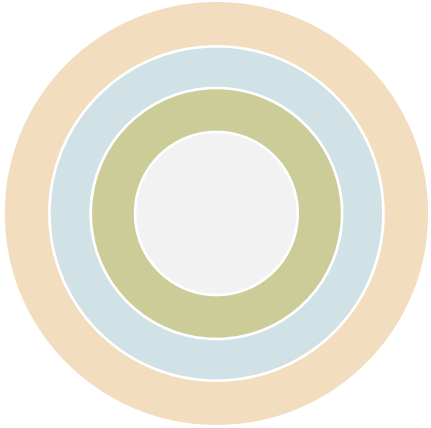
Outlook

Across the suburban market, redevelopment of flex-type properties into Class B laboratory facilities is popular, offering space at an attractive price point. Tenants looking for desired Class A lab space will consider build-to-suit options with landlords providing opportunities for asset conversion. With tenant demand driving this repositioning, non-core life sciences landlords typically require tenant commitments to ensure they receive their return on investment.

Suburban rent ring

Average asking rents for lab space varies across the suburban landscape

- Watertown rents mimic those of West Cambridge at $32.00 to $46.00 p.s.f. NNN
- Lexington / Bedford rates range from $26.00 to $32.00 p.s.f. NNN, Waltham has similar asking rates at $25.00 to $27.00 p.s.f. NNN
- Somerville / Medford incubator rents range from $25.00 to $32.00 p.s.f. NNN
- Woburn and Beverly rates are slightly lower at $19.00 to $25.00 p.s.f. NNN



1366 TECHNOLOGIES
The manufacturing solutions company signed a 41,000 s.f. lease at 6-8 Preston Court in Bedford. The tenant is relocating and expanding from 45 Hartwell Avenue in Lexington.

64 GROVE STREET
A 59,925 s.f. research facility (70.0% lab) in Watertown. Currently owned and occupied by Boston Biomedical Research Institute, which is looking to sell the property as a potential leaseback.

9 CROSBY DRIVE
Entegris purchased the 80,000 s.f. Bedford building from Duffy Properties for $7.1M, or $89 p.s.f. The company plans to convert the flex property to lab space.

DYNASIL
This Watertown tenant is seeking approximately 50,000 s.f., half of which will be devoted to R&D and products manufacturing and the other half to office.

The Greater Boston Suburbs provide a variety of lab growth options for space users at an attractive price point.

Activity key: Leasing | Development | Sales | Tenants in the Market | Large blocks of space

Seaport District

Overview

The Seaport ("Innovation") District has attracted a variety of users due to its proximity to downtown Boston and the rental savings to be found in contrast to surrounding hubs such as Cambridge. The most notable relocation is Vertex Pharmaceutical's decision to leave Cambridge and construct its new 1.1 million-square-foot office/lab headquarters by the end 2013. This colossal move fueled immense interest in the Seaport District for many life science tenants, both large and small. Due to rising popularity of this neighborhood, the landscape has changed with market rents rising and space options becoming few and far between. As a result, the Seaport District has quickly transformed into a very tight market where, over the past two years alone, over 14.5 percent of Seaport supply has been absorbed. Minimal space options remain for small and large tenants alike and thus recent lab activity has begun to slow.

Outlook

Given the current state of the Seaport District, and a forecast for only a tightening market, sizeable life sciences tenants will have to consider build-to-suit options here. As the existing landscape and infrastructure of the area continues to transform, build-to-suit options may become more and more attractive for established life sciences tenants.

ACETYLON
signed for approximately 10,000 s.f. at Seaport Center.

VERTEX
1.1M s.f. office/lab headquarters to deliver by end of 2013.

VERTEX
signed additional lease at One Harbor Street for 98,000 s.f., where space will be retrofitted to lab.

FUTURE DEVELOPMENTS
Life sciences activity in the Seaport District hinges on build-to-suit developments from established tenants.

Growing life sciences companies are opting to head off to try the new frontier of the "Innovation District," where tenants can locate close to downtown and see some possible cost savings.

Longwood

Overview

The Longwood Medical and Academic Area (LMA) is one of the world's premier medical, research and academic communities. This 213-acre site is comprised of 18.1 million square feet, where all buildings are institutionally owned with the exception of only two properties: BioMed Realty Trust's Center for Life Sciences at 3 Blackfan Circle (703,000 square feet) and Merck's Longwood Research Facility (466,000 square feet). Since Merck owns and occupies this building, it is truly only the Center for Life Sciences that constitutes the commercial leasable market. To meet the growing demand for leasable lab space, National Development and Alexandria Real Estate Equities are constructing a 413,000-square-foot research and development building at Longwood Center. Dana Farber signed on as the anchor tenant, agreeing to lease 154,000 square feet (37.3 percent).

Outlook

Others are also looking to expand their LMA lab footprint. Brigham and Women's (BWH) is building 358,000 square feet on the former Mass Mental Health Center site. They recently completed a long-term ground lease in order to construct 360,000 square feet of office and lab space from Emmanuel College. Children's Hospital announced plans for a new 445,000-square-foot clinical building in the heart of its campus and also has long-term plans to develop a 440,000-square-foot office and lab building a block from its campus. Adjacent to Longwood Center, the Winsor School plans for a third-party development of over 300,000 square feet on their "endowment" portion of its campus.

DANA FARBER
signed on as anchor tenant (154,000 s.f.) at Longwood Center (413,000 s.f.) with National Development and ARE.

BWH
will build 360,000 s.f. lab building on Emmanuel College campus and a new clinical & research facility on former Mass Mental Health site.

CHILDREN'S
The hospital is planning to construct a 445,000 s.f. clinical building on-campus and a 440,000 s.f. office and lab building adjacent to campus.

WINSOR SCHOOL
is planning third-party development of over 300,000 s.f. on "endowment" portion of campus.

The LMA is the second largest employment district in the state, surpassed only by downtown Boston. It is home to four of the top five independent hospital recipients of NIH funding.

Activity key: Leasing | Development | Sales | Tenants in the Market | Large blocks of space

Note: The Jones Lang LaSalle "Life Sciences Cluster Report[s]" for 2011 and 2012 were too large to include in their entirety. Therefore, only the pertinent pages are included in this appendix. The full reports can be found here:

2011:

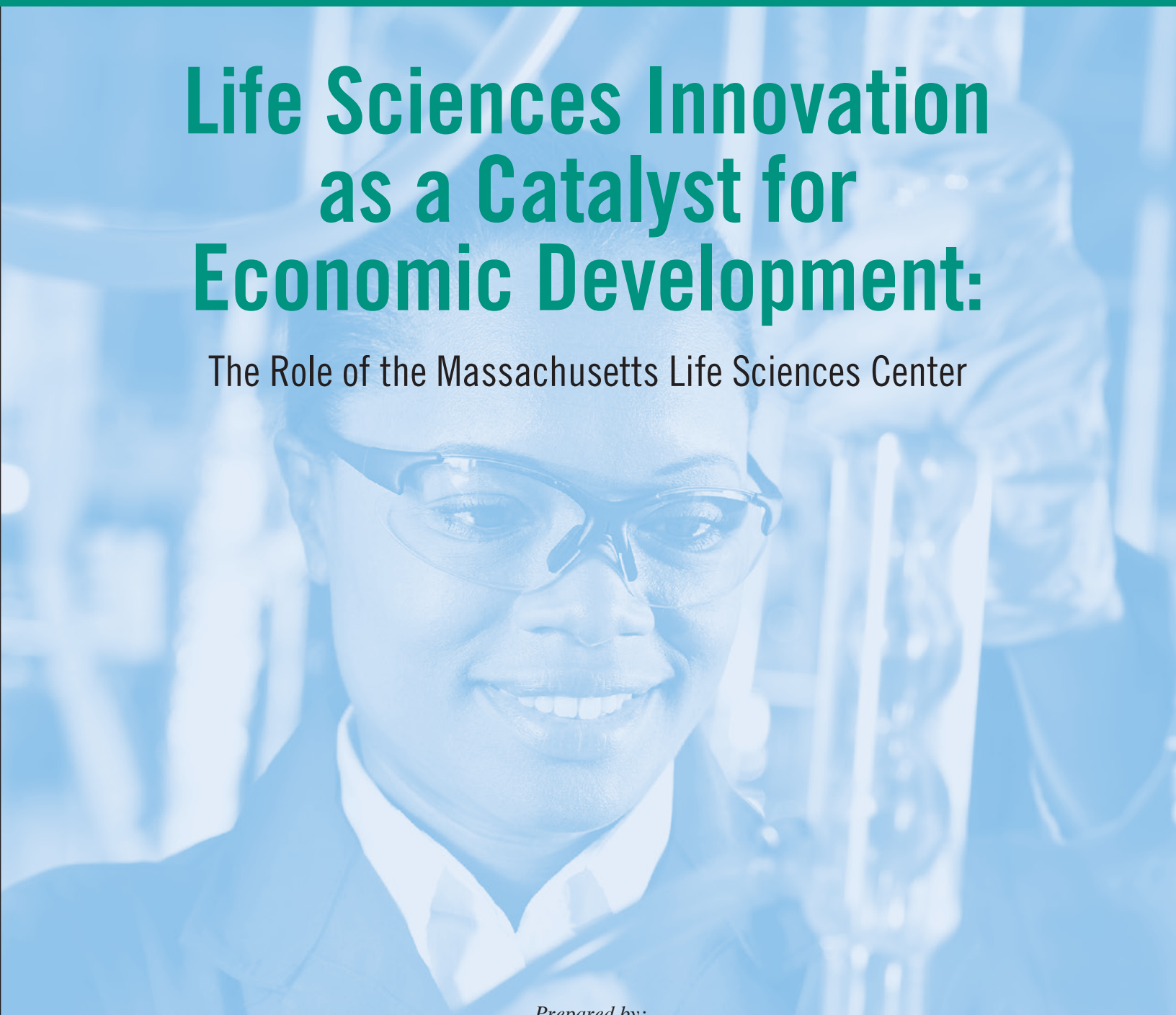
http://www.joneslanglasalle.com/ResearchLevel1/Global_Life%20Sciences%20Cluster%20Report_2011_gb.pdf

2012:

http://www.us.am.joneslanglasalle.com/ResearchLevel1/Life%20Sciences%20Cluster%20Report_Global_2012.pdf

Life Sciences Innovation as a Catalyst for Economic Development:

The Role of the Massachusetts Life Sciences Center



Prepared by:

The Kitty and Michael Dukakis Center for Urban and Regional Policy at Northeastern University

Northeastern University
Kitty and Michael Dukakis Center for Urban and Regional Policy

The Boston Foundation

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INNOVATION. INFORMATION. IMPACT.

About the Boston Foundation

The Boston Foundation, Greater Boston's community foundation, is one of the oldest and largest community foundations in the nation, with net assets of more than $800 million. In 2012, the Foundation and its donors made $88 million in grants to nonprofit organizations and received gifts of close to $60 million. The Foundation is a partner in philanthropy, with some 900 separate charitable funds established by donors either for the general benefit of the community or for special purposes. The Boston Foundation also serves as a major civic leader, provider of information, convener and sponsor of special initiatives that address the region's most pressing challenges. The Philanthropic Initiative (TPI), an operating unit of the Foundation, designs and implements custom philanthropic strategies for families, foundations and corporations around the globe. Through its consulting and field-advancing efforts, TPI has influenced billions of dollars in giving worldwide. For more information about the Boston Foundation and TPI, visit www.tbf.org or call 617-338-1700.

About the Kitty and Michael Dukakis Center for Urban and Regional Policy

The Kitty and Michael Dukakis Center for Urban and Regional Policy at Northeastern University conducts interdisciplinary research, in collaboration with civic leaders and scholars both within and beyond Northeastern University, to identify and implement real solutions to the critical challenges facing urban areas throughout Greater Boston, the Commonwealth of Massachusetts, and the nation. Founded in 1999 as a "think and do" tank, the Dukakis Center's collaborative research and problem-solving model applies powerful data analysis, a bevy of multidisciplinary research and evaluation techniques, and a policy-driven perspective to address a wide range of issues facing cities and towns. These include affordable housing, local economic development, workforce development, transportation, public finance, and environmental sustainability. The staff of the Dukakis Center works to catalyze broad-based efforts to solve urban problems, acting as both a convener and a trusted and committed partner to local, state, and national agencies and organizations. The Center is housed within Northeastern University's innovative School of Public Policy and Urban Affairs.

About the Authors

Barry Bluestone is a Founding Director of the Kitty and Michael Dukakis Center for Urban and Regional Policy and former Dean of the School of Public Policy and Urban Affairs at Northeastern University, where he is also the Stearns Trustee Professor of Political Economy. Previously, Professor Bluestone spent 12 years at the University of Massachusetts at Boston and 15 years at Boston College, where he directed the University's Social Welfare Research Institute. At the Dukakis Center, he has led research projects on housing, local economic development, state and local public finance, and the manufacturing sector in Massachusetts. He regularly consults with trade unions, business leaders, and serves on Gov. Deval Patrick's Economic Development Strategy Council. Professor Bluestone was raised in Detroit and attended the University of Michigan, where he received his Ph.D. in economics.

Alan Clayton-Matthews is an Associate Professor in Northeastern University's School of Policy Studies and Urban Affairs and in the Department of Economics. He is a contributing editor of *Massachusetts Benchmarks*, a joint publication of the University of Massachusetts and the Federal Reserve Bank of Boston that presents timely information and analysis about the performance of the Massachusetts economy. He is also a Director of the New England Economic Partnership (NEEP), a group of economists and managers from academia, business, and government who study and forecast the regional economy. He serves as the Massachusetts forecast manager for NEEP. Professor Clayton-Matthews also is currently serving on Governor Deval Patrick's Council of Economic Advisors. His applied research interests include analyzing the Massachusetts economy, including its structure, development, and short and long-run growth trends. His academic research includes the development of statistical procedures and tools for economic index construction and forecasting, and the relationship between higher education and economic development. Professor Clayton-Matthews holds a Ph.D. in economics from Boston College.

UNDERSTANDING BOSTON is a series of forums, educational events and research sponsored by the Boston Foundation to provide information and insight into issues affecting Boston, its neighborhoods, and the region. By working in collaboration with a wide range of partners, the Boston Foundation provides opportunities for people to come together to explore challenges facing our constantly changing community and to develop an informed civic agenda. Visit www.tbf.org to learn more about *Understanding Boston* and the Boston Foundation.

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Life Sciences Innovation as a Catalyst for Economic Development:

The Role of the Massachusetts Life Sciences Center

Authors

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March 2013

Preface

In 2003, a distinguished group of university leaders, educators and business representatives came together for a unique and unprecedented summit, spearheaded by Harvard Business School professor Michael Porter and hosted by the presidents of MIT and Harvard, Susan Hockfield and Drew Gilpin Faust. This was the same year those two universities played a major role in the international team that cracked the human genome.

The summit's purpose was to discuss the state's life sciences "super cluster," meaning all of the many sectors that are involved in the life sciences. Everyone attending agreed that strengthening the life sciences was not only smart and played to our state's strengths, it was crucial to our future global competitiveness. It could mean jobs for hundreds of thousands and billions added to the Massachusetts economy.

While the summit was stimulating, there was no established vehicle to build on the momentum that it generated. And so, in 2005, the Boston Foundation provided a grant of $125,000 to create the Massachusetts Life Sciences Collaborative. The Organizing Committee for the new group included the leaders of all of the Boston area's major universities, teaching hospitals, life-sciences companies and venture-capital firms.

In March of 2007, Governor Deval Patrick spoke at one of the Collaborative's meetings about the importance of the life sciences to the Commonwealth. He previewed an announcement he would make publicly later that year about the creation of a new Massachusetts Life Sciences Initiative, which represented a 10-year, $1 billion investment to enhance and strengthen the state's leadership in the life sciences.

The Boston Foundation was honored to play a major convening role in bringing together the stakeholders for those early discussions. And now we are proud to publish this first report on the Massachusetts Life Sciences Initiative and the work of the quasi-public agency charged with carrying out its mission.

We have published many reports researched by the lead author of this report, Barry Bluestone, Director of the Kitty and Michael Dukakis Center for Urban Affairs at Northeastern. Reports from the Dukakis Center are always thorough and compelling, but not all of them carry good news. This one does, especially when it comes to economic impact. The $56.6 million Massachusetts awarded in tax incentives to life sciences firms between 2009 and 2011 has created 2,500 jobs, which should generate more than $266 million in wages and salaries during the next five years. In fact, the Commonwealth's life sciences super cluster has risen to number one in the nation in terms of per capita employment, with close to 14,300 jobs for every one million residents.

These jobs are not just for workers with advanced degrees: at least one in five require no more than a two-year associate's degree and another 48 percent require just a bachelor's degree. For the Boston Foundation, this confirms our deep investment in supporting the full education pipeline and the importance of preparing college students for well-paying jobs in a field that will only grow.

Estimating the economic impact of this life sciences super cluster is within our grasp. Evaluating its broader value to society is daunting because of the almost limitless potential it has for improving the lives and well-being of people here in Massachusetts and around the world.

Paul S. Grogan
President & CEO

Contents

Executive Summary

This report provides an up-to-date, independent evaluation of the $1 billion, 10-year Massachusetts Life Sciences Initiative and the Massachusetts Life Sciences Center (MLSC) charged with the responsibility of carrying out its mission. The initiative was established in July 2008 by Governor Deval Patrick's Administration and the Legislature to encourage the growth of discovery and production in the life sciences, including biotechnology, pharmaceuticals, medical diagnostics, medical devices and bioinformatics in the Commonwealth. Based on the region's existing comparative advantage in life sciences research and development (R&D) emanating from the laboratories of its leading universities and medical institutions, this substantial infusion of public funds was undertaken with the ambitious goal of making this cluster of industry sectors the most successful in the world.

This evaluation comes at a propitious time, given the state of fiscal affairs in the Commonwealth and the nation. Virtually every unit of government is scrutinizing the use of each tax dollar to ensure that public revenue is being spent effectively and efficiently. Put simply, our goal in this evaluation was to gather as much data as possible to assess whether the Commonwealth's sizeable commitment of public resources is paying off in the form of a life sciences "super cluster" capable of attracting massive amounts of investment dollars, generating well-paying jobs for Massachusetts residents and yielding additional tax revenue for the Commonwealth.

The Life Sciences Super Cluster and the MLSC

After it was created, the MLSC sought to develop as a key element of its strategy the creation of a collaborative "ecosystem" encompassing all aspects of the state's life sciences. It would do this by encouraging the development of a dense, highly connected community of scholars, entrepreneurs, industry leaders, venture capitalists and government officials who were all dedicated to the success of this sector. Unlike many narrowly focused state economic development initiatives, the Center has chosen to guide its investments with a broad range of strategic priorities geared to enhance all aspects of the life sciences cluster. These include:

- funding translational research that converts new discoveries into marketable products and services
- investing in promising new technologies
- ensuring worker skill acquisition that aligns with the needs of life sciences industries
- creating new infrastructure with shared resources to accelerate life sciences innovation
- building partnerships among segments of the local and international life sciences communities

To accomplish these goals, the Center relies on a portfolio of seven distinct programs. These include:

Cooperative Research Grants to support industry-sponsored research at universities in order to facilitate scientific discoveries that lead to medical applications. These grants match industry contributions dollar for dollar.

Internship Challenge Program to provide funds for interns working at start-up and smaller Massachusetts life sciences companies.

New Investigator Grants to spur innovative research and advance the careers of new investigators working on cutting-edge research at academic research centers in Massachusetts.

