

# Federal R&D Funding in Boston

City's Intellectual Capital Yields Large Economic Benefits



THOMAS M. MENINO, *MAYOR*  
CITY OF BOSTON

Boston Redevelopment Authority  
Mark Maloney, *Director*

Clarence J. Jones, *Chairman*  
Consuelo Gonzales Thornell, *Treasurer*  
Joseph W. Nigro, Jr., *Co-Vice Chairman*  
Michael Taylor, *Co-Vice Chairman*  
Christopher J. Supple, *Member*  
Harry R. Collings, *Secretary*

Report prepared by  
Herbert Butler  
Dominic Modicamore  
Jim Vrabel  
Robert W. Consalvo

Policy Development and Research  
Robert W. Consalvo, *Director*

Report #557  
May 2002

## Table of Contents

Executive Summary.....	1
Major findings.....	2
Issues Facing Boston and Massachusetts.....	4
Conclusions.....	5
Federal R&D Funding in Boston.....	7
Introduction and Background.....	7
Definitions of R&D.....	7
Boston as a National Leader.....	9
Sources of Boston's Federal R&D Funding.....	11
Comparison of Boston and Massachusetts Federal R&D Funding.....	12
Boston's R&D Funds Recipients by Type of Institution.....	14
Medical Institutions.....	14
Institutions of Higher Education.....	16
Businesses.....	17
Other Institutions.....	17
Top Boston Recipients of R&D Funding by Awarding Agency.....	18
Health and Human Services.....	18
Department of Defense.....	19
National Science Foundation.....	20
Department of Veterans Affairs.....	20
Economic Impact.....	21
Issues Facing Boston and Massachusetts.....	23
Summary and Conclusions.....	28
Appendix A1 and A2.....	30
End Notes.....	31

## List of Tables

Table 1. Definitions of R&D .....	8
Table 2. Definitions of Funding for R&D Equipment and Facilities .....	9
Table 3. States Ranked by Amount of Federal R&D Funds Received.....	10
Table 4. Federal Agencies which Awarded R&D Funding to Boston and Massachusetts .....	12
Table 5. Total R&D Funding for Medical Institutions.....	15
Table 6. R&D Funding for Institutions of Higher Education .....	16
Table 7. Total R&D Funding for Businesses .....	17
Table 8. Top Recipients of RD Funding from Health and Human Services .....	18
Table 9. Largest Recipients of Department of Defense Funding.....	19
Table 10. Largest Recipients of National Science Foundation R&D Funding .....	20
Table 11. Partitioning of Federal R&D Funding in Boston .....	21
Table 12. Economic Impact of Federal R&D Spending in Boston and the Metro Area.....	21

---

## List of Figures

Figure 1. Percent of R&D Funds Distributed by Awarding Agency (1999) to the City of Boston and Massachusetts (1998).....	13
Figure 2. Percent of R&D Funds Awarded by Institution Type .....	14

# Federal R&D Funding in Boston

*City's Intellectual Capital Yields Large Economic Benefits*

## Executive Summary

Federal funding for Research and Development (R&D) has long been recognized as vitally important to Boston's economy. The city's world class hospitals and universities, and even its private businesses receive significant amounts of federal R&D funding annually. This report is the first complete and comprehensive look at federal R&D funding in Boston, including both the federal agencies which provide the funds and the institutions and firms in the city which are recipients of this funding.

This analysis is possible because of a new database of federal R&D awards called RaDiUS (Research and Development in the United States) developed by RAND; its companion publication entitled *Discovery and Innovation: Federal Research and Development Activities in the Fifty States, District of Columbia, and Puerto Rico*; and the National Institutes of Health (NIH) Website. The RaDiUS database for Boston consists of fiscal year 1999 data. Some additional data on the national level for FY 1998, the most recent national data available, were also used in this report.

R&D consists of three types of activities – basic research, applied research, and development as shown in the table below. R&D funds in these three areas are given as grants, contracts, or cooperative agreements and are used to cover the salaries of workers and other operating costs of R&D activities. R&D funding is also used for the acquisition of major R&D equipment and for the construction and rehabilitation of R&D facilities.

<b>Definitions of R&amp;D</b>		
<b>Types of R&amp;D Funded</b>	<b>Basic Research</b>	study directed toward knowledge or understanding of phenomena and facts without specific applications in mind
	<b>Applied Research</b>	study to gain knowledge or understanding by which a recognized and specific need may be met.
	<b>Development</b>	application of knowledge to create a product designed to meet specific requirements.

## Major Findings

A summary of the major findings about the amounts of R&D awards in Boston and the state, the awarding agencies, and the recipients in the city of Boston follows.

- Boston and the Commonwealth of Massachusetts are highly successful in the competition for R&D funds because of its large educated workforce and the presence of numerous world-class medical and educational institutions and entrepreneurial businesses.
- Massachusetts received more than \$3.6 billion of the \$75 billion in federal R&D funds that were awarded nationally and ranked sixth in the nation (FY 1998.)
- Boston received nearly \$1.1 billion in R&D funding— almost one-third of all the federal R&D funding in the state (FY 1999.)
- Boston ranked higher than all but eighteen of the nation's states in terms of total R&D funding; and the city received 20% of all federal R&D funding awarded to New England.
- Seventeen federal agencies awarded R&D funds to Boston and Massachusetts. The amounts awarded by these federal agencies to the city and the state are shown below.

<b>Federal Agencies which Award R&amp;D Funding to Boston and Massachusetts</b>		
<b>Awarding Agencies</b>	<b>Amount of R&amp;D Funding Provided to Boston</b>	<b>Amount of R&amp;D Funding Provided to Massachusetts</b>
Health and Human Services (HHS)	\$952,492,220	1,037,391,000
Department of Defense (DOD)	63,737,720	1,909,784,000
National Science Foundation (NSF)	23,540,166	177,423,000
Department of Veterans Affairs (DVA)	22,472,924	N/A
Department of Energy (DOE)	7,488,365	107,677,000
National Aeronautics and Space Adm. (NASA)	7,104,010	150,346,000
Department of Education (DED)	5,985,156	N/A
Department of Justice (DOJ)	2,021,643	N/A
Department of Commerce (DOC)	817,950	50,102,000
Department of Agriculture (USDA)	809,711	24,666,000
Department of Transportation (DOT)	548,852	55,529,000
Small Business Adm. (SBA)	362,000	N/A
Environmental Protection Agency (EPA)	325,000	20,901,000
Nuclear Regulatory Commission (NRC)	256,000	N/A
Department of Labor (DOL)	234,951	N/A
Department of the Interior (DOI)	40,000	6,762,000
Housing and Urban Development (HUD)	31,103	N/A
All Other	-----	70,268,000
<b>Total</b>	<b>\$1,088,267,771</b>	<b>3,610,848,000</b>

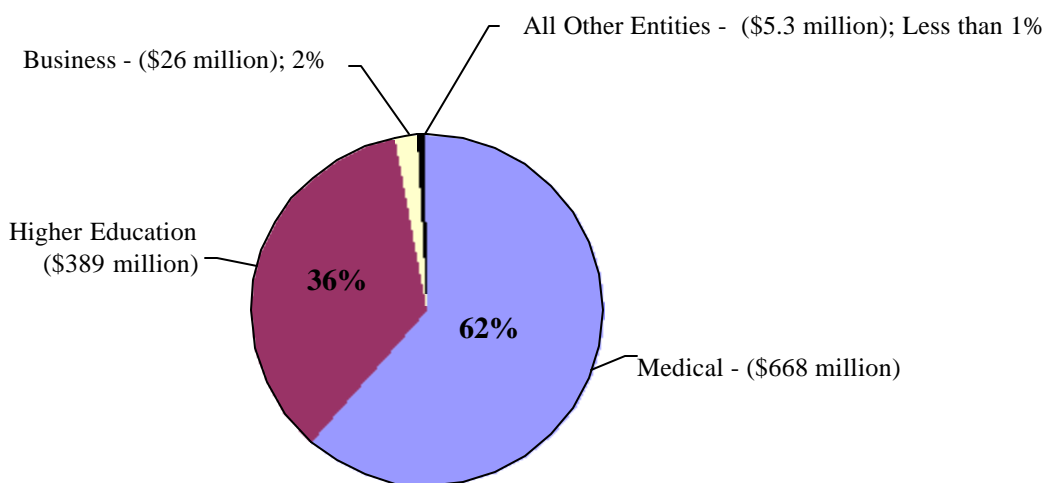
\*\*N/A refers to totals for smaller agencies that were not available for this report. The totals for N/A are included in the total for All Other

- The U.S. Department of Health and Human Services was by far the largest funder to Boston, providing approximately over \$952 million of the city's \$1.1 billion. Almost all of that amount (\$946 million) came directly from the National Institutes of Health.
- The next most significant amounts came from the Department of Defense - nearly \$64 million, the National Science Foundation - nearly \$24 million, and the Department of Veteran's Affairs - more than \$22 million.

