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## Recent Employment Developments and Projected Employment Trends in Biopharmaceutical-Related Industries and Occupations in Massachusetts and the U.S.

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## **Introduction**

Past and recent employment trends in biopharmaceutical-related industries of Massachusetts and the U.S. were identified and assessed in a series of previous research papers.<sup>1</sup> Payroll job growth rates in all biopharmaceutical-related industries combined in Massachusetts exceeded the statewide average in both the 1990s and over the more recent 2000-2005 period. A key research question is how well these industries are expected to perform in terms of job creation in our state and the nation over the coming decade. To answer this important question, we will analyze industry and occupational employment projections for Massachusetts for the 2004-2014 period.

Findings on industry employment projection for biopharmaceutical-related industries in Massachusetts will be compared to those for the U.S. over the same ten year period using national employment projections from the U.S. Bureau of Labor Statistics. In the final section of this paper, we will present findings from the Massachusetts job vacancy survey on the number and rate of job vacancies in 2006 in occupations that are frequently found in the state's biopharmaceutical-related industries. We will begin our analysis with a brief overview of wage and salary employment developments both overall and in biopharmaceutical-related industries of the state between 1990-2000 and 2000-2005. This overview of past employment developments will be useful in interpreting the employment projections for these industries.

## **Past and Recent Employment Trends in Massachusetts' and U.S. Biopharmaceutical Related Industries, 1990-2005**

Wage and salary employment levels in Massachusetts have been characterized by highly volatile changes over the past 25 years.<sup>2</sup> During the decade of the 1980s, the Commonwealth

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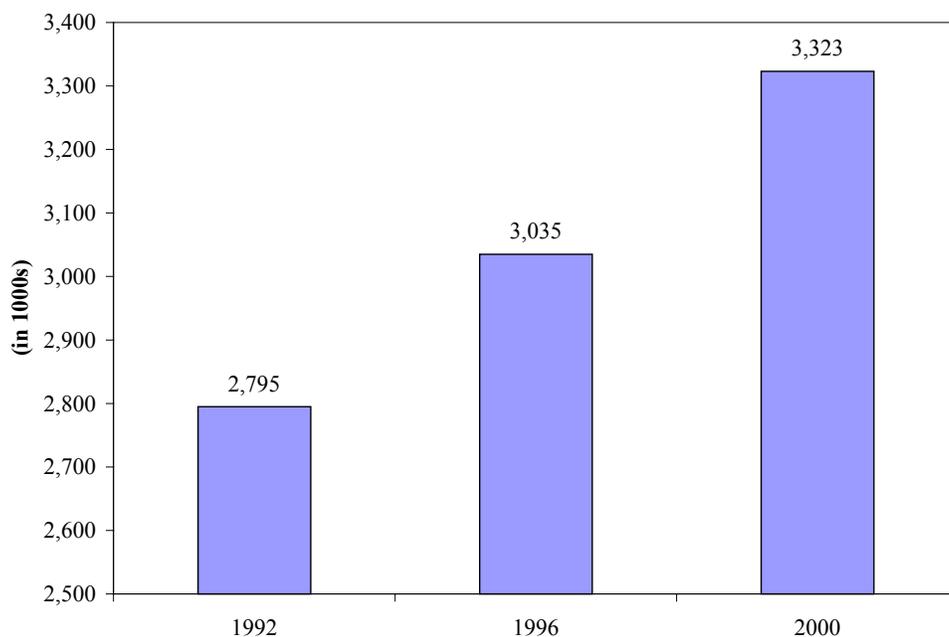
<sup>1</sup> (i) Joseph McLaughlin, Andrew Sum, Ishwar Khatiwada, Recent Trends in Payroll Employment in Massachusetts in the Pharmaceutical and Medicine Manufacturing, Surgical and Medical Instrument Manufacturing Industries, and Physical, Engineering, and Biological Research Service Industries of Massachusetts: A Comparative Perspective, Center for Labor Market Studies, Northeastern University, Prepared for The Pharmaceutical Research and Manufacturers of America, PhRMA Research Paper #2, December 2006; (ii) Ishwar Khatiwada, Andrew Sum, with Sheila Palma, Trends in Employment, the Number of Establishments, and Workers Per Establishment in Biopharmaceutical-Related Industries in Massachusetts and the U.S., Center for Labor Market Studies, Northeastern University, Prepared for The Pharmaceutical Research and Manufacturers of America, PhRMA Research Paper #8, March 2007.