Life Sciences Accelerator Loan Program to make loans available to early-stage companies and help leverage additional sources of capital.

Small Business Matching Grant (SBMG) Program to provide matching support to firms on the verge of commercializing new technologies developed with Phase II or Post-Phase II federal Small Business Innovation Research (SBIR) awards or federal Small Business Technology Transfer (STTR) grants.

Life Sciences Tax Incentive Program to offer a combination of 10 competitively awarded tax incentives available to companies that meet specified hiring goals.

TABLE 1
Distribution of MLSC Investments by Dollar Amount (June 2008–June 2012)

Capital Projects (12)	$186,950,000
Company Grants and Accelerator Loans (31)	$22,907,000
Academic Research Grants (35)	$23,346,344
Tax Incentives (56)	$56,595,093
Interns Funded for Workforce Development (884)	$6,903,164
Equipment and Supply Grants for Schools (32)	$3,333,675
Other Grants/Business Plan Competitions	$1,540,000
TOTAL	$301,575,276

Source: Massachusetts Life Sciences Center, 2013

Capital Projects Fund to provide capital for equipment and supplies for high schools in Gateway Cities, vocational/technical schools, and community colleges; and for capital projects at academic/research institutions, business incubators, and other not-for-profit organizations.

Between 2008 and June 30, 2012, the Center directly invested or committed more than $300 million in state funds that have leveraged more than $1 billion in third-party investments by private businesses, the federal government and foundations, according to the MLSC *FY2012 Report*. **Table 1** provides a breakdown of these investments.

Special Features of the Massachusetts Life Sciences Center

Our analysis revealed that, aside from its extraordinarily broad mandate, there are other factors that make the MLSC quite different from most government subsidy programs.

First, the MLSC operates under a Board of Directors that includes state government officials, but also industry CEOs, leaders from academia and medicine, bioscience researchers and others who have great knowledge of the life sciences.

Second, MLSC accelerator loans and other investments are reviewed by a panel of more than 200 specialists who advise the Center's Scientific Advisory Board (SAB), which itself is dominated by academic researchers, industry scientists, and private venture-capital experts who together can judge both the scientific and economic potential of an MLSC investment. Accelerator loans are also reviewed by private venture-capital experts who can assess the economic potential of recipient firms.

And third, the Center insists on accountability in terms of private sector investment matches. The Center also retains the power (and has utilized it) to "claw back" tax incentives if and when specific job creation goals are not reached by grant recipients.

We discovered from our interviews with life sciences executives, trade association leaders and members of the MSLC Scientific Advisory Board that the high level of professionalism associated with the Center's expert-based review process has resulted in MLSC investments that appear to have a high rate of return for the Commonwealth. We will return to this point, but must first touch upon a finding even more important than the measured rates of return to specific MLSC programs.

New vs. Old Growth Theory

To properly assess the value of the Life Sciences Initiative and the MLSC, it is useful to place its activities in the context of economic growth theory. What is now known as the "old growth theory" suggests that economic prosperity springs from the accumulation of ever greater stocks of the fundamental ingredients of production: capital, labor and natural resources. Those countries that find ways of increasing investment in plant and equipment, adding to labor supply and extracting more natural resources are the ones that will become more affluent.

While not completely discounting this approach to growth, a "new growth theory" has evolved that places technological progress at the very epicenter of growth dynamics—even more important than capital, labor and resource inputs. Advances in technology and interdependencies between new ideas and new investment provide the basis for entire new industries and products that generate additional wealth and raise living standards.

Innovation-based growth is so powerful because it avoids the classic problem of diminishing returns on any given investment. With this type of growth, once the fixed cost of creating a new technology has been incurred, the formula can be used over and over again at little or no cost. As such, there can be increasing returns paying enormous dividends to society.

Moreover, the new innovation-based growth theory

posits a strong reciprocity among the rate of skill acquisition by workers, investments in new capital and new inventions. Thus, programs that combine incentives for innovation along with resources to augment human capital should fuel rapid economic growth more than anything else society can do to promote prosperity.

What is special about the Massachusetts Life Sciences Initiative is that it focuses explicitly on increasing the rate of innovation by encouraging more research and development (R&D) in the life sciences and helping small firms in this super cluster convert basic research into marketable products and services. New growth theory posits that this activity is the very fountain of economic growth.

Has the MLSC Been Successful?

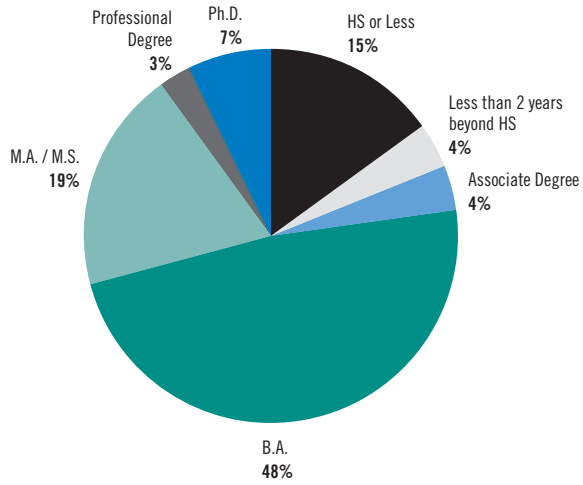
Unfortunately, keeping score on the success of innovation is difficult. Instead of a more-or-less certain return to a given infusion of capital under the old growth theory, under the new growth theory, innovation tends to deliver stronger long-term growth but it is "lumpy, discontinuous, and nonlinear." There can be a long gap between the time a new innovation is first incorporated into production and the time that it pays off in terms of increased productivity, output and jobs. In the short term, it can be discouraging, as investments in fundamental innovation usually have little immediate payoff. It will take decades to realize the full benefits to humanity and the economy from the advances now being made in drug discovery, medical diagnostics and medical devices.

What we can do is measure the short-term direct benefits of MLSC investments and consider the views of experts as to whether the Center has indeed played a critical role in creating a life sciences "ecosystem" that attracts investment and generates jobs in this sector.

Short-Term Benefits

As for the short-term benefits, we conducted a cost-benefit analysis of the Center's tax incentive program. According to our analysis based on MLSC data, the total value of tax incentives outstanding to Massachusetts life sciences firms as of June 30, 2012 was $56.6 million. Our best estimate is that a little over 2,500 jobs were created as a result of these incentives. Given the average $105,000 salary of these jobs, we predict they will generate more than $266 million in wages and salaries during the next five years. If our analysis proves correct, these workers will pay more than $93 million in state personal income and sales taxes during that period. As such, assuming all of these jobs were directly related to the tax incentives and that these jobs last at least five years, every dollar of tax incentive will repay $1.66 to state coffers, as **Table 2** reveals. This is an outstanding rate of return.

FIGURE 1
Education Distribution of New Hires by 2010 MLSC Tax Incentive Awardees



Source: Dukakis Center for Urban and Regional Policy

What is more, our analysis suggests that these jobs will go to a broad array of workers, not just those with advanced degrees. As **Figure 1** reveals, more than one in five jobs in life sciences firms require no more than a two-year associate's degree and nearly another half (48%) require no more than a bachelor's degree. Thus, the short-term benefits of MLSC tax incentives seem to have heavily outweighed the costs and the job benefits are broadly shared.

The Unique Growth Pattern of Regional Life Sciences Clusters

The most important benefits stemming from MLSC activities, however, will come in the future. This is due to the unique growth pattern of highly innovative sectors like the life sciences. The regional concentration of life-sciences companies happens in a very different manner than in other industries. In the case of traditional industrial sectors such as auto, aircraft engine, financial services and the like,

TABLE 2

Economic Return on the MLSC Tax Incentive Program

	Program Year 2009	Program Year 2010	Program Year 2011	3 Years of Incentives
Total Value of MLSC Tax Incentives ($) Outstanding	$15,245,500	$20,672,638	$20,340,884	$56,259,022
Net New Jobs Created	901	721	915	2,537
Tax Incentive per Job ($)				$22,175
Annual Tax Incentive per 5-year job ($)				$4,435
Average Salary per Job ($)				$105,037
Total Salaries Generated per Year ($)				$266,479,399
State Income Tax Revenue per Job per year ($)				$4,937
Total State Income Tax per year ($)				$12,524,532
Average Sales Tax per Job ($)				$2,404
Total State Sale Tax per year ($)				$6,099,447
Total Income+Sales Taxes per year ($)				$18,623,979
Average Income+Sales Tax/Job per year				$7,341
Total Income+Sales Taxes per 5-year Job				$36,705
Total Income+Sales Taxes over 5 years				**$93,120,585**
Tax Revenue/Incentive Ratio over 5 years				**1.66**
	Pharma	**Medical Devices**	**Scientific Research**	**Total**
Jobs	1,843	481	213	2,537
Average Salary ($)	$115,222	$66,913	$103,009	$105,037
Total Salary ($)	$212,353,256	$32,185,280	$21,940,863	$266,479,399
Share of Salary	0.7969	0.1208	0.0823	1.0000
State Income Tax By Sector ($)	$9,980,603	$1,512,708	$1,031,221	$12,524,532
Sales Tax by Sector ($)	$4,860,554	$736,689	$502,204	$6,099,447

Source: Dukakis Center for Urban and Regional Policy

a region becomes dominant in a particular cluster once a large anchor enterprise or a small number of them establish operations in that locale. Once the anchor enterprise is established, an array of smaller firms is attracted to that region to serve as part of the supply chain for the large anchor enterprise(s). Essentially, the small firms in the industry are dependent on the large ones.

For the life sciences and other highly innovative sectors, the reverse is true. The large companies that depend on the development of breakthrough innovations and sophisticated medical devices prosper by being near a concentration of small start-up firms. Even the largest of the life sciences companies, with substantial research budgets, do not have the resources to generate more than a handful of breakthroughs in the biosciences, genomics and similar fields. These big firms grow and prosper by carefully monitoring the scientific discoveries under way in university research laboratories and in the translational research carried out by small start-ups.

Those few start-ups that develop potential blockbuster drugs or devices become prime targets for acquisition by the larger firms. The secret to success in the acquisition process is being where the small firms are located. This permits the large companies to closely monitor the progress of smaller firms and buy the most promising ones before "Big Pharma" competitors or other medical device manufacturers can make a bid. To use a metaphor from nature, the large, globally important life sciences firms want to feed in the waters where the minnows are swimming.

Because Massachusetts has so many small life sciences firms, nine of the world's ten major drug companies have now set up shop in the Commonwealth. They are

investing billions in plant and equipment and creating thousands of additional jobs. These include Pfizer, Novartis, Johnson & Johnson, GlaxoSmithKline, Sanofi (which absorbed Genzyme), AstraZeneca, Abbott Laboratories, Merck and Bristol-Myers Squibb.

And here is the key to understanding the central role of the MLSC: While the large firms can easily exist without the MLSC's direct investments, the small life-sciences ventures need the Center to provide them with accelerator loans, research and development funds, and interns who can help them translate their ideas into commercially viable products. While the private venture capital market may provide some funds for this purpose, venture capitalists often demand a quicker return than can be obtained from this sector, which often has long lag times between initial research, proof of concept and a final product approved by the U.S. Food and Drug Administration.

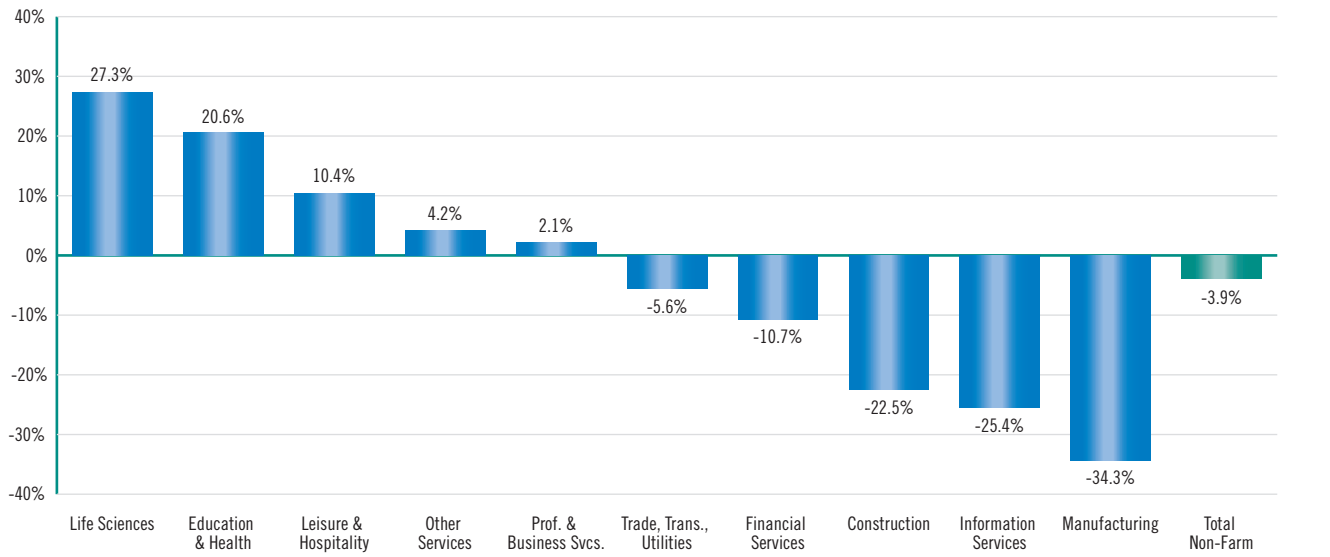
In this environment, the MLSC has become an important investment partner for smaller life sciences firms that grow out of local research universities and medical centers. By providing funds for translational research and development, the MLSC can help keep these growing companies in the Commonwealth instead of losing them to investment funds in other regions. To revert to metaphor again, it's because these minnows stay here that Big Pharma has come to swim in this pond. In addition, Big Pharma benefits from the Center's investments in workforce development, shared infrastructure resources and cooperative research projects between industry and academia. The result has been extraordinary output and employment growth.

The Massachusetts Life Sciences: A Record of Output and Employment Growth

The numbers are, indeed, impressive. As of 2012, according to the Massachusetts Biotechnology Council (MassBio), 1,198 life sciences companies were operating in New England and employing 103,006 workers. More than half of these firms are located in Massachusetts. Of all the Massachusetts firms listed in the 2012 MassBio directory, about half (514) are medical device companies; 232 are drug development firms; 147 are contract research and manufacturing enterprises and 146 produce research products and instrumentation for the life sciences.

The rapid growth in employment in the life sciences in Massachusetts provides a strong indication of how rapidly this sector is expanding. As **Figure 2** reveals, the life sciences far outpaced all other industry sectors between 2001 and 2011.

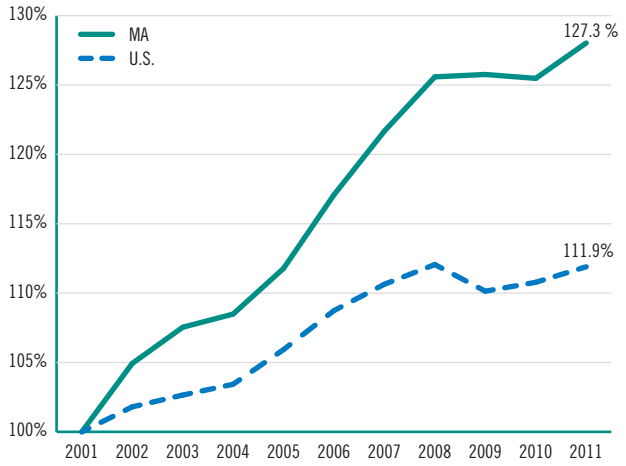
FIGURE 2
Massachusetts Employment Growth by Industry Sector 2001–2011



Source: BLS, Author's Analysis

FIGURE 3

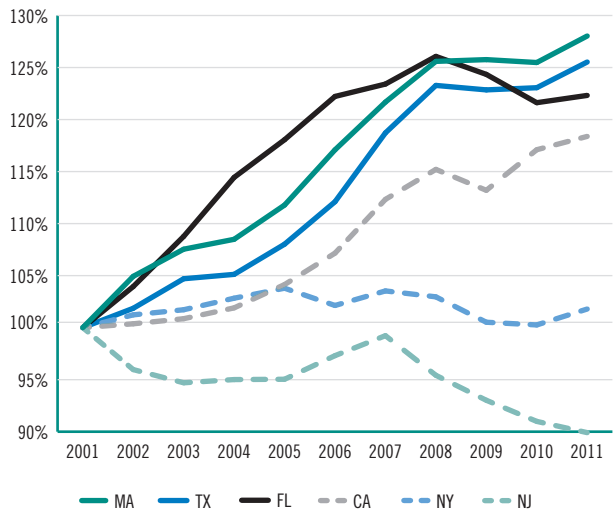
Employment in Life Sciences Indexed to 2001, Massachusetts vs. the U.S.



Source: Author's Analysis from BLS data

FIGURE 4

Employment in Life Sciences Indexed to 2001, Massachusetts vs. Big Competitor States



Source: Author's Analysis from U.S. Bureau of Labor Statistics (BLS) data

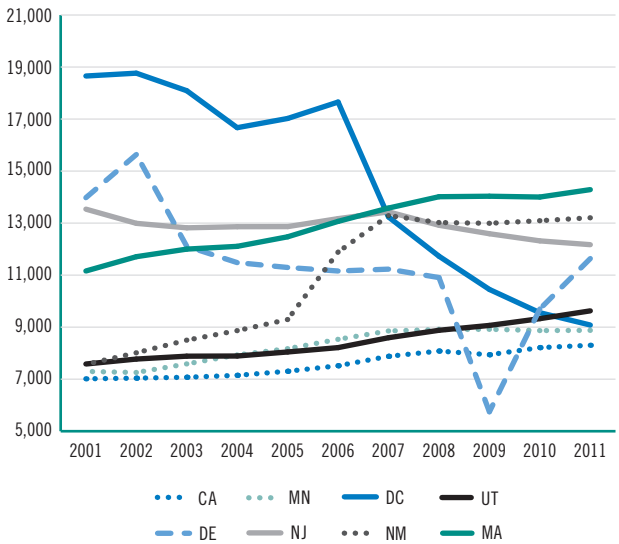
Even more impressive is the Boston-area super cluster's performance relative to the United States as a whole and to other states vying for supremacy in this rapidly evolving cluster of industries. The Commonwealth has indeed overtaken the rest of the nation in terms of employment growth in the life sciences, fulfilling an initial goal of the MLSC. **Figure 3** reveals the trend in life sciences employment in Massachusetts compared to that of the United States as a whole between 2001 and 2011. During this period, Massachusetts life sciences employment growth outperformed the nation by a factor of better than 2-to-1—growing by 27.3 percent vs. 11.9 percent for the nation.

The Commonwealth's main competitors in the life sciences are California, New Jersey, New York, Florida and Texas. But as **Figure 4** demonstrates, after 2008, the Commonwealth overtook all of these states in terms of the 2001-2011 employment growth rate.

Moreover, when we control for population size, Massachusetts is the clear winner for the entire life sciences cluster of industries. In **Figure 5**, we have controlled for the size of population of each state by measuring the number of life sciences jobs per 1 million residents. By 2011, given its rapid growth rate, the Massachusetts cluster had risen to #1 in terms of per-capita life sciences employment. With nearly 14,300 life sciences jobs for every 1 million residents, Massachusetts eclipsed all other states on this measure.