- Nearly all of Boston's \$1.1 billion in federal R&D funding was awarded to the city's prestigious research institutions: \$668 million - or 62% - was directed to the city's hospitals and medical research facilities; and \$389 million - or 36% - was awarded to Boston's institutions of higher education, which include the colleges and universities, graduate schools, and medical and dental schools in the city.
- Private businesses in Boston received nearly \$26 million - or 2% - of the city's federal R&D funding. While non-profit, governmental and unspecified entities (classified as "other") combined for a little over \$5 million - or the remaining 1% of all R&D funding received by Boston.

---

#### Percent of R&D Funds Awarded by Institution Type

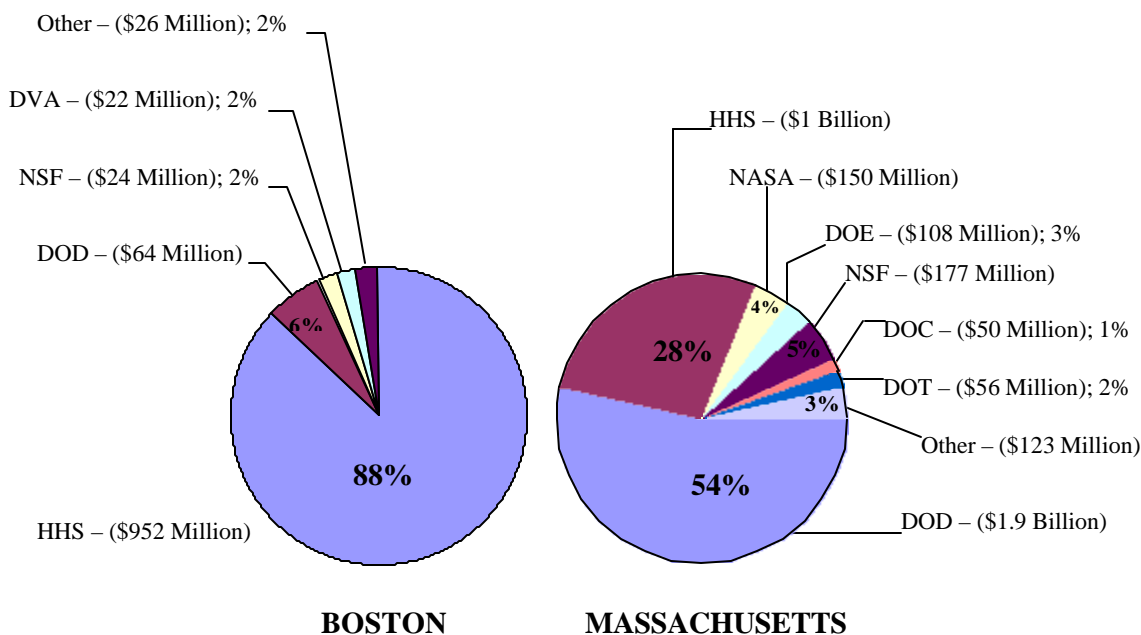


- 
- Massachusetts General Hospital was the number one recipient among all of the city's institutions with close to \$158 million in R&D support, followed by Brigham and Women's Hospital with a little over \$151 million in funding. In addition, General Hospital Corporation, which oversees funds for both of these hospitals, received almost \$22 million, making the combined total of over \$386 million for both hospitals and the corporation almost half of all the R&D funds received by Boston's hospitals.
  - Among the colleges and universities, Harvard University, which has its Medical School, School of Public Health and School of Dentistry located in Boston, topped the list with more than \$187 million, followed by Boston University with close to \$134 million. Tufts University (\$37 million) and Northeastern University (\$22 million) were two other institutions awarded a significant amount of R&D funds.
  - Stone and Webster Engineering was the biggest beneficiary of R&D funding among private firms. (Stone and Webster Engineering Co. was bought by the Shaw Group of Baton Rouge, LA after Stone and Webster Co. filed for bankruptcy in May of 2000.) Microoptical Corporation, Molecular Geodesics, and ABT Associates round out the top four with approximately \$2.1 million, \$1.2 million, and \$1 million respectively.
  - Boston received nearly all of its funding from the Department of Health and Human Services (88%), and most of that from the National Institutes of Health. The Department

of Defense accounted for 6% of Boston's total funding, while the National Science Foundation and Veterans Affairs each awarded about 2% of the total R&D funds received in Boston.

---

**Percentage of R&D funds Distributed by Awarding Agency to the City of Boston (1999)  
and Massachusetts (1998)**



- Massachusetts, on the other hand, received the majority of its federal R&D funding from the Department of Defense (54%). Health and Human Services was the next highest funding source at 28%, followed by the National Science Foundation (5%), the National Aeronautics and Space Administration (4%), the Department of Energy (3%), the Department of Transportation (2%), and the Department of Commerce (1%). Other agencies awarded a combined 3.5%.
- Boston's \$1.1 billion R&D funding resulted in substantial economic impact in the city and region. In Boston alone, federal R&D spending was responsible for generating 18,030 jobs and increasing the Gross Regional Product by \$842 million. When the suburban counties are considered, federal R&D spending accounts for an additional 2,310 jobs bringing the total number of jobs created to 20,340 in Boston and the metro region. Similarly, an additional \$128 million is generated in the suburban counties, bringing the total impact on the Gross Regional Product to more than \$970 million.

### **Issues Facing Boston and Massachusetts**

There are current and significant issues regarding Boston's and the state's ability to maintain its standing as leaders in higher education and research. These are summarized below.

- In its September 2000 report on NIH funding, the BRA noted that while Boston's level of funding increased in FY 1999, its percentage increase ranked third, behind San Diego and Philadelphia, as these and other cities become more competitive, particularly in the South and the West, and as they begin to recognize the value of this research as economic engines for themselves and their regions.
- The successes of the Boston-area medical research complex have caught the attention of politicians from other states which get less, who consider the funding process unfair, and who are threatening to change the funding allocations.
- New England's dominance of the higher education market is fading as the region is losing its share of research funding and college enrollment while the region's population of college-age youth is also declining. With New England's economy so dependent on higher education, any decline in investment will be felt in the economic decline of New England.
- The state's (and region's) public universities are not recognized among the ranks of the top research universities in the country and the recent cuts to the UMASS budget will only set the state's university system, and more particularly UMASS Amherst, further behind in its quest for greatness.
- Massachusetts was ranked dead last out of the 50 states in the change in FY 2002 appropriations for higher education from the previous year. While the average for the 50 states was a 4.6% increase, Massachusetts registered a 6.2% decrease, joining only Florida, Nebraska, Mississippi, and Iowa as states with declining funding this year. The two year change found Massachusetts in the 49<sup>th</sup> position with a total decrease of 2.9%. Only Mississippi was lower.
- In contrast to Massachusetts, other states are investing in their public institutions, and, in some specifically to strengthen their research capabilities. For example, Texas has established two new research funds projected to be worth \$100 million in 15 years; Kentucky, which is spending \$230 million to help public institutions attract top scholars; and California, which plans to spend \$225 million over the next three years on collaborative research involving the state higher education system and private industry.
- On the positive side, it will take many years for the city and state to lose their top ranking because of the presence of our formidable institutions. But, little by little, other parts of the country are catching on to the importance of intellectual capital in the new world economy and they are making headway by investing in their public universities and promoting research.

## **Conclusions**

Boston is a national leader in the quest for innovation in health care, cutting edge biomedical research, and the development of new technologies as shown by the significant amount of federal R&D funding awarded to institutions and businesses in the city. Boston's world renowned hospitals, research laboratories, and colleges and universities attract the intellectual capital that is the hallmark of this city and which gives Boston its competitive advantage in the global marketplace of research and ideas.

Federal R&D funding forms the foundation of the significant research undertaken in Boston's medical and higher education institutions and private businesses. The city attracts so



much funding that if Boston were a state, it would be ranked 19<sup>th</sup> in the nation in federal R&D funding. Just as Boston serves as the economic engine for the state and regional economy, so too does the research undertaken in Boston's institutions and businesses serve as the heart of the R&D undertaken in Massachusetts and the region.