<sup>2</sup> For an overview of payroll job developments in Massachusetts both overall and by major industrial sector during the decade of the 1980s and 1990s,

See: Andrew Sum, Paul Harrington, et al., The State of the American Dream in Massachusetts, 2002, Report Prepared for The Massachusetts Institute for a New Commonwealth, Boston, May 2002.

experienced a substantial labor market boom that substantially increased the number of wage and salary jobs in the state. Between 1979 and 1989, the Massachusetts economy generated 505,000 net new wage and salary jobs representing a 20% rate of job growth, matching the national job growth rate over this 10 year period.<sup>3</sup> The state jobs expansion unfortunately came to an end early 1989 and was followed by a severe state and regional recession that lasted into the early 1990's. Between 1989 and 1992, Massachusetts lost 320,000 wage and salary jobs, representing more than 10% of its job base in 1989. From 1992 to 2000, the state experienced another labor market boom that more than restored the number of jobs lost during the 1988-1992 recession. Between 1992 and 2000, total payroll employment in the Commonwealth grew substantially from 2.795 million jobs to 3.323 million jobs. The Massachusetts economy generated about 528,000 net new wage and salary jobs from 1992 to 2000, an increase of 19 % (Chart 1).

Chart 1:  
Trends in Non-Farm Wage and Salary Employment Levels in Massachusetts, 1992-2000  
(Annual Averages in 1000s)



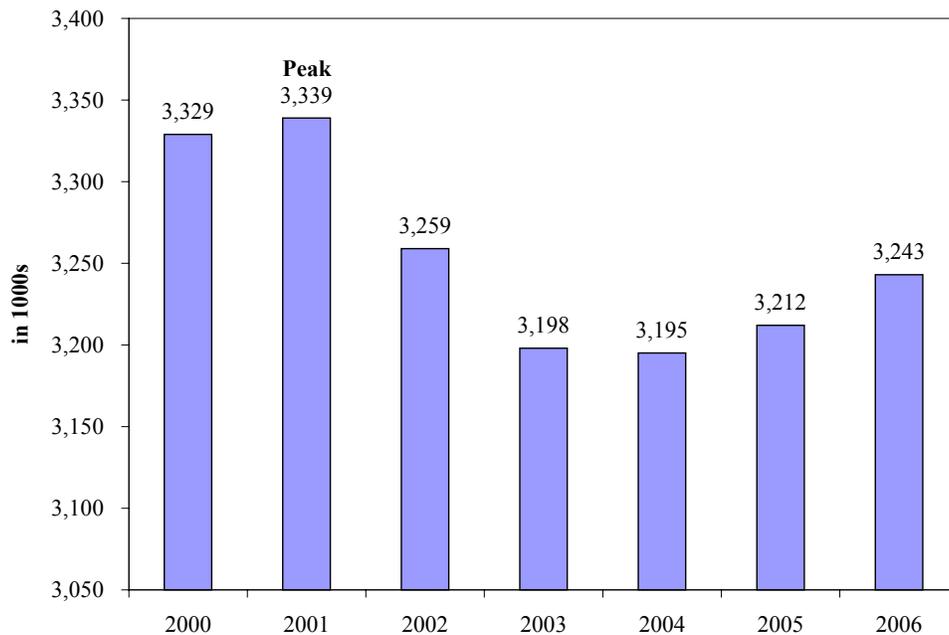
In early 2001, however, wage and salary employment growth in Massachusetts came to an abrupt halt as the U.S. economy entered a recession, and payroll employment levels would

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<sup>3</sup> The growth rate in nonfarm wage and salary employment for the entire U.S. over the same decade was 20.1% versus 19.8% for Massachusetts, near tie.

fall steadily over the next three years.<sup>4</sup> From the first quarter of 2001 through the first quarter of calendar year 2004, seasonally adjusted wage and salary employment in Massachusetts fell from 3.326 million to 3.127 million, a decline of just under 200,000 or 6%, far exceeding the rate of job decline in the U.S. and most other states. Since the first quarter of calendar year 2004, nonfarm wage and salary employment in Massachusetts has been rising. By 2006, annual average employment had climbed back to 3.243 million, but was still 96,000 below its level of 3.339 million in the peak employment year of 2001 (Chart 2). In the U.S., nonfarm wage and salary employment in 2006 was 4.35 million above its level in 2001.

Chart 2:  
Trends in Nonfarm Wage and Salary Employment in Massachusetts, Selected Years, 2000 –2006  
(Annual Averages, in 1000s)



