



THE LABOR MARKET SITUATION IN THE MASSACHUSETTS BIOTECHNOLOGY INDUSTRY

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TABLE OF CONTENTS

Introduction.....	1
Payroll Employment in the Biotechnology Sector.....	1
Bio Tech Staffing Patterns and Educational Requirements.....	4
Job Vacancies in the Biotechnology Industry.....	12
Institutional Sources of Labor Supply in SEIT Fields of Study in Massachusetts	17

Introduction

The Biotechnology industry cluster is composed of three specific types of private sector business establishments including: Pharmaceutical preparation manufacturing (NAICS 3254), medical instruments manufacturing (NAICS 3391) and physical, engineering and biological research service organizations (NAICS 54171).¹ The pharmaceutical preparations industry includes firms that manufacture biological and medicinal products. Surgical and medical equipment firms manufacture a wide range of instruments including surgical appliances, dental equipment and supplies, orthodontic and ophthalmic goods and appliances. The third and largest component of the Massachusetts biotechnology sector is not a manufacturing industry; rather it is composed of firms engaged in research and development in the physical and life sciences and engineering, including organizations that develop new biotechnology processes or new prototypes of genetically altered products.

Payroll Employment in the Biotechnology Sector

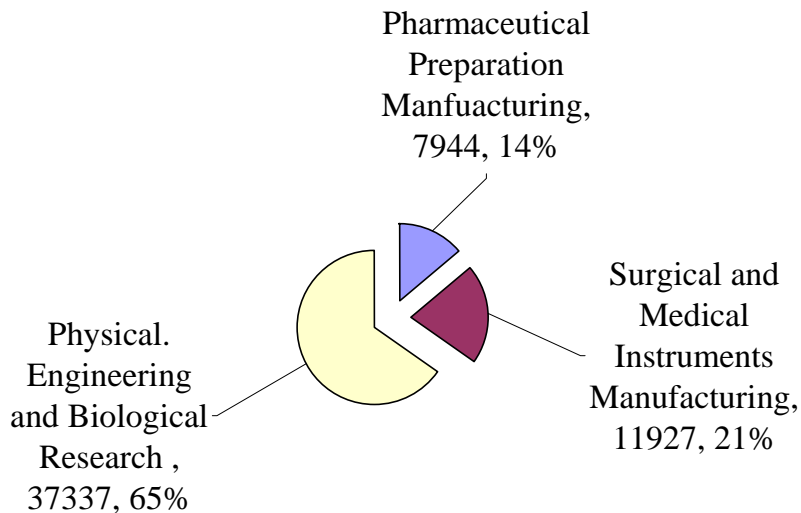
During 2006, the Massachusetts Biotechnology Sector employed a total of 57,200 regular payroll workers.² About one-third of these biotechnology jobs were located in the state's manufacturing sector. Pharmaceutical manufacturing employed about 7,900 workers, on average during 2006, accounting for 14 percent of biotech employment in the state. Medical and surgical instruments manufacturers employed 11,900 payroll workers during 2006, accounting for about one-fifth of biotechnology employment in Massachusetts. The research component of the biotech sector in the state was by far the largest single industry component of the sector, employing 37,300 workers or about two-thirds of all biotech workers in the state. This biotech research sector is among the highest wage sector in the state and has very high level staffing structures that utilize extraordinary shares of

¹ NAICS refers to the North American Industry Classification System, the system used by data collection agencies to categorize business establishments by the type of products they produce.

² These totals include only workers covered by the Massachusetts Unemployment Insurance program. Non payroll workers including consultants and temporary workers are not included in these industry employment totals.

workers with advanced degrees.³ This latter issue will be explored more fully in a subsequent section of this report.

Chart 1:
The Size and Composition of the Biotechnology Sector Wage and Salary Employment in Massachusetts, 2006 Annual Average



Source: Massachusetts Division of Career Services, ES-202, Covered Employment and Wages Program.

Beginning in the first quarter of 2001, Massachusetts experienced a considerable level of overall payroll employment decline associated with the national economic recession that began at that time. The Commonwealth continued to lose employment over the next few years until mid-2003, when state payroll employment levels began to slowly recover from the worst effects of the downturn. The findings provided in Table 1 examine trends in private sector payroll employment from the third quarter of 2003 through the third quarter of 2007 for each of the three components of the state's bio tech

³ For a more detailed discussion on the earnings of workers in the bio tech sector see: Ishwar Khatiwada and Andrew Sum, et al, *Annual Earnings Levels and Trends in the Real Annual Earnings of Workers in Biopharmaceutical Industries in Massachusetts and the U.S.* Center for Labor Market Studies, Northeastern University, Boston, January, 2007

sector.⁴ The data reveal that the state's private sector has increased its payroll employment levels by 96,900 jobs between 2003 III and 2007 III, representing a relative increase of 4 percent over the period. During the same time period the state's manufacturing industries experienced an overall loss of more than 27,000 jobs or 8 percent of employment, continuing a long-term downward trend in that segment of the state's economy. The overall rate of new job creation that has occurred in the state's biotech sector since the beginning of the recovery in 2003 is among the best of any industry sectors in the state. Payroll employment levels in the biotechnology sector stood at 55,900, on average, during the third quarter of 2003. By the third quarter of 2007, employment in the biotech sector had increased to 62,000, representing an increase of 11 percent over the period, and a rate of employment expansion that was 2.7 times more rapid than the overall rate of payroll employment growth within the state.

Within the biotech sector the biotech manufacturers' job generating performance was somewhat mixed. The state's medical instruments producers continued to shed jobs. Employment among these firms fell by more than 1,800 jobs, a 14 percent loss over the period of statewide economic expansion. The pharmaceutical preparation manufacturing industry was able to grow at about the average pace of overall private sector employment increasing payroll employment from 8,950 during 2003 III to 9,291 by 2007 III.

Table 1:
Trends in Private Sector Non Agricultural Wage and Salary Employment in
Massachusetts, 2003 III to 2007 III (not seasonally adjusted)

Industry Sector	2003 III	2007 III	Absolute Change	Relative Change
Total Private Sector Employment	2,767,524	2,864,429	96,905	4%
Manufacturing	322,055	294,964	-27,090	-8%
Pharmaceutical Preparation				
Manufacturing	8,950	9,291	341	4%
Surgical and Medical Instruments				
Manufacturing	13,036	11,210	-1,826	-14%
Physical. Engineering and Biological				
Research	33,972	41,528	7,557	22%
Total 3 Bio Tech Industries	55,958	62,029	6,072	11%

Source: Massachusetts Division of Career Services, ES-202, Covered Employment and Wages Program

⁴ The third quarter data are the most recent available

Among the most rapidly expanding sectors of the state's private industries was the physical, engineering and biological research industry. The research component of the biotech sector employed 33,972 wage and salary workers during the third quarter of 2003. By the third quarter of 2007, the number of workers on the payrolls of these private technical research organizations had ballooned by 22 percent to 41,528. Biotech research organizations were themselves an important source of overall employment gains during the first four years of employment recovery in the state. Indeed, while these firms had just 0.9 percent of the statewide private sector wage and salary employment during 2003 III they accounted for 7.8 percent of all new jobs generated in the state.