The Boston Redevelopment Authority (BRA) seeks to nurture these hospitals and schools, which are so important to Boston's economy. Between 1991 and 2000, the BRA has facilitated the new or renovated development of 16 research buildings, comprising almost two million square feet of R&D space. Currently there are eight more projects with 3.2 million feet of new research space in the pipeline, either under construction or being planned.

Boston and Massachusetts, however, can no longer take for granted their standing in higher education, health care, and research. The warning signs are visible. Other cities and states are beginning to recognize the importance of using intellectual capital as an economic development strategy and are beginning to garner larger shares of the research dollars available, or are investing in their own public institutions to increase their research capabilities. Persons elected to Congress are more aware of the disparity in federal R&D funding directed to Boston and the state vs. the areas they represent. This awareness could evolve into a movement to divide the federal R&D pot differently.

The good news is that Massachusetts and Boston are still number one. The bad news is that other regions, states, and cities have recognized the importance of this funding and are stepping up the competition at a time when Massachusetts is stepping back by disinvesting in higher education and health care – two of the most important industries that help form and attract the intellectual capital that makes the Boston and the state so successful. Our state and region must become more competitive than the states and regions which are trying to catch up to us. We must shake off any complacency and proactively work to remain in our leadership role. To do so, the support of a strong public higher education system with leading researchers and topmost research capabilities and the backing of a vigorous health care industry with top quality teaching and research hospitals are essential to the long term health of this region.

## **Federal R&D Funding in Boston** *City's Intellectual Capital Yields Large Economic Benefits*

### **Introduction and Background**

The federal research and development (R&D) funding received by Boston's various public and private institutions, non-profit agencies and businesses has been recognized as vitally important to the city's economy. Until recently, however, information on the amount of funding received and a breakdown by recipients has only been available from one of the federal agencies, the National Institutes of Health (NIH). While NIH funding is substantial (Boston has led the nation's cities in NIH funds received every year since 1994), a significant amount of federal R&D funding also comes to Boston from other sources.

This report utilizes a new database of federal R&D awards in Fiscal Year (FY) 1999 called RaDiUS (Research and Development in the United States)<sup>1,2</sup> developed by RAND, its companion publication entitled *Discovery and Innovation: Federal Research and Development Activities in the Fifty States, District of Columbia, and Puerto Rico*<sup>3</sup>, as well as the NIH Website<sup>4</sup> for fiscal year 1999 to present the first complete and comprehensive look at the federal R&D funding to Boston and a listing of recipients among the city's medical and higher educational institutions, businesses and other institutions.

**Definitions of R&D.** This report adopts the definitions used by the RaDiUS database for the three types of activities supported by federal R&D funding – basic research, applied research, and development as cited in the *Discovery and Innovation* book referenced above (See Table 1).

*Basic research* is a systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind. Basic research is often used in the

beginning stages of a project or research activity to build a foundation for further research. It is commonly used to gather facts that will be used in future research. An example of basic

**Table 1 - Definitions of R&D**

<b>Types of R&amp;D Funded</b>	<b>Basic Research</b>	study directed toward knowledge or understanding of phenomena and facts without specific applications in mind
	<b>Applied Research</b>	study to gain knowledge or understanding by which a recognized and specific need may be met.
	<b>Development</b>	application of knowledge to create a product designed to meet specific requirements.

research conducted in Boston during FY 1999 identified by RaDiUS was an integrated approach to the detection, localization, and classification of land mines. The Department of Defense funded this research, conducted at Northeastern University.

*Applied research* is a systematic study to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met. Applied research is used when a specific goal for a project or research activity is defined. An example of applied research in Boston was a study conducted at the University of Massachusetts-Boston, funded by the National Science Foundation (NSF) on the genetic variations among deep-sea mollusks. Previous research had been conducted on this subject, but researchers wanted to expand that research in an attempt to explain how oceanographic elements affect different kinds of mollusks. The specific need of the project was to identify geographic variation among the mollusks.

*Development* is a systematic application of knowledge toward the production of useful materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements. For example, Health and

Human Services awarded a project grant to Genitrix, LLC, to create a prototype molecule that will help in the creation and testing of a tumor vaccine on mice.

R&D funds are given as grants, contracts, or cooperative agreements and are used to cover the operating costs of R&D activity and the salaries of R&D workers. R&D funding is also used for equipment and facilities as defined in *Discovery and Innovation* and shown in Table 2. The funds may provide the money necessary to purchase new equipment or to build or upgrade facilities necessary to conduct the R&D being funded.

**Table 2 - Definitions of Funding for R&D Equipment and Facilities**

<b>R&amp;D Equipment</b>	The acquisition of major equipment for R&D. Includes expendable or movable equipment (e.g., spectrometers, microscopes) and specialized furniture and equipment. Routine purchases of ordinary office equipment or furniture and fixtures are normally excluded.
<b>R&amp;D Facilities</b>	The Construction and rehabilitation of R&D facilities. Includes the acquisition, design, and construction of, or major repairs or alterations to all physical facilities for use in R&D activities. Facilities include land, buildings, and fixed capital equipment, regardless of whether the facilities are to be used by the government or by a private organization, and regardless of where title to the property may rest. Includes such fixed facilities as reactors, wind tunnels, and particle reactors. Excludes movable R&D equipment.

### **Boston as a National Leader**

States and municipalities throughout the nation aggressively compete for federal R&D funding because of the important role it plays in creating jobs and boosting local economies. The Commonwealth of Massachusetts and the City of Boston are particularly successful in this competition, owing to the state's educated workforce and presence of numerous world-class medical and educational institutions and entrepreneurial businesses in the city.

During FY 1998, (the last year for which national data were available at the time this report was being written) a total of \$75,257,357,000 in federal R&D funds were awarded nationally.

**Table 3 – States Ranked by Amount of Federal R&D Funds Received**

<b>Rank</b>	<b>States (Including District of Columbia and Puerto Rico)</b>	<b>Total Federal R&amp;D Funds Received</b>	
1	California	\$14,420,247,000	
2	Maryland	8,078,434,000	
3	Virginia	4,592,915,000	
4	Georgia	4,428,750,000	
5	Texas	4,021,787,000	
<b>6</b>	<b>MASSACHUSETTS</b>	<b>3,610,561,000</b>	<b>Massachusetts (Total)</b>
7	Florida	3,173,704,000	<b>(\$3,610,561,000)</b>
8	New York	2,937,583,000	
9	Ohio	2,738,664,000	
10	District of Columbia	2,688,207,000	<b>MA without Boston</b>
11	Alabama	2,354,882,000	<b>(\$2,522,293,229)</b>
12	Pennsylvania	2,347,373,000	
13	New Mexico	2,307,407,000	
14	New Jersey	1,522,965,000	
15	Missouri	1,441,134,000	
16	Colorado	1,422,667,000	
17	Illinois	1,366,250,000	
18	Washington	1,254,429,000	<b>BOSTON</b>
19	North Carolina	922,825,000	<b>(\$1,088,267,771)</b>
20	Arizona	861,820,000	
21	Michigan	827,266,000	
22	Connecticut	819,497,000	
23	Tennessee	707,965,000	
24	Minnesota	652,853,000	
25	Rhode Island	515,347,000	
26	Indiana	474,974,000	
27	Nevada	380,036,000	
28	Utah	376,776,000	
29	Wisconsin	375,793,000	
30	Mississippi	321,814,000	
31	Oregon	320,120,000	
32	Idaho	273,549,000	
33	New Hampshire	270,182,000	
34	West Virginia	260,775,000	
35	Iowa	251,820,000	
36	Louisiana	244,331,000	
37	Hawaii	223,150,000	
38	South Carolina	204,764,000	
39	Kansas	165,404,000	
40	Oklahoma	164,666,000	
41	Alaska	134,847,000	
42	Arkansas	119,595,000	
43	Kentucky	112,498,000	
44	Nebraska	93,019,000	
45	Montana	79,650,000	
46	Maine	78,985,000	
47	Delaware	59,811,000	
48	Puerto Rico	58,810,000	
49	North Dakota	58,242,000	
50	Vermont	58,114,000	
51	Wyoming	40,783,000	
52	South Dakota	39,317,000	
-----	<b>TOTAL</b>	<b>\$75,257,357,000</b>	

Massachusetts ranked sixth among the fifty states, Puerto Rico, and District of Columbia in terms of the amount of R&D funding with \$3.6 billion, two-thirds of the \$5.4 billion in federal R&D funds received by all of the New England states. Connecticut received the second most among New England's states, \$819 million. Table 3 ranks federal FY 1998 R&D funding for the fifty states, Puerto Rico and District of Columbia.