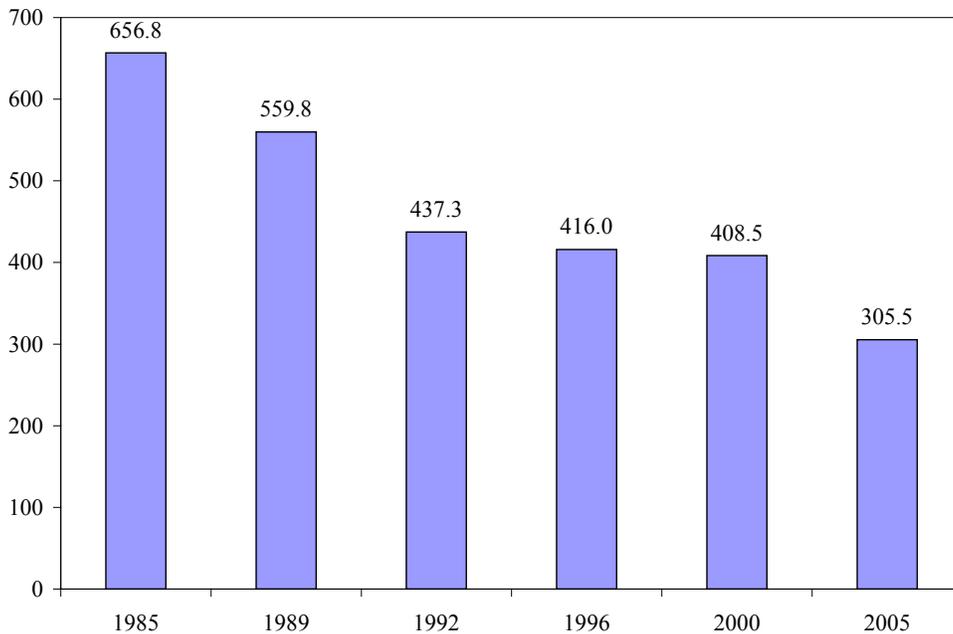
The employment structure of the state has also seen significant shifts in its industrial and occupational composition over the past two decades. In a previous research paper, we analyzed wage and salary employment trends in Massachusetts for manufacturing industries, including

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<sup>4</sup> For a recent comprehensive review of wage and salary job developments in the state from 2000-2006, See: Andrew Sum, Ishwar Khatiwada, Joseph McLaughlin, Jacqui Motroni, Sheila Palma, and Paulo Tobar, The Job Creation and Output Performance of the Massachusetts Economy, 1969-2006: Current and Future Challenges, Prepared for the Massachusetts Institute for A New Commonwealth, Boston, 2007.

biopharmaceutical-related manufacturing industries.<sup>5</sup> Our findings revealed a number of key structural changes in the industrial composition of employment in Massachusetts. The state's manufacturing sector has experienced a substantial loss of wage and salary jobs since the mid-1980s, including its vaunted high technology manufacturing industries. In 1985, there were 656,000 jobs in the manufacturing sector. By 2005, the number of manufacturing jobs in the state was reduced to 305,500, a reduction of more than one-half in the number of such jobs in 1985 (Chart 3). As revealed in our earlier report for the PhRMA group, the steep loss of jobs in the manufacturing sector of the state has seriously impacted the economy of the state, creating unfavorable labor market conditions for workers without college degrees and producing negative multiplier effects on other sectors that have complicated the problem of job loss in the industrial sector. Manufacturing industries had been key components of the state's export base, which generated jobs in many other sectors of the economy.

Chart 3:  
Trends in Wage and Salary Employment in Manufacturing  
Industries of Massachusetts, 1985- 2005  
(Annual Averages in 1,000s)



<sup>5</sup> See: Joseph McLaughlin, Andrew Sum, Ishwar Khatiwada, Recent Trends in Payroll Employment in Massachusetts Pharmaceutical and Medicine Manufacturing Industries, Surgical and Medical Instrument Manufacturing Industries, and Physical, Engineering, and Biological Research Service Industries: A Comparative Perspective, Prepared for The Pharmaceutical Research and Manufacturers of America, December 2006.

As noted above, the labor market boom of the 1990s came to an abrupt end in early 2001 as the national economy entered a recession. Payroll employment in Massachusetts would decline steadily for three consecutive years. Job losses in Massachusetts were widespread across most industries of the state although manufacturing industries were particularly adversely affected, and they registered steep losses in wage and salary jobs. Manufacturing employment in Massachusetts fell by 102,000 or 25 percent between 2000 and 2005, a rate of decline seven times as high as that for all nonfarm wage and salary jobs.

Table 1:  
Changes in Manufacturing Employment in the U.S. and Massachusetts, 2000-2005  
(Annual Averages, in 1000s)

	(A)	(B)	(C)	(D)
	2000	2005	Absolute Change	Percent Change
Massachusetts	408	306	-102	-25.0
U.S.	17,266	14,234	-3,032	-17.6