Not only has the biotech research sector expanded its own payroll employment levels rapidly, it has also helped to stimulate growth in other sectors of the state economy; both through high rates of direct purchases from other state businesses, and though induced effects associated with expanding payrolls with very high rates of compensation for those employed within the industry. Moreover, the biotech research industry is a major export industry. All of these factors contribute to a high employment multiplier. Indeed, a recent analysis of the biotech sector found the research sector has an employment multiplier of 2.4, implying that the growth in biotech industry of about 7,500 jobs helped create about 2.4 times that number of jobs within the state.⁵

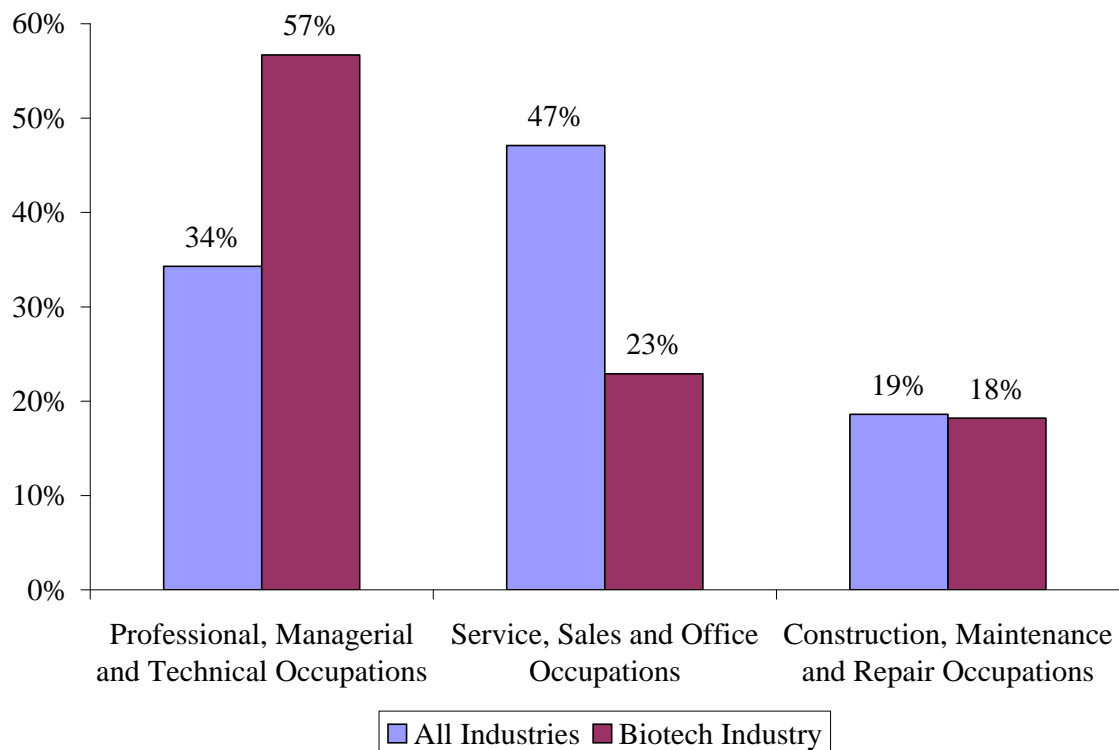
Bio Tech Staffing Patterns and Educational Requirements

The occupational composition of employment in Massachusetts is measured over a three-year cycle by the Occupational Employment Statistics (OES) survey program which is a cooperative federal-state statistical program operated by the U. S. Bureau of Labor Statistics and the Massachusetts Department of Labor and Workforce Development. The OES survey captures detailed information on the employment levels of workers in a wide range of occupations on an individual industry basis. These data are thus quite useful in gaining insights into occupational and skill requirements of individual industry sectors in the state.

⁵ Andrew Sum et al, *The Economic, Labor Market and Fiscal Performance and Impacts of the Biopharmaceutical Industries of Massachusetts*, PhRMA Research Paper No. 15, Center for Labor Market Studies, Northeastern University, Boston, August, 2007.

The findings from the OES survey for the Biotech industry in the state are summarized in Chart 2. The data reveal that the Biotech industry has a staffing pattern that is dominated by workers in management, professional and technical occupations, often collectively referred to as college labor market occupations because of the large share of workers in these fields who have earned a college degree. About 57 percent of all those employed in the state’s biotech sector work in college labor market fields, compared to 34 percent for all industries in the state. Thus the biotech industry can be considered an intensive employer of workers in these high end white collar fields.

Chart 2:
Staffing Structure of the Biotechnology Sector and All Industries in Massachusetts, 2003

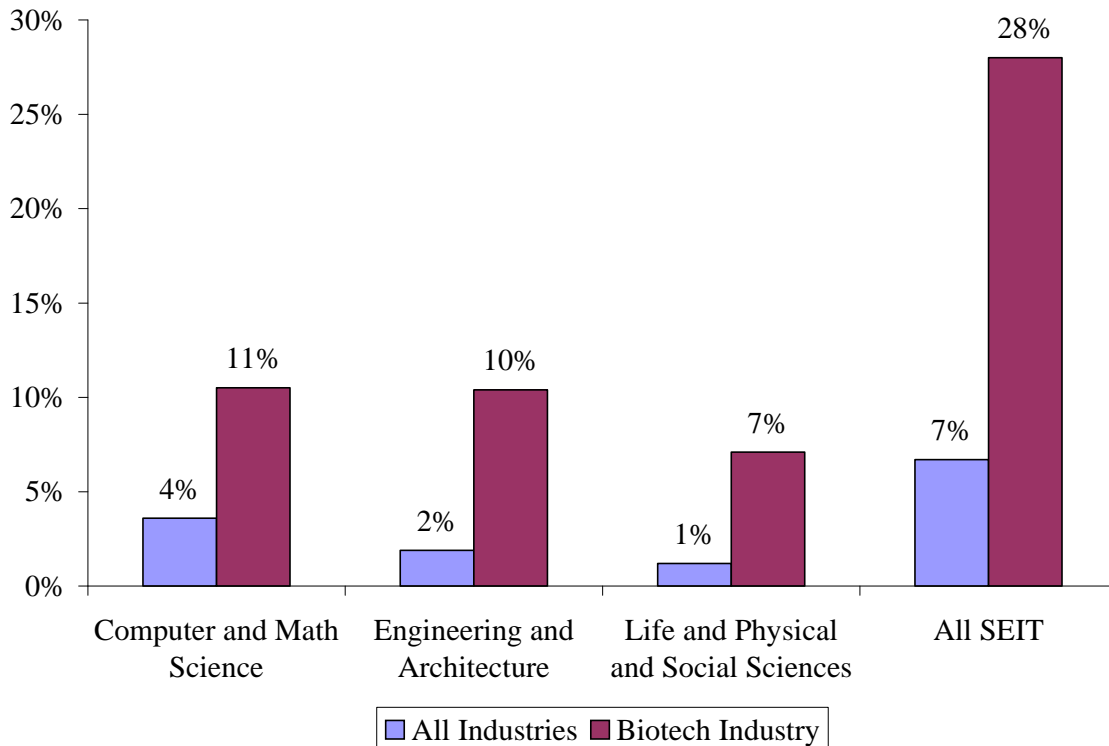


Source: Occupational Employment Statistics Survey, Massachusetts Department of Labor and Workforce Development, 2003

Within the college labor market fields the share of workers employed in scientific, engineering and information technology (SEIT) occupations is much higher than is found among other industries in the state. Computer and mathematical science occupations account for 10.5 percent of all workers in the state’s Biotech sector compared with just 4

percent in other industries statewide. Architecture and engineering positions account for 10 percent of Biotech employment but just 2 percent of all employment in the state and life and physical scientists account for 7.7 percent of employment within the industry, but just 1 percent of all payroll employment in the state. SEIT fields account for 28 percent of the staff in the state’s Biotechnology industry in the state. In contrast, fewer than 7 percent of workers on payrolls across the state are employed in SEIT occupations. Biotech industries employ SEIT workers at a rate that is equal to 4 times the state average employment level.