Nearly \$1.1 billion (\$1,088,267,771) – nearly one-third of the federal R&D funding received by Massachusetts – was directed to institutions and firms in Boston. And Boston received 20% of all federal R&D funding awarded to New England. Indeed, as shown in Table 3, the City of Boston would rank higher than all but eighteen of the nation's states in terms of total R&D funding if treated separately, and Massachusetts would fall from sixth to tenth place in the nation without Boston.

### **Sources of Boston's Federal R&D Funding**

The U.S. Department of Health and Human Services (HHS) is by far the largest source of R&D funding to Boston, providing approximately nearly \$1 billion (\$952,492,220) during FY 1999. Almost all of that amount (\$946,634,087) came directly from the National Institutes of Health (NIH). But sixteen other agencies also provide significant federal R&D funds to public and private institutions in Boston. The Department of Defense (DOD) provided nearly \$64 million (\$63,737,720), the National Science Foundation (NSF) nearly \$24 million (\$23,540,166), and the Department of Veteran's Affairs (DVA) more than \$22 million (\$22,472,924).

Table 4 provides the complete list of those agencies and Figure 2 illustrates the percentage of federal R&D funding by awarding agency to Boston (FY 1999) and to Massachusetts (FY 1998).<sup>5</sup>

**Table 4 – Federal Agencies which Award R&D Funding to Boston and Massachusetts**

<b>Awarding Agencies</b>	<b>Amounts of R&amp;D Funding Provided to Boston</b>	<b>Amounts of R&amp;D Funding Provided to Massachusetts</b>
Health and Human Services (HHS)	\$952,492,220 *	1,037,391,000
Department of Defense (DOD)	63,737,720	1,909,784,000
National Science Foundation (NSF)	23,540,166	177,423,000
Department of Veterans Affairs (DVA)	22,472,924	N/A
Department of Energy (DOE)	7,488,365	107,677,000
National Aeronautics and Space Adm. (NASA)	7,104,010	150,346,000
Department of Education (DED)	5,985,156	N/A
Department of Justice (DOJ)	2,021,643	N/A
Department of Commerce (DOC)	817,950	50,102,000
Department of Agriculture (USDA)	809,711	24,666,000
Department of Transportation (DOT)	548,852	55,529,000
Small Business Adm. (SBA)	362,000	N/A
Environmental Protection Agency (EPA)	325,000	20,901,000
Nuclear Regulatory Commission (NRC)	256,000	N/A
Department of Labor (DOL)	234,951	N/A
Department of the Interior (DOI)	40,000	6,762,000
Housing and Urban Development (HUD)	31,103	N/A
All Other	-----	70,268,000
<b>Total</b>	<b>\$1,088,267,771</b>	<b>3,610,848,000</b>

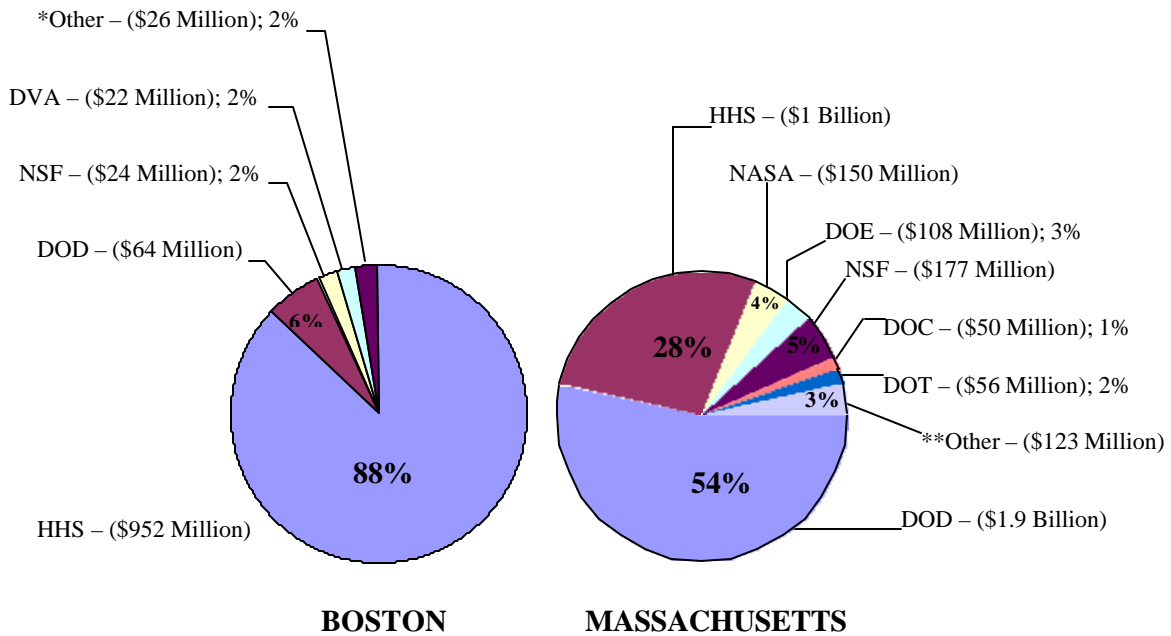
\*This total was obtained using data from the National Institutes of Health (NIH) web site at [www.nih.gov](http://www.nih.gov) and other non-NIH data from the RaDiUS Database. All other amounts are calculated from the RaDiUS Database.

\*\*N/A refers to totals for smaller agencies that were not available for this report. The totals for N/A are included in the total for All Other.

### **Comparison of Boston and Massachusetts Federal R&D Funding**

While Boston is among the leading cities and Massachusetts among the leading states in attracting federal R&D funding, the source of their funding differs. Figure 1 reveals that Boston received nearly all of its funding from the U.S. Department of Health and Human Services (88%), most of it from the National Institutes of Health. The Department of Defense accounted for 6% of Boston's total funding, while the National Science Foundation and the Department of Veterans Affairs each awarded about 2% of the total R&D funds received in Boston.

**Figure 1 – Percentage of R&D funds Distributed by Awarding Agency to the City of Boston (1999) and Massachusetts (1998)**



\*2% of total R&D funding for Boston includes money from these agencies---DOE, NASA, DED, DOJ, EPA, USDA, DOC, DOT, SBA, NRC, DOL, DOI, & HUD.

\*\*3% of the total R&D funding for Massachusetts includes USDA, DOI, DOT, EPA, DVA, DOC, etc.

Massachusetts, on the other hand, received the majority of its federal R&D funding from the U.S. Department of Defense (54%). The U.S. Department of Health and Human Services was the next highest funding source at 28%, followed by the National Science Foundation (5%), the National Aeronautics and Space Administration (4%), the Department of Energy (3%), the Department of Transportation (2%) and the Department of Commerce (1%). Other agencies awarded a combined 3.5%.

Boston received nearly all of federal R&D funding from the U.S. Department of Health and Human Services that was awarded to Massachusetts. Boston's colleges and universities received over half (56%) of the total R&D funds awarded to Massachusetts higher educational institutions, or about \$392 million of the total of \$703 million awarded to the state.<sup>6</sup>

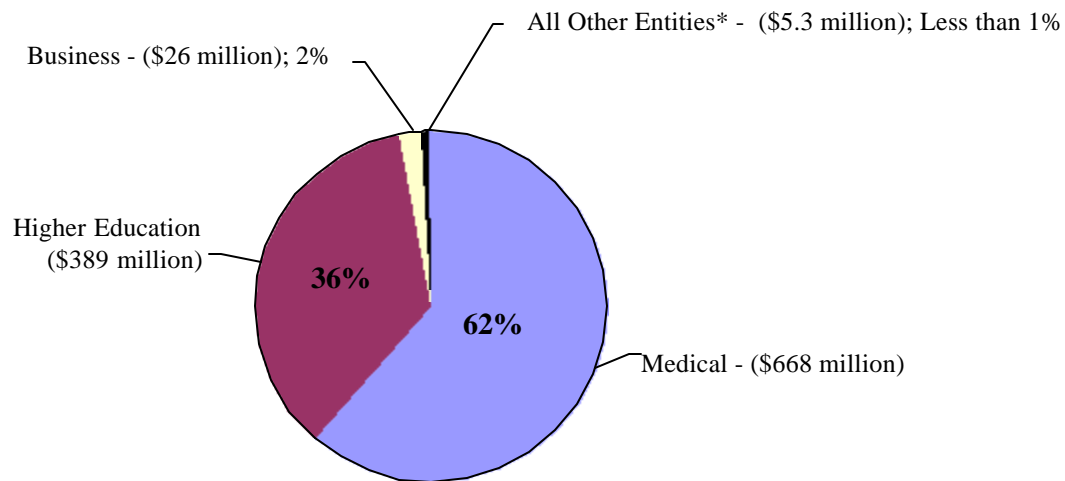


### **Boston's R&D Fund Recipients by Type of Institution**

Of the nearly \$1.1 billion in federal R&D funding was awarded to institutions and private firms in Boston in 1999, \$668,294,428 - or 62% - were directed to the city's hospitals and medical research facilities. Another \$388,833,364 - or 36% - of these R&D dollars were awarded to Boston's institutions of higher education, which include colleges and universities, graduate schools, medical, and dental schools.