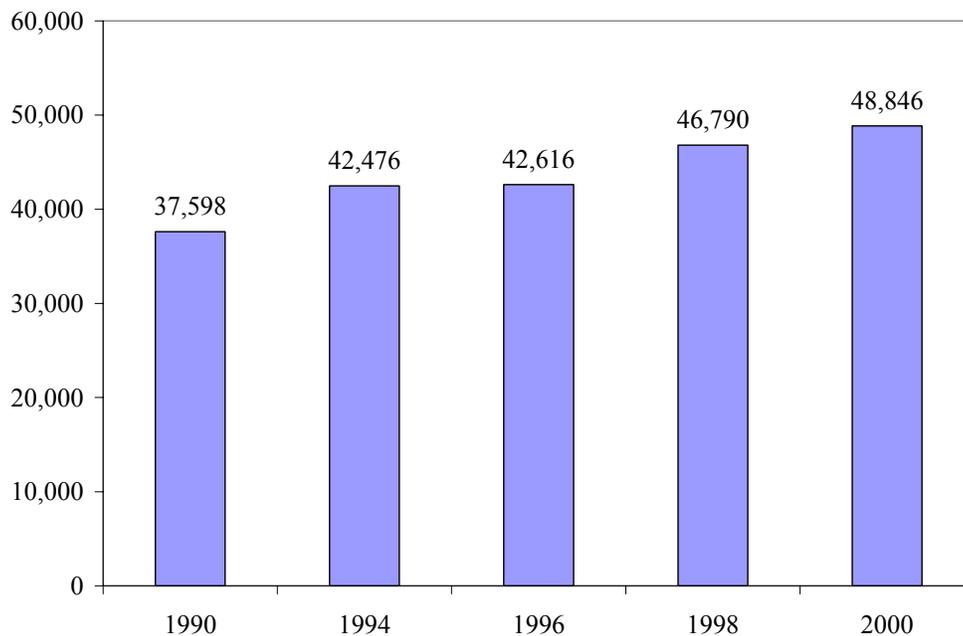
Source: U.S. Bureau of Labor Statistics, Current Employment Statistics Program (CES), web site, [www.BLS.gov](http://www.BLS.gov).

Manufacturing employment in the U.S. also was severely impacted by economic developments over the past five years. From 2000 to 2005, the nation’s manufacturing industries shed more than three million payroll jobs. In 2000, there were 17.266 million wage and salary workers employed in the nation’s manufacturing sector. By 2005, the number of manufacturing wage and salary jobs was 14.234 million or 3.032 million less than its 2000 level, a decline of nearly 18%. As the state continued to experience jobs losses in its manufacturing sector, other industries became the backbone of the Massachusetts economy in terms of new job creation. The pharmaceutical, life sciences, health, and biotechnology industries represented a group of individual industries with current and potential employment growth in the state.

In a set of earlier research papers, we analyzed employment trends in the industries that constitute the biopharmaceutical-related sector. Payroll employment data from the Quarterly Census of Employment and Wages (QCEW) for the three specific biopharmaceutical industries were tracked from 1990 through 2005. These biopharmaceutical-related industries are: pharmaceutical and medicine manufacturing (NAICS 3254), medical equipment and supplies

manufacturing (NAICS 3391), and physical, engineering, and biological research services (NAICS 54171). Trends in Massachusetts employment for these three biopharmaceutical-related industries combined are presented in Chart 4 and Chart 5 for two different time periods. Throughout the decade of the 1990s (1990-2000), payroll employment in the biopharmaceutical industries rose fairly steadily and strongly at an annual average rate of 3%. In 1990, there were approximately 37,600 wage and salary jobs in the three biopharmaceutical-related industries of Massachusetts. By 1996 the number of jobs in these industries had risen to 42,616, and the number of jobs in these biopharmaceutical-related industries continued to increase over the next four years, reaching just under 49,000 jobs by 2000, representing an increase of 11,248 or 30 percent over this ten year period.

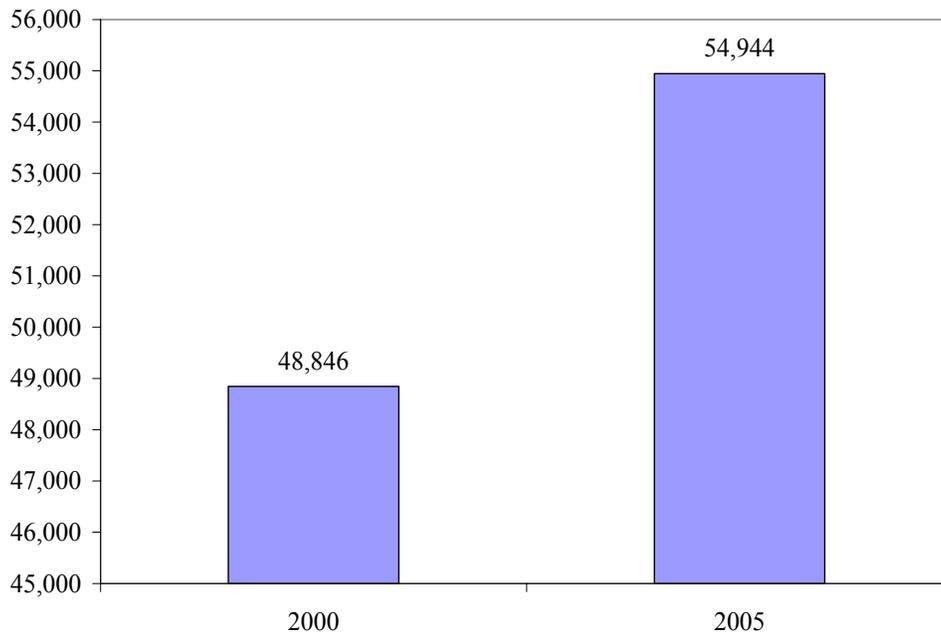
Chart 4:  
Trends in Wage and Salary Employment in Biopharmaceutical-Related  
Industries of Massachusetts, 1990 to 2000 Selected Years