Chart 3:
Share of Workers Employed in Scientific, Engineering and Information Technology Jobs in the Biotechnology Sector and All Industries in Massachusetts, 2003



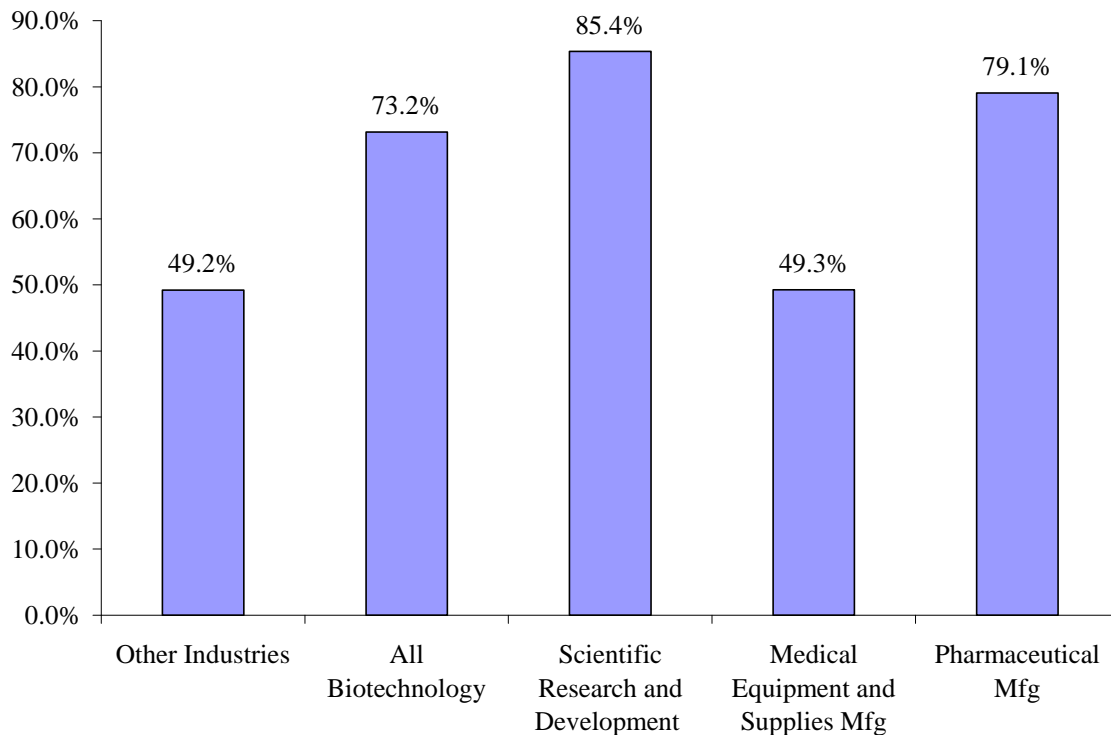
Source: Occupational Employment Statistics Survey, Massachusetts Department of Labor and Workforce Development, 2003

Offsetting the intensive use of college labor market occupations in the biotech field is a relatively small share of workers employed in service, sales and office occupations. These occupations include jobs such as protective services, food preparation, office clerical jobs and a variety of sales positions. While nearly half of all

workers on Massachusetts industry payrolls work in these fields, the share of the overall Biotech staffing level in these occupations is less than half that of the state. Finally, about 18 percent of the staff of Biotech producers in the state is employed in blue-collar occupations, about the same proportion that is found statewide. These occupations include precision production jobs, assembly positions mechanics and repairers. Differences in staffing patterns among industries reflect differences in education and skill requirements in these industries.

The occupational composition of the state’s biotechnology industry is dominated by jobs that typically require some type of post secondary educational credentials. Moreover, the large share of workers employed in SEIT fields further suggests that the biotechnology industry employs large shares of workers with advanced degrees, since professional employment in many SEIT fields requires completion of a master’s or doctor’s degree program. Using the American Community Survey, we have produced

Chart 4:
Share of Employed with a College Diploma in the Massachusetts Biotechnology Industry, 2005-2006



Source: U.S. Bureau of the Census, American Community Survey, 2005 and 2006 Public Use Micro data files. Tabulations by the Center for Labor Market Studies, Northeastern University.

estimates of the level of educational attainment of workers employed in the state's biotechnology industries by combining the public use data files from the 2005 and 2006 ACS surveys in Massachusetts.⁶ In this way we are able to produce accurate and up to date measures of the level of educational attainment of individuals who are employed in the state's biotech sector.

In Massachusetts, industries outside of the biotech sector are themselves intensive employers of workers with a college degree. The ACS findings reveal that about one-half of the workers employed in the state had earned a formal college degree, ranging from an associate's to a doctor's degree. The structure of staffing in the state's biotech industry implies that these industries employ large shares of workers with a college degree of some type. Indeed, the data reveal that nearly three-quarters of all those who work in the state's biotech sector have earned a college diploma of some type, although this proportion varies considerably across the specific industries that make up the state's biotech sector. Eighty-five percent of the state's scientific research and development industry's staff has a college degree, while 80 percent of the pharmaceutical manufacturing industry's staff have a college diploma. The medical equipment producers utilize college graduates at about the same rate as the other industries in the state.

Not only do the state's biotechnology producers utilize college degree holders at much higher rates in meeting their staffing requirements, but the level of college degrees held by workers within the biotechnology sector is much higher than that of workers in other industries in the state. Firms outside the biotech industry in Massachusetts have staffing structures that require about 17 percent of all their positions to utilize workers with an advanced degree (that is a master's degree, a first professional degree or a doctor's degree). The state's biotech producers are much more intensive employers of workers with such advanced degrees. The ACS surveys found that about 40 percent of all those employed in the biotech sector in Massachusetts had earned a master's degree or higher.

⁶ The American Communities Survey is a comprehensive survey of households across the nation and state that provides a wide range of measures of employment activities and outcomes of residents at the state level.

Table 2:
Percent Distribution of Persons Employed in the Massachusetts Biotechnology Sector, by
Level of Educational Attainment, 2005-2006

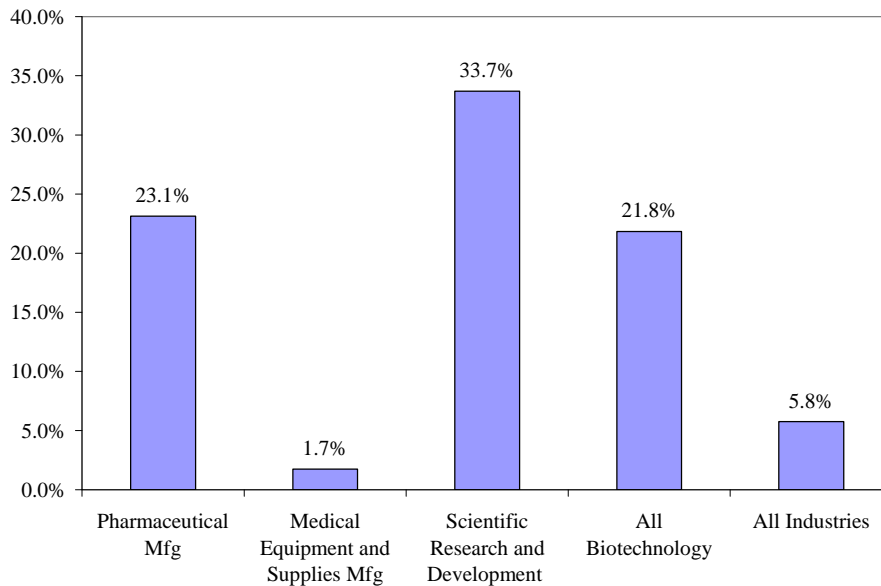
	Other Industries	All Biotechnology Industries
No H.S. Diploma	7.6%	2.3%
H.S. Diploma/GED	27.4%	14.9%
Some College	15.8%	9.7%
Associate's Degree	8.3%	5.1%
Bachelor's Degree	23.9%	28.1%
Master's Degree	11.6%	18.0%
Professional Degree	3.1%	3.4%
Doctorate Degree	2.3%	18.5%
Total	100.0%	100.0%

Source: U.S. Bureau of the Census, American Community Survey, 2005 and 2006 Public Use Micro data files. Tabulations by the Center for Labor Market Studies, Northeastern University.