Private businesses received \$25,823,735 - or 2% - in Federal R&D funding. Non-profit, governmental and unspecified entities (classified as "Other") combined for \$5,316,244 - or the remaining 1% - of all R&D funding received by Boston.

**Figure 2 – Percent of R&D Funds Awarded by Institution Type**



\* All Other Entities refers to various agencies that were categorized as "unspecified", "governmental," or "non-profit."

**Medical Institutions.** Some of the R&D activities included in Boston's medical sector involved research into disease prevention, medical procedures, drug trials, and genetic studies. For example, RaDiUS noted that Brigham and Women's Hospital received funding for a project that identified possible causes of ovarian cancer. Boston Medical Center conducted a study to determine how *Salmonella* circumvents the host immune system and causes disease, and

another study, conducted at Massachusetts General Hospital, examined the cell biology of the neurohypophyseal hormone, vasopressin, which plays a major role in the regulation of salt and water balance through its action on the kidney. All of these studies were awarded by the Department of Health and Human Services.

Table 5 shows the amount of R&D funding received by the city's medical institutions. Massachusetts General Hospital was the leading recipient with close to \$160 million in R&D support followed by Brigham and Women's Hospital with a little over \$151 million in funds. In addition, General Hospital Corporation, which oversees funds for both of these hospitals received almost \$22 million, making the combined total for both hospitals and the corporation \$386,191,113, almost half of all the R&D funds received by Boston's medical institutions.

**Table 5 – Total R&D Funding for Medical Institutions**

<b>Institution</b>	<b>Total Funding</b>
Massachusetts General Hospital	\$159,807,786
Brigham and Women's Hospital	151,046,608
Beth Israel Deaconess	75,336,719
Dana Farber Cancer Institute	68,231,401
Children's Hospital Boston	49,609,716
New England Medical Center	25,640,070
VA Medical Center	22,213,924
General Hospital Corporation*	21,880,473
Boston Medical Center	18,373,400
Center for Blood Research	17,633,231
Joslin Diabetes Center	14,150,847
Other	44,370,253
<b>All Medical Institutions</b>	<b>\$668,294,428</b>

\*Note: General Hospital Corporation oversees funds for both Mass. General Hospital and Brigham and Women's.

Beth Israel Deaconess, Dana Farber Cancer Institute, and Children's Hospital Boston were the other major recipients of R&D funding. Their totals ranged from nearly \$50 million for Children's Hospital Boston to \$75 million for Beth Israel Deaconess. New England Medical Center, VA Medical Center, Boston Medical Center, Center for Blood Research, and Joslin

Diabetes Center were others receiving a significant amount of funding, which ranged from \$14 million for Joslin Diabetes Center to \$26 million for New England Medical Center.

**Institutions of Higher Education.** Boston's many higher educational institutions also drew substantial R&D funding to the city<sup>7</sup>, much of it for medical studies. One example is a grant received by Northeastern University to study the effects of tobacco use. Tufts University received an NIH grant to research how Vitamin A levels affect the overall health of the elderly. Harvard Medical School was awarded funding from NIH to study how cocaine addiction damages the brain.

Table 6 identifies the amount of R&D funds received by the city's institutions of higher education. Harvard University, which has its Medical School, School of Public Health and School of Dentistry located in Boston, topped the list with more than \$187 million received during FY 1999, followed by Boston University with close to \$134 million. Tufts University and Northeastern University are two other institutions that were awarded a significant amount of R&D funds.

**Table 6 – R&D Funding for Institutions of Higher Education**

<b>Institution</b>	<b>Total Funding</b>
Harvard University*	\$187,331,132
Boston University	133,843,780
Tufts University**	37,455,771
Northeastern University	22,204,632
Boston College	3,469,771
UMASS Boston	2,364,999
New England College of Optometry	1,087,596
Simmons College	552,859
Wentworth Institute of Technology	406,000
New England Conservatory of Music	116,824
<b>All Institutions of Higher Education</b>	<b>\$388,833,364</b>

\*Harvard University refers to Harvard Medical School, School of Public Health, & School of Dentistry all located in Boston, MA.

\*\*Tufts University refers to Tufts School of Medicine, School of Veterinary Medicine, and other Tufts University facilities located in Boston, MA.

**Businesses.** Boston's private sector also attracts federal R&D funding. For example, the Teragram Corporation engaged in a project, funded by the National Science Foundation, that researched information retrieval and natural language processing to locate within free text the precise answers to direct English questions, without relying on the traditional and unnatural search methods of keywords and Boolean search strings. Microoptical Corporation conducted advanced development of electronics and communication equipment for the Department of Defense.

Table 7 identifies the amount of R&D funding received by the city's private sector. Stone and Webster Engineering was the biggest beneficiary of R&D funding during FY 1999 with nearly \$16 million. Microoptical Corporation, Molecular Geodesics, and ABT Associates round out the top four with approximately \$2.1 million, \$1.2 million, and \$1 million respectively.

**Table 7 – Total R&D Funding for Businesses**

<b>Businesses</b>	<b>Total Funding</b>
Stone and Webster Engineering*	\$15,577,000
Microoptical Corp.	2,090,000
Molecular Geodesics/Tensegra Inc.**	1,239,000
ABT Associates***	1,012,443
Other	5,975,292
<b>All Businesses</b>	<b>\$25,823,735</b>

\*Stone and Webster Engineering Co. was bought by the Shaw Group of Baton Rouge, LA after Stone and Webster Co. filed for bankruptcy in May of 2000. The firm still has a presence in Boston.

\*\*Moved outside of Boston and presently out of business.

\*\*\*Refers to R&D activity conducted within Boston according to ABT Associates.

**Other Institutions.** In addition to the medical and educational institutions and businesses that receive R&D funds are institutions classified as "Other" - including those listed as non-profit, governmental, and unspecified. These "Other" classifications combined made up about 1% of the total R&D funding received by Boston during FY 1999 - a total of \$5,316,244.

### **Top Boston Recipients of R&D Funding by Awarding Agency**

**Health and Human Services.** The U.S. Department of Health and Human Services funded Boston projects in various fields. One example was a study conducted at the Massachusetts Mental Health Center to clinically assess the ability to detect genes related to schizophrenia. Another example was a study conducted at Brigham and Women's to examine how properly timed exposure to bright light and darkness can rapidly reset the human circadian pacemaker to allow individuals to adapt to changing work schedules.

Table 8 shows the top Boston recipients of R&D funding from the U.S. Department of Health and Human Services during FY 1999. Harvard University (\$187 million) tops the list,

**Table 8 – Top Recipients of R&D Funding from Health and Human Services**

<b>Institution</b>	<b>Total Funding</b>
Harvard University*	\$187,331,132
Massachusetts General Hospital	157,860,012
Brigham and Women's Hospital	146,817,548
Boston University	104,546,198
Beth Israel Deaconess Hospital	72,833,298
Children's Hospital Boston	66,914,839
Dana Farber Cancer Institute	47,474,202
Tufts University	37,455,771
New England Medical Center	25,640,070
Boston Medical Center	18,373,400
Joslin Diabetes Center	14,150,847
Other	73,094,903
<b>Total for All Institutions**</b>	<b>\$952,492,220</b>

\*\*This total was obtained using data from the National Institutes of Health (NIH) Website at [www.nih.gov](http://www.nih.gov) and other non-NIH data from the RaDiUS Database. All other amounts are calculated from the RaDiUS Database.