From 2000 to 2005, the biopharmaceutical-related industries in the aggregate added over 6,000 net new jobs to the Massachusetts economy, representing an employment growth rate of

12.5%.<sup>6</sup> In 2005, there were nearly 55,000 wage and salary jobs in biopharmaceutical-related industries of the state. Job growth in the biopharmaceutical-related industries of Massachusetts stands in sharp contrast to the negative employment growth in the private and manufacturing sectors of the state over the same 2000 to 2005 period.

Chart 5:  
Trends in Wage and Salary Employment of Biopharmaceutical-Related  
Industries in Massachusetts, 2000-2005  
(Annual Averages)



### **Employment Projections for Biopharmaceutical-Related Industries of Massachusetts, 2004-2014**

To better understand the potential future employment impacts of biopharmaceutical-related industries in the Commonwealth of Massachusetts, we have analyzed findings of state employment projections from the Massachusetts Department of Workforce Development for the 2004 to 2014 period by industry and occupation.<sup>7</sup> Overall, the Massachusetts economy is expected to add 247,210 net new nonfarm wage and salary jobs between 2004 and 2014, representing an employment growth rate of just under 8 percent.

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<sup>6</sup> Job developments varied markedly across the three biopharmaceutical-related industrial subsectors between 2000 and 2005. In the medical equipment and supplies industries, employment declined over the period.

<sup>7</sup> See: Massachusetts Department of Workforce Development, Massachusetts Employment Projections Through 2014 by Industry and Occupation, Boston, 2006.

Table 2:  
Wage and Salary Employment Projections by Major Industry Sector, Massachusetts, 2004-2014

	(A)	(B)	(C)	(D)
Industry Sector	2004	2014	New jobs	Growth Rate (in %)
Total Non-Farm	3,181,120	3,428,330	247,210	7.8
Natural Resources and Mining	1,900	1,810	-90	-4.7
Construction	138,400	134,480	-3,920	-2.8
Manufacturing	312,930	281,210	-31,720	-10.1
Trade, Transportation, and Utilities	572,110	597,510	25,400	4.4
Information	87,440	97,820	10,380	11.9
Financial Activities	219,730	230,590	10,860	4.9
Professional and Business Services	451,080	538,190	87,110	19.3
Educational and Health Services	582,210	676,660	94,450	16.2
Leisure and Hospitality	290,800	325,450	34,650	11.9
Other Services	116,820	128,230	11,410	9.8
Government	407,700	416,380	8,680	2.1

Source: Massachusetts Department of Workforce Development.

Projected employment growth in Massachusetts varies quite widely across major industrial sectors of the state. Wage and salary employment declines are expected to occur in industries such as natural resources and mining, construction, and manufacturing. The state's manufacturing industries will account for a dominant share (89%) of the gross volume of employment losses in the state. About 31,720 manufacturing jobs are projected to disappear between 2004 and 2014, a decline of 10.1%, further eroding an important element of the state's export base. The construction industry, a source of strong job growth in the 1990s, is projected to experience a decline of 3,920 jobs or 2.8% between 2004 and 2014.

Each of the state's other major industrial sectors are expected to expand their employment base over the decade although projected growth rates vary quite considerably across major industries. Professional and business services and the educational and health services industries are projected to grow at 19.3% and 16.2% respectively, growth rates well above the state average. Information, leisure and hospitality, and other services industries are projected to experience employment growth rates between 10% and 12%.

A more detailed analysis of employment projections for specific biopharmaceutical-related industries in Massachusetts is presented in Table 3. As mentioned earlier, the Massachusetts economy is expected to increase its aggregate employment level by 7.8 percent between 2004 and 2014. The biopharmaceutical-related industries, which include the scientific research and development services, medical equipment and supplies manufacturing, and pharmaceutical and medicine manufacturing industries, are expected to generate 12,011 net new jobs between 2004 and 2014, representing a growth rate of slightly above 21%, three times the projected growth rate of total nonfarm employment in the state.