FIGURE 5

Life Sciences Jobs per 1 Million 2010 Population Top 8 States in 2011, by Year



Source: Author's Analysis from BLS data

With this growth dynamic at work, Massachusetts appears well positioned to continue to attract new investment in the life sciences super cluster. In a 2011 analysis of the established life sciences clusters worldwide, the commercial developer Jones Lang LaSalle concluded that Boston had become the #1 region for the life sciences. The report noted the Boston area's concentration of high-tech research and hospital/medical employment, its many science and engineering graduate students, its plentiful funding from the National Institutes of Health and venture capitalists, its investment in R&D as a percentage of state GDP and its research facilities. Boston had a composite score of 7, ranking it #1 overall. New York/New Jersey was #2 with a composite score of 24, followed by the Bay Area and Los Angeles in California, each with a score of 25. Boston remained #1 in the developer's 2012 report, while San Diego, the San Francisco Bay area, Raleigh-Durham, N.C., and Philadelphia overtook New York/New Jersey and Los Angeles.

Why Has the MLSC Been So Successful at Building the Life Sciences Ecosystem?

According to our interviews, the Center's successful record of investments in the life sciences is grounded in its reliance on a Scientific Advisory Board (SAB) along with a large panel of experts to guide the Center's Board of Directors in determining which firms show the greatest promise. This approach to distributing public funds has created credibility within the super cluster and its ecosystem. Over and over again, we heard adjectives like "rigorous" and "diligent" when our informants described the processes MLSC uses in selecting awardees and providing a platform for collaboration.

The interviews we carried out also suggested that the Center itself is being run quite effectively and efficiently and in a highly professional manner. Virtually all of our informants praised the management team and expressed special appreciation for the leadership's refusal to permit political considerations to trump scientific merit. Because the Scientific Advisory Board (SAB) selects awardees, "There is not an ounce of boondoggle in this agency," one informant told us. Another observed that the MLSC has "lots of moving parts" and all of them are working well. Several of the interviewees observed that the Center remains responsive to industry needs, meets its deadlines and stays focused on its mission. In its report on creating fiscally sound state tax incentives, the Pew Center on the States singled out the Massachusetts Life Sciences Tax Incentive Program for its focus on annual cost controls and its reliance on scientific merit in making awards.

Still another informant noted that the MLSC is successful because its leadership is committed to working "at the speed of business" and therefore has become a valued partner in the expansion of the industry.

Conclusions

All of our research suggests that the state will benefit from fully funding the remaining five years of the initiative in order to maintain the lead the life sciences super cluster has established in the Commonwealth. This is particularly important as other states ramp up their investments in hopes of creating their own life sciences ecosystems to entice the small and large firms Massachusetts has successfully attracted. California, Maryland, New Jersey, New York, Minnesota and Florida are not resting on their laurels, but continue to spend state funds on their own life sciences industries.

Over time, it should be possible for the Center to reach out to the private sector to help fund more of its initiatives, as it has done with the newly established Massachusetts Neuroscience Consortium. This consortium, established in September 2012, combines the efforts of the MLSC with seven global biopharmaceutical companies to jointly fund pre-clinical neuroscience research at Massachusetts academic and research institutions. Based on this model and with the plethora of larger, profitable firms coming to the state to expand their operations, one could imagine the Center funding more of its internships with private funds and having for-profit companies contribute to other programs (STEM: science, technology, engineering and math education, for example), allowing the Center to focus even more of its resources on accelerator loans and tax incentives for firms undertaking translational research.

We should also note that the success of the MLSC has lessons for other quasi-public entities in the Commonwealth. We can mention five of them here:

1. Long-term success in the use of tax incentives and business loans is most likely to occur when funds are focused on a cluster of firms and a set of technologies in a given industry, helping to create an industrial ecosystem which can attract new companies to the state.

2. The use of expert panels to determine the awarding of loans assures that these funds will be well utilized. "Claw-back" provisions protect the taxpayers by requiring firms to repay funds advanced by the Commonwealth if they fail to meet hiring goals.
3. A focus on encouraging firms in their early stage innovation activity is central to promoting economic growth and prosperity.
4. Helping fund workforce development efforts for critical industries as part of the mandate of the quasi-public entity helps ensure a pipeline of skilled workers for the industry and this itself helps attract new firms to the region.
5. Taking a "portfolio" approach to the entire range of activities in the life sciences—from investments in small innovative firms to helping train the future workforce to underwriting infrastructure—helps sustain the "ecosystem," undergirding a virtuous cycle of discovery, innovation, investment, and employment opportunity.

In the end, we applaud the Governor and the Legislature for their foresight in creating the Massachusetts Life Sciences Center and the $1 billion Life Sciences Initiative and we tip our hat to the MLSC for carrying out its public responsibilities in a most effective and efficient manner. The programs in place are fulfilling the goals set out in the original legislation and the Center's leadership has ensured that these programs work to the full benefit of the Commonwealth and its residents.

Introduction

The Massachusetts Life Sciences Initiative, conceived by Governor Deval Patrick's Administration and passed into law by the Massachusetts Legislature in July 2008, is a bold 10-year, $1 billion investment in the future of the state's economy. Based on the region's existing comparative advantage in the life sciences emanating from the laboratories of its leading universities and medical institutions, this substantial infusion of public funds was squarely aimed at making this cluster of industry sectors—including biotechnology, pharmaceuticals, medical diagnostics, medical devices, and bioinformatics—the most successful in the world. The Massachusetts Life Sciences Center (MLSC), founded two years earlier, was charged with the responsibility of implementing this bold experiment in public-private sector collaboration. If effective, the initiative was expected to boost investment and jobs in this evolving industrial sector, generating increased household income and tax revenue for the state.

In 2012, at the near halfway point of that 10-year initiative, the Dukakis Center for Urban and Regional Policy at Northeastern University was invited by the MLSC to measure the progress of the life sciences sector in Massachusetts and to carry out an evaluation of the Center's activities. We agreed to conduct such a study, but only under the condition that we would have full access to MLSC records, that our investigation would not be censored in any way by the MLSC staff, and that the staff of the Dukakis Center would have absolute control over the content of the final evaluation report. As a result, this report is being published by the Boston Foundation as part of its *Understanding Boston* series.

For the past year, Barry Bluestone, Director, and Alan Clayton-Matthews, Senior Research Associate at the Northeastern center, have carried out this evaluation. Both of us are economists who have extensive experience in industry studies and in program evaluation. Neither of us, however, was an expert on the life sciences sector when this evaluation project was first launched.

In the course of this research, we immersed ourselves in literature about the components of the life sciences industry cluster and about the role of public investment in innovation and economic growth. We analyzed existing employment data on each of the life sciences industries in the state; reviewed all of the annual reports of the MLSC; attended meetings of the MLSC Board of Directors where decisions over tax incentives and awards were made; and conducted lengthy interviews with leading executives of life sciences companies located in the state, industry trade association leaders, and members of the MLSC Scientific Advisory Board. This report is based on all of the data gathered over the year.

We began this research fully agnostic about what we might ultimately find, given the checkered record across the country of state industrial policy aimed at assisting other industries. But what we have found, based on our research, is that the Commonwealth's life sciences initiative is meeting, if not exceeding, the goals first established in 2008 by the Governor and the Legislature. Moreover, our interviews with key informants led us to the conclusion that the Massachusetts Life Sciences Center is executing its responsibilities in an effective, efficient, and professional manner. The initiative and the MLSC has performed exceptionally well in creating an *ecosystem* within which the cluster has prospered.

Moreover, we have concluded that the Center's mission, administration, and performance provide important lessons that can be applied to other state agencies charged with encouraging economic development.

This research could not have been carried out without the assistance of the staff of the MLSC and the many industry executives and experts who provided us with data and candid answers to our probing questions. We thank them all for their time and the information they afforded us.

CHAPTER ONE

About the Massachusetts Life Sciences Center

In June 2006, the Massachusetts Legislature created a new quasi-public agency, the Massachusetts Life Sciences Center (MLSC), to promote the life sciences within the Commonwealth. It was tasked with "investing in life sciences research and economic development . . . by making financial investments in public and private institutions."[1] Its mandate was broad: to encourage basic research, development, and commercialization in the biosciences; ensure the preparation of a skilled workforce to meet the needs of the state's bioscience industry cluster, and build stronger collaboration between the sectors of the local and international life sciences community.[2]

A year later, in May 2007, Governor Deval Patrick revealed an ambitious plan for a 10-year, $1 billion public initiative to enhance the Commonwealth's existing competitive advantage in this rapidly evolving and critically important sector of the U.S. economy. This would provide the funding for a major expansion in the activities of the Life Sciences Center. In June 2008, the legislature enacted the Governor's Massachusetts Life Sciences Initiative with the aspiration of building on the existing strengths of the state's research universities, its world-renowned health care sector, and its emerging private sector life sciences firms to promote the Commonwealth as the foremost center for the life sciences in the world.

With such a large commitment of state resources, how close has the Center come to meeting this goal? Has it helped attract life sciences companies to the Commonwealth, boosted R&D in the private life sciences arena, created job opportunities for Massachusetts workers and increased the state's revenue base by boosting employment, household income, and corporate profits?

This analysis of the MLSC comes at a propitious time. Massachusetts, along with most of its cities and towns—not to mention the nation as a whole—faces growing fiscal constraints. The economic recession that officially began in late 2007 and officially ended in 2009 has given way to an extended period of sluggish economic growth. This has diminished tax revenue just when the swelling cost of health care and public pensions is generating structural deficits.[3] Without additional tax revenue from more vigorous growth, these potential deficits will require either raising taxes or cutting public services, or both.

In this new economic environment, virtually every unit of government is being forced to husband its resources and scrutinize its spending to assure that every tax dollar is spent effectively and efficiently. As such, it is not surprising that the nation, the Commonwealth, and most of its municipalities are considering ways to cut "unnecessary" or "wasteful" spending. At the same time, they want to preserve essential public programs that meet critical social needs and improve the targeting of incentives to the private sector to accelerate economic growth.

A prime target in this new era of public scrutiny is the extensive set of "subsidies" and "tax expenditures" that governments have traditionally used to encourage specific types of consumption or investment. Every tax dollar that a government agency transfers to a private business or individual in the form of a *subsidy* means a dollar less that can be used in the short-term for other purposes. Every dollar that a business or individual saves on its taxes is an "uncollected" dollar—a *tax expenditure*—that could have been used to pay for one or another public service.[4] Because of the short-run "opportunity costs" attached to every dollar spent, there is a growing demand to ensure that public dollars are not being wasted on programs that have little payoff. Each program must be judged on whether the *long-term* gain from issuing a tax incentive, government grant, loan guarantee, or subsidy outweighs the *short-term* cost to the treasury.

Adding to the demand for more accountability has been a recent series of high-profile cases of "failed" government incentive programs. Solyndra, a manufacturer of solar photovoltaic systems, became the poster child for "misspent" federal funds during the last presidential campaign when it filed for bankruptcy after receiving

$535 million in U.S. Energy Department loan guarantees.[5] The same was true when A123, a manufacturer of lithium ion batteries for electric cars, went bankrupt after receiving a $130 million federal grant to build a plant in Michigan. It was, according to a series of *Washington Post* reports, the fifth clean-energy firm the current Washington administration subsidized with loans or grants that filed for bankruptcy protection. During the campaign, Republicans claimed both Solyndra and A123 were prime examples of "cronyism" in President Obama's stimulus program.[6]

Closer to home was the failure of Curt Shilling's 38 Studios video-game firm. It closed its doors and laid off all of its employees after Rhode Island lured it from Massachusetts with a $75 million loan guarantee. This case raised anew an old question. Under what circumstances should states use tax abatements, subsidies, and other inducements to encourage investment and create jobs in the private sector?[7]

As the Massachusetts Life Sciences Initiative approaches the halfway mark in its 10-year legislative life, it is altogether appropriate that this report attempt to ascertain whether, and to what extent, the Massachusetts Life Sciences Initiative has already produced tangible positive gains for the Commonwealth, and whether maintaining the initiative will likely produce even greater long-term benefits for the state's residents and taxpayers.

For the purposes of this report, we define the Life Sciences cluster as consisting of sixteen (16) specific 6-digit NAICS industry sectors as shown in **Table 1**.[8] These include two research and development industries, two laboratory industries, two medical distribution

TABLE 1
Life Sciences Sectors

Group	NAICS	Title
1	325411	Medicinal and Botanical Manufacturing
1	325412	Pharmaceutical Preparation Manufacturing
1	325413	In-Vitro Diagnostic Substance Manufacturing
1	325414	Biological Product (except Diagnostic) Manufacturing
2	334510	Electromedical and Electrotherapeutic Apparatus Manufacturing
2	334516	Analytical Laboratory Instrument Manufacturing
2	334517	Irradiation Apparatus Manufacturing
3	339112	Surgical and Medical Instrument Manufacturing
3	339113	Surgical Appliance and Supplies Manufacturing
3	339114	Dental Equipment and Supplies Manufacturing
4	423450	Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers
4	424210	Drugs and Druggists' Sundries Merchant Wholesalers
5	541711	Research and Development in Biotechnology
5	541712	Research and Development in Physical, Engineering, and Life Sciences (except Biotechnology)
6	541380	Testing Laboratories
6	621511	Medical Laboratories

Source: Battelle and the Biotechnology Industry Organization (June 2012)

sectors, and ten different manufacturing industries.[9] The cluster also includes the life sciences departments in universities and medical institutions in the Commonwealth.[10]

As of 2012, according to the Massachusetts Biotechnology Council (MassBio), there were 1,198 life sciences companies operating in New England employing 103,006 workers, the vast majority of these firms located in Massachusetts. More than one-third of these New England firms were founded after 2004 and 80 percent are relatively small with sales under $100 million a year. More than two out of five of these firms (43%) have annual sales of less than $5 million. Of all the Massachusetts firms listed in the 2012 MassBio directory, about half (514) are medical device companies; 232 are drug development firms; 147 are contract research and manufacturing enterprises; and 146 produce research products and instrumentation for the life sciences.[11]

CHAPTER TWO

The Size and Scope of Public Tax Expenditures and Public Subsidies

To begin our assessment, it is useful to put the Commonwealth's $1 billion investment in the life sciences into perspective. According to the Congressional Research Service, at the federal level there are over 200 separate tax expenditures which taken altogether are projected to cost the U.S. Treasury more than $1.1 trillion in FY2014.[12] The bulk of these take the form of exemptions, deductions, and exclusions from the personal income tax such as the mortgage interest deduction. These tax provisions are intended to encourage such "virtuous" behavior as home ownership, charitable contributions, and family saving.[13]

While paling in comparison to these personal tax expenditures, federal corporate subsidies cost the Treasury almost $100 billion a year, according to research conducted by the Cato Institute.[14] A full quarter of these go to farmers in the form of agricultural subsidies and crop insurance, but other subsidies underwrite applied research and development under way at defense contractors, energy companies, housing developers, airlines, AMTRAK, universities and research labs, the National Institutes of Health, NASA, and small businesses.[15] In searching for ways in 2013 to cut federal spending in order to reduce federal deficits, one can be certain that some, if not many, of these tax expenditures and subsidies will be reviewed for possible modification or elimination.

States and municipalities have also provided the private sector with billions in tax expenditures and subsidies. In a recent series of articles, a trio of *New York Times* investigative reporters found that across the nation, states, counties, and cities dole out over $80 billion in "business incentives" each year.[16] The key industries receiving such tax preferences and subsidies are manufacturing; agriculture; the oil, gas, and mining industries; and the film industry. Technology companies like Twitter and Facebook, according to the *Times* report, are not far behind.

The *Times* analysts collected data on all 50 states. In their review of Massachusetts, they found 48 state programs that provide nearly 1,500 grants or incentive packages to specific companies. The total annual cost to state and municipal governments for these programs was reported to be at least $2.26 billion, equal to seven percent of the state budget or $345 per capita. Of this total, more than a third ($786 million) take the form of corporation income tax credits, rebates, or reductions. Another $130 million is paid out by the state treasury in the form of cash grants, loans, or loan guarantees.

The *Times* reporters listed a group of 94 Massachusetts companies that received nearly $165 million in grants, tax incentives, and subsidies between 1994 and 2011. Of this total, 26 were life sciences companies accounting for $48.7 million or nearly 30 percent of the total. Among the companies receiving these funds were Vertex Pharmaceuticals, Organogenesis, Shire Human Genetics Therapies, Sanofi, and Cubist Pharmaceuticals. The company receiving the largest state subsidy, however, was Liberty Mutual, an insurance company. Between 2006 and 2009 alone, the Massachusetts Film Office doled out nearly $150 million in tax credits to film companies.[17]

States like Alaska, West Virginia, Texas, and Michigan spend two to three times as much per capita as Massachusetts on such business incentives, but other states including New Hampshire ($30), North Carolina ($69), California ($112), South Carolina ($194), New York ($210), Florida ($212), Oregon ($226), Connecticut ($241), and Ohio ($281) spend less.

Obviously, in a time of tight fiscal budgets, such expenditures of tax revenue need to be carefully evaluated as elements of what is known as "industrial policy"—government support of private business.

*To assure that this assessment of the Massachusetts Life Sciences Center is placed in proper context, we need to begin by considering the ways in which government can encourage private sector economic development in an efficient and effective way. In doing this, we need to pay particular attention to understanding the role of government-induced innovation in spurring economic growth.*This foray into these theoretical issues will provide us with guidance as to what types of government tax expenditures and subsidies are more likely to yield positive benefits for society and thereby help us to assess the value of the MLSC.

CHAPTER THREE

Industrial Policy: Pros and Cons

For decades, economists have debated the role of government in the promotion of private industry. At various times in our history, the federal government has helped to establish industries that went on to be central to our economy. The growth of the nation's aircraft industry was aided by the U.S. Post Office, which subsidized airlines with lucrative air-mail contracts in the early days of air travel. In the aftermath of Sputnik, the federal government invested billions of research dollars into perfecting solid state guidance systems and software for rockets and missiles, helping to create what today is our high-tech universe of cell phones, the Internet, iPads, GPS devices, and a dizzying array of gadgets based on the integrated circuit and the software that runs them.

Yet, as a recent Center for Economic and Policy Research working paper put it, "For the past generation, the dominant view among economists was that giving businesses a free hand—that is, little regulation and low taxes—was the most important contribution governments could make to encourage productive investments. The corollary to this view was that, as much as possible, overall investments in the economy should be undertaken by the private sector, as opposed to any sort of government entity."[18]

The argument *against* a public "industrial policy" is that governments are not capable of "picking winners" and therefore too often waste tax dollars. The conservative Cato Institute claims that government subsidies inevitably distort economic activity and "create even larger failures than might have existed in the marketplace."[19] By aiding some businesses, others are placed at a disadvantage either by reason of having to pay higher taxes or having to compete with subsidized firms. Hence, diverting resources from businesses preferred by the market to those preferred by policy makers leads to losses for the overall economy."[20]

The argument *for* public investment in the private sector is that rather than "crowding out" private capital, public investments actually "crowd in" private investment and can be used to "incubate new technologies and help private businesses bring these innovations to the stage where they can be effective in the marketplace."[21] In brief, well-placed public funds in the private sector can yield large long-term gains at relatively modest short-term cost.

But what makes for "well-placed" public funds? A good part of the answer lies in whether the funds contribute significantly to a growing economy and increasing numbers of jobs.