Most employers in Massachusetts do not utilize large share of workers with doctor’s degrees or professional degrees. The latter group includes those workers who have earned professional degrees in such fields as law and medicine, while the former group is largely composed of those who have earned a doctor of philosophy or equivalent degree. Overall, the ACS found that just under 6 percent of employed persons in the state held one of these terminal advanced degrees. In contrast the state’s biotech sector devotes an extraordinary share of its staffing to workers with doctor’s or professional degrees. Overall the data reveal that 23 percent of all those employed in the biotech sector in Massachusetts. This is nearly 4 times the share of these highly educated workers that are found on other industries in the state.

Especially high proportions of doctor’s and professional degree holders were employed in the state’s scientific research and development industry—a specific industry sector that as we observed earlier is both the largest component of the biotech sector and that has expanded payroll employment levels rapidly over the past few years. The pharmaceutical manufacturing sector, which has also registered employment gains over the last year similarly, has a staff with a very high share of workers at the highest level of educational attainment. Only the medical surgical instruments sector employs small shares of staff with doctorate or professional degrees.

Chart 5:
Share of Employed with a Doctor's or Professional Degree in the Massachusetts
Biotechnology Industry, 2005-2006



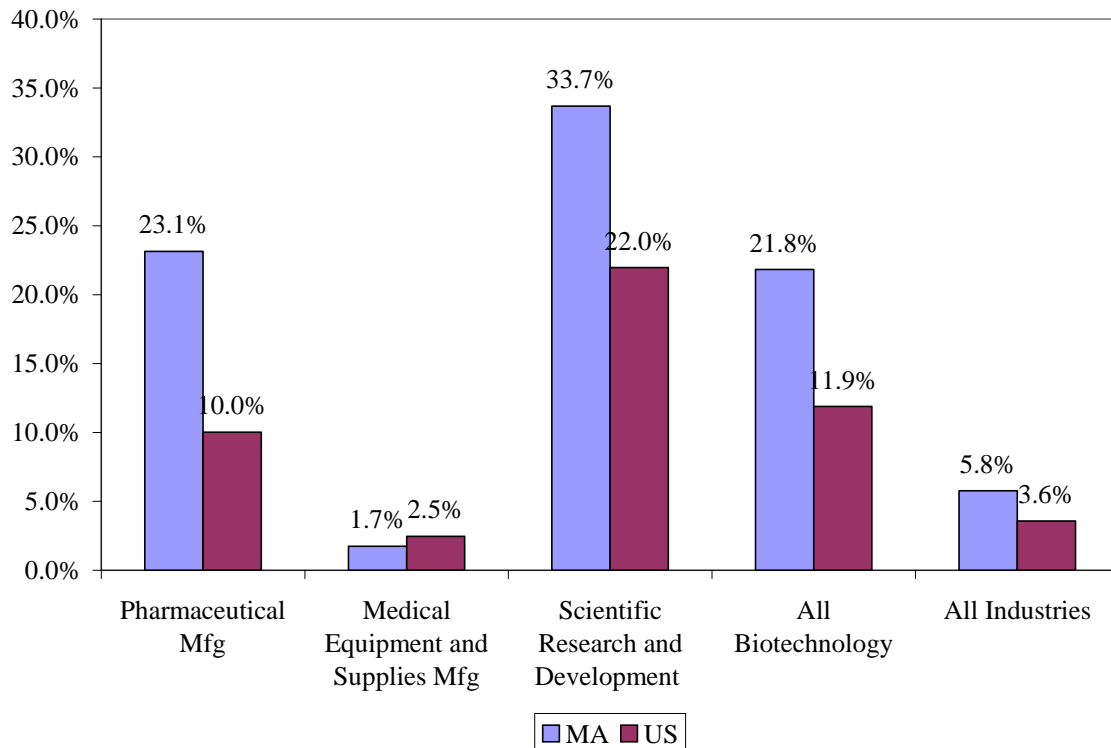
Source: U.S. Bureau of the Census, American Community Survey, 2005 and 2006 Public Use Micro data files. Tabulations by the Center for Labor Market Studies, Northeastern University.

The utilization of large shares of workers with doctor's and first professional degrees appears to be somewhat unique to Massachusetts's biotech producers relative to their counterparts in the nation as a whole. Nationally, about 12 percent of those employed in the biotech industry held a doctor's or professional degree, while among Massachusetts biotech firms this proportion was 23 percent, 1.9 times the national average. Part of this difference may be associated with a different mix of specific biotech industries in the state compared with the nation.

For example the medical device-manufacturing sector, which employs few workers with this level of educational attainment may account for a much higher share of biotech workers in the nation compared to Massachusetts. Yet a closer look at the findings provided in Chart 6 reveal that this is not the cause of the disparity in educational attainment between Massachusetts's biotech producers and their counterparts in the state. Instead, the data reveal that two of the three industry components of the state's biotech sector employ higher shares of workers with doctorate and first professional degrees compared to their national counterparts (within the same industry

components). The Massachusetts scientific research and development industry’s share of workers with doctor’s or professional degrees is 1.5 times greater than that of the nation as a whole. Similarly, 23 percent of those employed by Massachusetts pharmaceutical manufacturing producers had a doctor’s or professional degree compared to 10 percent in this industry in the nation as a whole. The only component of the biotech sector in the state that used workers with a doctor’s or professional degree at a lower rate than their counterparts in the nation was the medical instruments industry. In this instance both the in state and national producers were very unlikely to employ individuals with this level of educational attainment.

Chart 6:
Share of Employed with a Doctor’s or Professional Degree in the Biotechnology Industry in Massachusetts and the United States, 2005-2006



Source: U.S. Bureau of the Census, American Community Survey, 2005 and 2006 Public Use Micro data files. Tabulations by the Center for Labor Market Studies, Northeastern University.

The biotech industry in Massachusetts has a set of educational and skill requirements that are truly exceptional whether judged at the state or national level (and we suspect the international level as well). These educational and training requirements

indicate the need for a very sophisticated educational development system that can supply the extraordinary skills required by this industry sector. In a subsequent section of this report we will examine the responses of various components of the state higher education system—both public and private—to this very challenging industry. However, before we examine institutional labor supply responses we will examine the current ability of biotech producers to fill available positions for which they are actively seeking workers and make an appraisal of the potential areas of labor shortages within the biotech sector

Job Vacancies in the Biotechnology Industry

A key measure of labor market conditions within an industry or occupation is the number and rate of unfilled job openings. Labor shortages often manifest themselves by high and rising rates of job vacancies in a particular area. Measures of job vacancies are usually designed to shed insights into the size and characteristics of unfilled labor demand in a way that is analogous to the measure of unemployment serves as a measure of available but unutilized labor supply. The household unemployment measure classifies individuals in the working age population as unemployed if they are:

- jobless,
- are actively seeking work in the 4 weeks prior to the survey reference week,
- are available for work at the time of the survey.

The measure of job vacancies is usually constructed in a parallel fashion. The count of job vacancies includes wage and salary positions for which:

- a specific position exists that is available to workers outside the firm
- the employer is actively seeking workers outside the firm
- and the position could be filled within thirty days of the survey.