The scientific research and development sector alone is expected to create 9,790 new jobs accounting for 80% of the new jobs in the biopharmaceutical-related sector.<sup>8</sup> Employment growth in this sector will be primarily driven by the biotechnology and academic sector which is heavily dependent on government and private sector research grants. The pharmaceutical and medicine manufacturing industries are projected to add over 1,700 jobs, representing a growth rate of 25.2 percent between 2004 and 2014. Employment in medical equipment and supplies manufacturing industries will grow at a much more modest 3.7 percent pace, generating only 470 new jobs by 2014, but this would represent an improvement over their job creation performance in recent years.

As revealed in our analysis of the employment projections for each individual biopharmaceutical industry, the projected growth in biopharmaceutical-related employment in our state will not be distributed evenly across these three industries. The projected employment growth of Massachusetts' biopharmaceutical industries combined between 2004 and 2014 will clearly surpass the growth performance of the entire nonfarm sector (7.8%), and it stands in sharp contrast to the projected 10.1% decline in overall manufacturing employment over the same time period. Overall, the biopharmaceutical industries of the state will capture 5% of the state's job growth from 2004 to 2014.

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<sup>8</sup> Because of limitations on disaggregations of the industry employment projections data, we were unable to separate the Scientific Research and Development Services industry sector into the two subsectors that constitute this industry: the Research and Development in the Physical, Engineering, and Life Sciences and the Research and Development in the Social Sciences and Humanities. The latter subsector contains jobs that are not related to the biopharmaceutical sector.

Table 3:  
Projected Wage and Salary Employment Growth in Biopharmaceutical-Related Industries in Massachusetts, 2004-2014

Industry Sector	(A) 2004	(B) 2014	(C) Net New jobs	(D) Growth Rate (in %)
Scientific research and development services	36,600	46,390	9,790	26.7
Medical equipment and supplies manufacturing	12,800	13,270	470	3.7
Pharmaceutical and medicine manufacturing	6,949	8,700	1,751	25.2
<b>Total Above 3 Biopharmaceutical-Related Industries</b>	<b>56,349</b>	<b>68,360</b>	<b>12,011</b>	<b>21.3</b>
Manufacturing	312,930	281,210	-31,720	-10.1
<b>Total NonFarm</b>	<b>3,181,120</b>	<b>3,428,330</b>	<b>247,210</b>	<b>7.8</b>

Source: Massachusetts Employment Projections through 2014, Massachusetts Department of Workforce Development, 2006.

In order to provide a comparative perspective on the projected employment outlook for the Massachusetts biopharmaceutical sector, we also have analyzed employment projections at the national level for biopharmaceutical-related industries. According to the national employment projections provided by the U.S. Bureau of Labor Statistics, aggregate nonfarm wage and salary employment in the U.S. is expected to increase by 14 percent between 2004 and 2014 (Table 4).

Table 4:  
Projected Wage and Salary Employment Levels in Biopharmaceutical-Related Industries of the U.S., 2004-2014

Industry Sector	2004	2014	Net New jobs	Growth Rate (in %)
Scientific research and development services	547,600	612,900	65,300	11.9
Medical equipment and supplies manufacturing	304,100	312,000	7,900	2.6
Pharmaceutical and medicine manufacturing	291,000	367,000	76,000	26.1
<b>Total Above 3 Biopharmaceutical-Related Industries</b>	<b>1,142,700</b>	<b>1,291,900</b>	<b>149,200</b>	<b>13.1</b>
Manufacturing	14,329,600	13,553,300	-776,300	-5.4
<b>Total, Non-farm</b>	<b>132,191,700</b>	<b>150,876,800</b>	<b>18,685,100</b>	<b>14.1</b>

At the national level, biopharmaceutical-related industries are projected to generate 149,200 net new jobs over the 2004-2014 period. In contrast to the earlier findings for Massachusetts, the largest contributor to employment growth in biopharmaceutical industries at the national level will be the pharmaceutical and medicine manufacturing industry sector, which alone is expected to create 76,000 new jobs, a growth rate of 26.1% between 2004 and 2014. On the other hand, Massachusetts' employment growth in research and development industries will outperform that of the U.S., suggesting a larger geographic concentration of R&D services in the state, which would capture about 15% of the national job growth in this sector (Table 5). The pharmaceutical and medicine manufacturing industries will increase their employment levels by a strong 26 percent between 2004 and 2014 adding about 76,000 new jobs. Massachusetts will capture a smaller share (2.3%) of the projected national employment growth in the pharmaceutical and medicine manufacturing industries. The smaller medical equipment and supplies manufacturing sector will expand at a rate similar to that of Massachusetts (2.6 percent). These industries would add about 7,900 new jobs by 2014. Massachusetts would capture about 6 percent of the national job growth in the medical equipment and supplies manufacturing industry sector, a relatively high share of national job growth in this sector. To achieve this very desirable objective, the industry in our state would have to experience an important turnaround in its recent economic fortunes (Table 5).