\*Harvard University refers to Harvard Medical School, School of Public Health, & School of Dentistry all located in Boston, MA.

followed by Massachusetts General Hospital (\$158 million), Brigham and Women's Hospital (\$147 million), Boston University (\$105 million) and Beth Israel Deaconess (\$73 million). Together, these institutions accounted for 70% of all the R&D funds awarded by Health and Human Services to Boston. Dana Farber Cancer Institute (\$47 million), Children's Hospital

Boston (\$67 million), Tufts University (\$37 million), New England Medical Center (\$26 million), Boston Medical Center (\$18 million), and Joslin Diabetes Center (\$14 million) also received significant funding from Health and Human Services.

**Department of Defense.** The U.S. Department of Defense funds a variety of computer development, telecommunications, and military medical research in Boston. One study at Boston University examined the neuro-psychological functioning in Persian Gulf Veterans. Another study at the Dana Farber Cancer Institute examined estrogen signaling in breast cancer. Researchers developed a biological specimen bank to enhance population-based studies of inherited breast cancer genes.

Table 9 shows the largest recipients of R&D funding from the Department of Defense, with the General Hospital Corporation (approximately \$22 million) and Stone and Webster Engineering Co. (\$15 million) receiving the majority (57%) of DOD funding in Boston. They were followed by Boston University (\$9 million), Northeastern University (\$4.5 million), Brigham and Women's Hospital (\$2.5 million), and Tufts University (\$2 million).

**Table 9 – Largest Recipients of Department of Defense Funding**

<b>Institution</b>	<b>Total Funding</b>
General Hospital Corporation*	\$21,880,473
Stone and Webster Engineering**	15,321,000
Boston University	8,974,220
Northeastern University	4,550,522
Brigham and Women's Hospital	2,545,839
Tufts University	2,350,616
Other	8,115,050
<b>Total for All Institutions</b>	<b>\$63,737,720</b>

\*General Hospital Corporation Oversees funding for both Mass.

General Hospital and Brigham and Women's Hospital

\*\*Stone and Webster Engineering Co. was bought by the Shaw Group of Baton Rouge, LA after Stone and Webster Co. filed for bankruptcy in May of 2000. The firm still has a presence in Boston.

**National Science Foundation.** Scientific research in Boston funded by the National Science Foundation included genetic studies, meteorology, and life sciences. For example, NSF funded studies at Boston University on the human impact upon the rainforests of Borneo. Another study conducted at Northeastern University examined the effects of the sun's ultra-violet rays upon Antarctic marine life.

Most of the R&D funding from the National Science Foundation went to the city's colleges and universities. Northeastern University was the top recipient of NSF funds with approximately \$12 million. Boston University was second on the list with \$9 million, followed by Massachusetts General Hospital (\$1 million), Teragram Corporation, (\$400,000), and UMASS Boston (nearly \$350,000). Five institutions divided the remaining \$700,000 in NSF funds.

**Table 10 – Largest Recipients of National Science Foundation R&D Funding**

<b>Institution</b>	<b>Total Funding</b>
Northeastern University	\$11,729,393
Boston University	9,451,960
Massachusetts General Hospital	915,442
Teragram Corporation	399,700
UMASS Boston	347,934
Other	695,737
<b>Total for All Institutions</b>	<b>\$23,540,166</b>

**Department of Veterans Affairs.** The Department of Veterans Affairs funded research projects that included studies to benefit health care for veterans. For example, Boston's V.A. Medical Center received R&D funding to evaluate alcohol consumption as a potential risk factor for the development of cardiovascular diseases. Another project at the V.A. Medical Center examined post-traumatic stress disorder in Vietnam veterans.

The Department of Veterans Affairs allocated most of its funding to Boston's V.A. Medical Center (\$22,213,924). Two contracts (totaling \$259,000) went to Boston University.

## **Economic Impact**

Budgets for the R&D research projects typically involve salaries and benefits for the researchers and their assistants, as well as the costs of general supplies, materials, equipment, communication, travel, and other similar costs directly required for the work being undertaken, as well as overhead for the institutions where the research is conducted.

While R&D budgets will often have some funding set aside for equipment and supplies necessary for the research being conducted, sometimes funding is provided only for specialized R&D equipment and facilities. The RaDiUS database used here does not account for the R&D monies used solely for specialized equipment and facilities<sup>8</sup>.

Table 11 shows a partitioning of Federal R&D funding in Boston, with amounts used for Overhead (\$337,497,045), Direct Costs (\$750,770,726), and Salaries (\$375,385,363). (See endnote 9 for further discussion of this partitioning.<sup>9</sup>)

**Table 11 – Partitioning of Federal R&D Funding in Boston**

a. Total R&D Funding in Boston	\$1,088,267,771	100%
b. F&A (Overhead) Costs	\$337,497,045	31%
c. Direct R&D Funds Available for Salaries and Other Direct Costs	\$750,770,726	69%
d. R&D Funds for Researcher Salaries	\$375,385,363	50% of c.

Using the REMI econometric model<sup>10</sup>, the economic impact of the \$1.088 billion directly available for R&D research was calculated in terms of jobs created and dollar additions to the Gross Regional Product. The results of this analysis are shown in Table 12.

**Table 12 – Economic Impact of Federal R&D Spending in Boston and the Metro Area\***

Impact	Boston	Metro Area
Number of Jobs Created	18,030	20,340
Gross Regional Product Created**	\$842,252,800	\$970,025,600

\*Impact in 2001 dollars. The metro area includes Boston and Suffolk, Middlesex, Norfolk, Essex, and Plymouth counties.

\*\*The value of additional production generated from R&D spending.



In Boston alone, federal R&D spending is responsible for generating 18,030 jobs and increasing the Gross Regional Product by \$842,252,800. When the suburban counties are considered, federal R&D spending accounts for an additional 2,310 jobs bringing the total number of jobs created to 20,349 in Boston and the metro region. Similarly, an additional \$127,772,800 is generated in the suburban counties, bringing the total impact on the Gross Regional Product to \$970,025,600 in Boston and the metro area.

## **Issues Facing Boston and Massachusetts**

Boston's intellectual capital is cited time and time again as the reason for its successes as a center of innovation, research, medical care, education, and business, which are the foundation of its strong economy. Since 1992, *Fortune* magazine has named Boston as one of the best cities for business six times – each time citing its intellectual capital. “Few places match the intellectual power of Boston ...” wrote *Fortune*. College students were called the city's “secret weapon,” and our colleges and universities were described as “a magnet for innovative enterprises of all types.” Of its medical care industry, *Fortune* said, “Boston is so livable that it's even a great place to get sick.” And highlighting the role of the city's 35 colleges and universities, *Fortune* wrote, “Bright people from all over the world show up and go to school. Then they like the area so much, they never leave.”<sup>11</sup>

The city's greatness in medical research is shown not only by the amount of R&D funding as detailed in this report, but also by the fact that the Boston has topped the nation's cities in the amount of NIH funding for seven straight years (1994 –2000), and extended its lead over its closest rival, New York City, each year.<sup>12</sup>

Nevertheless, there are some warning signs that show Boston's research lead slipping. In its September 2000 report on NIH funding<sup>13</sup>, the BRA noted that while Boston's level of funding increased in FY 1999, its percentage increase ranked third, behind San Diego and Philadelphia. Other cities are beginning to see the value of NIH research in their economies, and the dramatic increase in NIH funding passed by Congress in FY 2000 was aided in part by the fact that other parts of the country were also going to benefit greatly from the research dollars. On this point, the Greater Boston Chamber of Commerce took a leadership role in fighting for this increased R&D funding by establishing the National Business Coalition for Federal Research and was joined by 28 other Chambers across the country.

“But the Boston-area medical research complex has done so well that politicians from states that get relatively paltry amounts from the National Institutes of Health have begun to

complain to top NIH officials,” wrote Michael Kranish in a recent article in the Boston Globe, in which he also reported Boston’s NIH funding in 2000 jumped to \$1.08 billion or 14% more than \$946 million received in 1999 as reported earlier in this study.<sup>14</sup> Kranish quoted Senator Thad Cochran, Republican of Mississippi and a senior member of the Senate Appropriations Committee, as calling the peer review funding process “unfair,” because “[t]hose who decide where the money goes are in many cases in those cities that do so much of the research.” According to Kranish, Senator Cochran threatened to try to change the funding allocation in the future, “though he acknowledged this would be a longshot.”

Also quoted in the same Globe article is Anthony Fauci, Director of the National Institute of Infectious Diseases, who said that the era of “euphoric largesse” in NIH funding “can’t last forever. I would love it to last forever, but it can’t last forever.”