Several years ago the Massachusetts Department of Labor and Workforce Development began a survey of business establishments in the state designed to measure job vacancies by occupation. The Massachusetts Job Vacancy Survey (JVS) is not organized in a way that allows the estimation of the number of job vacancies for the biotechnology industry sector. However, it does provide us with insight into overall trends in levels of unfilled labor demand in the state, recent developments among the larger industry segments in which the biotech sector is located, and perhaps most

importantly the JVS provides estimates of the number of job vacancies and the job vacancy rate for a number of specific occupations that are key components of the staffing structure of the state's biotechnology industry.

Over the past year the Massachusetts labor market has experienced a modest increase in the number of available job openings, even as the number of unfilled jobs in the nation had declined as a consequence of the national economic slowdown. Between 2006 IV and 2007 IV the number of job vacancies in the state increased from 89,600 to 92,000, a rise of 2.7 percent over the period. The job vacancy rate, a measure of labor demand largely analogous to the unemployment rate as a measure of unutilized labor supply, rose to 3.2 percent at the end of 2007. The job vacancy rate varied quite sharply across industries in the state. For example the state's construction sector had only about 1 percent of its jobs vacant at the end of 2007 IV, while the information industry had a job vacancy rate of 3.5 percent. The industry sector with the highest job vacancy rate in the

Table 3:
The Number of Job Vacancies and the Job Vacancy Rate of Major Industry Sectors in Massachusetts, 2007 IV

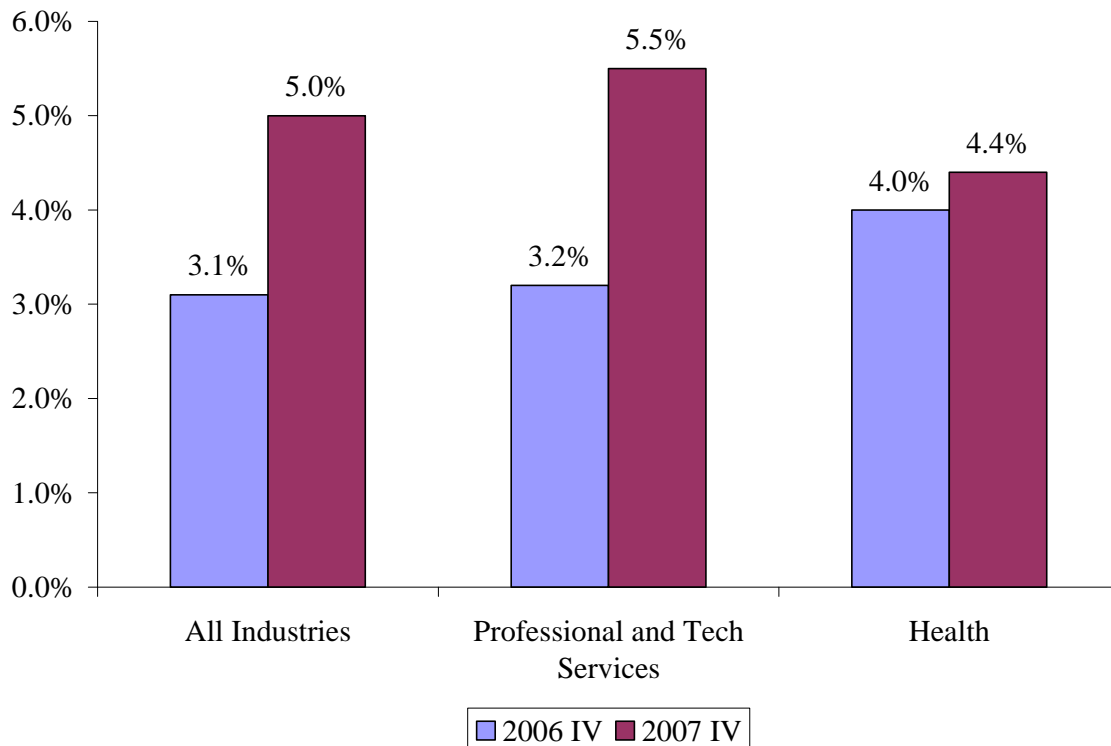
Industry	Number of Job Vacancies	Job Vacancy Rate	Industry	Number of Job Vacancies	Job Vacancy Rate
Utilities	127	1.0%	Professional & Technical Services	11,527	5.5%
Construction	1,601	1.3%	Management	1,508	2.5%
Manufacturing	5,753	2.1%	Administrative & Waste Services	3,383	3.7%
Wholesale Trade	2,252	2.0%	Educational Services	4,230	1.3%
Retail Trade	13,504	4.2%	Healthcare	20,016	4.4%
Transportation & Warehousing	1,727	1.8%	Arts, Entertainment & Recreation	1,598	3.7%
Information	2,885	3.5%	Accommodation & Food Services	10,580	4.6%
Finance & Insurance	5,432	3.3%	Other Services	2,237	2.7%
Real Estate, Rental & Leasing	736	2.1%	Public Administration	2,862	2.6%

Source: Massachusetts Department of Labor and Workforce Development, unpublished data, April, 2008

state as well as the second largest absolute number of vacant jobs was, unsurprisingly, the professional and technical services industry, an industry grouping in which the biotech sector represents a considerable part. The professional and technical services industry's staffing structure, reflective of the biotech field is dominated by professional occupations that require high levels of specific field of study education at both the undergraduate and graduate level. At the end of 2007, 11,500 jobs were vacant in the professional and technical services industry, yielding a job vacancy rate of 5.5 percent. This finding suggests that this industry has the highest rate of unfilled demand of any industry sector in the state.

The job vacancy rate within the professional and technical services industry has increased considerably over the last year. At the end of 2006 the job vacancy rate in the professional and technical services industry was 5.0 percent, but by the end of 2007 the vacancy rate had climbed to 5.5 percent as the number of unfilled jobs in the industry

Chart 7:
Trends in Job Vacancy Rates in Massachusetts, by Selected Industries,
2006 IV to 2007 IV



Source: Massachusetts Department of Labor and Workforce Development, unpublished data, April, 2008

increased over the year from 10,100 to 11,500, a 13 percent increase over the period. The only other high end staffing industry in the state that had a comparable increase in unfilled labor demand was the health industry where the number of vacancies increased from 17,600 vacant jobs at the end of 2006 IV to 20,000 unfilled positions by the end of 2007 IV.

The over the year rise in unfilled demand appears to have been particularly strong in the SEIT occupational areas. Between 2006 IV and 2007 then number of unfilled job openings in the state increased by about 2,400 positions, a relative increase of 2.7 percent. Over the same period of time the SEIT fields all experienced much sharper increases in the number of unfilled positions. At the end of 2006 IV there were about 4,000 vacant computer and math scientist jobs. By 2007 IV this number had risen to nearly 4,800, about a one-fifth increase in the number of unfilled jobs. The level of unfilled demand for engineers also rose by about one fifth over the year, with the number of engineering and related positions rising from about 2,500 unfilled jobs at the end of 2006 to about 3,100 vacant positions at the end of 2007. The life and physical scientist fields had the largest relative increase in the number of jobs left unfilled over the year. These occupations experienced a one-third rise in the number of unfilled jobs between 2006 IV and 2007 IV, raising the occupation's job vacancy rate from 4.2 percent to 5.6 percent over the year.