Table 5:  
Massachusetts' Share of Projected U.S. Employment Growth between  
2004 and 2014 by Selected Industry Sector

Industry	Share of Employment Change 2004-2014 (in %)
Scientific Research and development services	15.0
Medical equipment and supplies manufacturing	5.9
Pharmaceutical and medicine manufacturing	2.3
Biopharmaceutical Industries	8.1
Total, Nonfarm	1.3

We also conducted an analysis of employment projections for selected occupations in Massachusetts to identify the employment outlook for those occupations that accounted for a very high share of employment in the state's biopharmaceutical related industries. Using data

from the 2005 American Community Surveys (ACS), we have identified the top 16 individual occupations that accounted for 50 percent of total employment in the biopharmaceutical-related industries of Massachusetts in 2005 (Table 6).

Table 6:  
Occupational Distribution of Jobs in Massachusetts Biopharmaceutical-Related Industries,  
Selected Top Sixteen Occupations, 2005

Occupation	Number of Jobs	% of Total Employment in Biopharmaceutical Industries
Physical Scientists, all other	3,746	6.0
Managers, All Other	3,693	5.9
Medical Scientists, Except Epidemiologists	3,223	5.1
Miscellaneous Assemblers and Fabricators	2,916	4.6
Miscellaneous Engineers	1,927	3.1
First-Line Supervisors/Managers of Production and Operating Workers	1,782	2.8
Inspectors, Testers, Sorters, Samplers, and Weighters	1,774	2.8
Chemist and material scientists	1,731	2.8
Life, Physical, and Social Science Technicians, Other	1,594	2.5
Biological Scientists	1,540	2.5
Marketing and sales Managers	1,447	2.3
Chemical Technicians	1,367	2.2
Engineering Technicians, Except Drafters	1,286	2.1
Secretaries and Administrative Assistants	1,259	2.0
Sales Representatives, wholesale and manufacturing	1,063	1.7
Computer Software Engineers	988	1.5

Source: American Community Surveys (ACS) 2005, U.S. Census Bureau, tabulations by authors.

Given the levels of employment in these 16 individual occupations which accounted for 50 percent of all jobs in biopharmaceutical-related industries, we can see that employment in these industries is dominated by occupations that require a relatively high level of education and training. With the exception of the two production occupations (assemblers and fabricators; inspectors, testers, sorters, samplers) and two office related occupations, secretaries and administrative assistants, the rest of the occupations are in fields in which a four year college degree and/or significant work experience is required for entry into employment.

We have also analyzed the projected employment outlook for the above sixteen occupations for the entire state of Massachusetts for the 2004-2014 period. This analysis is

based on employment projections by occupation for the state provided by the Massachusetts Department of Workforce Development.

Table 7:  
Employment Projections for Selected Occupations in Massachusetts, 2004-2014

Occupation	(A) 2004 Jobs	(B) 2014 Jobs	(C) Net New Jobs	(D) Growth Rate	(E) Replacement Openings	(F) Total Job Openings
Computer Software Engineers	41,370	57,550	16,180	39.1	4,090	20,270
Medical Scientists, Except Epidemiologists	5,390	7,100	1,710	31.7	2,660	4,370
Biological Scientists	3,190	3,940	750	23.5	990	1,740
Marketing and sales managers Life, Physical, and Social Science Technicians, All Other	19,520	22,630	3,110	15.9	3,600	6,710
Physical Scientists, excluding Chemists and Material Scientist	2,850	3,230	380	13.3	680	1,060
Chemist and Material Scientists	4,910	5,560	650	13.2	1,190	1,840
Electrical and Electronic Engineers	3,070	3,410	340	11.1	1,010	1,350
Chemical Technicians	11,860	12,570	710	6.0	2,330	3,040
Engineering Technicians, Except Drafters	2,010	2,200	190	9.5	500	690
Managers, All Other	14,920	15,920	1,000	6.7	3,180	4,180
Executive Secretaries and Administrative Assistants	23,900	25,490	1,590	6.7	4,660	6,250
Assemblers and Fabricators, All Other	118,130	118,960	830	0.7	8,880	9,710
First-Line Supervisors/Managers of Production and Operating Workers	3,860	3,720	-140	-3.6	1,000	1,000
Inspectors, Testers, Sorters, Samplers, and Weighters	13,910	13,310	-600	-4.3	2,920	2,920
	10,530	9,420	-1,110	-10.5	2,400	2,400

Source: Massachusetts Employment Projections through 2014, Massachusetts Department of Workforce Development, 2006.