New vs. Old Growth Theory

In economics, there are two fundamentally different views about what contributes most to growth. What is now known as the "old growth theory" suggested that economic prosperity emanates from the accumulation of ever greater stocks of the fundamental ingredients of production: capital, labor, and natural resources. Those countries that find ways of increasing investment in plant and equipment, adding to labor supply, and extracting more natural resources are the ones that will become more affluent. Just consider the United States or Saudi Arabia versus poor countries in Africa or Southeast Asia. Clearly, without capital, labor, and natural resources, output cannot be produced.

While not completely discounting this approach to growth, a "new growth theory" has evolved that "places technological progress at the very epicenter of growth dynamics, rather than capital investment per se."[22] Advances in technology and interdependencies between new ideas and new investment provide the basis for entire new industries and products that create new wealth and raise living standards. "In the new model, technology provides the engine for sustained growth in the face of the diminishing productivity associated with additions to the stock of physical and human capital."[23]

In addition to avoiding diminishing returns, innovation-based growth has an additional salutary feature relative to other ingredients in the growth equation: Once the fixed cost of creating a technology has been incurred,

the formula can be used over and over again at little or no cost. Indeed, this *spillover* property is taken to be the defining characteristic of technology. As Paul Romer, one of the founders of new growth theory puts it, "The idea behind the transistor, the principles behind internal combustion, the organizational structure of the modern corporation, the concepts of double-entry bookkeeping—all these pieces of information and many more like them have the property that it is technologically possible for everybody and every firm to make use of them at the same time without additional costs."[24] As such, instead of diminishing returns to investment, there can be increasing returns.

Moreover, the new growth theory posits a strong reciprocity between the rate of skill acquisition among workers and the growth dividend society obtains from new capital and new inventions. *Thus, programs that combine incentives for innovation along with resources to augment human capital should, according to this theory, fuel rapid economic growth more than anything else society can do to promote prosperity.*

But here is the rub. Keeping score on the success of innovation is difficult. Instead of a more or less certain return to a given infusion of capital under the old growth theory, innovation under the new growth theory tends to deliver faster and stronger long-term growth, but it is "lumpy, discontinuous, and nonlinear."[25] There can be long lags between the time a new innovation is first incorporated into production and the time that it pays off in terms of increased productivity, output, and jobs. The introduction of the steam engine in the mid-18th century did not pay off in terms of improved productivity until the early 19th century.[26] In the short term, it can be discouraging, as investments in fundamental innovation usually have little immediate payoff.

To be productive, innovation needs to be perfected and diffused, and this takes time. According to a study of 265 major and minor innovations over the past couple of centuries, it took a typical new innovation forty-one years, on average, to move from the 10 percent to the 90 percent diffusion level.[27] The diesel locomotive, for example, was clearly superior to the steam locomotive, yet twenty years after the first diesel was introduced in 1925, there were still nearly ten steam locomotives in service for every diesel-powered engine. The first integrated computer circuits were introduced in the 1960s, but it was not until the 1990s that the full productivity premium of the computer generation was finally realized.[28] It will take decades to realize the full benefits to humanity and the economy from the advances now being made in drug discovery, medical diagnostics, and medical devices.

Unfortunately, in an era of intense concern over short-term deficits, it is often hard to marshall the patience needed to invest sufficiently in technological innovation or the firms that create it. As a corollary, investments made today in research and development (R&D) are often risky propositions from the perspective of the short-term balance sheet. Yet without massive infusions in R&D, continuous breakthrough innovation cannot occur. Nowhere is this truer than in the life sciences.

Public Investment in R&D

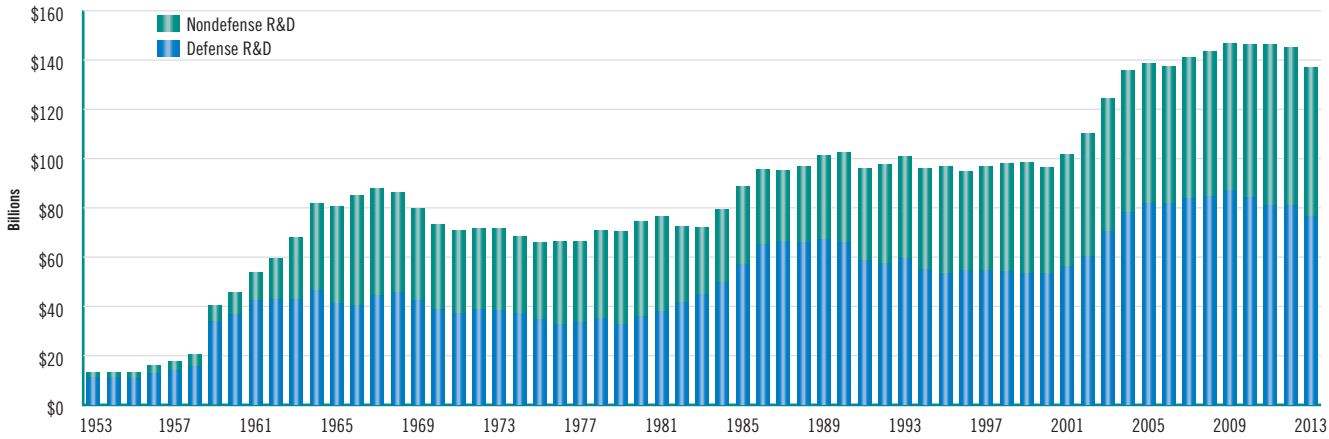
Worldwide, no country spends more than the United States on R&D, and this investment has played an important role in the nation's economic development, at least since World War II.[29] According to the Battelle Institute, total R&D spending in the U.S. reached $436 billion in 2012, of which about 29 percent ($126 billion) was supplied by the federal government while 64 percent ($280 billion) was provided by private industry. The remainder came from foundations and other non-profits ($14.5 billion), university-owned funds ($12.3 billion), and a tiny amount from state and local governments ($3.8 billion).[30]

Despite its smaller share of overall R&D funding relative to the private sector, the importance of the federal government in spurring innovation should not be underestimated. Without government investment, it is likely that private firms would underinvest in R&D, particularly basic research. The reason is that the social rate of return to investment in basic research often exceeds the private rate. Unlike investments in tangible capital such as machinery, the ideas flowing from R&D are, in the words of economists, "nonrival" and not fully "appropriable." *Nonrival* means that my learning of a new innovation does not prevent you from using it. When returns are not fully *appropriable*, the original innovator cannot gain all the profit that flows from the eventual application, especially the commercialization, of the new process or product.[31] In this case, firms will often wait for others to do the innovating. As Federal Reserve Bank Chair-

FIGURE 1

Federal Spending on Defense and Nondefense R&D

Outlays for the conduct of R&D, FY 1953–2013, billions of constant FY 2012 dollars



Source: American Association for the Advancement of Science

man Ben Bernanke recently reminded an audience at a Washington, D.C. conference, "James Watson and Francis Crick received a minute fraction of the economic benefits that have followed from their discovery of the structure of DNA."[32] Without government-sponsored basic research, society loses out on innovation.

Public sector R&D also encourages private sector R&D spending. Research reveals that there is a strong positive correlation between the trajectory of private R&D spending in a given year following public expenditures a year earlier.[33]

The Trend in Federal R&D Spending

Given (1) the importance of innovation as the prime driver of economic prosperity, (2) the role of R&D in promoting innovation, and (3) the fact that without public funding of R&D total research investment would be suboptimal because of the inability of private investors to fully appropriate its monetary benefit, how much has the federal government invested in this vital factor?

As **Figure 1** reveals, federal spending on defense and nondefense R&D (in inflation-adjusted FY2012 dollars) rose sharply between 1953 and 1965 from less than $15 billion to more than $80 billion before dipping back to just over $60 billion in 1976. Spending was back to more than $100 billion by 1989 and remained flat through 2001. It rose sharply after that, increasing to over $140 billion by 2009. In FY 2013, under pressure to reduce federal spending, total federal R&D spending once again declined.[34]

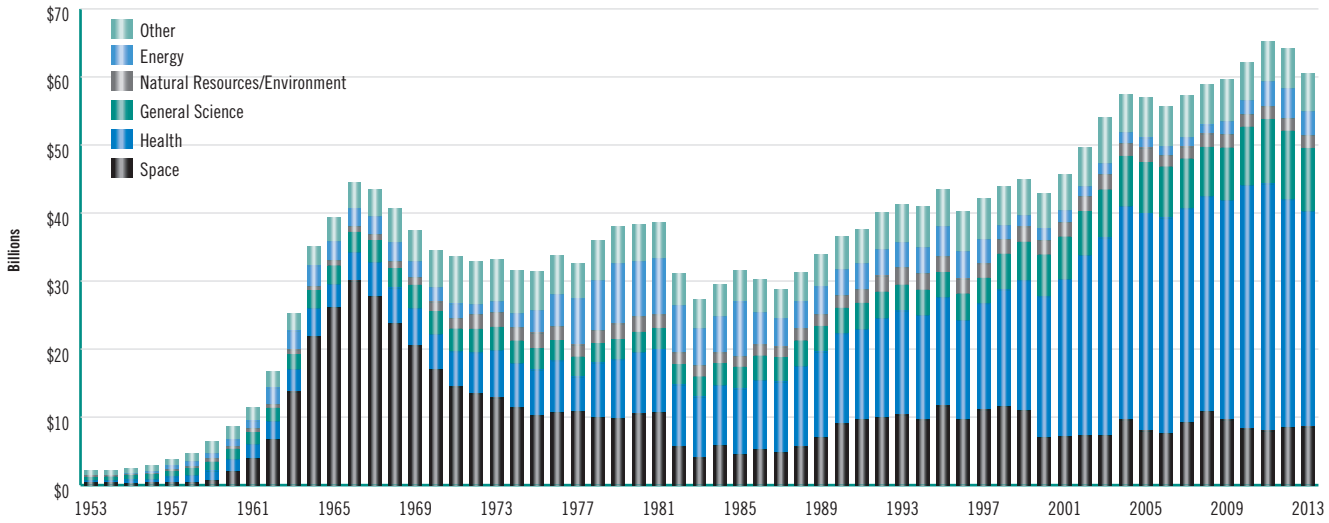
As **Figure 2** demonstrates, virtually *all* of this growth in non-defense federal R&D spending has been in the health field, mainly through the National Institutes of Health. While federally sponsored health research only accounted for about seven percent of total non-defense federal R&D spending in 1965, by 2013 it accounted for more than half (52%). Much of this basic public investment is going into the life sciences, and of all fifty states, Massachusetts trails only California in NIH funding. In 2011, California institutions received $3.5 billion in NIH funding; those in Massachusetts received $2.5 billion.[35] Yet, on a per capita basis, the Commonwealth swamps all other states in NIH funding, obtaining four times as much as the Golden State.

This growth in federally sponsored R&D seems impressive, but as a share of the nation's Gross Domestic Product (GDP), the federal government's role is roughly half of what it was in the early 1960s (**see Figure 3**). Spending rose rapidly in the 1950s and 1960s, surpassing 1.9 percent of GDP in 1964, up from just 0.7 percent in the early 1950s.[36] Much of this was in direct response to the Soviet Union's launching of Sputnik and President John F. Kennedy's goal of sending a man to the moon before 1970. After reaching its nadir of just 0.67 percent in 2000, it has slowly climbed back to 0.85 percent today.[37]

FIGURE 2

Trends in Nondefense R&D by Function, FY 1953–2013

Outlays for the conduct of R&D, billions of constant FY 2012 dollars



Source: American Association for the Advancement of Science

As we have seen, new growth theory suggests that our nation's prosperity is intimately tied to the rate of innovative activity. If innovation slows down, growth will suffer. Hence, the big question is whether the United States can maintain its rate of innovation activity into the future and thereby sustain economic prosperity and full employment.

The Role of R&D Investment at the State Level

As noted above, states have historically played a minor role in funding research and development. Their $3.8 billion spent in FY2012 amounted to less than 1 percent of total spending on R&D and no more than 3 percent of government-sponsored R&D. Indeed, given that the full benefits from basic research cannot be easily appropriated by the funder, it might seem foolish that an individual state would spend its own revenue on investments that can be appropriated by entities in other states.

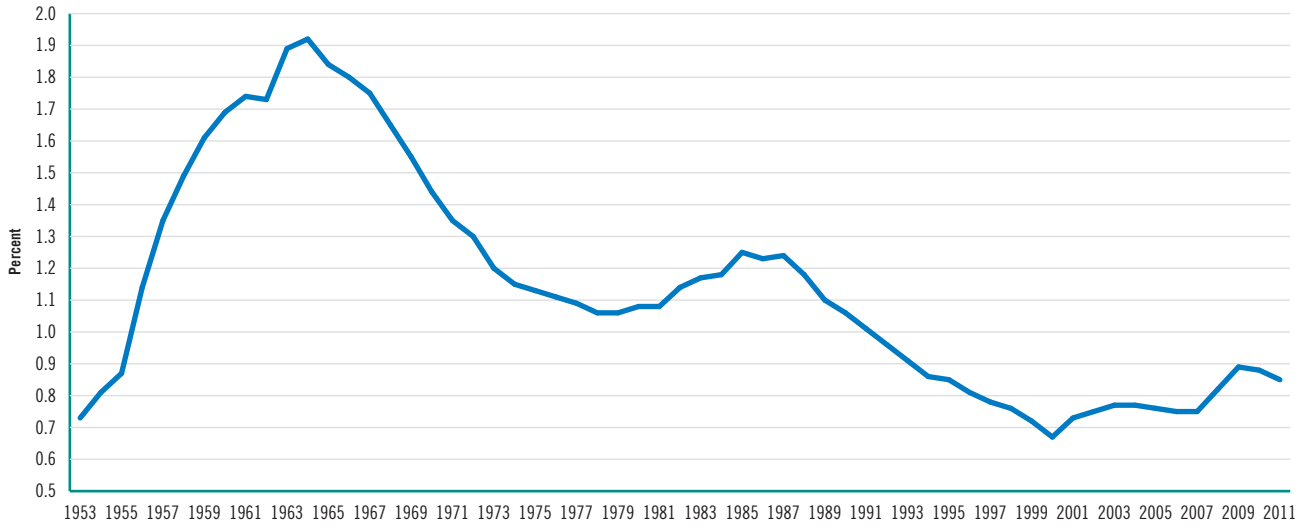
So why should a state invest anything in R&D?

Invested in the appropriate industries, public funds can help encourage the growth of an industrial cluster in a given region that, once incubated, can maintain a self-sustaining locational advantage that provides a magnet for new private investment in the region's cluster. Such locational advantages are called *agglomeration economies* and refer to the benefits, savings, or cost reductions resulting from the clustering of economic activities.[38] The clustering of such industries can give rise to an "industrial climate" or "ecosystem" that is self-perpetuating as the result of a regional congregation of specialized facilities, labor pools, education and training institutions, and specialized legal, accounting, and financial services.

Such agglomeration economies explain the economic success of most metropolitan areas. In New York City, for example, the cluster of financial industries and advertising is responsible for much of the growth in wealth. The birth of the early auto industry in and around Detroit in the early part of the 20th century would ultimately allow Detroit to take advantage of agglomeration economies and blossom into the world's "Motor City" by the end of World War II. By 1949, the median family income of Detroiters was higher than that of any other city in America except Chicago (whose residents enjoyed a 1949 median family income exactly one dollar higher), and 29 percent above the national figure.[39] Chicago's prosperity was built on being the transportation hub for America. Seattle became the center for jet aircraft production.

In the postwar period, the most successful new indus-

FIGURE 3
Federal Spending on R&D as Percent of GDP
FY1953–FY2012



Source: National Science Foundation "Science and Engineering Indicators 2012"

trial cluster was built in Silicon Valley in and around Palo Alto, California. Beginning in 1939 with the founding of Hewlett-Packard— the brainchild of two Stanford graduate students—the valley would attract a host of firms that would ultimately build the modern computer industry and make this region one of the wealthiest in the world.[40]

In the case of Detroit, local, state, and the federal governments essentially subsidized the auto industry through the public provision of streets, roads, and highways. Chicago's prosperity was underwritten by public subsidies to the railroads. Seattle's aircraft industry has benefited not only from the early airmail contracts but from massive defense spending that provided most of the resources needed to develop both military and then commercial jet airframes and jet engines.[41] While private venture capital has played a major role in the success of Silicon Valley, the federal government has played a significant role as well. From less than $10 million in 1960, federal research funding of computer science climbed to almost $1 billion by 1995, while the U.S. expenditure on research in electrical engineering (which includes semiconductor and communications technologies) has fluctuated between $800 million and $1 billion since the 1970s. According to the National Research Council, such funding "has constituted a significant fraction of all research funds in the computing field, particularly underwriting academic research. Federal support has constituted roughly 70 percent of total university research funding in computer science and electrical engineering since 1976."[42]

The lesson is that the prosperity of many metropolitan areas has been stimulated in large measure by public investments in particular industry clusters. Given an early start in an industry, public funds can help build the agglomeration economies that in turn cement a single region's leadership in that industry nationally and globally. The Massachusetts Life Sciences Center was established precisely to this end. How successful has it been?

CHAPTER FOUR

The Emergence of the Massachusetts Biotechnology Super Cluster

In 2010, four scholars at the Massachusetts Institute of Technology (MIT) developed a schematic to explore the complement of elements needed to produce a successful American biotechnology cluster.[43] This schematic is summed up in **Table 2**. The schematic includes three innovation stages and four critical factors. Based on this matrix, the team was able to describe all of the aspects of what they called the Massachusetts Biotechnology Super Cluster.

A thriving science-based cluster must take basic research and transition it into commercial products and services. To do this requires funding, skilled labor, a legal framework that protects intellectual property (IP), and a diverse set of industries that includes both new innovative firms as well as established ones. As the authors suggest, "inadequacies in any area can threaten the cluster."[44]

As a whole, the U.S. biotechnology cluster benefits from access to both public and private sources of funding. These include, on the public side, NIH, the Department of Defense (DOD), Small Business Innovation Rewards (SBIR) to support basic research; foundation support from private nonprofits; and, on the for-profit side, angel and venture capital (VC) investors who provide funds for translating basic research into new products and services. The cluster is also supported by public and private customers for its end products, which at times are subsidized through tax expenditures and subsidies.

The talent pool for this sector ranges from creators and craftspeople who play the role of principal investigators on research grants and contracts, entrepreneurs who form new firms to commercialize the output of the sector and workers who range from those with just a high school diploma to those with Ph.Ds.

To be successful, the cluster must also enjoy a legal system that protects intellectual property through patents and licenses and IP enforcement in the courts.

Long-term success for the cluster also requires a diverse set of "tradable agglomerating" companies comprised of new innovative enterprises that can power future

TABLE 2
The Prototypical American Biotechnology Cluster

Critical Factors		Innovation Stages		
		Basic Research	Translation	Commercialization
Funding	Public	NIH	DOD, SBIR	Payers, Tax Policy
	Private	Foundations	Angel, VC, Industry	Customers
Talent	Creators	PIs	Entrepreneurs	Senior Execs
	Craftspeople	Grad Students	BA/MS/PhD	HS - PhD
Laws & Norms	Intellectual Property	Bayh-Dole	Patentability & Scope	IP Enforcement
	Experimentation	New Field Encouragement	Independence Over Security	Reinvention
Diversity	Tradable Agglomerating	Stem Cells	RNA, Interventional Imaging	Biologics
	Tradable Converging	Bio-processing	Molecular Diagnostics	Biomanufacturing
	Local Sustaining	Medical Centers	Science Parks	

Source: Trusheim, Berndt, Murray, and Stern, 2010

growth through the development of breakthrough products, "tradable converging" firms which remain globally competitive in existing products, and a set of local entities including medical centers and science parks that provide local services to the cluster.