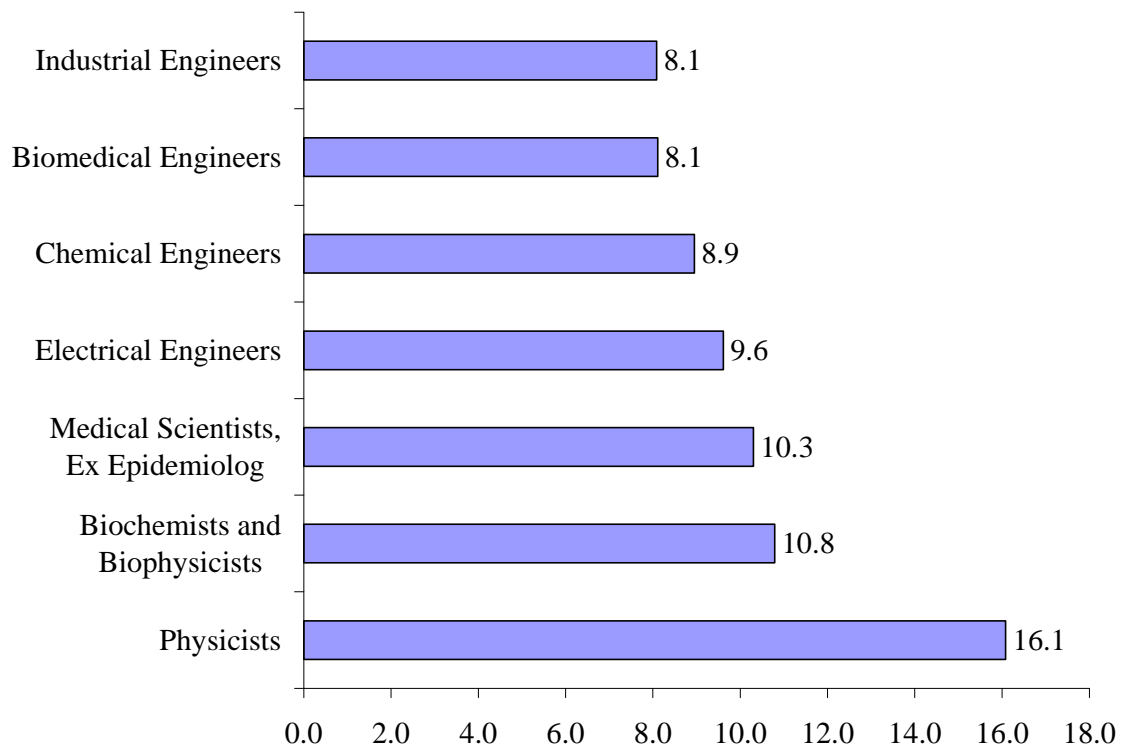
Table 4:
Trends in Job Vacancy Rates in Massachusetts, by SEIT Occupations
2006 IV to 2007 IV

	2006 IV		2007 IV		Change	
	Number of Job Vacancies	Job Vacancy Rate	Number of Job Vacancies	Job Vacancy Rate	Absolute Change	Relative Change
Total, all Job Vacancies	89,620	3.1%	92,021	3.2%	2,401	2.7%
Computer and Mathematical	4,020	3.5%	4796	4.2%	776	19.3%
Engineering Architecture	2,521	3.4%	3093	4.2%	572	22.7%
Life, Physical, and Social Services	1,964	4.2%	2612	5.6%	648	33.0%

Source: Massachusetts Department of Labor and Workforce Development, unpublished data, April, 2008

Separate estimates of job vacancy rates are available for a selected set of engineering and scientific occupations that are major components of the biotech sector's staffing structure. The state JVS survey found extraordinarily high job vacancy rates within a number of these occupations at the end of 2007. The vacancy rate in medical scientist and biochemists and biophysicists occupations were both in excess of 10 percent. Vacancy rates among chemical and electrical engineering fields were also extremely high with between 9 and 10 percent of these engineering positions unfilled.

Chart 8:
Job Vacancy Rates in Selected SEIT Occupations, Massachusetts, 2007 IV



Source: Massachusetts Department of Labor and Workforce Development, unpublished data, April, 2008

Similarly, industrial engineering and biomedical engineering occupations had vacancy rates at the end of the year of about 8 percent. These vacancy rates suggest considerable labor shortage problems within these particular occupational specialties. With one tenth of all positions unfilled at the end of 2007, this suggests that firms that utilize workers in these fields were confronted with problems of lost production and sales as they were

unable to acquire workers with the vital high level knowledge and skills required to expand the productive capacity of their organizations. While strong expansion in demand accounts for part of the apparent labor shortage problem within the biotech sector, it is likely that slow growth in institutional sources of labor supply to these fields has also played a role in constraining employment and output growth within the state's biotech fields

Institutional Sources of Labor Supply in SEIT Fields of Study in Massachusetts

One of the key sources of labor supply to biotechnology industry is the state's system of colleges and universities. Nearly three-quarter of the workers in the Massachusetts biotechnology have earned a college degree. Moreover, a very large share of the staff of the biotech industry in the state has earned an advanced degree beyond the bachelor's level. Higher education institutions are therefore the principle source of new labor supply for these industries. In this section we analyze the outputs of the state's higher education system in an effort to understand the institutional supply responses to the increased demand for high-end biotech workers that we found in the previous sections of this report.

Information and data on the number of diplomas awarded by postsecondary institutions in Massachusetts are derived from IPEDS data (Integrated Post Secondary Data Systems). The IPEDS data are gathered and disseminated by National Center for Education Statistics (NCES) of the U.S. Department of Education. The IPEDS data collections system gathers annual data on a range of outcomes and characteristics of higher education institutions. The IPEDS data are collected at the individual institution level and not at the individual student level. All postsecondary institutions that offer students Higher Education Act Title IV financial aid, including such programs as the Pell grant program and the Stafford college loan program are required to participate in IPEDS. Consequently, virtually all degree granting higher education institutions in the nation submit data required by NCES under the IPEDS system. Because of the complete enumeration of all degree granting colleges and universities in the nation each year, the

IPEDS data present a unique source of high quality information about higher education at the national, state, and local level as well at the institutional level.

The IPEDS collects information on the annual number of undergraduate and graduate degrees that are awarded by American colleges and universities, in total and by specific major fields of study. The information about major fields of study is organized by the Classification of Instruction Program (CIP) code, which is a major field of study classification system that is closely tied to analogous labor demand classifications including the Standard Occupational Classification and the O*NET system. This connection facilitates comparisons of labor market skill requirement information with data on the characteristics of institutional sources of undergraduate labor supply.

The postsecondary institutional labor supply pertinent to the biotechnology industries is concentrated in what is commonly known as the SEIT fields of study. SEIT is an acronym for scientific, engineering and information technology fields of study. SEIT data presented in this report are based on our definition of SEIT that include major fields of biological sciences, life sciences, information technology, engineering, physical

Table 5:
Trends in the Number of SEIT Degree Awards in Massachusetts
and the Nation, by Degree Level, 1996 to 2006

	1996	2006	Absolute Change	Relative Change
<u>Massachusetts</u>				
Total SEIT	13,000	13,950	950	7%
Associate's	1,347	1,479	132	10%
Bachelor's	7,864	7,995	131	2%
Master's	2,715	3,253	538	20%
Doctorate	1,074	1,223	149	14%
<u>United States</u>				
Total SEIT	366,758	449,667	82,909	23%
Associate's	80,380	103,782	23,402	29%
Bachelor's	209,339	250,443	41,104	20%
Master's	58,934	74,466	15,532	26%
Doctorate	18,105	20,976	2,871	16%

Source: National Center for Education Statistics, Integrated Post Secondary Education Data System, Public Use Files, 1996 and 2006, tabulations by the Center for Labor Market Studies, Northeastern University.

sciences, and mathematics.⁷ We have processed the IPEDS data files for 1996 and 2006 for Massachusetts and the nation to gauge the level and trends in the labor supply from postsecondary institutions in SEIT major fields of study. Thus we use the number of graduates produced annually in SEIT fields of study at the associates, bachelor's, master's, and doctorate degrees awarded as our measure of institutional labor supply to the college labor market segment of the biotechnology sector.