Employment projections for selected individual occupations for the state of Massachusetts are presented in Table 7. The occupations displayed in this table represent those occupations that accounted for the largest share of employment in the state's biopharmaceutical-related industries during 2005. The projected employment growth rates for the above occupations vary quite widely, ranging from projected declines of -10% and -4% in production–

related occupations to highs well above the state average of 8%. Engineering and life, physical and social science occupations are projected to grow at rates between 10 percent and 31 percent. Medical scientists are projected to grow at a 31.3% rate between 2004 and 2014, the highest growth rate across all biopharmaceutical-related occupations, followed by Biological scientists with a projected growth rate of 23.5 percent. A total net increase of 25,590 new jobs will be created by the 15 occupations presented in Table 7. An additional 40,000 job openings are expected in these same 15 occupations combined because of the need for companies to replace workers that are expected to retire, die or change careers.

### **Job Vacancies in Biopharmaceutical-Related Occupations in Massachusetts, 2006 II Quarter**

The availability of information on the numbers, characteristics, and geographic locations of available job openings by industry and occupational area across the state is crucial to help identify the degree of labor shortage or surplus in industries and occupational groups at a given point in time and over time. The Commonwealth of Massachusetts' Department of Workforce Development has been conducting a semi-annual job vacancy survey since 2002.<sup>9</sup> The Massachusetts job vacancy survey provides data on the estimated number of job vacancies and job vacancy rates for the state as a whole and for major industrial sectors and major occupational group in the state. Job vacancies represent currently available job openings in the firm for which the employer is making an active effort to recruit applicants from outside the firm. Positions for consultants, independent contractors, and other non-employee positions are excluded from the count of job vacancies.<sup>10</sup> The job vacancy rate for a given occupational group is calculated by taking the ratio of the number of job vacancies in a given occupation to the level of employed persons in that occupation (V/E).

While the job vacancy survey does provide estimates of job vacancies for major industries, it does not provide published estimates for industries at a fine enough level of detail to estimate vacancies for biopharmaceutical-related industries. As an alternative, we have selected a

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<sup>9</sup> For a review of job vacancy concepts, measures, and their uses at the national level in the JOLTS survey, See: Kelly A. Clark and Rosemary Hyson, "New Tools for Labor Market Analysis: JOLTS," Monthly Labor Review, December 2001, pp. 32-37.

<sup>10</sup> The Massachusetts job vacancy survey is conducted during the second and fourth quarters of each calendar year. For details on the design features and outputs of the job vacancy survey, See: Website of the Massachusetts Department of Workforce Development.

set of individual occupations closely related to the biopharmaceutical sector and analyzed data on job vacancy levels and rates for those occupations provided by the Massachusetts Department of Workforce Development for the second quarter of 2006. Estimates are presented in Table 8. Total job vacancies across all occupations in the second quarter of 2006 were estimated to be over 86,000 representing an overall job vacancy rate of 3.0%. The vacancy rate has risen steadily over the past three years as employment growth resumed across the state.

Table 8:  
Job Vacancy Levels and Vacancy Rates for Selected  
Biopharmaceutical-Intensive Occupations in Massachusetts, 2006 II

	Vacancies	Vacancy Rate (in %)
<b>All Occupations</b>	<b>86,296</b>	<b>3.0</b>
Medical Scientists, excluding epidemiologists	574	12.0
Biochemists and Biophysicists	157	10.3
Chemists	222	7.8
Marketing Managers	457	6.6
Industrial Engineers	392	6.2
Computer Software Engineers, Applications	1,197	5.6
Biomedical Engineers	55	4.1
Sales Managers	422	3.9
Computer Systems Analysts	575	3.5
Exec. Secretaries & Admin. Assistants	1,311	3.0
Sales Reps, Wholesale & Manufacturing, Technical & Scientific	235	1.3
Biological Technicians	37	1.0
Chemical Technicians	16	0.8

Massachusetts job vacancy rates for selected individual occupations that are frequently found in biopharmaceutical-related industries of the state are presented in Table 8. These job vacancy rates varied quite considerably across occupational category during the second quarter of 2006. Medical scientists registered a considerably high job vacancy rate in the 2<sup>nd</sup> quarter of 2006 at 12.0%, followed closely by biochemists and biophysicists with a job vacancy rate of 10.3%. These two occupations registered job vacancy rates that were three to four times as high as the state average. Other occupations closely related to the biopharmaceutical sector with relatively high job vacancy rates were the following: chemists (7.8%), marketing managers

(6.6%), industrial engineers (6.2%), computer software engineers (5.6%), and biomedical engineers (4.1%). Each of these occupations had job vacancy rates that were between 1 and 3 percentage points higher than the state average for all occupations.

The existence of high vacancy rates for a number of occupations that are closely linked to the state's biopharmaceutical-related industries suggests that there are important opportunities for workforce development programs to boost employment and output in these industries. Available evidence on unemployment rates for workers in these same occupations indicates that there are relatively few unemployed workers with skills in these occupations in the state. An expansion of job training programs and post-secondary educational programs aimed at preparing currently unemployed and future workers for these occupations could help expand employment and output levels in these key export-based industries of the state. Future research on the educational and skill requirements for workers in these occupations and institutional constraints on future supply is needed.