A good deal of this requires a collaborative form of industrial policy with both the federal and state government playing major roles in the emergence of the cluster. In the 1950s, the federal government continued its funding of R&D in the biosciences as part of its Cold War strategy. The VC model was invented and the first high-tech firms founded. In the 1970s, the federal government declared a "War on Cancer" with NIH funding, while the first recombinant DNA experiments were undertaken in university laboratories and private research firms.

In 1980, the Bayh-Dole Act was adopted, giving universities IP ownership of the output from federally funded research while the first recombinant DNA products hit the market. In the Commonwealth, the Massachusetts Biotechnology Council was created in 1985, one of the first in the nation. In the 1990s, the first genomics companies were founded, led initially by Millennium Pharmaceuticals (established by a former Genentech executive).

Much of this early work came to fruition in the first decade of the 21st Century. During this period, the human genome was sequenced and the George W. Bush administration committed itself to doubling the NIH budget.

Here in the Commonwealth, a final piece of the cluster puzzle was put in place with the founding of the MLSC, followed by the state's funding of the Life Sciences Initiative to help cement the region's lead in this important cluster and maintain that lead into the future. With all of the other parts of the matrix in place in Massachusetts, the state became a magnet for Big Pharma.

By the end of the first decade of the 21st Century, Massachusetts was home to 9 of the top 10 major drug companies in America, surpassing New Jersey. Pfizer, Novartis, GlaxoSmithKline, Genzyme's successor Sanofi, AstraZeneca, Abbot Laboratories, Merck and Bristol-Myers Squibb had all committed to operations in the Bay State. The largest of these big firms, in order of employment, are Genzyme (Sanofi), Pfizer, Biogen Idec, Novartis, Shire, Thermo Fisher Scientific, EMD Millipore, Vertex, Parexel International, and Hologic.[45] Only the Swiss pharmaceutical giant, Roche—the world's third-largest biopharma firm—has not moved into Massachusetts.[46]

According to a separate comprehensive analysis of the global life sciences cluster completed in 2011, the commercial developer Jones Lang LaSalle concluded that Boston had become the #1 region for the biosciences based on its concentration of high tech research and hospital/medical employment, its number of scientific and engineering graduate students, its level of NIH and venture-capital funding, its investment in R&D as a percentage of state GDP, and its thousands of square feet of academic and research institute facilities. Boston had a composite score of 7 ranking it #1 overall. New York/New Jersey was #2 with a composite score of 24, followed by the Bay Area and Los Angeles each with a score of 25.[47]

CHAPTER FIVE

The Massachusetts Life Sciences Center

What role does the MLSC play in the MIT schematic? Beginning with its creation, the MLSC took as its strategic mission the role of pulling together all of the parts of the matrix into a life sciences ecosystem, creating a dense, highly connected community of scholars, entrepreneurs, industry leaders, venture capitalists, and government officials dedicated to the success of the life sciences super cluster in the Commonwealth. Unlike many state economic development initiatives, the Center has a broad range of strategic priorities geared to enhance all aspects of the life sciences cluster. These include:

- funding translational research—research that converts basic research into marketable products and services
- investing in promising new technologies
- ensuring worker skill acquisition that aligns with the needs of the life sciences industries
- creating new infrastructure from shared resources that accelerates innovation
- building partnerships between sectors of the local and international life sciences communities

To accomplish these goals, the Center relies on a portfolio of seven distinct programs.[48] These include:

Cooperative Research Grants—Supports industry-sponsored research at universities and facilitates scientific discoveries that lead to medical applications. These grants of $250,000 per year for up to two years match industry contributions dollar for dollar.

Internship Challenge Program—Provides up to $7,200 in funds for interns working at Massachusetts companies with fewer than 100 employees and fewer than 250 globally.

New Investigator Grants—Spurs innovative research and advances the careers of new investigators who are working on cutting-edge research at Massachusetts academic research centers with grants of $100,000 per year for up to three years.

Life Sciences Accelerator Program—Provides financing of up to $1 million for early-stage companies to help leverage additional sources of capital.

Small Business Matching Grant (SBMG) Program—Provides matching support capped at $500,000 per company to firms on the verge of commercializing new technologies developed using Phase II or Post-Phase II Small Business Innovation Research (SBIR) awards or Small Business Technology Transfer (STTR) grants from the federal government.

Life Sciences Tax-Incentive Program—Issues a combination of 10 competitively awarded tax incentives available to companies that meet specified hiring goals. These include:

- A refundable 10% investment tax credit[49]
- A refundable in-state research tax credit
- A refundable job creation tax credit (50+ jobs)
- A refundable FDA user fee credit
- Extension of net operating losses to 15 years
- Deduction of orphan drug clinical testing
- Elimination of the sales factor throwback provision
- Special sales tax exemption
- Life sciences research credit for out-of-state costs
- Construction sales tax exemption

Capital Projects Fund—Provides capital for equipment and supplies for high schools in Gateway Cities, vocational/technical schools, and community colleges; and for capital projects in academic/research institutions, business incubators, and other not-for-profit organizations in the Commonwealth.

Between 2008 and June 30, 2012, the Center had directly invested or committed over $300 million that has leveraged more than $1 billion in third-party investment, according to the MLSC's report for fiscal year 2012. If none of that investment would have been made in Massachusetts in the absence of the MLSC commit-

ments, each dollar of taxpayer money spent by the Center resulted in the attraction of $3.40 in additional, outside investment creating a public-private investment fund of more than $1.3 billion.[50]

There are four factors that make the MLSC quite different from most government subsidy programs:

- Instead of simply providing tax benefits to a few private firms to lure them to the Commonwealth, the MLSC has a portfolio of investment tools that include direct investments in life sciences companies; grants to academic organizations and medical centers and grants for "shovel ready" public and non-profit sector capital projects that help influence the location decisions of life sciences companies.
- The MLSC operates under a Board of Directors that includes state government officials, industry CEOs, leaders from academia and medicine, bioscience researchers and others who have great knowledge of the life sciences.
- Investments are reviewed by a panel of more than 200 experts who send their recommendations to the Center's Scientific Advisory Board, which itself is dominated by academic researchers, industry scientists and private venture capital experts who together can judge the scientific and economic potential of an MLSC investment.
- The Center insists on accountability in terms of private sector investment matches and specific job creation goals and retains the power to "claw back" tax incentives and other investments when these goals are not reached by grant recipients.[51]

In the four-year period between June 2008 and June 2012, the Center invested nearly $190 million in 12 capital projects, provided 31 company grants and loans worth nearly $23 million, issued 35 academic research grants with a value in excess of $23 million and 56 tax incentives (still outstanding) valued at close to $57 million, invested $7 million to fund 884 interns as part of the Center's mission to help develop the life sciences workforce, provided more than $3.3 million in equipment and supply grants to schools and spent $1.5 million on other grants including the funding of business plan competitions. As of June 30, 2012 the Center was managing a portfolio of approximately 200 grants, loans, and tax incentives.[52]

Examples of *infrastructure activity* as listed in MLSC's FY2012 report include:

- $5 million in support of the construction of the Joslin Center's Translational Center for the Cure of Diabetes
- $10 million to the Dana Farber Cancer Institute to support the expansion of its $20 million Molecular Cancer Imaging Facility
- $5 million to the Boston Museum of Science for the construction of its "Hall of Human Life," which helped leverage $11 million in private financing
- $14.6 million to the University of Massachusetts Dartmouth to build its new Massachusetts Biomanufacturing Center in Fall River
- $10 million to UMass Lowell to equip laboratories within its new Emerging Technologies and Innovation Center
- $14.3 million to help build the Framingham Wastewater and Pumping Station that will allow bioscience firms to operate in that community

Examples of accelerator loans awarded in FY2012 to provide working capital to early stage life sciences companies include:

- $750,000 to Allurion of Wellesley for developing a novel medical device for inducing weight loss in obese patients
- $750,000 to Alcyone Lifesciences, Inc. for the development of a micro-catheter for treating neurological conditions
- $245,000 to Strohl Medical for the creation of a medical device for accelerating the treatment of stroke victims

Subsequent to receiving accelerator loans, early stage firm recipients have raised more than $100 million in either private or public funding to grow their firms or in acquisition proceeds. Already six firms that have received accelerator loans have paid them off early, permitting the MLSC to construct a revolving fund, thus expanding the resources the Center has for this purpose.

In addition to the accelerator loans, the MLSC has begun a Small Business Matching Grant Program (SBMG), which complements funds received by firms from NIH, the National Science Foundation (NSF), and DOD. In 2012, the Center awarded a $500,000 grant to Firefly BioWorks, Inc. of Cambridge after full review by the

MLSC Scientific Advisory Board. The company has already been able to launch its first commercially viable product for help in diagnosing cancer, neurological disorders, and other diseases.

Examples of matching grants for academic research include:

- $5.1 million in grants to early career investigators working in research institutions within the Commonwealth which have in turn helped generate over $13 million in federal government, foundation, and private company research grants
- $4.8 million in cooperative research grants (between 2008 and 2011) to encourage industry-sponsored research at Massachusetts institutions, resulting in more than $8.6 million in research grants from other sources

Examples of the $20.6 million in 2011 program tax incentives to 26 life sciences companies include $3 million to Shire HGT, Inc.; $2.45 million to Vertex; $2.3 million to AVEO Pharmaceuticals; and $1.84 million to Biogen Idec MA, Inc. Smaller tax incentives of less than $500,000 went to such firms as Blueprint Medicines Corporation in Cambridge and T2 Biosystems, Inc. in Lexington. Under the Life Sciences Act, the Department of Revenue has the authority to "claw back" incentives from companies that the Center determines have not met the minimum job creation thresholds in their tax-incentive agreements.

In addition, the MLSC Internship Challenge Program has placed more than 1,000 interns in more than 290 companies across the state where host companies provide dedicated mentors to help expand the pool of prospective life sciences workers for the future. Those college students receiving MLSC internships are majoring in biology, engineering, chemistry, business, computer science and physics and end up interning in companies that produce medical devices, pharmaceutical products, diagnostic services, and biotechnology research. In FY2012, the Center also awarded $180,000 to four programs to encourage science, technology, engineering and math (STEM) education, especially for women and minorities.

Table 3 provides a summary of the investments made by the MLSC between June 2008, when the Life Sciences Initiative funding first became available, and June 2012.

TABLE 3

Distribution of MLSC Investments by Dollar Amount June 2008–June 2012

Capital Projects (12)	$186,950,000
Company Grants and Accelerator Loans (31)	$22,907,000
Academic Research Grants (35)	$23,346,344
Tax Incentives (56)	$56,595,093
Interns Funded for Workforce Development (884)	$6,903,164
Equipment and Supply Grants or Schools (32)	$3,333,675
Other Grants/Business Plan Competitions	$1,540,000
Total	**$301,575,276**

Source: Massachusetts Life Sciences Center, 2013

This comprehensive approach to an entire industry cluster differs significantly from other federal, state, and local incentive programs that target a single company or, at best, a single industry.

We can now ask: "*Has this approach, and the investments made through the MLSC, paid off?*"

We begin to answer this question by tracking output and employment in the life sciences cluster and consider the results in terms of the creation of the Center in 2006.

But given what we have learned about the role of innovation in spurring economic growth, we can ask a more fundamental question. "Has the creation of the Center and the Life Sciences Initiative paid off in terms of nurturing a rich 'ecosystem' within which the entire life sciences super cluster can flourish now and in the future, providing a platform for further growth in economic opportunity for Massachusetts residents?"

CHAPTER SIX

Output and Employment in the Massachusetts Life Sciences Super Cluster

The life sciences super cluster began to benefit the Commonwealth by the middle of the last decade, even before the MLSC was established. By 2006, publicly traded companies in Massachusetts were already generating $30 billion in sales, an increase of nearly 50 percent in just four years. With $7.5 billion in exports, the Massachusetts life sciences sector accounted for 30 percent of total state exports.[53] Between 2001 and 2006, employment in Massachusetts life sciences industries increased by 13,000—more than 16 percent. The life sciences were generating jobs during a period when total non-farm employment in Massachusetts was actually *declining* by 2.8 percent. While total employment in the life sciences in 2006 accounted for just 26 out of every 1,000 jobs in the state, this sector was growing faster than any other, including education and health services (See **Figure 4**).

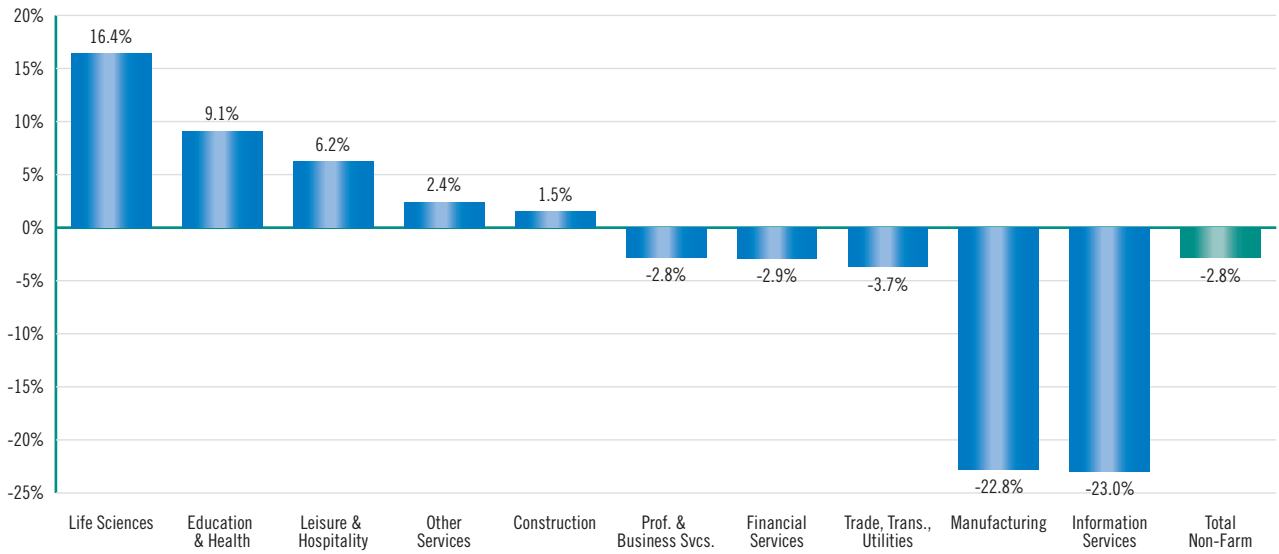
As **Figure 5** reveals, the life sciences cluster continued to generate jobs between 2006 and 2011, but not quite as rapidly as during the previous five years. However, it was still faster than every other sector save education and health services. The national recession that began at the end of 2007 weighed on the life sciences sector, as it did most other industries. Life sciences remained a small sector in terms of overall non-farm state employment, but given its faster growth, accounted for nearly 30 jobs out of every 1,000 in the Commonwealth by 2011.

Taking the entire decade (2001–2011) as a whole, the life sciences far outpaced all other industry sectors in terms of its employment growth rate as shown in **Figure 6**.

Within the cluster, however, the growth in employment has varied greatly across individual industry segments as shown in **Table 4**. During the entire period between 2001 and 2011, employment in research, testing, and medical laboratories increased by more than 50 percent, nearly twice as fast as the life sciences cluster as a whole (and 2½ times as fast as education and health services). Yet the production of medical devices—the

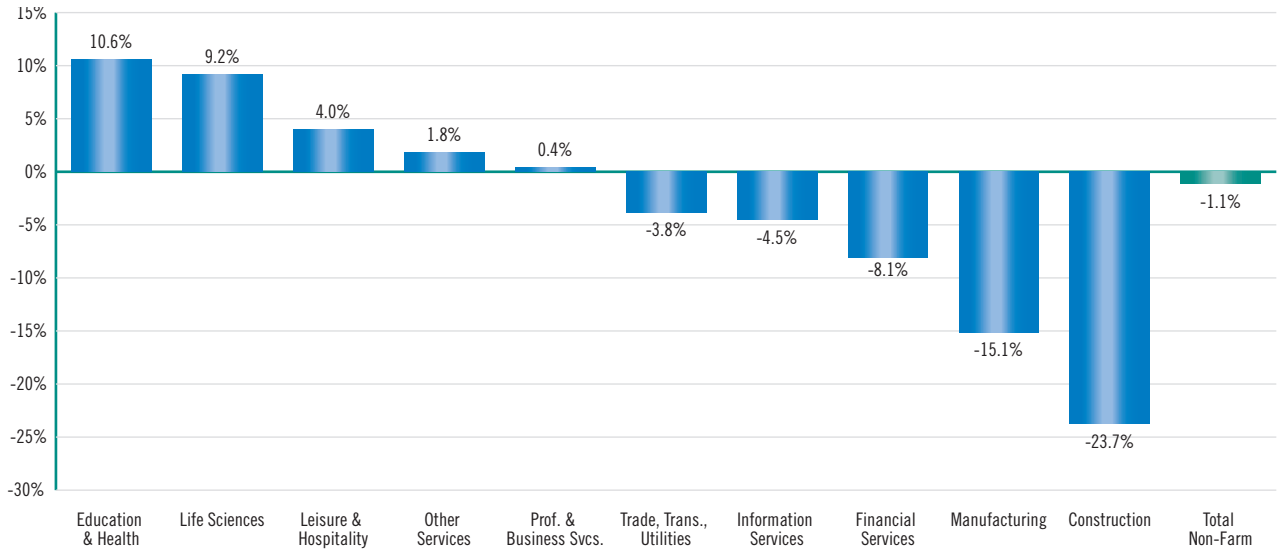
FIGURE 4

Massachusetts Employment Growth by Industry Sector 2001–2006



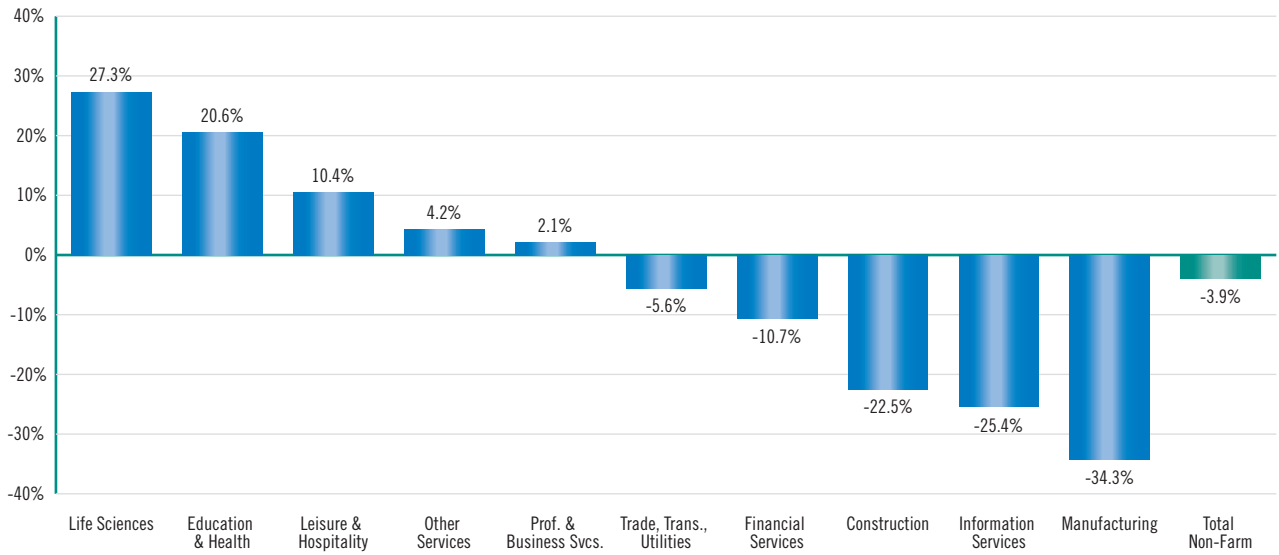
Source: Bureau of Labor Statistics, Author's Analysis

FIGURE 5
Masssachusetts Employment Growth by Industry Sector 2006–2011



Source: Bureau of Labor Statistics, Author's Analysis

FIGURE 6
Massachusetts Employment Growth by Industry Sector 2001–2011



Source: Bureau of Labor Statistics, Author's Analysis

key *manufacturing* segment of the life sciences cluster —remained nearly constant over this period, increasing by just 0.2 percent.