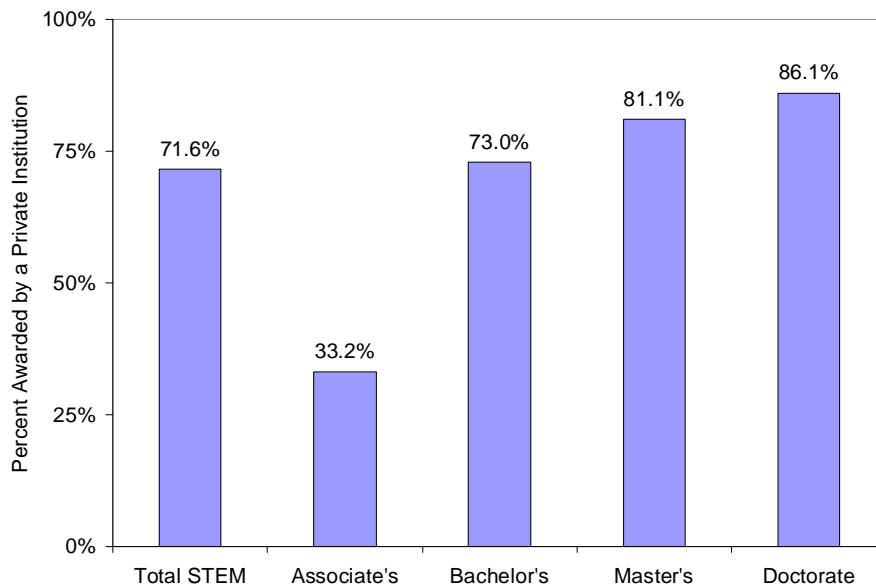
Massachusetts has increased the number of degree awards in the SEIT fields by just 950 degrees or 7 percent between 1996 and 2006. This rate of growth of the SEIT institutional labor supply in Massachusetts is less than one-third of the rate of growth in SEIT degree awards across the nation. The nation awarded nearly 83,000 more degrees in SEIT fields of study in 2006 compared to 1996, representing a growth rate of 23 percent. The rate of growth of SEIT associate's degree awards in Massachusetts was only one-third as high as that of the nation (10 percent versus 29 percent). At the bachelor's degree level, postsecondary institutions in Massachusetts were able to grant only 131 additional awards, yielding a 2 percent growth rate. Over the same time period, SEIT bachelor's degree awards in the nation increased by one-fifth; a rate of growth that was 10 times as high as that in Massachusetts.

Even at the master's and doctorate degree levels, Massachusetts lagged behind the nation in the rate of growth of its SEIT degree awards, albeit not as far behind as in the case of associate's or bachelor's degree awards. The number of master's level SEIT degree awards increased by 20 percent in Massachusetts and 26 percent in the nation whereas the number of students awarded a doctorate degree in one of the SEIT fields increased by 14 percent in the state and 16 percent in the nation. At each award level in SEIT study areas, Massachusetts had a much weaker growth in degree awards compared to the nation with the differences being particularly large at the bachelor's and associate's degree levels.

⁷ We do not use the more common STEM definition that is employed by the National Science Foundation since this definition includes graduates of social science fields of study that are employed in much different industries and occupations compared to graduates of SEIT fields

Much of the state’s existing capacity to produce graduates with degrees in SEIT fields of study is found in private institutions of higher learning. Moreover at higher degree levels the share of SEIT degrees awarded by private colleges and universities rises. A large majority of all SEIT degrees in Massachusetts were awarded by private institutions. In 2006, about 72 percent of all SEIT degrees were awarded by private institutions. Unlike other degree levels the states’ community colleges awarded a substantial majority of all SEIT associate’s degrees. Two-thirds of all associate’s degree awarded in SEIT fields of study in the Bay State were granted by public postsecondary institutions. However, private institutions accounted for 73 percent of SEIT bachelor’s awards, 81 percent of master’s awards and 86 percent of doctor’s awards.

Chart 9:
Shares of SEIT Degrees in Massachusetts Awarded by Private Institutions, 2006



Source: National Center for Education Statistics, Integrated Post Secondary Education Data System, Public Use Files, 1996 and 2005, tabulations by the Center for Labor Market Studies, Northeastern University.

An examination of the trends in the number of SEIT degrees awarded by public and private institutions in Massachusetts reveals that although the total number of degree awards increased by 7 percent among both institution types, there were wide variations between them in the trends of SEIT degrees awarded at different degree levels. Both

public and private institutions in the state had about the same change in the rate of increase in SEIT associate degree awards. Private institutions granted 9 percent more SEIT associate's degrees in 2006 compared to 1996 and public institutions granted 10 percent more SEIT associate's degrees over the same time period. At the Bachelor's degree level, private institutions granted 32 fewer degrees in 2006 compared to 1996, yielding a 1 percent decline in the numbers of SEIT bachelor's degrees conferred. In contrast, public institutions of higher education granted an additional 163 SEIT bachelor's degrees representing an 8 percent growth over the 10-year time period.

The trends between the number of master's and doctorate degrees in SEIT fields of study granted by private and public institutions in Massachusetts were widely divergent. Private colleges and universities granted 508 or one-quarter more master's

Table 6:
Trends in the Number of SEIT Degree Awards Conferred by Public and Private Institutions of Higher Education in Massachusetts, by Degree Level, 1996 to 2006

Degree Type	1996	2006	Absolute Change	Relative Change
<u>Private</u>				
Total SEIT	9,340	9,983	643	7%
Associate's	451	491	40	9%
Bachelor's	5,883	5,801	-82	-1%
Master's	2,130	2,638	508	24%
Doctorate	876	1,053	177	20%
<u>Public</u>				
Total SEIT	3,710	3,967	257	7%
Associate's	896	988	92	10%
Bachelor's	2,031	2,194	163	8%
Master's	585	615	30	5%
Doctorate	198	170	-28	-14%

Source: National Center for Education Statistics, Integrated Post Secondary Education Data System, Public Use Files, 1996 and 2005, tabulations by the Center for Labor Market Studies, Northeastern University.

degrees in SEIT fields of study in 2006 compared to 1996. Public institutions also granted more master's degrees in SEIT fields, but the pace of expansion was at a much slower rate. Between 1996 and 2006, public postsecondary institutions in the Bay State area awarded only 30 additional master's degrees representing an increase of just 5

percent. The patterns of growth were even more widely divergent at the doctorate level. Private institutions coaxed out 177 more doctorate graduates in 2006 compared to 1996, yielding an impressive growth of 20 percent. In sharp contrast, public higher education institutions in the state reduced the number of doctorate degree awards in SEIT fields of study from 198 in 1996 to 170 in 2006. This decline of 28 degree awards represents a 14 percent decline over the 10-year time period.

An examination of the number of degree awards by Massachusetts postsecondary institutions within the SEIT fields of study in 1996 and 2006 found that the number of degree awards increased in three out of the four SEIT fields of study and declined in one field. The largest increase occurred in information technology fields of study. The total number of degree awards in these fields increased by 1,285 representing an 81 percent increase over the 10 year time period. Private sector degree awards in these fields increased much more rapidly than the public sector IT degree awards. Degree awards

Table 7:
Trends in the Number of SEIT Degree Awards Conferred by Institutions of Higher Education in Massachusetts, by SEIT Field of Study, 1996 to 2006

SEIT fields	1996	2006	Absolute Change	Relative Change
Total SEIT	13,000	13,950	950	7%
• Public	9,290	9,983	693	7%
• Private	3,710	3,967	257	7%
Biology & life sciences	3,202	3,341	139	4%
• Private	2,284	2,423	139	6%
• Public	918	918	0	0%
Information technology	1,589	2,874	1,285	81%
• Private	950	1,860	910	96%
• Public	639	1,014	375	59%
Engineering	6,066	5,455	-611	-10%
• Private	4,417	3,948	-469	-11%
• Public	1,649	1,507	-142	-9%
Sciences & mathematics	2,143	2,280	137	6%
• Private	1,639	1,752	113	7%
• Public	504	528	24	5%

Source: National Center for Education Statistics, Integrated Post Secondary Education Data System, Public Use Files, 1996 and 2006, tabulations by the Center for Labor Market Studies, Northeastern University.

increased by 137 or 6 percent in physical sciences and mathematics fields of study, and by 139 degree awards or 4 percent in the fields of biological and life sciences. All of the increase in the number of biological and life sciences degrees conferred in the state occurred among private institutions whereas the number of degrees conferred in the fields of physical sciences and mathematics occurred among private and public institutions, albeit at a slightly higher rate among private institutions.