Dr. James J. Mongan, President of Massachusetts General Hospital, in a recent op-ed piece in the Boston Globe, argued convincingly that criticisms of the high health care costs in Massachusetts are “misdirected and very misleading.” Arguing that the flow of NIH research dollars into the state is one reason why it appears that hospital costs are deceptively higher here than other parts of the nation, he stressed that these funds are “very valuable, out-of-state dollars which stimulate good jobs directly and indirectly. For example, a full 25 percent of the jobs at MGH are due to medical research. Even more important, these dollars stimulate the state’s burgeoning biotech industry, which is now the largest in the nation.” Mongan also cited the role of medical education in making the state’s health care costs appear misleadingly higher, but noted that Massachusetts “provides more medical training than nearly any other state, and we should be proud of this. Just like our great universities, our teaching hospitals bring the best and the brightest of the nation’s young health professionals to the state and keep many of the best of them. This medical talent supports the excellent quality of medical care in this state and stimulates the thriving biotechnology industry.” Mongan concluded that the city’s and state’s

health care industry “fuel[s] the engine that generates the largest bio-tech industry in the nation and the jobs, wealth, and medical progress that go with that industry.”<sup>15</sup>

A warning of changes in New England’s dominance of higher education also appeared in the February 2002 issue of the *Chronicle of Higher Education*<sup>16</sup>. In his article *New England Loses Its Edge in Higher Education*, Jeffrey Selingo wrote that “New England has been the beacon of higher education...But these days, the region’s dominant hold on the higher education market is fading.” Selingo cited statistics that showed the region losing its share of research funding and college enrollment while the region’s population of college-age youth is also declining. “Indeed, this is as much a story about the growing power of other regions, especially in the South and West, as it is about the decline of New England’s influence. Call it the ‘nationalization’ of higher education. What the movement has brought in the last half century is knowledge, prestige, and more important, economic development to all corners of the country. In other words, New England’s loss has been everyone else’s gain.” Selingo quotes Robert A. Weygand, president of the New Board of Higher Education as saying, “We have to be concerned. Our economy is uniquely tied to higher education, both public and private, and a decline in investment is a formula for the long-term economic decline of New England.”

Selingo made much of New England’s reliance on the more costly private colleges and universities as opposed to the growth in strong, more affordable, public universities in other parts of the country. In the *Chronicle* article, university research expert Irwin Fuller notes that research is no longer the province of the New England private schools, and that stronger public universities have been able to join the ranks of the top research universities “in many states – except those in New England.” The publics in New England,” said Feller, “are not major research institutions by any measure, and that’s hurting the region.”

Selingo also contrasts New England’s lack of support for research in public colleges and universities with other states like Texas, which has established two new research funds projected to be worth \$100 million in 15 years; Kentucky, which is spending \$230 million to help

public institutions attract top scholars; and California, which “plans to spend \$225 million over the next three years on collaborative research involving the state higher education system and private industry.”

While the University of Massachusetts has made strides in recent years to build up its research dimension and to attract top quality students, the recent budget crisis in Massachusetts will undoubtedly stall its progress. Once scorned for having one of the highest costs for public education in the nation, the state system began a series of tuition rollbacks over the past few years. Unfortunately, the mid-year budget cut for FY 2002 and proposed cuts for FY 2003 have forced the schools to increase fees and dormitory charges, though freezing tuition, but overall reversing the recent downward trend of the cost of attending the state college system.

Patrick Healy, in a recent Boston Globe story, wrote, “The University of Massachusetts at Amherst’s ambition to join the top ranks of public universities has been severely undermined by state budget cuts that are now striking at its academic priorities...” Healy cites the impact of this year’s \$11 million cut and projected further losses on the academic program, the loss of faculty, and student recruitment. But one of the most serious impacts according to some, is the inability to “meet the rigorous requirements for entrance into higher education’s most elite club, the Association of American Universities, a group founded in 1900 that includes 63 elite North American graduate research schools.”<sup>17</sup> This latter failing strikes at the heart of the need of the city, state, and region for educated workers and the constant flow of new ideas generated by research to maintain its intellectual capital and economic standing.

In another analysis of higher education funding conducted by the Chronicle of Higher Education in January of 2002, Massachusetts was ranked dead last out of the 50 states in the change in FY 2002 appropriations for higher education from the previous year. While the average for the 50 states was a 4.6% increase, Massachusetts registered a 6.2% decrease, joining only Florida, Nebraska, Mississippi, and Iowa as states with declining funding this year.

The two year change found Massachusetts in the 49<sup>th</sup> position with a total decrease of 2.9%. Only Mississippi was lower. Granted Massachusetts has been affected by the recent recession, but the state's strong economy has been less impacted by the recession than other parts of the country where funding increases were seen.<sup>18</sup>

The people of Boston and Massachusetts take pride in the excellence of our city's and state's higher education institutions and in the cutting edge research undertaken by our great universities and hospitals. The ideas and innovations flowing from these world renowned clusters of excellence not only stimulate more innovation in the region but also influence the progress of research and learning in the nation and the world. And the entrepreneurial culture which is generated by these ideas and innovations shapes the future of the region's economy. But the warning signs are growing stronger each year that both the city and state are losing their leadership role in these areas. On the positive side, it will take many years for the city and state to lose their top ranking because of the presence of these formidable institutions. But, little by little, other parts of the country are catching on to the importance of intellectual capital in the new world economy and they are making headway by investing in their public universities and promoting research.

The Boston Redevelopment Authority (BRA) recognizes the importance of our city's colleges and universities both as economic engines as well as advancers of knowledge. The BRA will continue to support their development with the tools available to it. But the changes in the health care funding mechanisms have brought many of Boston's hospitals to their knees. Washington's drastic cuts in support for graduate medical education have only made it harder for the city's teaching hospitals, which are so important to producing the next generation of physicians and health care advances, to balance their budgets. And cuts to our public higher education system today will come back to haunt us later as the pool of intellectual capital grows shallow. This is especially true given the increasing immigrant population in the state and the

region, which need the affordable and flexible education and training options traditionally offered by public colleges and universities.

### **Summary and Conclusions**

Boston is a national leader in the quest for innovation in health care, cutting edge biomedical research, and the development of new technologies as shown by the significant amount of federal R&D funding awarded to institutions and businesses in the city. Boston's world renowned hospitals, research laboratories, and colleges and universities attract the intellectual capital that is the hallmark of this city and which gives Boston its competitive advantage in the global marketplace of research and ideas.

Federal R&D funding forms the foundation of the significant research undertaken in Boston's medical and higher education institutions and private businesses. Boston received nearly \$1.1 billion in federal R&D support in FY 1999 from 17 different federal agencies. Just as Boston serves as the economic engine for the state and regional economy, so too does the research undertaken in Boston's institutions and businesses serve as the heart of the R&D undertaken in Massachusetts and the region. Boston's awards represented nearly one-third of the \$3.6 billion received in the state, and 20% of the R&D funds in all of New England. If Boston were a state, it would be ranked 19<sup>th</sup> in the nation in federal R&D funding.

Most of the R&D funds were directed to the city's renowned medical institutions (\$667 million). Boston's educational institutions, however, also attracted a significant amount (almost \$390 million), and private businesses also received substantial funding (\$26 million).

R&D creates not only an environment of learning and innovation in Boston but also positive economic benefits for all of its residents and workers. Though concentrated on only 2% of the city's land area, the hospitals and universities serve as important economic engines in the city. R&D investments in Boston have a significant ripple effect throughout Boston's economy, creating over 20,000 jobs in the region and generating \$842 million dollars in economic activity

in Boston alone and \$128 million more in the metro region. For every \$1.00 of R&D investment, an additional \$.89 in economic activity is generated.

The Boston Redevelopment Authority (BRA) seeks to nurture these hospitals and schools, which are so important to Boston's economy. Between 1991 and 2000, the BRA has aided in the development of 16 research buildings – new or renovated – comprising almost two million square feet of R&D space either built or renovated. Currently there are eight more projects with 3.2 million feet of new research space in the pipeline, either under construction or being planned. (See Appendix A1 and A2.)

Boston and Massachusetts can no longer take for granted their standing in higher education, health care, and research. The warning signs are visible. Other cities and states are beginning to recognize the importance of using intellectual capital as an economic development strategy. Persons elected to Congress are more aware of the disparity in federal R&D funding directed to Boston and the state vs. the areas they represent. This awareness could evolve into a movement to divide the federal R&D pot differently. Such moves are not without precedent as can be seen in the history of defense spending.