What is notable, however, is that the employment growth rate actually *increased* in the second period (2006–2011) for both the pharmaceutical industry and

TABLE 4
Employment Change by Life Sciences Cluster Segment

	2001	2006	2011	% Δ2001–2006	% Δ2006–2011	% Δ2001–2011
Drugs & Pharma	7,794	7,944	8,537	1.9%	7.5%	9.5%
Medical Devices & Equipment	22,835	21,645	22,882	–5.2%	5.7%	0.2%
Research, Testing, & Medical Labs	34,849	47,072	52,819	35.1%	12.2%	51.6%
Bioscience-Related Distribution	9,607	10,877	11,377	13.2%	4.6%	18.4%
Total	**75,085**	**87,538**	**95,615**	**16.6%**	**9.2%**	**27.3%**

Source: Bureau of Labor Statistics, Author's Analysis

medical device manufacturing, despite recession conditions nationally and regionally. Indeed, all four sectors in **Table 4** exhibited increased employment during this difficult economic period.

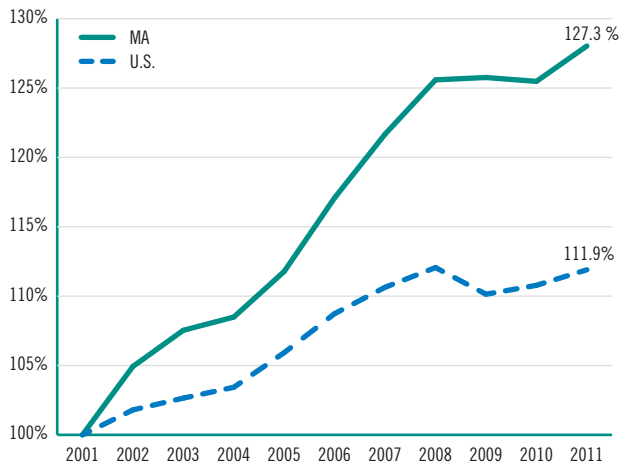
Life Sciences Employment Trends: Massachusetts vs. the United States

The capacity of the Commonwealth's life sciences to create jobs at a faster pace during the past decade than all other major Massachusetts industries is one indicator of the successful development of this sector. Even more important is how the state's life sciences have performed relative to the country as a whole and other states vying for supremacy in this rapidly evolving cluster of industries. The data we have gathered on employment trends reveal that the Commonwealth has indeed overtaken the rest of the nation in terms of employment growth in the life sciences, fulfilling the initial goal of the MLSC.

Figure 7 reveals the trend in life sciences employment in Massachusetts compared to that of the nation as a whole between 2001 and 2011. During this period, Massachusetts life sciences employment growth outperformed the nation by a factor of better than 2-to-1—growing by 27.3 percent vs. 11.9 percent for the nation.

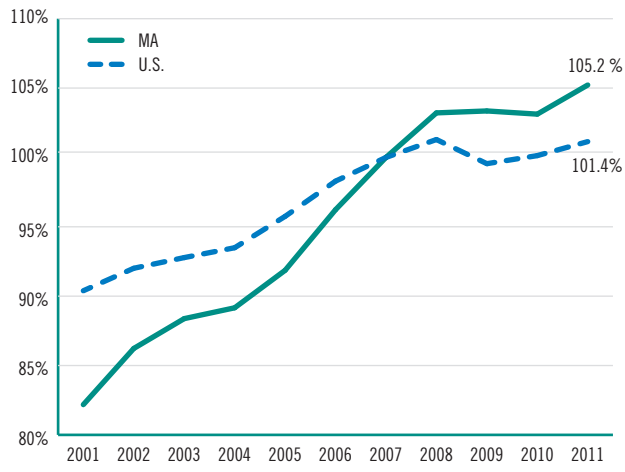
Figure 8, which indexes employment growth to 2007, reveals how the Commonwealth's life sciences cluster grew at a faster clip than the nation's, surpassing the nation and now remaining firmly ahead of it in terms of employment growth.

FIGURE 7
Employment in Life Sciences Indexed to 2001, Massachusetts vs. the U.S.



Source: Author's Analysis from BLS data

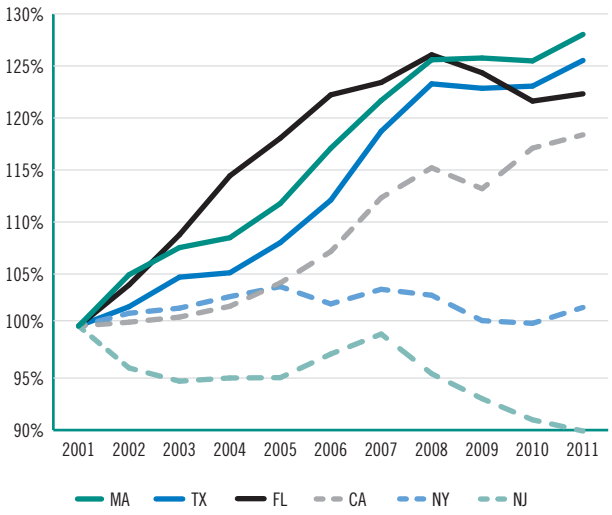
FIGURE 8
Employment in Life Sciences Indexed to 2007, Massachusetts vs. the U.S.



Source: Author's Analysis from BLS data

FIGURE 9

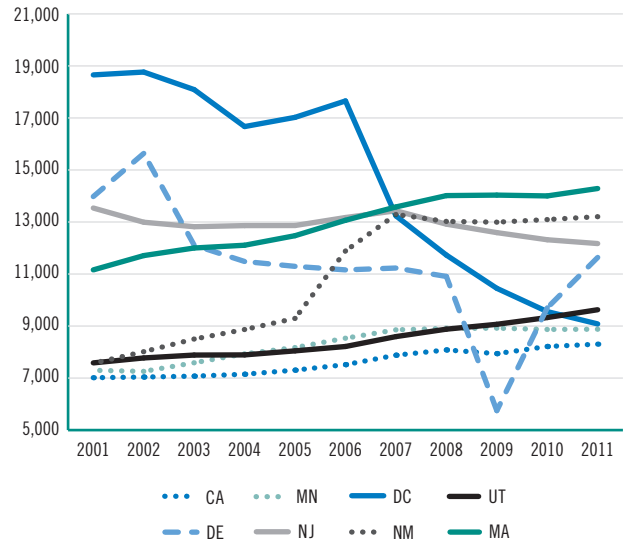
Employment in Life Sciences Indexed to 2001, Massachusetts vs. Big Competitor States



Source: Author's Analysis from BLS data

FIGURE 10

Life Sciences Jobs per 1 Million 2010 Population Top 8 States in 2011, by Year



Source: Author's Analysis from BLS data

The Commonwealth's main competitors in the life sciences include California, New Jersey, New York, Florida, and Texas. But as **Figure 9** demonstrates, after 2008 the Commonwealth overtook all of these states in terms of its 2001–2011 employment growth rate. Florida's nascent life sciences sector had been growing faster, but has fallen behind the Bay State during the past four years. Texas has been trying to catch up, but still trails Massachusetts. Over the decade, California's life sciences employment grew by just 18.4 percent compared with the Commonwealth's 27.3 percent. The growth rate in New York has been anemic, adding only 2 percent to its life sciences workforce while New Jersey, once the pharmaceutical capital of the nation, has seen its life sciences cluster decline sharply since 2007.

Even with Massachusetts's #1 position in the life sciences employment growth rate, it is not surprising that other states still have a larger absolute number of life sciences jobs. Of the top six states, Massachusetts ranked 5th in 2011, as **Table 5** reveals. California leads the pack with nearly 310,000 life sciences jobs.

Yet even as a much smaller state in total population, Massachusetts now leads all other states in the number of jobs in the vital biotechnology R&D sector within the life sciences super cluster. In 2011, the Commonwealth boasted more than 28,000 jobs, exceeding second place California (22,600) and third place Pennsylvania (11,200).[54] Since 2007, this particular sector grew faster in the Commonwealth than in any other state, adding more than 3,500 jobs.

When we control for population size, Massachusetts is the clear winner for the entire life sciences cluster of industries. In **Figure 10**, we have controlled for the size of population of each state by measuring the number of life sciences jobs per 1 million residents. In 2001, the District of Columbia actually had the highest per capita number of life sciences jobs, presumably because of the physical presence of the National Institutes of Health. Delaware ranked second followed by New Jersey. California actually lagged Minnesota, Utah, and New Mexico on this measure. Massachusetts ranked #4.

But by 2011, given its rapid growth rate, the Massachusetts cluster had risen to #1 in terms of per capita life sciences employment. With nearly 14,300 life sciences jobs per 1 million people, Massachusetts had eclipsed New Jersey (12,171) and continued to far outstrip California (8,300).

TABLE 5

States with Largest Life Sciences Employment (2011)

California	309,344
New York	109,750
New Jersey	107,007
Texas	96,969
Massachusetts	95,615
Florida	83,836

Source: Author's Analysis from BLS data

Clearly, the life sciences cluster has enjoyed stellar growth in the Commonwealth over the past decade, and it appears that after the MLSC was created, the pace of growth outdistanced all of Massachusetts's rivals.

Clearly, the life sciences are flourishing in Massachusetts and the timing of the sector's employment growth suggests at least a correlation between the creation of the MLSC and the ability of the state's life sciences super cluster to overtake the rest of the nation.

But what evidence do we have of causation rather than simply correlation? What role has the MLSC played in the stellar growth of this set of industries? Here we find the interviews we conducted with key informants provided additional information on the role MLSC has played in this 21st-Century story of industrial success.

CHAPTER SEVEN

The Key Role of the MLSC: What We Learned from the Interview Data

To obtain a firsthand view of what part the MLSC may have played in the emergence of the Commonwealth's life sciences ecosystem, we conducted a series of "key informant interviews" with executives in the industry, with leaders of related trade associations, and with a number of scientists who have an intimate knowledge of the range of activities of the Center. In order to obtain an honest and unbiased assessment of the $1 billion initiative itself and the functioning of the Center, we assured each of our informants strict confidentiality. Interviews were carried out with executives in both large and small companies in the industry, with those mostly devoted to research and development, and with those whose companies are now involved with the manufacture of scientific and medical products.

While we probed on many fronts, we asked each informant to consider a fundamental "counterfactual": *Would the life sciences in Massachusetts be much different from what they are today if the MLSC had never been created and the state had not committed long-term funding to assist the array of universities, research institutes, and companies that make up the life sciences super cluster?* What we learned provided us with a vital and deeper understanding of the critical role the MLSC has played.

Here are our key findings.

The Development of the Life Sciences "Ecosystem"

The leaders of large firms told us that given the scale of their operations, the MLSC plays at best a *minor direct role* in their own development, but an *immense indirect role* that helped to attract them to Massachusetts. The term that surfaced in virtually all of our interviews is "ecosystem," and that the MLSC has been central to the creation of the life sciences ecosystem that has made the Commonwealth more attractive than competing regions.

According to our interviews, the MLSC has indeed been instrumental in bringing together a tight-knit community of life sciences institutions including universities, research hospitals, small start-up bioscience firms, medical device manufacturers, and Big Pharma. These stakeholders all interact on a regular basis to assist each other in the promotion of their activities. The ecosystem includes the nurturing of small firms through the MLSC's accelerator-loan and tax-incentive programs, assistance to the life sciences research labs in the state's public higher education system, the provision of funds for student interns in relevant fields, and countless opportunities for executives, scientists, and industry employees to meet and explore opportunities for expanding the life sciences super cluster in the Commonwealth. The Center has been critical, according to our key informants, in helping to build a "platform" for the entire sector and cultivate a "collaborative gene" among all of its separate parts.

As one recent example of this role, the MLSC helped create the Massachusetts Neuroscience Consortium, announced at the 2012 BIO International Convention in Boston. With charter sponsors including Abbott Labs, Biogen Idec, EMD Serono, Janssen Research & Development LLC, Merck, Pfizer, and Sunovion Pharmaceuticals, Inc., the consortium provides an arrangement whereby companies that normally compete with each other collaborate on funding preclinical neuroscience research under way at academic and research institutions throughout the state. With leadership provided by the MLSC, each of the founding sponsors has pledged $250,000 toward this effort, and the Center will administer the funds.[55] The research results will be shared with all participants and all companies and academic researchers will have access to any tools developed as a result of these investigations. Without the Center playing this convening role, it is unlikely that such a consortium would have come into existence.

The Center has also been responsible for helping to nurture international cooperation among life sciences firms and academic institutions. The Center provided a $300,000 grant to the Northern Ireland Massachusetts Connection (NIMAC) for a new multinational research

study on non-invasive procedures to detect pre-malignant lesions. Finland and Catalonia have joined NIMAC as well. MLSC is also helping to develop alliances between Massachusetts companies and Israeli firms through the Massachusetts-Israel Innovation Partnership (MIIP). The Center has contributed $300,000 to this effort so far, funding two Massachusetts firms working in partnership with Israeli firms. A second round of funding for this program is pending.

All of these efforts are part of building an ever larger life sciences ecosystem based in the Commonwealth.

The Unique Growth Pattern of Regional Life Sciences Clusters

The most important lesson we derived from our interviews, however, was the unique growth pattern of the life sciences cluster. The regional concentration of life-sciences companies happens in a very different manner than in other industries. In the case of traditional industrial sectors such as auto, aircraft engine, financial services and the like, a region becomes dominant in a particular cluster once a large anchor enterprise or a small number of them establish operations in that locale. Once the anchor enterprise is established, an array of smaller firms is attracted to that region to serve as part of the supply chain for the large anchor enterprise(s).

Once Detroit became home to Henry Ford's car company and General Motors and Chrysler built huge auto assembly facilities in Michigan, hundreds of small parts plants, design studios, and small engineering facilities opened their doors nearby in order to easily serve the industry's "Big Three." The same is true of the aircraft engine industry in New England dominated by Pratt & Whitney in East Hartford, Connecticut, and General Electric's Aircraft Engine facility in Lynn-Everett, Massachusetts. These massive facilities attracted hundreds of aircraft engine parts suppliers to New England, making the region one of the core jet-engine manufacturing centers in the United States. *Essentially, the small firms in the industry are dependent on the large ones.*

For the life sciences, the reverse is true. For companies that crucially depend on the development of breakthrough innovations and sophisticated medical devices, *the large firms prosper by reason of being proximate to a panoply of small start-up firms*. The reason for this is that despite their substantial research budgets, even the largest of the life sciences companies do not have the resources to generate more than a handful of breakthrough innovations in the biosciences, genomics, and other sophisticated fields. These large firms grow and prosper by carefully monitoring the scientific discoveries under way in university research laboratories and in the translational research carried out by small start-up firms. Those few start-ups that end up with potential blockbuster drugs or devices become prime targets for acquisition by the larger firms. Only a fraction of the long-term revenue generated by Big Pharma and the largest biotech and medical device companies has its origin in their own research labs. The majority comes from the absorption of successful smaller firms.

The secret to success in the acquisition process is being where the small firms are located. This permits the large firms to closely monitor the progress of smaller firms and buy the most promising ones before other Big Pharma or other competitors can make a bid. To use a metaphor from nature, the large, globally important life sciences firms want to feed in the waters where the minnows are swimming.

Pfizer, for one, has moved operations into Cambridge from other locations for this purpose.[56] In 2010, it announced that Cambridge would become one of Pfizer's worldwide research and development hubs, and it relocated approximately half of the current employees from its BioTherapeutics R&D organization to Kendall Square. A year later, Pfizer announced plans to move two existing research units, Cardiovascular Medicine (CVMed) and Neuroscience from Groton, Connecticut, to Cambridge, leasing 180,000 square feet of lab and office space from MIT to house these two research units.

In June 2011, Pfizer opened the Boston Centers for Therapeutic Innovation (CTI), an entrepreneurial network of partnerships with leading academic medical centers. According to the company, "these partnerships reduce the time and cost of drug discovery and development by accessing leading translational researchers."[57] Boston is also the global headquarters for the CTI network, which has established partnerships in New York City and San Francisco. The richness of the Massachusetts life sciences ecosystem prompted Pfizer to expand still further in the Commonwealth, with the company's newest building in Cambridge scheduled to be completed in 2013.

Over the past three years, Massachusetts is the only state where Pfizer has added jobs, not California, Connecticut, New Jersey, or New York. As an executive of this company told us in one interview, "Innovation between the big, the small, and the in-between is what makes the industry succeed." Another Pfizer executive noted that while his company has not taken a dollar from the MLSC, the Center has helped the firm by creating a "mentality" about the life sciences that has permeated the state right down to the local level, making it possible to speed local permitting and rezoning where necessary.

Executives at Sanofi-Aventis SA, which acquired Genzyme in 2011 in a $20 billion deal, have relied on the MLSC to "act as a bridge" between the company and such research institutions as the Cummings School of Veterinary Medicine at Tufts University and the University of Massachusetts Medical Complex in Worcester. Like Pfizer, Sanofi is expanding in Cambridge in order to have a "front row seat" for acquisitions.[58]

And here is the key to understanding the central role of the MLSC. *While the large firms can easily exist without the MLSC, the small life sciences firms need the Center to provide them with accelerator loans, research and development funds, and interns who can help them translate their ideas into what could be commercially viable products. While the private venture capital market may provide some funds for this purpose, venture capital often requires a quicker return than can be obtained from this industry, which often has long lag times between initial research, proof of concept, and a final FDA-approved product.*

In 2012, according to data gathered by PricewaterhouseCoopers, venture capital investments in biotech and health-care startups fell to their lowest level since 1995.[59] Investment in biotech firms in the Boston area dropped to $869 million in 2012, a 24 percent reduction from 2011 levels. Regulatory uncertainty facing the health-care industry is making this "a more challenging time for life sciences companies to raise money," according to Terry McGuire, general partner of Polaris Venture Partners, a Waltham-based VC firm with about half its portfolio invested in health-care companies.[60] Another reason biotech investments may be dwindling is that new software companies are on the rise and the return on investments in these firms tends to be much more "capital-efficient," paying off relatively rapidly.

The lack of easy access to VC funds has worried small life sciences firms about the "valley of death"—the gap in funding needed to move basic research into commercial products. In this environment, the MLSC has become an important investment partner for smaller life sciences firms, providing them with funds for translational research and development. These smaller firms may grow out of local research universities and medical complexes, but they can then turn to the MLSC for investment assistance. This tends to help keep them in the Commonwealth instead of losing them to investment funds in other regions.