Even at these anemic rates of growth in the number of degrees conferred by Massachusetts institutions of higher education in physical, life, and biological sciences and mathematics, the state’s colleges and universities performed considerably better in these fields than in the field of engineering. Between 1996 and 2006, postsecondary educational institutions in Massachusetts awarded 611 fewer engineering degrees representing a 10 percent decline. Private institutions saw a decline of 11 percent, a somewhat larger decline than the 9 percent decline that occurred among the state’s public institutions.

With the exception of information technology fields the trends in the state’s higher education output in SEIT fields of study were quite weak. In the absence of the increase in the number of information technology degrees awarded, the state would have seen a decline in the number SEIT degree awards. A majority of SEIT degrees were

Table 8:
Percent of SEIT Degree Awards Conferred Upon Resident Alien Students by Institutions of Higher Education in Massachusetts and the U.S., 2006

	Massachusetts	United States
Total SEIT	14.0%	11.0%
Biology and Life Sciences	7.9%	5.7%
Information Technology	12.8%	10.7%
Engineering	16.4%	12.8%
Science and Mathematics	18.9%	14.6%

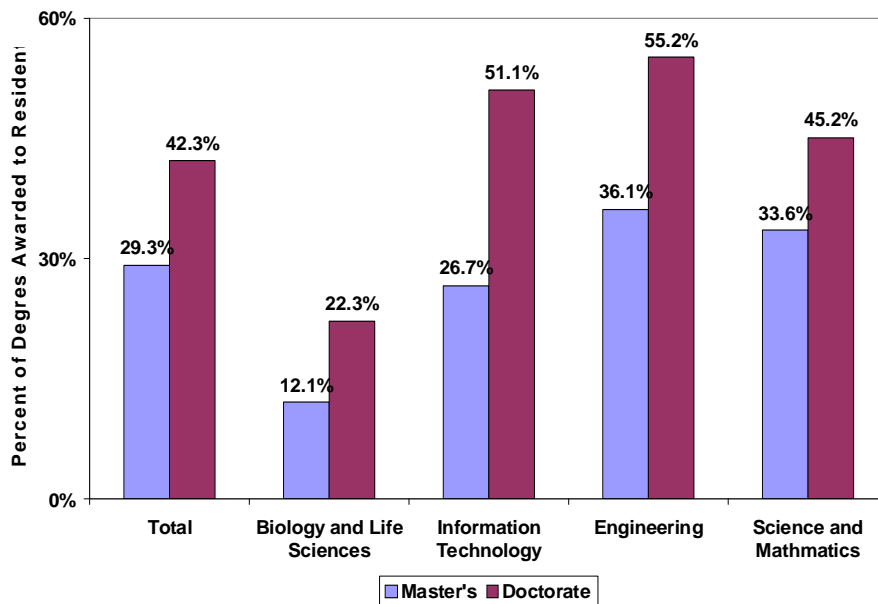
Source: National Center for Education Statistics, Integrated Post Secondary Education Data System, Public Use Files, 1996 and 2006, tabulations by the Center for Labor Market Studies, Northeastern University.

awarded by private colleges and universities in the state. There were sharp differences in the trends in the number of SEIT degrees awarded by public and private institutions.

Although both private and public institutions saw similar increases in the number of associate’s degrees awarded in SEIT fields of study, at the bachelor’s, master’s and doctorate degree levels, the two institution types saw divergent trends in degree awards. The differences were particularly large at the Master’s and doctorate levels with private institutions considerably outperforming public institutions in increasing the SEIT degree output.

The IPEDS data also contains information on the number of degree awards by characteristics of graduates such as gender, race-ethnicity, and immigration status. The IPEDS data can inform us of the number of degrees that were conferred upon students who were legal immigrants but not citizens of the United States—labeled as resident aliens in the IPEDS system. Our examination of the shares of degrees awarded to resident aliens found that in the SEIT major fields of study, Massachusetts awarded 14 percent of the degrees to immigrant students whereas postsecondary institutions in the nation awarded immigrants with 11 percent of all SEIT degrees. The proportion of degrees

Chart 10:
Shares of SEIT Degrees in Massachusetts Awarded to Resident Aliens (Immigrants), 2006



Source: National Center for Education Statistics, Integrated Post Secondary Education Data System, Public Use Files, 1996 and 2006, tabulations by the Center for Labor Market Studies, Northeastern University

awarded to resident aliens in Massachusetts varied from 8 percent in the biological and life sciences fields to a high of nearly one-fifth in the physical science and math fields of study. In each of the four SEIT major fields, the share of degrees awarded to immigrants was higher in Massachusetts than in the nation.

Sizable proportions of SEIT degrees in Massachusetts at the highest levels—master’s and doctorate—were conferred upon immigrants. SEIT degree output at the highest degree levels—those that are demanded by the biotechnology industries—is highly dependent upon non-citizens. Statewide nearly 30 percent of all master’s degrees and 42 percent of all doctorate degrees in SEIT major fields were conferred to immigrant students in 2006. The smallest share of immigrant graduates were among those who had majored in biological or life science fields of study. Over 12 percent of these graduates with a master’s degree and 22 percent of their counterparts with a doctorate degree were resident aliens.

The remaining three SEIT fields of study had much larger shares of immigrant master’s degree and doctorate degree graduates who were resident aliens. Over one-quarter (27 percent) of all master’s degrees in information technology, 36 percent in engineering, and one-third in physical sciences and mathematics were conferred upon immigrant students. A majority of doctorate degrees in information technology fields of study and engineering in Massachusetts were awarded to immigrant students. The proportion of doctorate degrees in physical sciences and mathematics that were awarded to immigrant students was 45 percent.

Our study of the IPEDS data has found that the rate of growth of SEIT degrees has been much slower in Massachusetts than the nation. In the absence of the sharp increases in degrees conferred in information technology fields of study, SEIT degree production in the state would have declined. Most of the increase in SEIT degree production in the state, especially at the highest degree levels occurred among private institutions of higher education in the state. Moreover, large shares of these highest level degrees were awarded to immigrant students.

The biotechnology industry has an above average degree of dependence on immigrant labor. Likewise, institutions of higher education that constitute the main

source of highly educated workforce required in most biotechnology firms confer large shares of degrees, particularly at the master's and doctorate levels, to foreign-born resident alien students. If the trends of the past 10 years continue into the future, labor supply to the state's biotechnology industry may not increase at a rate that would fulfill labor demand in this industry. Furthermore, the industry will likely increase its reliance on foreign-born workers—through direct immigration as well as immigrant students who earn degrees from higher education institutions in the United States. Although immigration is a good source of labor supply, because of the uncertainties in the flow of highly educated immigrants to the U.S. and the flow of international students to American universities, a stronger focus on home grown labor supply (from native born workers) to the biotechnology industry would be a desirable goal of any workforce development policy for this industry.