The good news is that Massachusetts and Boston are still number one. The bad news is that other regions, states, and cities have recognized the importance of this funding and are stepping up the competition at a time when Massachusetts is stepping back by disinvesting in higher education and health care – two of the most important industries that help form and attract the intellectual capital that makes the Boston and the state so successful. Our state and region must become more competitive than the states and regions which are trying to catch up to us. We must shake off any complacency and proactively work to remain in our leadership role. To do so, the support of a strong public higher education system with leading researchers and topmost research capabilities and the backing of a vigorous health care industry with top quality teaching and research hospitals are essential to the long term health of this region.



**Appendix A1**  
**Research Facilities Built in Boston Over the Past Decade**

<b>Year</b>	<b>Institution</b>	<b>Project</b>	<b>Size in SF</b>	<b>Total \$</b>
1991	Boston College	Chemistry Building	87,000	\$13M
1991	Children's Hospital	Enders Research Expansion	143,000	\$51M
1991	Harvard Medical School	BLDG D Penthouse	21,544	
1992	Massachusetts College of Pharmacy	Renovation	61,000	\$10M
1992	Harvard Medical School	Alpert Building	194,447	
1993	Center for Advanced Biomedical Research	Biosquare Building 1	180,000	\$65M
1994	Northeastern University	Material Sciences Center (Egan Center)	95,000	\$32M
1994	Beth Israel Hospital	Research North Renovation	114,000	\$60M
1994	Joslin Diabetes Center		84,000	\$28M
1995	Harvard School of Public Health	Health Research Building	75,000	\$23M
1995	Massachusetts General Hospital	Proton Center	44,000	\$20M
1996	Dana Farber	Research Building	266,000	\$106M
1998	Boston University	Photonics Center	220,000	\$75M
1998	Harvard Institutes of Medicine		250,000	\$75M
2000	Evans Biomedical Research	Biosquare Building 2	160,000	\$65M
<b>Total</b>			<b>1,994,991 SF</b>	

**Appendix A2**  
**Research Facilities Currently Under Construction or Being Planned in Boston**

<b>Institution</b>	<b>Project</b>	<b>Size in SF</b>	<b>Status</b>	<b>Total \$</b>
Tufts University	Biomedical & Nutrition Research Complex	146,800	Under Construction	\$40M
Children's Hospital	Research Building	439,000	Under Construction	\$177M
Harvard Institutes of Medicine		435,000	Under Construction	\$120M
Emmanuel College	Merck Building	640,470	Under Construction	\$300M
Joslin Diabetes Center	Research Facility	652,630	Received PNF	\$205M
Massachusetts General Hospital	Alzheimer's Research (Building 114 Navy Yard)	90,000	Reviewing Application	\$7M
Tufts University	South Station Air Rights	390,000	Met with BRA 12/4/01	
Blackfan Research Center	Private Development	450,000	Scope Due	\$120M
<b>Total</b>		<b>3,243,900</b>		

## End Notes

<sup>1</sup> RaDiUS Database from the Science and Technology Policy Institute: RAND; Arlington, VA, 2000.

<sup>2</sup> Special thanks to the BRA's Linda Kowalcky for her role in securing the data base, initiating the analysis, and reviewing the work through its publication; and to Donna Fossum of RAND for her help in accessing and using the database.

<sup>3</sup> All FY '98 data for the nation and states were obtained from *Discovery and Innovation: Federal Research and Development in the Fifty States, District of Columbia, and Puerto Rico*. Donna Fossum, Lawrence Painter, Valerie Williams, Allison Yezril, Elaine Newton, & David Trinkle. Research and Development in the United States (RaDiUS), Science and Technology Policy Institute: RAND, Arlington, VA, 2000.

<sup>4</sup> FY 1999 data for Boston were compiled using the RaDiUS database and NIH Website, [www.nih.gov](http://www.nih.gov).

<sup>5</sup> The reader is reminded that FY 1998 data were available for the state of Massachusetts and FY 1999 data were available for the city of Boston. The authors of this report have no reason to believe that there would have been a significant shift in the state's distribution of R&D funds during FY 1999.

<sup>6</sup> Similar comparative data for hospitals, businesses, and other institutions were not available.

<sup>7</sup> Boston College is included in these data because of its connection to Boston, although its main address is in Chestnut Hill.

<sup>8</sup> Fossum, Donna. RAND. Personal communication. Nationally, about three percent of all federal R&D dollars are used to fund only equipment and supplies. These dollars are not included in the RaDiUS database for Boston.

<sup>9</sup> Institutions and businesses charge a *facilities and administrative* (F&A) cost (also called indirect or overhead costs) of the funded institution or business. F&A costs generally include those costs associated with the operation of the institution that cannot be directly attributed to the federally funded research being undertaken, but are essential for the successful operation of the institution and the R&D project. F&A costs typically include such items as utilities, access to high-powered computers, the use of common facilities such as libraries and classrooms, building and grounds maintenance, and salaries of central office and other general administrative staff.

F&A costs vary both by type of institution (i.e., higher education, hospital, business) and region of the country. Each institution has its own rate, which is negotiated with the federal government based upon stringent guidelines and accounting records. According to a study by RAND (*Paying for University Research Facilities and Administration*, Charles A. Goldman, T. Williams with David M. Adamson, Kathy Rosenblatt, RAND, 2000. (<http://www.rand.org/publications/MR/MR1135.1/index.html>), federal outlays for F&A costs, in general, across all federal agencies are approximately 25% of the total award; while for NIH awards, the rate rises to about 31%. The RAND study also reported that in the northeast, F&A costs supported by NIH are higher on average than those in other parts of the country though varying by type of institution: higher education – 33.3%, hospitals – 31.2%, small businesses – 20.3%. (Comparable figures for other federal agencies were not available.) The northeast F&A rates for higher education and hospitals were the highest among the regions, but the small businesses rate was second lowest.

F&A costs total \$337,497,045 for Boston's R&D funding. More specifically, the amounts for each type of institution (using the RAND findings by type of institution and whether the funds came from NIH or other federal agencies) are shown in the Table below.

**Table 11 – F & A Costs Associated with Federal R&D Funding in Boston**

Institution	NIH Funding and F & A Rates and Costs Associated with NIH Funding			All Other Federal Funding and F & A Rates and Costs Associated with All Other Federal Funding		
	\$ Amount	F & A Rate %	F & A Costs	\$ Amount	F & A Rate %	F & A Costs
Higher education	\$336,253,522	33.3	\$111,972,423	\$52,579,842	25	\$13,144,961
Hospital	607,421,516	31.2	189,515,513	60,872,912	25	15,218,228
Business	2,959,049	20.3	600,687	22,864,686	25	5,716,172
All Other	NA		NA	5,316,244	25	1,329,061
Total	\$946,634,087		\$302,088,623	\$141,633,684		35,408,422

Based upon these averages, slightly over two-thirds of the \$1.088 billion spent on *direct* R&D activities - or \$751 million - is used for the direct costs associated with the research being conducted including salaries, benefits, travel, and materials and supplies related specifically to the research being undertaken. According to local university officials at Tufts University and Boston University, about half of every federal R&D budget is used for salaries of the researcher and assistants, bringing the salary total to more than \$375 million. While some of the remaining overhead costs of \$337 million are also used for salaries within the general and administrative costs of the institutions, how that money is partitioned is not known.

<sup>10</sup> Regional Economic Models Inc., 306 Lincoln Ave., Amherst, MA 01002. [www.remi.com](http://www.remi.com)

<sup>11</sup> *Fortune Once Again Names Boston One of the Best Cities for Business*. Boston Redevelopment Authority, January 2000.

<sup>12</sup> *Boston Leads Nation Again in NIH Awards*. Boston Redevelopment Authority, September 2000. Kranish, Michael. *Hub's share of NIH fund tops in US*. Boston Globe, February 18, 2002.

<sup>13</sup> *Boston Leads Nation Again in NIH Awards*. Boston Redevelopment Authority, September 2000.

<sup>14</sup> Kranish, Michael. *Hub's share of NIH fund tops in US*, Boston Globe, February 18, 2002.

<sup>15</sup> Mongan, James, J. *The true cost of Massachusetts health care*. Boston Globe, March 18, 2002.

<sup>16</sup> Selingo, Jeffrey. *New England Loses Its Edge in Higher Education*. The Chronicle of Higher Education, February 15, 2002.

<sup>17</sup> Healy, Patrick. *Budget cuts at UMass undermine ambitions*. Boston Globe, March 17, 2002.

<sup>18</sup> *State Appropriations for Higher Education*. The Chronicle of Higher Education, January 18, 2002.