In a number of cases, we found that smaller companies were being lured to relocate to other states, but according to their executives, the MLSC moved quickly to narrow the interregional cost differential and keep these firms in the Commonwealth. They did this through tax incentives and investment credits. And because these "minnows" stay here, Big Pharma has come from all over the world to swim in this pond. By helping to attract small life sciences companies to Massachusetts as well as incubating new ones begun in the state, the MLSC has created a well-stocked fishing ground for Big Pharma. In 2012 alone, a large array of small- and medium-sized domestic and international firms chose to establish operations in Massachusetts, including Era7 Bioinformatics, Algeta U.S., QServe, Scivax USA, ReproCELL, Inc., Human Metabolome Technologies, Inc., Alacrita, Arrayjet, ARGO Medical Technologies, BioAxone, BioSurplus, Promedior, and KeraFAST.

By the end of 2012, nine of the ten major drug companies in the world had set up shop in Massachusetts.[61] To house these firms, 3.4 million square feet of biotech-related office and laboratory space is now under construction across Massachusetts with massive buildings now being completed for Pfizer and Novartis. This adds to the 2.4 million square feet of commercial lab space erected between 2007 and 2011.[62] The other Big Pharma firms with major investments in Massachusetts are Johnson & Johnson, GlaxoSmithKline, Sanofi (which absorbed Genzyme), AstraZeneca, Abbott Laboratories, Merck, and Bristol-Myers Squibb. A decade ago, none of these global firms had a significant presence or any presence at all in the state, according to Mass Bio, the state's life sciences trade group.[63] Only Roche, the Swiss company and third largest biopharmaceutical firm in the world, has yet to establish a presence in the Commonwealth.

With this growth dynamic at work, Massachusetts appears well positioned to continue to attract new investment in the life sciences cluster.

The MLSC "Modus Operandi"

In the course of this study, many of those interviewed commented on the protocols that the MLSC follows in carrying out its activities. According to these sources, the Center's success in funding firms is grounded in its reliance on a Scientific Advisory Board (SAB) to guide the Center's Board of Directors in determining which firms show the greatest promise of economic and scientific success. The Center has established a competitive process for securing assistance and the SAB has made certain that the process is transparent. Over and over again, we heard in our interviews words like "rigorous" and "diligent" when describing the processes MLSC uses in selecting awardees.

It should be noted that other states that have created similar life sciences initiatives have had a less-than-stellar record of maintaining a process free of political considerations. In early 2013, the Texas Legislature essentially defunded the state's Cancer Prevention and Research Institute (CPRIT), which had been established by referendum in 2007. This followed the resignation of the agency's chief scientific officer, along with many of the institute's high-profile grant reviewers, in protest over how the independent peer review system had been disrespected.[64] According to the chair of the MLSC's Scientific Advisory Board, here in the Commonwealth the Center has been scrupulous in following the recommendations of the Center's Board of Directors and the SAB.

This has apparently contributed to the Center's exceptional record of assisting firms that ultimately succeed and grow. Accountability measures implemented by the Center have also contributed to the success of the Center's tax program. As **Table 6** reveals, the Center had

TABLE 6

Firms Receiving Tax Incentive Funding (Program Years 2009-2011)—Active Awards

		Hiring Goal	Hiring Actual	% of Goal	Hiring Potential
2009	Shire	150	153	102%	153
2009	Cubist	58	60	103%	60
2009	Biogen	50	235	470%	235
2009	Merrimack	50	53	106%	53
2009	Lightlab	29	32	110%	32
2009	Constellation	26	21	81%	26
2009	Sepracor	25	108	432%	108
2009	InfraReDX	21	25	119%	25
2009	OmniGuide	18	10	56%	18
2009	Organogenesis	15	26	73%	26
2009	Dyax	15	23	153%	23
2009	Still River	10	18	180%	18
2009	Nova	10	25	250%	25
2009	Infinity	18	14	78%	18
2009	STD Med	10	54	540%	54
2010	Shire	150	141	94%	150
2010	Sanofil	100	101	101%	101
2010	Vertex	90	136	151%	136
2010	NX Stage	50	27	54%	50
2010	Merrimack	50	37	74%	50

TABLE 6

Firms Receiving Tax Incentive Funding (Program Years 2009-2011)—Active Awards *(continued)*

		Hiring Goal	Hiring Actual	% of Goal	Hiring Potential
2010	Ironwood	37	56	151%	56
2010	Instrumentation Laboratory	30	30	100%	30
2010	Valeritas	18	10	56%	18
2010	Organogenesis	17	44	259%	44
2010	Bluebird	10	13	130%	13
2010	Bind	10	8	80%	10
2010	NormOxys	10	–5	–50%	10
2010	LeMaitre	19	43	226%	43
2010	Foundation Medicine	40	25	63%	40
2010	Lightlab	14	45	321%	45
2010	Nova	10	10	100%	10
2011	Shire	100			100
2011	Vertex	100			100
2011	AVEO Pharma	94			94
2011	Biogen Idec	75			75
2011	Ironwood	75			75
2011	DePuy Othopaedics	50			50
2011	Momenta Pharma	50			50
2011	PerkinElmer	50			50
2011	Organogenesis	35			35
2011	Aegerion Pharma	27			27
2011	Lightlab	26			26
2011	Cell Signaling Tech	20			20
2011	Quanterix Corp	19			19
2011	NinePoint Medical	15			15
2011	Pharmalucence	12			12
2011	Metamark Genetics	11			11
2011	New England Biolabs	10			10
2011	Nova	10			10
2011	T2Biosystems	10			10
2011	Boston Heart Diagnostics	31			31
2011	Ra Pharma	10			10
2011	Blueprint Medicines	15			15
2011	PAREXEL International	32			32
2011	Moderna Therapeutics	13			13
2011	Courtagen Life Sciences	13			13
2011	Knome	12			12
	2009–2011 Awardees	**1,160**	**1,578**	**136%***	**2,639****

Source: Massachusetts Life Sciences Center

* Proportion of hiring goal for 2009–2010 active awardees only; no data available on 2011 awardees at this time

** Minimum total jobs created if, on average, all firms meet or exceed hiring

31 outstanding tax incentive packages from the 2009 and 2010 programs as of June 30, 2012.

In a number of cases, hiring targets were exceeded by a factor of four or greater. In only one case did a firm receiving an award actually reduce its staff. As of June 30, 2012, the currently active 31 awards from the 2009/2010 program have produced 1,578 new jobs, exceeding the aggregate hiring goal of 1,160 by 36 percent. Adding in the 2011 program awards for which we do not yet have data on hiring, the potential number of new hires could exceed 2,600 if all firms, on average, meet or exceed hiring goals.

As noted above, the accelerator loan program is also meeting with success, with six of the 20 firms that received such loans already repaying them in full.

Table 7 provides additional data on the outstanding awards to firms from the 2009 program, the first year of the program. The outstanding amount of the tax incentive awards as of June 30, 2012 amounts to $15.25 million. Fifteen firms received tax incentive awards in that year totaling $15.25 million. They ranged in size from $6.3 million to Shire Human Genetic Therapies to $121,000 to STD Med, Inc. In 2009, these firms had a base headcount of 5,427. The target headcount associated with these awards was 5,932—an increase of 505 hires. By the end of 2011, 12 of these firms had met or exceeded their hiring targets.

What adds to the efficiency of these awards is a "claw-back" feature requiring firms that fail to meet their approved hiring goals to return to the Center the funds they were provided. A number of firms have done just that when they were unable to meet their specified minimum job-creation targets.

TABLE 7

Annual Report: 2009 Tax Incentive Program Results—for annual reporting period ending December 31, 2011

			Per Agreement			Actual	2011	Actual	
		$ Award Provided	Base Hdct	Adds	Targeted	12/31/2011 Hdct	Actual Growth (from base)	% of Adds (from base)	Achieved or exceeded target
	COMPANY								
	Active awards								
1	Shire Human Genetic Therapies, Inc.	$6,277,057	986	150	1136	1280	294	196%	Yes
2	Cubist Pharmaceuticals, Inc.	$1,740,000	355	58	413	415	60	103%	Yes
3	Biogen Idec MA, Inc.	$1,500,000	1899	50	1949	2134	235	470%	Yes
4	Merrimack Pharmaceuticals, Inc.	$1,500,000	124	50	174	214	90	180%	Yes
5	LightLab Imaging, Inc.	$188,951	64	29	93	141	77	266%	Yes
6	Constellation Pharmaceuticals, Inc.	$513,252	41	26	67	62	21	81%	No
7	Sepracor Inc. / Sunovion	$750,000	601	25	626	709	108	432%	Yes
8	Infraredx, Inc.	$630,000	60	21	81	85	25	119%	Yes
9	OmniGuide, Inc.	$ 540,000	62	18	80	72	10	56%	No
10	Infinity Pharmaceuticals, Inc.	$ 540,000	172	18	190	186	14	78%	No
11	Organogenesis Inc.	$ 245,240	241	15	256	311	70	467%	Yes
12	Dyax Corp.	$ 100,000	94	15	109	117	23	153%	Yes
13	Mevion (formerly Still River Systems), Inc.	$ 300,000	73	10	83	91	18	180%	Yes
14	Nova Biomedical Corporation	$ 300,000	498	10	508	533	35	350%	Yes
15	STD Med, Inc.	$ 121,000	157	10	167	211	54	540%	Yes
	TOTALS	$ 15,245,500	5427	505	5932	6,561	1,134		

Source: Massachusetts Life Sciences Center

Based on wage and salary data from the companies receiving tax-incentive awards between 2009 and 2011, we carried out an economic analysis of the cost and benefit of this MLSC program. The results are found in **Table 8**. Our analysis suggests that as of June 30, 2012, the Center had $56.3 million in outstanding tax incentives. Altogether, the firms receiving these incentives added more than 2,500 jobs by 2012. The vast majority (1,843) of these were in pharmaceutical firms with the remainder generated by medical device companies (481) and scientific research enterprises (213). The average annual salary of these jobs exceeded $105,000. As such, these new jobs generated a total of over $266 million in wages and salaries each year.

Based on estimates from the Massachusetts Department of Revenue, we estimate that, on average, the added workers employed by these firms paid more than $4,900 in income taxes to the Commonwealth and $2,400 in sales taxes.[65] Assuming that each of these jobs lasts on average just five years, the added state revenue generated by these workers over that period is close to $37,000 per worker or a total of $93 million in tax revenue.

Compared with the total cost of the incentive program, each dollar in awards will generate $1.66 to the state in added tax revenue. This represents an extraordinary rate of return on this public investment.

TABLE 8
Economic Return on the MLSC Tax Incentive Program

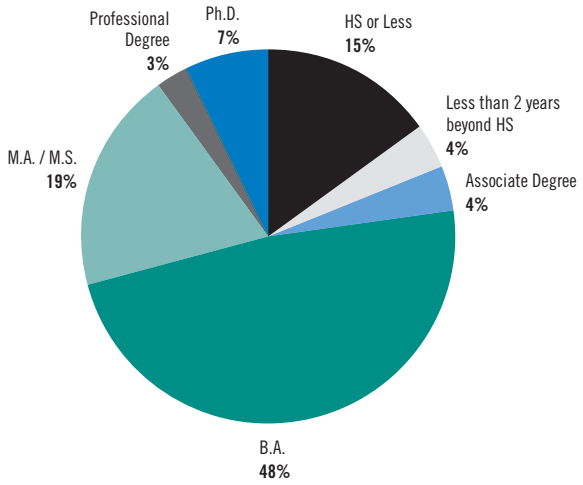
	Program Year 2009	Program Year 2010	Program Year 2011	3 Years of Incentives
Total Value of MLSC Tax Incentives ($)	$15,245,500	$20,672,638	$20,340,884	$56,259,022
Net New Jobs Created	901	721	915	2,537
Tax Incentive per Job ($)				$22,175
Annual Tax Incentive per 5-year job ($)				$4,435
Average Salary per Job ($)				$105,037
Total Salaries Generated per Year ($)				$266,479,399
State Income Tax Revenue per Job per year ($)				$4,937
Total State Income Tax per year ($)				$12,524,532
Average Sales Tax per Job ($)				$2,404
Total State Sale Tax per year ($)				$6,099,447
Total Income+Sales Taxes per year ($)				$18,623,979
Average Income+Sales Tax/Job per year				$7,341
Total Income+Sales Taxes per 5-year Job				$36,705
Total Income+Sales Taxes over 5 years				$93,120,585
Net State Revenue Gain (5 years) ($)				$36,860,872
Ratio of Tax Revenue/Incentive over 5 years				1.66

	Pharma	Medical Devices	Scientific Research	Total
Jobs	1,843	481	213	2,537
Average Salary ($)	$115,222	$66,913	$103,009	$105,037
Total Salary ($)	$212,353,256	$32,185,280	$21,940,863	$266,479,399
Share of Salary	0.7969	0.1208	0.0823	1.0000
State Income Tax By Sector ($)	$9,980,603	$1,512,708	$1,031,221	$12,524,532
Sales Tax by Sector ($)	$4,860,554	$736,689	$502,204	$6,099,447

Source: Dukakis Center for Urban and Regional Policy

FIGURE 11

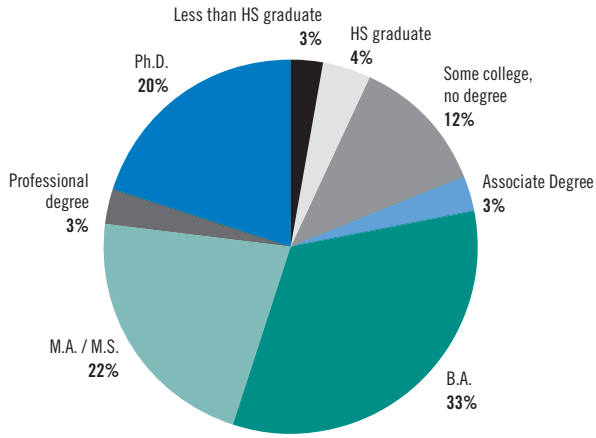
Education Distribution of New Hires by 2010 MLSC Tax Incentive Awardees



Source: Dukakis Center for Urban and Regional Policy

FIGURE 12

Education Distribution—Pharma

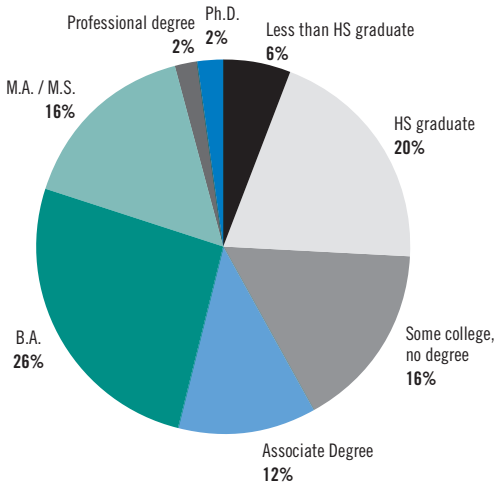


Less than B.A.: 22%

Source: Dukakis Center for Urban and Regional Policy

FIGURE 13

Education Distribution—Medical Devices

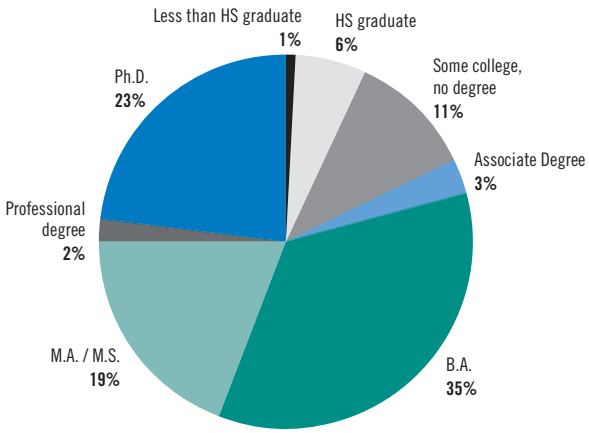


Less than B.A.: 54%

Source: Dukakis Center for Urban and Regional Policy

FIGURE 14

Education Distribution—Diagnostics, Tools, and Related Products and Services



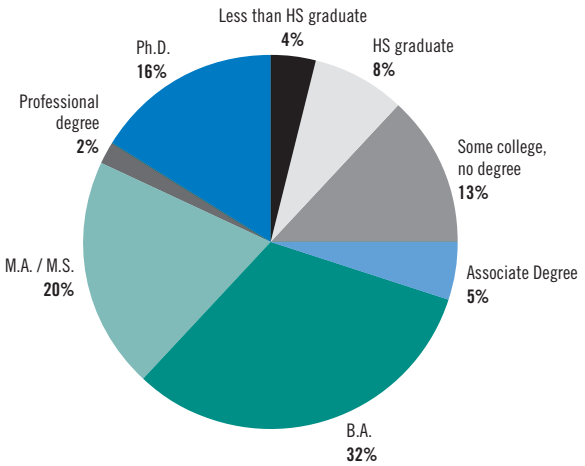
Less than B.A.: 21%

Source: Dukakis Center for Urban and Regional Policy

Of course, it is possible that these firms would have generated some or perhaps even many of these jobs without the MLSC award. But given the importance of the life-sciences ecosystem created in the Commonwealth, at least partly as a result of Center activity, it is reasonable to suggest that many of these jobs and their associated tax revenue would not have been created without the help of the Center. Moreover, our estimates do not consider any "multiplier" effects. The added spending of these new hires in the Commonwealth helped generate additional jobs as these workers spent money in the state, creating jobs in a wide range of industries.

FIGURE 15

Education Distribution—Life Sciences Cluster Pharma/Medical Devices/Diagnostics, Tools, and Related Products and Services



Less than B.A.: 30%

Source: Dukakis Center for Urban and Regional Policy

A concern that one might have about the employment generated by the life sciences super cluster is that the jobs created all go to the most educated workers in the state, leaving behind those who have not had the benefit of a college degree or post-graduate education. But based on the hiring records of a number of firms in the industry, it turns out that like other industries, life sciences firms need to hire workers who have a range of skills. In addition to Ph.D. scientists and other highly educated workers, these firms need laboratory technicians and clerical staff, and they employ a range of other workers in occupations that require a good deal less education. **Figure 11**, based on these hiring data, reveals that less than a third (29%) of those working in the life sciences have a Master's degree, professional degree, or Ph.D. Nearly half (48%) have the B.A. or B.S. as their highest level of education, while nearly a quarter (23%) of the workforce has no more than an associate's degree, often from a community college.

Using national data from the 2010 *American Community Survey* (ACS) available from the U.S. Census Bureau, we were able to estimate the education distribution for the individual sectors within the life sciences super cluster. As **Figures 12–15** demonstrate, the proportion of workers in each of the cluster segments needing less than a B.A. (or B.S.) ranges from 21 percent in diagnostics, tools, and related products and services and 22 percent in pharmaceutical firms to more than half in medical devices. According to these national estimates, the total workforce in the super cluster requiring less than a 4-year college degree is 30 percent, a bit higher than the 23 percent in Massachusetts. Essentially, with such a highly educated workforce in the Commonwealth, firms here are able to insist on somewhat higher educational credentials for their employees.

What adds to the value of the life sciences labor market in the Commonwealth are the high wages paid in this sector. As **Table 9** reveals, based on an analysis of Census data, the average annual wage in the state's

TABLE 9

Estimated Annual Earnings for Life Sciences Workers (2006–2010)

	Pharma	Medical Devices	Scientific R&D	Total
Less than High School graduate		$35,142	$51,685	$36,702
HS graduate	$42,966	$33,250	$71,418	$44,225
Some college, no degree	$62,745	$46,684	$61,816	$55,386
Associate's degree	$96,171	$61,400	$53,712	$61,285
Bachelor's	$95,147	$98,853	$85,080	$92,033
Master's	$102,851	$114,019	$102,045	$105,143
Professional school degree	$150,264	$118,399	$182,999	$161,195
Doctorate	$171,596	$249,332	$112,626	$134,195
Total	$102,961	$78,498	$96,379	$91,805

Source: Dukakis Center Analysis of American Community Survey (Census) data

life sciences varies from $78,500 in medical devices to nearly $103,000 in the pharmaceutical industry.[66] Those with a Ph.D. earn, on average, nearly $250,000 in the medical-device sector and well over $100,000 in other sectors within the cluster. But even those who have not completed high school average nearly $37,000 a year, the equivalent of more than $18.00 an hour. High school graduates average more than $44,000 and those with an associate's degree, more than $61,000.

Compared with other industries, the life sciences provide some of the highest paying jobs in the Commonwealth. With an average annual salary of nearly $92,000, this sector rewards its workforce with higher pay than those who work in manufacturing as a whole, construction, real estate, education, government, health care, and transportation. The average salary in the life sciences industries in the Commonwealth exceeds the all-industry Massachusetts average by 68 percent.[67]

The Long-Term Impact of the Commonwealth's Life Sciences Initiative

Based on all of the data we collected about the MLSC and its activities, the analysis we conducted on the expansion of the life sciences industries in the Commonwealth, and the information we gleaned from the interviews, our overall conclusion is that because of its unique comprehensive approach to an entire industry super cluster and its reliance on scientific peer-reviewed procedures for awarding grants, the Commonwealth has reaped a substantial return on its life sciences initiative investment. Moreover, given the number of firms that have been attracted to the state, in large measure because of the ecosystem the Center has helped nurture, the benefits from the state's investment in this initiative are likely to pay off bountifully in the years to come.

Many of our informants for this report noted that by 2018, when the $1 billion Life Sciences Initiative sunsets, the state will still need an agency that encourages innovation among smaller life sciences firms. Innovation, they note, must be a continuous process for the region to remain prosperous. This will be particularly important as China, India, Singapore, and other foreign countries compete for a share of this expanding super cluster by offering massive incentives to life sciences start-ups.

The big question is whether Massachusetts can continue to lead the nation in the evolution of this critical industry or whether other regions of the country will be able to capture this industry and the jobs that go with it. Massachusetts was once the premier textile center of the nation until the south captured much of the industry in the early part of the 20th century. The Commonwealth led in the development of the commercial computer industry in the 1970s and 1980s with the growth of Digital Equipment Corporation (DEC), Data General, Prime Computer, and Wang, but lost out to Silicon Valley in California and companies like Dell in Texas. Today, other states including New Jersey, California, New Mexico, Utah, and Minnesota are all vying to expand their life sciences clusters.The state's concentration of globally prominent "eds and meds" has clearly been critical to the evolution of the life sciences in the Commonwealth.

One area where the MLSC might wish to pay more attention in the years to come is the medical-device industry. As noted earlier in this report, employment in this component of the life sciences cluster has been stagnant. According to our interviews, other states including Indiana, Michigan and Minnesota are targeting this sector with state funding. Unlike Big Pharma, which can be more patient in the marketplace and worry less about cost pressures, medical-device firms need to move quickly in the market to commercialize their products and they need to be vigilant about reducing costs. To the extent that the MLSC can assist these firms, Massachusetts could remain a center for this sector and employment growth could ensue.

But overall, based on the state's continued commitment to the life sciences, we fully expect to see further growth in the size of private-sector investments in the state's life sciences industries and further increases in employment opportunity.

Assessment of the MLSC Staff

The interviews we carried out also suggested that the Center itself is being run quite effectively and efficiently and in a highly professional manner. Virtually all of our informants praised the management team and especially appreciated the leadership's reliance on peer review and its refusal to permit political considerations to trump scientific merit. As one expert informant noted, the MLSC has "lots of moving parts" and all of them are working well and the Center remains responsive to

industry needs, meeting deadlines, and staying focused on its mission. As another informant put it, with the reliance on the Scientific Advisory Board (SAB) to select awardees, "there is not an ounce of boondoggle in this agency." In its report on creating fiscally sound state tax incentives, the Pew Center on the States singled out the Massachusetts Life Sciences Tax Incentive Program for its focus on annual cost controls and its reliance on scientific merit in making awards.[68]

Still another informant noted that the MLSC is successful because its leadership is committed to working "at the speed of business" and therefore has become a valued partner in the expansion of the industry.

Conclusions

All of our research suggests that the state will benefit from fully funding the remaining five years of the initiative in order to maintain the lead the life sciences have established in the Commonwealth. This is particularly important as other states ramp up their investments in hopes of creating their own life-sciences ecosystems to entice the small and large firms Massachusetts has successfully attracted. California, Maryland, New Jersey, New York, Minnesota, and Florida are not resting on their laurels, but continue to spend state funds on their own life-sciences industries.

Over time, it should be possible for the Center to reach out to the private sector to help fund more of its initiatives, as it has done with the Massachusetts Neuroscience Consortium. With the plethora of larger, profitable firms coming to the state to expand their operations, one could imagine the Center funding more of its internships with private funds and having private firms contribute to other programs (STEM education, for example), allowing the Center to focus even more of its funding on accelerator loans and tax incentives for firms undertaking translational research.

We should also note that the success of the MLSC has lessons for other quasi-public entities in the Commonwealth. We can mention five of them here:

1. Long-term success in the use of tax incentives and business loans is most likely to occur when funds are focused on a cluster of firms and a set of technologies in a given industry, helping to create an industrial ecosystem which can attract new companies to the state.
2. The use of expert panels to determine the awarding of loans assures that these funds will be well utilized. "Claw-back" provisions protect the taxpayers by requiring firms to repay funds advanced by the Commonwealth if they fail to meet hiring goals.
3. The focus on encouraging firms in their early-stage innovation activity is central to promoting economic growth and prosperity.
4. Helping fund workforce development efforts for critical industries as part of the mandate of the quasi-public helps assure a pipeline of skilled workers for the industry and this itself helps attract new firms to the region.
5. Taking a "portfolio" approach to the entire range of activities in the life sciences—from investments in small innovative firms to helping train the future workforce to underwriting infrastructure—helps sustain the "ecosystem," undergirding a virtuous cycle of discovery, innovation, investment, and employment opportunity.

In the end, we applaud the Governor and the Legislature for their foresight in creating the Massachusetts Life Sciences Center and the $1 billion Life Sciences Initiative. The structure put in place is fulfilling the goals set out in the original legislation and the Center's leadership has continually assured that the structure works effectively and efficiently.

Endnotes

Chapter One

1. The Massachusetts Life Sciences Center, "About the Center," www.masslifesciences.com/mission.html.

2. Massachusetts Life Sciences Center, *Fiscal Year (FY) 2012 Annual Report*, "Outpacing the Competition," Cover Letter, September 28, 2012.

3. According to an analysis prepared by the Massachusetts Budget and Policy Center, the Commonwealth faces at least a $1.2 billion deficit in FY2014. This is based on current tax rates and expected spending. See Massachusetts Budget and Policy Center, "A Preview of the FY2014 Budget," January 10, 2013.

4. Following on the early work of Stanley Surrey who served as Assistant Secretary of the U.S. Treasury for Tax Policy, the Congressional Budget and Impoundment Act of 1974 (CBA) defines *tax expenditures* as "those revenue losses attributable to provisions of the Federal tax laws which allow a special credit, a preferential rate of tax, or a deferral of tax liability." See Stanley Surrey, Pathways to Tax Reform: The Concept of Tax Expenditures (Cambridge, MA.: Harvard University Press, 1974); U.S. Congress, Congressional Budget Act of 1974.

5. Joe Stephens and Carol D. Leonnig, "Solyndra: Politics Infused Obama Energy Program," *Washington Post*, December 25, 2011.

6. Carol D. Leonnig, "Battery Firm backed by Federal Stimulus Money files for Bankruptcy," *Washington Post*, October 16, 2012.

7. Jason Schwartz, "End Game," *Boston Magazine*, August 2012.

8. The specific life sciences industry sectors used in this report are based on the non-agricultural 6-digit NAICS (North American Industry Classification System) as reported in the *Battelle/Bio State Bioscience Industry Development 2012 Report* produced jointly by the Battelle Institute, the Biotechnology Industry Organization (BIO), and MPM Public Affairs Consulting, Inc. (June 2012).

9. This set of NAICS industries omits perhaps 50 percent of the growth in life sciences jobs in Massachusetts because it omits life sciences in research in hospitals and universities. These jobs are not counted in the Battelle report because the NAICS industrial coding system cannot distinguish between research jobs in hospitals and other jobs in hospitals such as physicians and nurses, and life sciences research jobs in universities and other jobs such as English and social science professors.

10. It is important to note that because we could not break out faculty, staff, and students involved in the life sciences departments and research institutes from all others employed at universities and hospitals, this report does not include an analysis of the educational attainment, earnings, and occupations for those working in these institutions. Clearly, if we could have done this, our estimates of the number of those employed in the life sciences in Massachusetts would be much greater.

11. Massachusetts Biotechnology Council, "The Complete Guide to the 2012 New England Life Sciences Industry," p. 4.

12. Jane G. Gravelle and Thomas L. Hungerford, "The Challenge of Individual Income Tax Reform: An Economic Analysis of Tax Base Broadening," Congressional Research Service, 7-5700, March 22, 2012.

Chapter Two

13. The largest of these include the exclusion from taxable income of employer contributions for medical insurance premiums and medical care; the net exclusion of contributions to 401(k) pension plans, Individual Retirement Accounts (IRAs), and Keogh plans; the deductibility of home mortgage interest on owner-occupied homes, the deductibility of charitable contributions, and the preferential tax rates on long-term capital gains.

14. Tad DeHaven, "Corporate Welfare in the Federal Budget," Policy Analysis No. 703, Cato Institute, July 25, 2012.

15. Ibid., Table 1, pp. 3–5.

16. See Louise Story, Tiff Fehr and Derek Watkins "As Companies Seek Tax Deals, Governments Pay High Price," *New York Times*, December 1, 2012, p. 1; "Lines Blur as Texas Gives Industries a Bonanza," New York Times, December 2, p. 2; "Michigan Town Woos Hollywood, but End Up with a Bit Part," *New York Times*, December 3, p. 1.

17. MA Film Office, "Mass Film Tax Credit by the Numbers," http://www.mafilm.org/mass-film-tax-credit-by-the-numbers

Chapter Three

18. Robert Pollin and Dean Baker, "Public Investment, Industrial Policy and U.S. Economic Renewal," Center for Economic and Policy Research, Working Paper Series Number 211, December 2009, p. 2.

19. DeHaven, op. cit., p. 6.

20. DeHaven, op.cit., p. 6

21. Pollin and Baker, op. cit., p. 3

22. Barry Bluestone and Bennett Harrison, *Growing Prosperity: The Battle for Growth with Equity in the 21st Century* (New York: Houghton Mifflin Company and The Century Foundation, 2000), p. 207.

23. Bluestone and Harrison, op. cit., p. 207.

24. Paul Romer, "The Origins of Endogenous Growth," *Journal of Economic Perspectives*, Vol. 8, No. 1 (Winter 1994).

25. Bluestone and Harrison, op. cit., p. 210.

26. See Jeremy Greenwood, "The Third Industrial Revolution," Paper prepared for the American Enterprise Institute, October 25, 1996.

27. See B. Jovenovic and S. Lach, "Product Innovation and the Business Cycle," *International Economic Review*, February 1997.

28. See a series of papers by Erik Brynjolfsson and Lorin M. Hitt including "Computers and Productivity Growth: Firm-Level Experience," MIT Sloan School of Management, January 1997; "Information Technology as a Factor of Production: The Role of Differences among Firms," *Economics of Innovation and New Technology*, Vol. 3, No. 4 (1995); and "Paradox Lost: Firm-Level Evidence on the Returns to Information Systems Spending," *Management Science*, Vol. 42, No. 4 (April 1996).

29. Battelle Institute, "2012 Global R&D Funding Forecast," *R&D Magazine*, December, 2011.

30. Battelle Institute, op.cit, p 6.

31. Bluestone and Harrison, op.cit., p. 216.

32. Ben S. Bernanke, "Promoting Research and Development: The Government's Role," Remarks before the Conference on New Building Blocks for Jobs and Economic Growth," Washington, D.C., May 16, 2011.

33. See Martin Bailey, "Trends in Productivity Growth," in Jeffrey C. Fuhrer and Jane Sneddon (eds.), *Technology and Growth: Conference Proceedings*, Federal Reserve Bank of Boston, Conference Series No. 40, June 1996.

34. Matt Hourihan, "The Federal R&D Budget: Process and Perspectives," Presentation before the AAAS Leadership Seminar in Science and Technology Policy, American Association for the Advancement of Science, November 12, 2012.

35. MassBio "Biopharma Industry Snapshot, 2012," p. 22 based on data from the National Institutes of Health and the U.S. Census.

36. Congressional Budget Office, "Federal Support for Research and Development," June 2007.

37. National Science Board, *Science and Engineering Indicators 2012* (Washington, D.C.: National Science Foundation, January 2012).

38. See Economic Geography Glossary, http://faculty.washington.edu/krumme/gloss/a.html.

39. Steven J. K. Walters, "Unions and the Decline of U.S. Cities, *Cato Journal*, Vol. 30, No. 1 (Winter 2010), p. 119.

40. For a fascinating history of Silicon Valley, see the three-part series on National Public Radio, *The Birth of Silicon Valley* produced by Laura Sydell. These include "A Rare Mix Created Silicon Valley's Startup Culture" (April 4, 2012); "America's Magnet for Innovation and Investments" (April 5, 2012); and "Intel Legends Moore and Grove: Making It Last" (April 6, 2012).

41. IEEE History Center, "A Brief History of the U.S. Federal Government and Innovation (Part III): World War II and Beyond (1945-1987) (Washington, D.C.: Institute of Electrical and Electronic Engineers, n.d.).

42. See National Research Council, Funding a Revolution: Government Support for Computing Research, (Washington, D.C. 1999), pp. 2–3.

Chapter Four

43. This section is based on Mark R. Trusheim, Ernst R. Berndt, Fiona Murray, and Scott Stern, "American Entrepreneurial Chaos or Collaborative Industrial Policy: The Emergence of the Massachusetts Biotechnology Super-Cluster," Contributed Paper for the 2nd Conference on Corporate R&D (European Commission, 2010).

44. Trustheim, Berndt, Murray, and Stern, op.cit., p. 13.

45. MassBio "Biopharma Industry Snapshot, 2012," p. 23 based on MassBio membership reports and the *Boston Business Journal Book of Lists, 2012.*

46. See Greg Turner, "Boston is a Big Force in Pharma, *Boston Herald*, December 14, 2012.

47. Jones, Long LaSalle, "Life Sciences Cluster Report: Global 2011," p. 16. Boston ranked #1 on each component of the composite score with the exception of venture capital funding where it ranked #2.

Chapter Five

48. MassBio, "Massachusetts Life Sciences Incentives," Fact Sheet, September 2012.

49. "Refundable" tax credits are payments made to a taxpayer by the Internal Revenue Service or the Commonwealth's Department of Revenue. Such payments can offset other tax liabilities or in the case of no tax liability are a form of "negative" tax.

50. Massachusetts Life Sciences Center, *Fiscal Year (FY) 2012 Annual Report*, p. 4.

51. According to an MLSC memo to the Secretary of Administration and Finance, "The MLSC Tax Incentive Program has enforcement mechanisms, including strict monitoring and reporting requirements for recipient companies. Within 30 days of the end of each calendar year following the award, awardees are required to provide an annual report to the Center that permits the Center to determine whether the awardee's job targets have been met. The statute provides for 'clawback' provisions for companies that are found not to be fulfilling their job creation commitments to the state. Companies that fail to achieve at least 70% of their job targets at the end of any annual reporting period are subject to an investigation to determine the cause of this 'material variance.'" In cases where it is found that the company cannot meet its requirements, the Center

notifies the Massachusetts Department of Revenue so that the department can initiate claw-back procedures to recover the tax value any award provided. If a company has met at least 70% of its goal, the Center may permit the company a second year to fully meet this requirement before notifying the DOR. See memo to Jay Gonzales, Secretary, Executive Office for Administration and Finance from Susan Windham-Bannister, President and CEO of the Massachusetts Life Sciences Center, August 27, 2012.

52. Massachusetts *Life Sciences Center, Fiscal Year (FY) Annual Report*, op. cit., p. 6.

53. UMass Donahue Institute, *Growing Talent: Meeting the Evolving Needs of the Massachusetts Life Sciences Industry* (Cambridge, MA.: Massachusetts Life Sciences Center and Massachusetts Biotechnology Council, 2008), p. 15.

54. U.S. Bureau of Statistics, *Quarterly Census of Employment and Wages* as reported in MassBio "Biopharma Industry Snapshot, 2012," p. 4. These statistics are for NAICS Code 541711.

Chapter Seven

55. See D.C. Denison, "Drugmakers, Mass. Form Consortium," *The Boston Globe*, June 20, 2012, p. B1.

56. Pfizer: Science at our Core, "R&D Locations: Cambridge, MA." http://www.pfizer.com/research/rd_works/cambridge.jsp.

57. Pfizer: Science at our Core, op. cit.

58. See Jeanne Whalen and Mimosa Spencer, "Sanofi wins Long-Sought Biotech Deal," *Wall Street Journal*, February 17, 2011.

As a case in point, on January 29th, 2013 Sanofi announced the launch of LeGoo, a biopolymer gel that allows surgeons to temporarily stop blood flow during surgery without the use of clamps, elastic loops or other conventional occlusion devices that may risk trauma to blood vessels. LeGoo was developed by Pluromed, a young company that was one of the first to receive a loan through the Center's Accelerator Loan Program in 2009. The Accelerator Loan provided support for Pluromed at a critical stage in the development of LeGoo. Pluromed repaid its loan with interest to the Center following its acquisition by Sanofi.

59. See Michael B. Farrell, "Startup Funding Declines Across US," *The Boston Globe*, January 18, 2013, p. B5.

60. Michael B. Farrell, "Startup Funding Declines Across US," op. cit., p. B9.

61. See Greg Turner, "Boston is a Big Force in Pharma," *Boston Herald*, December 13, 2012.

62. MassBio "Biopharma Industry Snapshot," 2012, p. 9.

63. Greg Turner, "Boston is a Big Force in Pharma," op.cit.

64. Monya Baker, "Texas Cancer Institute gets no Funds for new Grants in Proposed Budget," *Nature.com*, January 16, 2013.

65. According to estimates prepared by the Mass DOR from recent annualized tax revenue data, state income tax revenues in the Commonwealth average 4.7% of wage and salary income and sales tax revenues average 48.7% of income tax revenues.

66. These estimates are based on data for 2010 from the American Community Survey (ACS).

67. See Barry Bluestone, et. al, *Staying Power II: A Report Card on Manufacturing in Massachusetts 2012*, Dukakis Center for Urban and Regional Policy, September 2012, Table 1.10, p. 32 based on data from the U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages.

68. "Avoiding Blank Checks: Creating Fiscally Sound State Tax Incentives, Pew Center on the States, December 2012, Table 1, p. 5 and p. 14.